Mastery in early old age: life course influences and its association with physical capability in the MRC National Survey of Health and Development

Frances Helen Harkness

Thesis submitted for the Degree of Doctor of Philosophy

MRC Unit for Lifelong Health and Ageing at UCL

Department of Epidemiology and Public Health

University College London

2020

I, Frances Helen Harkness confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

ABSTRACT

Mastery is one of many related constructs indicating the sense of control a person believes they hold over their own life; associated with multiple aspects of health and wellbeing. Despite this, factors contributing to differences in mastery, and its adaptive mechanism, remain poorly understood. This thesis used a life course approach to investigate how factors across life contribute to mastery and to examine associations between mastery and physical capability in early old age.

Data from the MRC National Survey of Health and Development (NSHD) were used. NSHD is a nationally representative sample of 5362 males and females, born in England, Scotland and Wales in March 1946 and followed up to 24 times across life. Mastery was assessed at age 68-9 (n=2038). Groups of socioeconomic and psychosocial resources across life were tested through linear regression. Associations between mastery and physical capability (physical performance scores, and functional limitations) at age 69-70 were tested using linear and ordinal logistic regressions.

The early life factors (pre- age 16) of stressful life events (SLEs), perceived parental psychological control, weaker parental support, and poorer cognitive ability were associated with lower mastery in early old age (Chapter 3). Factors across adulthood were also associated with mastery (Chapter 4); higher occupational position (age 53), a higher accumulation of SLEs between 26 and 69, and contemporaneous factors such as lower social support, less comfortable income perception, and poor health. The positive association between mastery and physical capability was partially explained by fewer fears about falling, rather than more proactive health behaviours (Chapter 5). Finally, mastery was an effect modifier, buffering the association between physical performance and functional limitations; although not for more advanced disability (Chapter 6).

Better understanding of the socioeconomic and psychosocial pathways across life, which relate to mastery, along with deeper understanding of the mechanism between mastery and physical capability, provides opportunities to intervene to support individuals to have greater mastery and maintain, or minimise losses to, their physical capability and independence in early old age.

IMPACT STATEMENT

This thesis generated a number of novel findings with impact within and outside of academia.

First, this thesis has identified pathways across life that are associated with mastery in early old age and furthered gaps in understanding about mastery to date. The findings indicated numerous factors across life that can be targeted to improve mastery and therefore improve physical capability. The role of psychological processes acting between mastery and physical capability was highlighted.

Next, thesis findings can inform at a policy level. These findings reiterate the socioeconomic health and wellbeing gradient long reported by the National Study of Health and Development (NSHD). Policies designed to allow more control at work despite occupational level, and the provision of more support to individuals struggling financially may improve mastery; with expected benefits to multiple health outcomes. Despite established socioeconomic inequalities relating to mastery, the lasting impression of this thesis is the value to individuals of their psychosocial resources and perception. Even without reducing structural disparities, national policies which allow more time, space, and free activities to encourage early family attachments and later social support, may bring lifelong benefits. Public health interventions could particularly educate society on the need for parental autonomy-granting; especially in what is plausibly a more tightly controlled early environment than previous decades.

Finally, in addition to potential intervention targets for mastery, this thesis can have clinical impact in furthering understanding of the role of psychological processes in maintaining and improving physical capability. With an increasing public health focus on maintaining physical capability in older age, and extending independence and quality of life, it is important to ensure that psychological processes such as mastery are not neglected.

Throughout the research process findings from this thesis have been continually disseminated through presentations and public activities. Findings from all analytical thesis chapters are in preparation to be submitted to peer-reviewed journal articles. All papers will be widely advertised to ensure that they have far-reaching impact in research settings. Three international oral presentations have been delivered: at the Longitudinal and Life Course (SLLS) conference, Germany 2017; and 2019; and by invitation of the Longitudinal Ageing Study Amsterdam (LASA), Netherlands, 2019. Three national oral presentations (University College London) and five poster presentations have been delivered (British Psychological Society 2016, ESRC Research Methods Festival 2017, Society for Social Medicine 2018, Lancet Public Health Science 2018, Epidemiology and Public Health UCL (Best Poster Presentation 2017).

Public engagement opportunities have allowed a wide range of people to become directly engaged in the findings of this thesis. Tangle at the Green Man Festival (1500 people), Life Course Golf (450 people) at the Science Museum, Talismans at the Bloomsbury Festival (70 people) and the Three Minute Thesis (UCL IEHC winner 2018) – introduced people of all ages and backgrounds to consider their own mastery.

ACKNOWLEDGEMENTS

It's impossible for a sheet of A4 to bring to life how hard a thesis is to write, or all the tiny (and not so tiny) things that other people have done to help me either shape it or cope with it.

First come my family. My 'closest person', Louis who brings me chocolate in bed while I'm writing at night. Every night. Robin, who stops me working to play. Dodo who I have to finish my corrections for. Mum, Ro, Dad, and Grampa maintain my self-esteem and motivation. "You can do it Franny" says Grampa. My family make me feel like I can do anything. My friends, particularly those who have been through it (Dr Dani, Dr Jen) have given such helpful pulls along.

My mind has expanded since I sat next to Professor Diana Kuh at an open day and shared my ideas. I'm grateful she encouraged me to apply. Thank you to my supervision team. Prof Rachel Cooper, Dr Mai Stafford, and Prof Marcus Richards have given their time, effort and kindness to bringing out the best in my work and thinking. Prof Annie Britton joining near the end gave me greatly appreciated confidence. I've learnt from and been emotionally supported by all the team at the MRC LHA (I owe you 500 biscuits).

I've been privileged by institutional support. My Medical Research Council funding, along with the consideration to student development and support within the UCL department of Epidemiology and Public Health has given me remarkable opportunities (thank you to Andreas Opitz and the rest of the team).

It's been an honour to be part of the National Survey of Health and Development. I loved meeting the study members at the 70th birthday parties. Thank you for sharing your lives with us.

This thesis is dedicated to Dr Aradhna Kaushal and Dr Joanna Blodgett. Thank you. I wish we could do our PhDs together every day.

TABLE OF CONTENTS

MASTERY IN EARLY OLD AGE: LIFE COURSE INFLUENCES AND ITS ASSOCIATION WITH PHYSICAL CAPABILITY IN THE MRC NATIONAL SURVEY OF HEALTH AND DEVELOPMENT

ABSTRACT 4
IMPACT STATEMENT 5
ACKNOWLEDGEMENTS 7
LIST OF TABLES 13
LIST OF FIGURES 15
ABBREVIATIONS 17

1: INTRODUCTION 18
1.1 Background: perceived control constructs and mastery 19
1.1.1 Sense of mastery 19
1.1.2 Measurement of mastery 21
1.1.3 Public health significance of mastery 22
1.2 Potential health mechanisms of mastery 23
1.2.1 The behavioural pathway between mastery and health 24
1.2.2 The psychological pathway between mastery and health 24
1.3 A life course approach to investigating mastery 26
1.3.1 Understanding a life course approach 26
1.3.2 Mastery across the life 27
1.3.3 Socioeconomic pathways to mastery 28
1.3.4 Psychosocial pathways to mastery 32
1.3.5 Summary and limitations of the literature 37
1.3.6 Using the MRC National Survey of Health and Development 39
1.4 Investigating mastery and physical capability 42
1.4.1 Public health significance of physical capability 42
1.4.2 Measurement of physical capability 43
1.4.3 Potential pathways between mastery and physical capability 44
1.4.4 Proposed behavioural pathway 45
1.4.5 Proposed psychological pathway 46
1.4.6 Effect modification between physical capability and disability 47
1.4.7 Summary and limitations of the literature 48
1.5 Structure of thesis 50
2 DATA AND ANALYTICAL STRATEGY 53
2.1 Aim, objectives and hypotheses 53
2.1.1 Life course influences on mastery: hypotheses relating to objectives i-iii (chapters 3 and 4) 54

2.1.2 Associations between mastery and physical capability - hypotheses relating to objective iv (chapter 5) 55
2.1.3 Potential mediators of the association between mastery and physical capability- hypotheses relating to objective v (chapter 5) 56
2.1.4 Mastery as an effect modifier between physical capability and disability- hypotheses relating to objective vi (chapter 6) 56
2.2 Introduction to the MRC National Survey of Health and Development data and participants 56
2.3 Measures 59
2.3.1 Mastery 59
2.3.2 Early environment socioeconomic exposures 60
2.3.3 Early environment psychosocial exposures 61
2.3.4 Adult environment socioeconomic exposures 64
2.3.5 Adult environment psychosocial exposures 65
2.3.6 Health variables 67
2.3.7 Physical capability and disability outcomes 70
2.3.8 Potential explanatory variables 74
2.3.9 Potential confounders 75
2.4 Analyses 76
2.4.1 Analytical sample 76
2.4.2 Descriptive analyses 77
2.4.3 Regression modelling 78
2.5 Summary and next chapter 79
3 ASSOCIATIONS BETWEEN THE EARLY ENVIRONMENT AND MASTERY IN EARLY OLD AGE 80
3.1 Introduction 80
3.1.1 Background to testing the early environment and mastery in early old age 80
3.1.2 Identifying pathways between the early environment and mastery 82
3.1.3 Background literature: Associations between the early environment and mastery in adulthood 83
3.1.4 Literature review: The early socioeconomic environment and mastery in adolescence 85
3.1.5 Literature review: The early psychosocial environment and mastery in adolescence 86
3.1.6 Literature discussion and summary 88
3.2 Analysis plan 90
3.2.1 Analytical sample 91
3.2.2 Descriptive analyses 91
3.2.3 Regression models 93
3.3 Results 93
3.3.1 Descriptive statistics for mastery 93
3.3.2 Description of early socioeconomic environment and mastery 94

3.3.3 Description of early psychosocial environment and mastery 96
3.3.4 Interplay between early socioeconomic and psychosocial exposures 99
3.3.5 Main findings: Associations between early socioeconomic exposures and mastery 100
3.3.6 Main findings: Associations between early psychosocial environment and mastery 102
3.3.7 Main findings: Mutually adjusted associations between early environment and mastery 103
3.4 Discussion 104
3.4.1 Summary of early environment and mastery findings 104
3.4.2 Early socioeconomic processes and mastery 104
3.4.3 Early psychosocial process and mastery 108
3.4.4 Methodological considerations 110
3.5 Conclusion and next chapter 111
4. ASSOCIATIONS BETWEEN EXPOSURES FROM ACROSS LIFE AND MASTERY IN EARLY OLD AGE 112
4.1 Introduction 113
4.1.1 Theoretical background behind the adult environment and mastery 113
4.1.2 Literature review: socioeconomic pathways to mastery 114
4.1.3 Literature review: Adult psychosocial environment and mastery 116
4.1.4 Literature discussion and summary 119
4.2. Analysis plan 122
4.2.1 Analytical sample 123
4.2.2 Descriptive analyses 123
4.2.3 Regression models 124
4.3 Results 125
4.3.1 Description of adult socioeconomic environment and mastery 125
4.3.2 Description of adult psychosocial environment and mastery in early old age 127
4.3.3 Description of chronic health conditions and depressive symptoms 129
4.3.4 Interplay between socioeconomic and psychosocial factors from across the early environment to early old age 131
4.3.5 Main findings: Associations between adult socioeconomic exposures and mastery 132
4.3.6 Main findings: Associations between adult psychosocial exposures and mastery 134
4.3.7 Main findings: Mutually adjusted associations between exposures from across adulthood and mastery 134
4.3.8 Mutually adjusted associations between exposures from the early environment throughout adulthood, and mastery in early old age 136
4.4. Discussion 139
4.4.1 Summary of findings 139
4.4.2 Pathways between the adult socioeconomic environment and mastery 139
4.4.3 Pathways between the adult psychosocial environment and mastery 141
4.4.4 Earlier life environment 141
4.4.5 Methodological considerations 142

4.5 Conclusion and next chapter 144

5. MASTERY AND PHYSICAL CAPABILITY: EXPLAINING THE ASSOCIATION 146

5.1 Introduction 146

5.1.1 Potential explanatory pathways between mastery and physical capability 147

5.1.2 Evidence of associations between mastery and physical performance 148

5.1.3 Evidence toward associations between mastery and functional limitations 149

5.1.4 Evidence supporting potential explanatory pathways between mastery and physical capability. 149

5.1.5 Summary of evidence and gaps to be addressed in the current study 152

5.2 Analysis plan 156

5.2.1 Analytical sample 157

5.2.2 Descriptive analyses 157

5.2.3 Regression models 158

5.3 Results. 161

5.3.1 Characteristics of physical capability 161

5.3.2 Descriptive pathway between mastery and physical capability 162

5.3.3 Main findings: Associations between mastery and physical performance 165

5.3.4 Main findings: Associations between mastery and functional limitations 166

5.3.5 Main findings: Mastery and potential mediating variables 167

5.3.6 Main findings: Potential mediators and physical performance 168

5.3.7 Main findings: Potential mediators and functional limitations 168

5.3.8 Main findings: Explaining the association between mastery and physical performance 170

5.3.9 Main findings: Explaining the association between mastery and functional limitations 171

5.3.10 Extending analysis: adjustment for grouped covariates 171

5.3.11 Checking the statistical criteria for mediation analysis 172

5.3.12 Extending analysis: in a physically capable sub-group 174

5.4 Discussion 175

5.4.1 Summary of findings 175

5.4.2 Explaining the association between mastery and physical capability 175

5.4.3 Methodological considerations 177

5.5 Conclusions and next chapter 179

6 THE MODIFYING EFFECT OF MASTERY ON THE ASSOCIATION BETWEEN PHYSICAL CAPABILITY AND DISABILITY 181

6.1 Introduction 181

6.1.1 Background to modification between physical capability and disability 182

6.1.2 Background to mastery as an effect modifier between physical capability and disability 182

6.1.3 Literature on mastery as an effect modifier between physical capability and disability 183

6.1.4 Summary of evidence and gaps to be addressed in the current study 185

6.2 Analysis plan 186

6.2.1 Analytical sample 187

6.2.2 Descriptive analyses 187
6.2.3 Regression models 187
6.3 Results 189
6.3.1 The modifying effect of mastery on the association between physical performance and functional limitations 189
6.3.2 The modifying effect of mastery on the association between physical performance, functional limitations and activities of daily living (ADLS) 192
6.4 Discussion 197
6.4.1 Summary of findings 197
6.4.2 Explaining the findings 197
6.4.3 Methodological considerations 198
6.4.4 Conclusion and next chapter 199
7 DISCUSSION 200
7.1 Summary of main findings 200
7.2 Explanations of findings 205
7.2.1 Current circumstances and mastery in early older age 205
7.2.2 The integration of factors across life into mastery in early older age 206
7.2.3 Suggested socioeconomic processes 207
7.2.4 Suggested psychosocial processes 209
7.2.5 Pathways between mastery and physical capability 211
7.2.6 Mastery as a moderator of physical capability 212
7.3 Generalisability 213
7.4 Strengths 214
7.5 Limitations 216
7.6 Implications for policy and practice 217
7.7. Future work 220
7.8 Conclusion 222
REFERENCES 224
APPENDIX A 253
APPENDIX B 254
APPENDIX C 262

LIST OF TABLES

TABLE 2.1 PEARLIN PERSONAL MASTERY SCALE 59
TABLE 2.2 PATERNAL EDUCATION; MATERNAL EDUCATION CODING 60
TABLE 2.3 EARLY ENVIRONMENT STRESSFUL LIFE EVENTS 61
TABLE 2.4 PARENTAL BONDING INSTRUMENT 63

TABLE 2.5. ADULT STRESSFUL LIFE EVENT ITEMS....66
TABLE 2.6. CLOSE PERSON'S QUESTIONNAIRE....67
TABLE 2.7. 28-ITEM GENERAL HEALTH QUESTIONNAIRE....68
TABLE 2.8 FUNCTIONAL LIMITATION ITEMS. 72
TABLE 2.9 ACTIVITY OF DAILY LIVING ITEMS AGE 69-70. 73
TABLE 3.1. DESCRIPTIVE CHARACTERISTICS OF EARLY SOCIOECONOMIC ENVIRONMENT OF STUDY MEMBERS WITH COMPLETE MASTERY DATA BY SEX [A] 95
TABLE 3.2. MEAN MASTERY SCORE ACCORDING TO SOCIOECONOMIC CHILDHOOD ENVIRONMENT IN STUDY MEMBERS WITH COMPLETE MASTERY DATA [A] 96
TABLE 3.3. DESCRIPTIVE CHARACTERISTICS OF EARLY PSYCHOSOCIAL ENVIRONMENT OF STUDY MEMBERS WITH COMPLETE MASTERY DATA BY SEX [A] 97
TABLE 3.4. MEAN MASTERY SCORE ACCORDING TO EARLY PSYCHOSOCIAL ENVIRONMENT IN STUDY MEMBERS WITH COMPLETE MASTERY DATA [A] 98
TABLE 3.5. SUMMARY TABLE OF CROSS-TABULATIONS BETWEEN MULTIPLE INDICATORS OF EARLY ENVIRONMENT USING CHI-SQUARED TESTS OF ASSOCIATION 99
TABLE 3.6 ASSOCIATIONS BETWEEN MULTIPLE DIMENSIONS OF EARLY SOCIOECONOMIC ENVIRONMENT AND MASTERY, FROM MULTIPLE LINEAR REGRESSION MODELS 101
TABLE 3.7 ASSOCIATIONS BETWEEN MULTIPLE DIMENSIONS OF EARLY PSYCHOSOCIAL ENVIRONMENT AND MASTERY, FROM MULTIPLE LINEAR REGRESSION MODELS 102
TABLE 3.8 FULLY ADJUSTED MODEL SHOWING ASSOCIATIONS BETWEEN EXPOSURES FROM MULTIPLE DOMAINS OF EARLY ENVIRONMENT AND MASTERY, IN LINEAR REGRESSION MODELS....103
TABLE 4.1 DESCRIPTIVE CHARACTERISTICS OF ADULT SOCIOECONOMIC ENVIRONMENT OF STUDY MEMBERS WITH COMPLETE MASTERY DATA BY SEX [A] 126
TABLE 4.2 MEAN MASTERY ACCORDING TO INDICATORS OF ADULT SOCIOECONOMIC ENVIRONMENT IN STUDY MEMBERS WITH COMPLETE MASTERY DATA BY SEX [A]....127
TABLE 4.3 ADULT PSYCHOSOCIAL CHARACTERISTICS OF STUDY MEMBERS WITH COMPLETE MASTERY DATA[A]....128
TABLE 4.4 MEAN MASTERY ACCORDING TO INDICATORS OF ADULT PSYCHOSOCIAL ENVIRONMENT IN STUDY MEMBERS WITH COMPLETE MASTERY DATA BY SEX [A]....129
TABLE 4.5 ADULT MENTAL AND PHYSICAL HEALTH OF STUDY MEMBERS WITH COMPLETE MASTERY DATA BY SEX [A] 130
TABLE 4.6 MEAN MASTERY ACCORDING TO INDICATORS OF ADULT CHRONIC HEALTH CONDITIONS IN STUDY MEMBERS WITH COMPLETE MASTERY DATA BY SEX [A]....130
TABLE 4.7. SUMMARY TABLE OF CROSS-TABULATIONS BETWEEN MULTIPLE INDICATORS OF EARLY ENVIRONMENT USING CHI-SQUARED TESTS OF ASSOCIATION 131
TABLE 4.8. ASSOCIATIONS BETWEEN ADULT SOCIOECONOMIC ENVIRONMENT AND MASTERY, FROM LINEAR REGRESSION MODELS 133
TABLE 4.9 ASSOCIATIONS BETWEEN ADULT PSYCHOSOCIAL ENVIRONMENT AND MASTERY, FROM MULTIPLE LINEAR REGRESSION MODEL....134

TABLE.4.10 MULTIPLY ADJUSTED ASSOCIATIONS BETWEEN EXPOSURES FROM ACROSS ADULTHOOD, AND MASTERY IN EARLY OLD AGE, FROM LINEAR REGRESSION MODELS 136
TABLE 4.11 MULTIPLY ADJUSTED ASSOCIATIONS BETWEEN EXPOSURES FROM THE EARLY ENVIRONMENT THROUGHOUT ADULTHOOD, AND MASTERY IN EARLY OLD AGE, FROM LINEAR REGRESSION MODELS..... 138
TABLE 5.1. CHARACTERISTICS OF COMPOSITIVE PHYSICAL CAPABILITY IN STUDY MEMBERS WITH COMPLETE MASTERY AND PHYSICAL CAPABILITY DATA[1]..... 163
TABLE 5.2. PHYSICAL CAPABILITY AND MASTERY ACROSS POTENTIAL MEDIATORS IN STUDY MEMBERS WITH COMPLETE DATA[A] 165
TABLE 5.3. ASSOCIATIONS BETWEEN MASTERY AND PHYSICAL CAPABILITY OUTCOMES IN SEPARATE ANALYSES AT AGE 69-70..... 166
TABLE 5.4.ASSOCIATIONS BETWEEN MASTERY AND SMOKING, IN MULTINOMIAL REGRESSION..... 167
TABLE 5.5. ASSOCIATIONS BETWEEN MASTERY AND LTPA, BMI, AND FEAR OF FALLING 167
TABLE 5.6. ASSOCIATIONS BETWEEN POTENTIAL MEDIATING VARIABLES AND PHYSICAL PERFORMANCE AT AGE 69-70 168
TABLE 5.7. ASSOCIATIONS BETWEEN POTENTIAL MEDIATORS AND FUNCTIONAL LIMITATIONS 169
TABLE 5.8. SUMMARY ASSOCIATIONS BETWEEN MASTERY AND PHYSICAL CAPABILITY..... 170
TABLE 5.9 ASSOCIATIONS BETWEEN MASTERY AND PHYSICAL CAPABILITY, WITH GROUPED ADJUSTMENT. 172
TABLE 5.10 ADDITIONAL MEDIATION ANALYSIS BETWEEN MASTERY AND PHYSICAL PERFORMANCE + POTENTIAL CONFOUNDERS USING PARAMETRIC REGRESSION MODELS 173
TABLE 5.11 ADDITIONAL MEDIATION ANALYSIS BETWEEN MASTERY AND FUNCTIONAL LIMITATIONS + POTENTIAL CONFOUNDERS USING PARAMETRIC REGRESSION MODELS 174
TABLE 5.12. SUMMARY ASSOCIATIONS BETWEEN MASTERY AND PHYSICAL CAPABILITY AT AGE 69-70 IN A SUBSET OF 299 WITH GOOD PHYSICAL CAPABILITY AT AGE 60-64[A]. 174
TABLE 6.1. PREVALENCE OF FUNCTIONAL LIMITATIONS BY PHYSICAL PERFORMANCE TERTILE..... 189
TABLE 6.2 ASSOCIATION BETWEEN PHYSICAL PERFORMANCE AND FUNCTIONAL LIMITATIONS 190
TABLE 6.3 INTERACTION BETWEEN MASTERY AND ITS EFFECT ON PHYSICAL PERFORMANCE AND FUNCTIONAL LIMITATIONS FROM POISSON REGRESSION MODELS..... 190
TABLE 6.4 ASSOCIATIONS BETWEEN PHYSICAL PERFORMANCE AND FUNCTIONAL LIMITATIONS, STRATIFIED BY MASTERY TERTILE..... 191
TABLE 6.5. PREVALENCE OF EACH INDIVIDUAL ADL ITEM IN STUDY MEMBERS WITH COMPLETE DATA[A] 192
TABLE 6.6. PREVALENCE OF DIFFICULTIES WITH ADLS ACROSS COVARIATES IN STUDY MEMBERS WITH COMPLETE DATA[1] 193
TABLE 6.7. PREVALENCE OF DIFFICULTIES WITH ADLS ACROSS MASTERY, FUNCTIONAL LIMITATIONS, AND PHYSICAL PERFORMANCE AT AGE 69-70 194
TABLE 6.8 ASSOCIATIONS BETWEEN PHYSICAL CAPABILITY AND DIFFICULTIES WITH ADLS 195
TABLE 6.9. INTERACTION BETWEEN MASTERY AND ITS EFFECT ON PHYSICAL PERFORMANCE AND ADLS AT AGE 69 -70 FROM ORDINAL LOGISTIC REGRESSION MODELS 196

TABLE 6.10. INTERACTION BETWEEN MASTERY AND ITS EFFECT ON FUNCTIONAL LIMITATIONS AND ADLS AT AGE 69 -70 FROM ORDINAL LOGISTIC REGRESSION MODELS 196
TABLE A.1 MISSING DATA SUMMARY OF STUDY MEMBERS: WITH COMPLETE MASTERY (CHAPTERS 3-4); WITH COMPLETE PHYSICAL CAPABILITY AND MASTERY (CHAPTERS 5-6).....253
TABLE B.1 PROPORTION OF STUDY MEMBERS WITH EACH INDIVIDUAL FUNCTIONAL LIMITATION AT AGE 69-70; (%) YES (LIMITATIONS) OR NO LIMITATIONS 254
TABLE B.2. DISTRIBUTION OF PHYSICAL CAPABILITY ACROSS MASTERY QUARTILE IN STUDY MEMBERS WITH COMPLETE DATA[A] 255
TABLE B.3. INDIVIDUAL PHYSICAL PERFORMANCE SCORES ACROSS POTENTIAL CONFOUNDERS IN STUDY MEMBERS WITH COMPLETE DATA[1] 256
TABLE B.4. INDIVIDUAL PHYSICAL PERFORMANCE ACROSS POTENTIAL MEDIATORS IN STUDY MEMBERS WITH COMPLETE DATA[1].....258
TABLE B.5. PREVALENCE INDIVIDUAL FUNCTIONAL LIMITATIONS ACROSS POTENTIAL CONFOUNDERS, IN STUDY MEMBERS WITH COMPLETE DATA [1] 259
TABLE B.6. PREVALENCE INDIVIDUAL FUNCTIONAL LIMITATIONS ACROSS EACH POTENTIAL MEDIATOR, IN STUDY MEMBERS WITH COMPLETE DATA[1].....260
TABLE B.7 INDIVIDUAL LINEAR REGRESSION MODELS TESTING ASSOCIATIONS BETWEEN MASTERY AND PHYSICAL PERFORMANCE SCORES 261
TABLE B.8. INDIVIDUAL LOGISTIC REGRESSION MODELS TESTING ASSOCIATIONS BETWEEN MASTERY AND EACH FUNCTIONAL LIMITATION.....261
TABLE C.1. ASSOCIATION BETWEEN EACH PERFORMANCE SCORE AND FUNCTIONAL LIMITATION 262
TABLE C.2 INTERACTION BETWEEN MASTERY AND ITS EFFECT ON EACH PHYSICAL PERFORMANCE AND EACH FUNCTIONAL LIMITATION.....263
TABLE C.3 ASSOCIATION BETWEEN EACH INDIVIDUAL PHYSICAL PERFORMANCE ITEM, EACH FUNCTIONAL LIMITATION AND DIFFICULTIES WITH ADLS AT AGE 69-70 264
TABLE C.4. INTERACTION BETWEEN MASTERY AND ITS EFFECT ON EACH PHYSICAL PERFORMANCE SCORE AND ADLS FROM ORDINAL LOGISTIC REGRESSION MODELS 265
TABLE C.5 INTERACTION BETWEEN MASTERY AND ITS EFFECT ON EACH FUNCTIONAL LIMITATION AND ADLS FROM ORDINAL LOGISTIC REGRESSION MODELS 266

LIST OF FIGURES

Figure 1.1. Conceptual Model Theorising Pathways Of Association Between Socioeconomic And Psychosocial Exposures Across Life And Mastery In Early Old Age 41
Figure 1.2 Conceptual Model Theorising Pathways Of Association Between Life Course Exposures And Mastery; And Associations Between Mastery And Physical Capability In Early Old Age 50

Figure 2.1 Target Samples And Responses From Postal Questionnaire And Home Visit At Age 68-70. Figure Adapted From Kuh Et Al. 2016.[263] 58
Figure 3.1. Conceptual Model Theorising Pathways Of Associations Between Early Exposures And Mastery In Early Old Age 90
Figure 3.1. Distribution Of Mastery Scores At Age 68-9 In 2038 Study Members With Complete Data (Left Side Female N=1009, Right Side Male N= 1029). 94
Figure 4.1 Conceptual Model Theorising Pathways Of Association Between Exposures Across Life And Mastery In Early Old Age 122
Figure 5.1 Conceptual Model Theorising Pathways Of Association Between Mastery And Physical Capability 156
Figure 5.2. Distribution Of Sex-Stratified 1) Physical Performance Scores (0-4); 2) Prevalence Of Any Functional Limitations (0-6) In Study Members With Complete Data On Mastery And Physical Capability At Age 68-70. 161
Figure 6.1 Conceptual Model Theorising Pathways Of Association Between Physical Capability And Adls With Mastery As An Effect Modifier 186

ABBREVIATIONS

ACE-III	Addenbrooke's Cognitive Examination (version III)
ADL	Activity of Daily Living
BMI	Body Mass Index
CI	Confidence Interval
CVD	Cardiovascular Disease
ELSA	English Longitudinal Study of Ageing
GHQ	General Health Questionnaire
HRS	Health and Retirement Study
IRR	Incidence Risk Ratio
InCHIANTI	Invecchiare nel chianti
IADL	Instrumental Activity of Daily Living
ICD-10	International Classification of Diseases 10th Revision
LASA	Longitudinal Amsterdam Study Ageing
MIDUS	Midlife in United States
MICE	Multiple Imputation by Chained Equations
MRC	Medical Research Council
NSHD	National Survey of Health and Development
OR	Odds Ratio
RRR	Relative Risk Ratio
SD	Standard Deviation
SEP	Socioeconomic Position
SPPB	Short Physical Performance Battery
TUG	Time Up and Go Test
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation

1: INTRODUCTION

Beliefs regarding the possession of control of oneself or one's environment have long been recognised for their adaptive value [1-3]. Higher perceived control is associated with better physical functioning [4], fewer chronic diseases [5], better mental health and greater longevity [6-8]. For those exposed to objectively hard to manage circumstances, maintaining control beliefs is considered to have a buffering effect [9-11]. In this context, the World Health Organisation (WHO) suggest using a life course approach to identify the drivers of control beliefs from all stages of life; to support people to optimise their health and wellbeing [12, 13].

Mastery is one of many constructs indicating the sense of control a person believes they hold over their own life [7]. Using data from the Medical Research Council (MRC) National Survey of Health and Development (NSHD; the British 1946 birth cohort) this thesis aims to: investigate the life course influences of mastery in early old age and its association with physical capability.

Within a life course framework, this thesis first examines the pathways between multiple indicators of the socioeconomic and psychosocial environment across the life, and mastery in early old age. Second, to further understanding of how mastery is adaptive; assessing the contribution of indicators of health behaviours or psychological processes to explain associations between mastery and physical capability in early old age; and the role of mastery as a potential moderator of the pathway between physical capability and disability.

This chapter introduces the construct of mastery, methodological considerations related to its use (section 1.1) and its proposed health mechanisms (section 1.2). Literature describing pathways between exposures from across the life course and mastery are examined (section 1.3). The focus on physical capability in this thesis is introduced along with evidence for associations between mastery and physical capability; and its potential mechanisms (section 1.4). This chapter concludes by presenting the aims, objectives and conceptual model of this thesis as developed by the literature (section 1.5).

1.1 Background: perceived control constructs and mastery

In 1996, Skinner reported the existence of more than 100 constructs reflecting perceived control [14]. These constructs are generally measured with questionnaires assessing the degree to which a person agrees with statements rating their personal control over their own environment. Theories on personal control specify that control beliefs influence people through primary and secondary mechanisms; actively changing their environment; or using acceptance and adaption [15]. Over many decades of perceived control research, there have been numerous variations of the constructs themselves. The most well established are sense of mastery [7], agency [16], locus of control [2], self-efficacy [17], fatalism [18] and environmental mastery [19]. These constructs share the assumption that life is not something that passively happens to people but is shaped by them [20]. Although mastery overlaps with other perceived control constructs, several key distinctions are highlighted when the constructs are positioned side by side.

1.1.1 Sense of mastery

Mastery is the "understanding that people harbour about their ability to manage the circumstances of their lives" [7]. It is a self-concept; defined as how one perceives oneself [21]. The American sociologist Len Pearlin is considered the leading expert in mastery and the studies in this thesis use the scale developed by him and his colleagues [22]. The following paragraphs emphasise the key features of mastery; particularly in comparison to fellow perceived control constructs.

The object of perceived control in mastery is existing circumstances in an individual's life; how individuals see themselves as being able to manage those circumstances [7]. Exposures tested in association with lower mastery tend to be circumstances which are objectively hard-to-manage, such as a disruptive life event, or those which compromise people's energy or resources for coping with daily life, such as poor health or socioeconomic disadvantage (see section 1.3). Mastery contrasts from fatalism [18] and locus of control [2], because those constructs indicate perception of the source of life's circumstances [7]. Fatalism

and locus of control, at the extreme, involve attributions of the individual's circumstances to fate or luck [23]. Mastery is the individual's appraisal of whether they can manage the circumstances.

Mastery is a fluid perception of control; the reserve of mastery appears to both slowly accumulate across the life course and change in response to new circumstances [24, 25]. The perception of new circumstances (whether an individual believes they are manageable) is itself influenced by existing mastery [26-28]. This is another difference between mastery and perceived control constructs such as internal locus of control which is a fixed attribution [2].

Although it is dynamic, mastery is further differentiated by its connections between the past and present. The mastery an individual brings to each new situation is informed by both the occurrence of circumstances and their perception of how well they managed them [20]. The scope of mastery differs from agency and self-efficacy, which are present and forward facing constructs that identify if the individual perceives that they can control 'their destiny', or a chosen event or behaviour [7, 16, 17, 20].

Perceived control constructs share the suggestion that control beliefs operate in some way on a range of indicators of health, wellbeing and even mortality [6-8]. For example, in Britain, the seminal work from the Whitehall II study identified an association between lower perceived control at both work, and home, and more chronic diseases [29, 30]. Evidence to date has not clearly established the mechanism operating between mastery and any indicator of health (see section 1.2). Unlike constructs such as self-efficacy and Ryff's environmental mastery, Pearlin's sense of mastery does not reference knowledge or skills which might explain health differences [19, 31]. It is a generalised sense of control which does not indicate whether or not the individual has the skills to change their circumstances [20]. Self-efficacy represents confidence that one has the skills to execute the behaviour required to produce a desired outcome [17, 32]. Different patterns emerge for self-efficacy and mastery in the same analyses [33-36]: higher mastery was associated only with maintenance of independence and physical capability in older age, whereas self-efficacy was associated with actual improvements in strength and mobility. Environmental mastery similarly

emphasises skills in competencies to manage tasks such as finances and home responsibilities [19]. In contrast, evidence is available that some individuals have high mastery despite low levels of competency, in for example, managing chronic health conditions or mental health, and enduring socioeconomic stressors [37, 38]. This reinforces that alternative processes may operate between mastery and health.

Considering the differences in key features between perceived control constructs, it is likely that they are influenced by different factors and operate in different ways. Therefore, each construct requires its own investigation. The next sections discuss the public health value of mastery itself and the processes potentially underlying mastery and indicators of health and wellbeing.

1.1.2 Measurement of mastery

As outlined in the previous section, the mastery scale was developed in the late 1970s by Len Pearlin and his colleagues to study the social origins of stress and how people cope [22]. The scale has been validated across the globe [39-43]. This thesis has limited the literature reviewed to studies based on the measure of mastery constructed by Pearlin et al. [22], referred to as personal mastery or sense of mastery. It is a 7-item questionnaire answered with a 4 point Likert scale (strongly agree, agree, disagree, strongly disagree); producing a score denoting the degree to which the respondent perceives that they are in control of their own life circumstances.

Some research has used only several items from the scale, or created a new measure from them, such as Mirowsky and Ross's [44] "sense of control" index. This is an 8-item redesign of the Pearlin original measure that balances positive and negative control statements. More recently authors have used factor analysis on the scale to produce "constraints and competencies" [45] and "constraints and mastery" [46] in which mastery or competencies are the positively worded items from the Pearlin mastery scale and negative items are constraints. Throughout this thesis, redesigned mastery questionnaires that focus on positive and negative control statements will be referred to more generally as "perceived control". Another issue to keep in mind is that researchers have varied the length

of the “disagree/agree” Likert scale used in response to the mastery items from 4 to 5. The addition of more responses on the Likert scale means an option to answer ‘do not agree or disagree’ is included. No study has compared findings on different interpretations of the measure and it is not clear whether it impacts the study findings. In this thesis, differences between mastery measures will be highlighted.

1.1.3 Public health significance of mastery

Many decades of research have established mastery as a feature of good health and wellbeing; it is associated with better cardiovascular and respiratory health, better symptom management of chronic health conditions, stronger physical capability, better mental health, and greater longevity [6, 8, 47-49]. Despite the potential for a bi-directional relationship between mastery and poor mental health and chronic physical conditions (introduced in section 1.1.1), many studies show residual associations between mastery and health. That is, an association between baseline mastery and health outcomes over time beyond what would be expected from pre-existing mental and physical health symptoms. In addition, a wealth of evidence supports the role of mastery as a moderator. Research indicates that in those exposed to the same difficult contexts, individuals with higher mastery are less affected by expected symptoms (e.g. fatigue, pain, allostatic load and poor mental health) compared to those with lower mastery [6, 27, 50, 51].

These data suggests that mastery could be a valued psychological resource; particularly at a time when the gap between life expectancy and disability-free life expectancy is widening [52, 53]. Qualitative research into perceptions of ageing in the MRC National Survey of Health and Development (NSHD) reiterates that sense of control over ageing is a priority for adults in early old age. For example, one NSHD study member reported,

“I won't have the ability to do what I've been able to do or have the control, the mental control maybe over the things that I've been able to do in the past. And that is going to be an issue” [54]

As introduced earlier in this chapter, the WHO's Health 2020 Policy and the recently revisited Marmot Review emphasise the importance of empowering individuals to optimise their health, wellbeing and quality of life [12, 55]. Indicators of socioeconomic gradient are powerful contributors to inequalities in health [56]. As a potential moderator, mastery falls within the WHO's remit to maximise individual control available despite unequally distributed access to power or resources [12]. Although greater mastery is more likely in conditions which are objectively controllable or if an individual has the financial or occupational resources to regain control, there are suggestions that other factors contribute to mastery beliefs (see section 1.3) [37, 38, 57]. Research has highlighted that some individuals, with poor socioeconomic resources or quite objectively disruptive lives, have the same perception of control as individuals with far more stable life circumstances, and vice versa [27, 28, 58, 59]. This thesis investigates whether psychosocial factors across life can explain differences in mastery in the same way that socioeconomic resources have been found to [12].

In summary, there is good justification for examining how to increase mastery, protect people from decline in mastery, and at the same time investigate how mastery may operate on health and wellbeing- an ongoing public health priority [12, 53, 60]. The following section explores theories behind potential mechanisms between mastery and health before section 1.3 outlines processes across the life suggested to contribute to mastery.

1.2 Potential health mechanisms of mastery

As introduced in section 1.1.1, mastery differs from several perceived control constructs in that there is not a solid base of evidence suggesting how mastery influences health. Pearlin suggested two broad processes explaining health and wellbeing differences associated with mastery [31]. First, through a behavioural pathway, people who believe they control their circumstances act to delay, reduce or avoid declines in their health. Second, people with high mastery appraise stressors as less threatening, and therefore are exposed to, i) less downstream stress-linked physiological damage, and/or ii) fewer negative psychological processes such as fear-linked inaction or restriction. The next sections use the available evidence to review these processes.

1.2.1 The behavioural pathway between mastery and health

The suggestion that people with higher mastery act proactively with regard to their health has perpetuated [61-63] despite relatively little testing [64]. There is no available evidence assessing whether people with high mastery are more likely to be aware of lifestyle-linked health problems or are those who set behavioural goals. In one study, mastery did not predict lifestyle change six weeks or a year after cardiovascular diagnosis, in contrast to self-efficacy which did [35]. Despite a lack of studies testing behaviour change, cross-sectional associations between mastery and health behaviours suggest that those with higher mastery are more likely to report frequent leisure time physical activity (LTPA) [46, 65, 66], maintain a healthier weight [23, 67, 68], and less likely to be current smokers [69, 70].

Several studies assume that people with higher mastery are less likely to use unhealthy behavioural coping strategies than those with lower mastery [22]. For example, for nurses in a high stress environment, and for individuals residing within a high concentration of fast-food restaurants, higher mastery weakened associations between the environmental exposure and an increase in BMI or a higher metabolic score, respectively [67, 68]. It is possible that people with higher mastery may be less likely to partake in unhealthy behaviours rather than more likely to increase healthy behaviours.

1.2.2 The psychological pathway between mastery and health

In addition to a behavioural pathway, there is a proposed psychological mechanism of mastery to health. The psychological stress perspective approaches differences in health as a result of stress linked to subjective evaluations of ability to manage demands [71-74]. As well as mastery fluctuating in response to new circumstances, mastery is a subjective evaluation of ability to manage circumstances [75]. Pre-existing mastery may therefore adapt the perception of new circumstances as a demand. Research suggests that individuals with higher mastery are more positive and less likely to become overwhelmed or frightened by their circumstances than those with lower mastery [76, 77]. There could be a number of pathways to physical functioning.

Being fearful due to not feeling able to manage circumstances is expected to trigger the “flight or fight” stress response [78]. Short term, this process mobilises physical systems to respond to a challenge; chronic or repeated acute stress may dysregulate physiological systems and increase the risk of chronic diseases, decline in physical capability, and premature mortality [79]. Laboratory evidence suggests that participants with higher mastery do not evaluate stressors in the same way as counterparts with lower mastery. Measurements of skin conductance, blood pressure, cortisol and noradrenaline indicate that participants with higher mastery become less physiologically aroused, i.e. stressed, in response to laboratory stressors, and return to their resting physiological state more quickly [28, 80, 81]. Population studies also suggest that study members with lower mastery have a more harmful physiological response to objectively stressful circumstances such as care-giving or stressful life events than those with higher mastery [26, 82, 83].

A more fearful appraisal of circumstances may contribute to associations between low mastery and poorer health through denial and avoidance coping methods, and delays in help-seeking or even general inaction [84, 85]. Active-coping strategies, associated with higher mastery [22], rather than denial, avoidance and inaction (associated with lower mastery), could support the maintenance of physical functioning [86, 87]. This pathway may be key for older adults for whom inactivity can contribute to functional decline and disability [88-90].

Socioeconomic and psychosocial resources may contribute to differences in both mastery and the appraisal of stressors [84]. Clarifying antecedents of mastery is key to clarify how mastery operates on physical functioning, whether through proactive behavioural pathways, a more positive psychological mindset, or shared factors which pattern both mastery and health. The following sub sections (within 1.3) describe the numerous theories as to how some individuals perceive themselves as more in control of their own lives than others.

1.3 A life course approach to investigating mastery

1.3.1 Understanding a life course approach

The WHO suggests using a life course approach to understand the integration of antecedents of control from all stages of life [12]. This approach, coined by Kuh and Ben-Schlomo [91] considers the dynamic interplay between multiple factors and periods of a person's life when investigating their present health and wellbeing. It is particularly appropriate to take a life course approach to mastery as mastery is thought to be based not only on how manageable current circumstances objectively are, but the individual's prior concept of themselves as someone who managed their own life [92-94]. Briefly, this section explains several of the guiding processes identified within a life course framework [95] which may be relevant to investigating mastery beliefs.

Systematic variation in individual environments, known as health inequalities, contribute in at least some way to the trajectory of many indicators of health [96]. There is a large school of research similarly highlighting structural socioeconomic differences in mastery [20, 94, 97, 98] which will be explained in section 1.3.2. There may be a number of life course processes acting simultaneously to impact an individual's current mastery; both along socioeconomic lines, and through other environmental exposures.

An important life course concept is that some exposures track across the life from the earliest environment into older age. Multiple similar circumstances associated with low mastery may each add to an increasingly lower sense of mastery over many years. Exposures may also establish a chain of risk, wherein it is the final exposure which has associations with the outcome of interest. For example, low parental education may lead to low education and occupation, which impacts income in early old age, which is associated with low mastery.

A life course framework also recognises that there are sensitive periods of life during which an individual's trajectory of development is particularly malleable to external exposures. For example, relevant to mastery, fewer opportunities for independence and more stressful life events in adolescence appear to have a

stronger effect on the development of the self-concept than they do in childhood or adulthood [21]. Effects in a sensitive period may be resolved at a later time with help, such as public health interventions.

Some factors are effect moderators, producing conditions in which the effect between two variables is weakened or amplified. For example, impaired parent-child bonds in early life can strengthen the association between stressors and poor mental health, while in the other direction, better positive social support has been shown to ameliorate the association between early interpersonal difficulties and poor wellbeing in early old age [99, 100]. Mastery itself has long been tested as a moderator of challenging circumstances, as outlined earlier in section 1.1.

The testing of pathways between an exposure and outcome helps to guide public health interventions. Some conditions have direct associations. For example, targeting early socioeconomic inequalities may support mastery in later life, in addition to changing midlife or contemporaneous conditions. There may also be indirect pathways. Mediators, or explanatory variables, are factors which explain how an environmental condition might be acting on an outcome. Utilising a life course framework to consider the available evidence on mastery may help individuals and policy makers to identify processes that empower mastery, from the earlier environment, into working and adult life, and into old age [12, 53, 60].

1.3.2 Mastery across the life

It is clear that a life course approach lends itself to extending understanding of the complex construct of mastery. As explained earlier (section 1.1.1), multiple factors and periods of a person's life are considered relevant to their current sense of mastery. The following sections detail how socioeconomic processes and psychosocial processes are proposed to explain differences in mastery. Integrating the wide-ranging literature will inform the application of a life course framework to this thesis, and the testing of many years of longitudinal data from a birth cohort study such as the MRC National Survey of Health and Development (introduced in section 1.3.4.1); to extend the evidence base as to how some people have more mastery than others in early old age.

1.3.3 Socioeconomic pathways to mastery

As previously mentioned, like many exposures and outcomes studied in the field of public health, there are structural socioeconomic differences in mastery [20, 94, 97, 98]. Below, shared and unique socioeconomic processes proposed to explain differences in mastery across the life are described: family socioeconomic background (section 1.3.3.1), education (section 1.3.3.2), occupational position (section 1.3.3.3), current income, and current perception of income (section 1.3.3.4). The studies cited testing associations between socioeconomic indicators and mastery are reviewed further in chapters 3 and 4.

1.3.3.1 Early environment socioeconomic exposures and mastery

As already described, a life course approach allows consideration of how the earlier environment may play a role in the trajectory of mastery. Several studies have linked indicators of family socioeconomic position (SEP) and mastery; finding that mastery increases more sharply during adolescence for those with higher family SEP [101, 102]. Longitudinal studies of year-on-year growth indicate that mastery can be near its highest by the end of adolescence. Adolescence is therefore, potentially, a sensitive period for mastery development [101-103].

Several pathways between early socioeconomic position and mastery have been proposed; through family occupational position, parent education, and family material living conditions. Pearlin and colleagues suggested that societal expectations, based on family occupational position, can reflect to individuals from a young age what they can expect to control [75, 92, 94, 98, 104]. Parents with higher education simultaneously tend to have higher occupational positions. Higher parental education is proposed to contribute to mastery development in itself through more parent-to-child modelling of effective problem-solving skills [105-107]. Lastly, the potential stress of disadvantaged family material conditions is suggested to compromise parenting practices central to the development of an independent self-concept such as mastery [108-111]. These multiple socioeconomic circumstances- parent education, occupation, and material home conditions- tend to co-occur with each other so it has been difficult to examine each pathway to mastery more closely in studies with limited data.

Moreover, those early socioeconomic circumstances can overlap with other factors, both in the early environment, such as parenting, and early cognitive development, and later on into adulthood, such as education. Taking cognitive development as an example, in the NSHD, upwards mobility in paternal occupational position was associated with increases in early cognitive test scores. Children re-coded into higher socioeconomic strata by their fathers change in job scored higher on cognitive tests than peers they left behind yet lower than those they joined [112]. Self-fulfilling prophesies linked to teachers' social biases, or parental encouragement with schooling could explain links between professional parental occupations and higher cognitive ability in their offspring [113]. Evidence for associations between early SEP and mastery may be explained by the development of cognitive processes which support people to feel in control of their own lives. This example emphasises how the influence of family socioeconomic exposures on mastery can only be understand by examining the context of co-occurring exposures which people live within.

1.3.3.2 Education and mastery

Education is suggested to link early family life to mastery in older age. Human capital theory treats education as a process which builds skills and would confer a direct benefit to mastery [114]. As Rutter outlined, schooling teaches skills needed for problem-solving such as self-organisation, logic, and perseverance; these skills are theorised to help manage one's circumstances and therefore promote a sense of mastery [105, 115]. Several studies suggest that mastery increases with additional years of education [102, 116]. However, it is unclear whether this is the effect of education itself or progressing through adolescence and obtaining more independence. Factors which limit young people from education such as disadvantaged material home conditions, unsupportive parents, and stressful life events may further explain differences in mastery between those who stay in school and those who do not.

Although, education develops cognitive ability [117, 118], there is no available evidence testing whether education explains differences in active-problem solving skills in those with different levels of mastery [22, 119, 120]. Extending previous evidence of associations between education and mastery while

accounting for evidence of a relationship between cognitive ability and mastery [121], may help clarify processes underlying education and mastery. It is also important to account for socioeconomic processes potentially on the pathway between education and mastery. For example, individuals with higher education are more likely to be employed than those of lower education; often, individuals with higher education have more complex, creative jobs with involvement in decision-making and better pay [114, 122, 123].

1.3.3.3 Occupational position and mastery

Signalling theory argues that education merely operates as a credential for selection into the labour force and therefore occupational position [124]. Occupational position encompasses both the type of work people do (categorised by skill) as well as being a measure of social stratification likely indicating an individual's level of income, education and social standing. Thus, occupational position is plausibly associated with mastery through two mechanisms.

First, lower graded occupations are less likely to be characterised by job autonomy, schedule control, and enriching work, factors which the classic Whitehall II research linked with higher sickness absence, mental illness, heart disease, and diabetes [30, 125]. Cross-sectional evidence suggests that these characteristics of greater job autonomy, schedule control, and enriching work are also associated with higher mastery [122, 123]. It seems unlikely for those in higher occupational positions that education had no influence on mastery via cognitive processes. However, many studies in this area do not test both education and occupational position to ascertain their relative pathways.

Occupational position is also proposed to be associated with mastery through social comparisons of status and achievement. Rosenberg and Pearlin used social comparison theory to explain that those who are aware of others judged to be superior to them will feel lower in position themselves [98]. No studies have formally tested whether appraisal of status or achievement informs mastery. However, Pearlin and colleagues theorised that the social grading of mastery is explained by "outcomes such as successes and failure (being attributed) to personal characteristics like ability and effort" (pg. 154) [126]. An individual

believes that they can control their own circumstances because they have been successful in socioeconomic attainments such as degrees, pay rises and promotions. Society tends to reinforce these beliefs, treating people of higher SEP as if they are responsible for their own achievements. Theories of occupational status and achievement behind mastery partially overlap with theories of associations between income and mastery; yet again, most research in this area does not test the contribution of income to mastery relative to occupational position.

1.3.3.4 Income and mastery

Health commodity theory reduces the association between socioeconomic position and mastery to individuals with more material advantage having money to buy the things they want and need [127]. A number of cross-sectional studies have indicated that greater income is associated with higher mastery [45, 122, 128, 129]. However, inconsistent measures of income and limited additional explanatory variables confuse clarification of why a greater income might be associated with mastery. Plausibly, a certain level of income allows more choices: to choose your home, where to work, and how to bring up a family. Money may make it easier to manage life circumstances where they become disruptive [97, 130].

It is useful to consider perception of income as well as objective income in relation to mastery. Low self-reported financial satisfaction, and self-reported economic security have been shown to be associated with lower mastery, independently of income band [92, 123]. Financial worries may be the final exposure in a chain of risk taking in low educational achievement, unskilled occupations and inadequate income [31].

There is little literature simultaneously testing associations between multiple indicators of socioeconomic position over a life time and mastery. Likewise, evidence that accounts for additional explanatory pathways between socioeconomic position and mastery is sparse. Without this approach, it is hard to clarify the relative contribution of these conditions and gain a better understanding of how to encourage mastery through public health intervention.

The following section outlines psychological pathways which may contribute to mastery, alongside, in combination, or supplanting the relevance of socioeconomic circumstances.

1.3.4 Psychosocial pathways to mastery

On top of attempts to reduce societal structural inequalities, the World Health Organisation has emphasised the need to empower individuals to feel more in control regardless of their socially structured circumstances or health inequalities [12]. Mastery is more common in people with socioeconomically advantaged positions, yet strikingly some individuals with high SEP have low mastery, and some with low SEP have a sense of mastery more commonly associated with advantaged individuals [37, 50, 130]. This may be because mastery is "the control of conditions that individuals regard as importantly affecting their own personal lives, not on all personal conditions" [131]. Personal lives are not confined to the working life or material possessions but extend to social relationships and life events. Moreover, psychodynamic theories highlight the understanding that examining the early psychosocial environment can bring to an individual's current presentation[132]. The following sections explore how forms of close social support and stressful life events, dating right back to early life, could be associated with current mastery.

1.3.4.1 Social support and mastery

The stress process takes the perspective that social support buffers the negative impacts of stress on health [31]. Those with good social support do not perceive that circumstances are as unmanageable as those with low social support [133, 134]. Logically, mastery may be low if circumstances are perceived as unmanageable. Multiple studies have reinforced that mastery is higher in those with higher social support. The type of support - perceived or actually received; instrumental (physical help) or emotional (advice or sharing); or context of necessity - does not appear to change the pattern of positive associations between indicators of social support and higher mastery [135-141].

When extending investigation of the association between mastery and social support, it is vital to account for factors which may affect both. Pearlin and

colleagues emphasised the concept of linked lives [20]: the social networks individuals are embedded in have reciprocal effects on their life course. For example, documents how poor health of a family member can have a negative impact on an individual's job stability [142, 143], and economic strain is associated with a greater likelihood of interpersonal conflict [134, 144, 145].

Socially structured positions such as indicators of socioeconomic advantage, and sex, as well as exposures such as stressful life events (SLEs) and chronic physical and mental health conditions have not consistently been accounted for when testing associations between social support and mastery [135-141]. One study, highlighting the necessity to assess overlapping pathways, reported that higher income was only associated with higher mastery because those with higher income were more likely to report positive social support [146]. A context of poor health or SLEs, might explain the only available study reporting an association between higher social support and lower mastery. Ang and Malhotra (2016) reported that the more types of social support received by family members, the lower the sense of mastery of older Singaporean adults [147]. Older adults dependent on comprehensive social support in their daily life due to their circumstances may feel more helpless than in control.

1.3.4.2 Stressful life events and mastery

Stressful life events (SLEs) are a core theoretical aspect of the degree of control a person perceives over their life [94]. SLEs are "occurrences of sufficient magnitude to bring about changes in the usual activities of most individuals who experience them" [148]. SLEs such as bereavement, relationship crises, or even moving to a new house are disruptions of normal circumstances which, as Pearlin suggested, at best weaken people's capacity to manage their daily lives and at worse provoke feelings of despondency and helplessness [25, 48]. It is possible that an increase in depressive symptoms explains associations between SLEs and mastery, however this has not been tested. Understanding better why SLEs can compromise mastery may help to target support for people undergoing difficult circumstances.

There are other gaps in the literature assessing the contribution of SLEs to sense of mastery. Few studies have investigated the extent to which more than one stressful life event influences mastery, and there is little available evidence testing how long associations between SLEs and mastery persist [149, 150]. The general stress literature suggests that accumulations of SLEs over time are associated with long lasting changes to cognitive and psychological processes which may also be relevant to mastery [31, 97, 133, 142, 151]. As before, this knowledge may help inform when individuals are likely to need support to protect their mastery beliefs.

It is also possible that other factors in the context of SLEs are the factor which is most relevant to mastery. According to stress process literature, SLEs are socially structured [31]. Evidence suggests they are more heavily distributed in lower socioeconomic positions than in the lives of people with more education, occupational seniority, or income [75, 94, 133, 150, 152, 153]. These associations do not always hold. In the National Survey of Health and Development there was no indication that SLEs were distributed by socioeconomic position [154]. Nonetheless, to extend the current understanding of how differences in mastery emerge and are maintained, it is necessary to account for the interplay between multiple explanatory factors across the life.

1.3.4.3 Early environment psychosocial exposures and mastery

As described in section 1.3.1, a life course approach would consider how the earlier environment integrates with experiences across life to arrive at the individual's current mastery. Although self-concepts such as mastery may change over the life course in accordance with adult experiences discussed in above they are viewed as first developing in the family environment [155]. Several studies suggest that distal early environment exposures may impact adult psychological indicators outside of their associations with more proximal exposures [156, 157]. For example, Stafford et al. demonstrated that elements of parenting and SLEs during early life were related to mental wellbeing at 60-64 in the NSHD, over and above adult socioeconomic position [158]. It is unclear how far into adulthood associations between exposures in the earlier environment and adult mastery may persist.

1.3.4.4 Parental support and autonomy granting

As introduced earlier in section 1.3.1, adolescence could be a sensitive period for mastery development [21]. It has been proposed that young people with low mastery compared to their peers at the end of adolescence never catch up; although this is untested [92, 93]. Bowlby classically proposed that experiences with attachment figures lay the foundation for the self-concepts that individuals use throughout their life [159, 160]. Parental support and the granting of autonomy may develop a child's self-concept of how controllable their environment is and how competent they are in controlling it [161]. These parenting characteristics (support and autonomy-granting) have been extended in more recent decades into three typologies of parenting relevant to broader healthy child development as well as mastery: support, behavioural control, and psychological control [145, 162-166].

Each of these typologies plausibly could underlie the development of mastery. Parental support, which is comprised of "nurturance, warmth, responsiveness, acceptance, and attachment", is proposed to guide young people to learn to manage circumstances independently [167]. Accordingly, several studies have reported that mastery is higher in adolescents with stronger parental support [162, 163]. Parental behavioural control limits autonomy by regulating children's behaviours in accordance with family standards, for example, home responsibilities and manners [167, 168]. While some conformity is a key part of growing up, an excessive requirement for behavioural conformity has been linked to lower self-confidence in adolescence which could influence mastery [169, 170]. The third parenting typology is psychological control, also known as intrusive parenting and denial of psychological autonomy. Parents measuring high in psychological control use methods such as withdrawing love and giving criticism to control the child [166, 167, 171]. The parent is overly involved in the child's daily life and emotions which makes it difficult for the child to develop independent thought and abilities [164]. Young people may absorb from both types of over-controlling parenting the message that they are not able to control events in their own lives [172].

Although each parenting typology is plausibly linked to differences in mastery in itself, taking later circumstances into account will clarify the processes acting between parenting and mastery. As described in 1.3.1 it is plausible that evidence of associations between early life exposures and later mastery are explained due to formative conditions tracking across the life [117, 151, 173-176]. For example, the offspring of high psychologically controlling or low support parents may be less likely to acquire the interpersonal competence used to create and maintain positive social support in adolescence and throughout adulthood [163, 177, 178].

The literature exploring early life factors associated with mastery at any age are largely limited to examining singular pathways rather than an interplay of multiple processes. Returning to the early environment, the interplay between the psychosocial factor of parenting and indicators of the early socioeconomic environment is suggested to explain differences in self-concepts such as mastery [179-181]. It has been proposed that the single most important factor accounting for differences between low SEP and high SEP children is the higher exposure to stress and its consequences on parenting [179]. In addition to the potential chronic stress of early socioeconomic disadvantage, the lingering role of early SLEs in later mastery should be considered when attempting to understand how individuals have more or less mastery.

1.3.4.5 Early stressful life event (SLEs)

Classic research into adult psychological resilience to adversity indicates that later exposures such as adult SLEs are often not independent of what occurred before in people's lives, such as early SLEs [151, 176]. Memories of feeling out-of-control during SLEs at a young age could alter how manageable individuals perceive new events throughout their lives; therefore, having long lasting influence on mastery. Furthermore, studies have reported that each additional stressful event can accumulate an associated risk for poor mental and physical outcomes, which are then linked to poorer mastery [151, 182, 183]. Yet only one study, limited to follow up in early adulthood, has investigated the extent to which more than one early SLE contributes to sense of mastery without testing contributing factors [103].

The association between early SLEs and mastery may be mediated by other later circumstances. Early SLEs may disrupt education (relevant to cognitive processes and entry to the labour market), and the forming of social bonds, in addition to increasing the risk of proliferating adult SLEs [133, 151, 163, 165, 176, 177]. Investigating psychosocial factors, such as SLEs, across the whole of a person's life may elucidate why some people have lower than expected mastery and emphasise areas for interventions to support them.

1.3.5 Summary and limitations of the literature

The sections above outlined multiple plausible theoretical mechanisms as to how people have more or less mastery across their life and in their present circumstances. The studies informing these theoretical pathways will be reviewed in further detail in their relevant chapters. In summary, there is evidence that adolescents with a more advantaged socioeconomic family background have higher mastery; and that in adulthood, those with higher education, a more senior occupational position, higher income, and more comfortable income perception have higher mastery. There is also some evidence that early environment exposures of parenting which is supportive and behaviourally and psychologically autonomy granting, along with fewer early SLEs, are associated with higher mastery in adolescents. Better quality social support has repeatedly been documented in individuals with higher adult mastery, while there is some evidence to support theories that adult SLEs are related to lower mastery.

While the available evidence suggests multiple factors across the life course which could be associated with mastery (and therefore open to public health intervention), this literature has its limitations. Many adult studies are limited in understanding pathways to mastery across life due to data being cross-sectional or collected over a short time frame. Some exposures may be associated with mastery at the time, but not have lasting effects. Adolescent studies testing associations between early environment circumstances and mastery have not continued to survey mastery to test whether associations between early exposures and mastery persist into adulthood.

A lack of prospectively collected data prompts questions of recall bias. Particularly, one study testing differences in recalled memories of early traumatic SLEs found that adults with current higher mastery did not report these SLEs to have been as distressing as those with lower mastery in adulthood [184]. It is unclear whether the SLEs were less distressing to them at the time, potentially because of better support, or whether feeling in control as an adult affected the ability to remember past trauma.

The published literature has also been restricted in the hypotheses it can test regarding how each separate indicator of the socioeconomic or psychosocial environment may be associated with mastery. As indicated earlier, many socioeconomic and psychosocial factors are plausibly interrelated with each other across life.

It is unclear if unique indicators of the socioeconomic or psychosocial environment contribute to mastery because of processes relating to their relative characteristics, or for some factors, due to their placement in a chain of exposures culminating in mastery. Few studies have had the data to simultaneously test multiple exposures in association with mastery in the same cohort.

Narrow ranges of measures available in the published literature also mean that plausible pathways to mastery have not been considered. As suggested in section 1.3.3.1, associations between early life family SEP and mastery may be explained by encouragement in cognitive development, rather than processes specific to either parental education, occupation or material deprivation. Equally, adult socioeconomic inequalities in mastery may plausibly be explained by health inequalities. As emphasised by the theory of fundamental causes, individuals living in low SEPs do not have the same access to resources needed to protect or improve their health, as those from higher SEPs [185]. Many studies have reported lower mastery in those living with chronic health conditions such as diabetes, cardiovascular disease, arthritis, and respiratory symptoms [5, 47, 81, 186]. The time-consuming and disruptive nature of many chronic health problems may weaken people's perception that they can manage their own lives rather than the socioeconomic context these health problems exist in. Symptoms of depression and anxiety, such as fear, low confidence, and being overwhelmed,

may similarly mediate between difficult socioeconomic disadvantage and low mastery [48, 187].

Lastly, the published findings on mastery have rarely been based on a British population. Cultural differences in values, or the prevalence, or interpretation of experiences connected to mastery, may affect the applicability of findings from one culture to another. Several studies comparing mastery data across cultures have emphasised differences that cultural differences may account for [40, 138, 188-191]. The large majority of available mastery evidence is based on American cohorts. A study limited to one item of the personal mastery scale reported that a far larger proportion of older Americans agreed with the statement, "I control my own life", than their UK counterparts [192]. Perceived control may be a dominant part of the American national consciousness in a way that it isn't in the UK. As such, investigations are required to extend the generalisability of the evidence base to British populations.

In the following section, the MRC National Survey of Health and Development is introduced as an opportunity to comprehensively test how processes across life are related to mastery in British adults in early old age.

1.3.6 Using the MRC National Survey of Health and Development

The WHO has proposed that it is necessary to use a life course approach to extend findings on complex drivers of sense of control (see section 1.3). For this it is important to use a long running birth cohort study, such as the MRC National Survey of Health and Development (NSHD). The NSHD is a nationally representative British birth cohort comprised of 5362 study members selected from all births during one week in March 1946 [193, 194]. The study members have been followed up to 24 times throughout their life. The most recent wave at age 68-70 included Pearlin et al.'s measure of mastery [22]. The NSHD will be described in more detail in chapter 2 of this thesis.

The NSHD provides an opportunity to extend the current literature on how multiple processes across life influence mastery. Study members are of varied social backgrounds, enabling assessment of differences in mastery according to

socioeconomic indicators [195]. Key findings from NSHD data have emphasised the importance of psychosocial processes across the life net of socioeconomic inequalities [154, 158]. For example, structural inequalities disadvantage children of lower SEP backgrounds; yet independently, psychosocial parental input and a stable childhood can have lifelong positive effects on opportunities, mental health and wellbeing [113, 196]. Study members are now in early old age and have already experienced differences in chronic health conditions hypothesised to relate to mastery [197]. These characteristics make the NSHD ideal to explore how experiences from across life may contribute to mastery, while coping with challenging circumstances such as chronic health conditions and lower SEP in early old age.

The rich data collected over nearly 70 years of the NSHD enables multiple socioeconomic and psychosocial processes from birth to early old age to be tested in association with mastery. Examining individual factors as well as considering the context of related-exposures across the life course may help understand the complex contributions to mastery. Socioeconomic and psychosocial pathways will be better understood by investigating contributions of early cognitive ability, adult cognitive function, and current chronic health conditions and mental health. Additionally, the repeat data available within the NSHD allows consideration of an association between accumulated SLEs across adulthood and mastery, rather than limited proximal counts of SLEs or reliance on recalled measures.

In this thesis, indicators of socioeconomic environment tested for contributions to mastery will be paternal occupational position, maternal and paternal education, own education, adult occupational position, income and perception of income. Indicators of early psychosocial environment will be perceived parental behavioural control, psychological control and support, and a number of early SLEs. The adult psychosocial factors are SLEs across adulthood, and positive social support and negative social support. These variables are all explored in greater detail in section 2.3 of chapter 2. The conceptual framework depicting pathways tested in each analysis chapter (3-6) is shown in Figure 1.1.

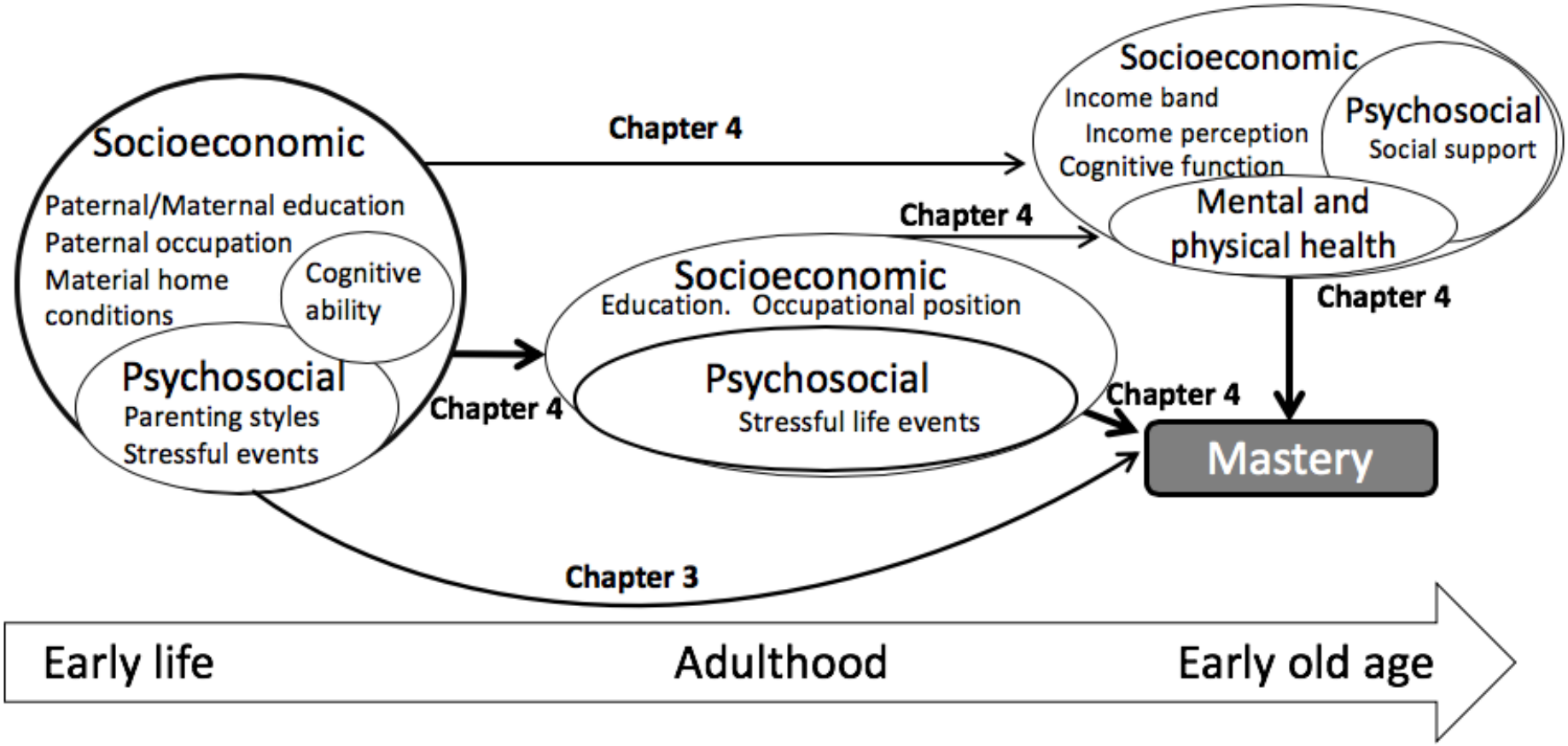

Figure 1.1. Conceptual model depicting pathways of association between socioeconomic and psychosocial exposures across life, and mastery in early old age; overlapping circles depict the potential for co-occurring exposures.

1.4 Investigating mastery and physical capability

The second part of this thesis aims to clarify mechanisms by which mastery may be adaptive; potentially through suggested behavioural or psychological pathways (section 1.2). As outlined in section 1.3.1, decades of findings emphasise that individuals who perceive that they control their own circumstances have better health and wellbeing and live longer independent lives than those without the same beliefs [6-8]. In addition to understanding how and when to target support to develop mastery, elucidating mechanisms by which mastery operates for individuals fits within public health priorities [12, 53, 60].

1.4.1 Public health significance of physical capability

In this thesis investigation of the adaptive mechanism of mastery is centred on that between mastery and physical capability in early old age. The World Health Organisation propose that broad assessments of functioning are far better predictors of positive outcomes in older age than a single disease or even multi-morbidities [198]. Capturing older people's intrinsic capability is useful for predicting their long-term functioning and dependent care needs. Investigating mastery and intrinsic capability fits within the aim of the WHO's world report on active ageing; to support the drawing together of mental and physical resources to maintain inclusion, participation, and quality of life in older age [199].

Physical capability has great public health significance to individuals such as the NSHD study members. At least 30% of older people aged 65-69 report difficulties with activities of daily living (ADLs) -which is characterised as disability [200]. ADL difficulties are a health inequality; disproportionately affecting women and people with lower education and wealth,[200], net of morbidity differences. Reduced physical capability in later life, that is- the ability to perform ADLs- can limit personal autonomy, restrict mental wellbeing and social relationships, and increase the likelihood of premature mortality [54, 201-205]. Qualitative research in the NSHD reinforces that 'physical decline', 'slowing up' and 'being less able' are common disadvantages of ageing [54]. It is clear that there is a public health need to investigate adaptive resources to support people in active ageing [199].

Physical capability in early old age is also a useful tool by which to extend knowledge about processes underlying mastery. Ageing processes such as degeneration in muscle, cartilage, or bone quality, neurological and hormonal changes, and an increased prevalence of chronic health conditions, are associated with later life declines in physical capability [205-207]. However, not all older people will experience disability. An individual's experience of physical capability and disability is the product of a dynamic interaction between their physical impairment, environmental support, and personal responses such as personality and affective symptoms [198, 208, 209]. This thesis concentrates on extending understanding of the personal response of mastery; its role in maintaining physical capability and therefore independence in older age [210].

1.4.2 Measurement of physical capability

Before describing associations between mastery and physical capability in more detail this section introduces the measures capturing the spectrum of physical capability. The spectrum accounts for high physical performance at one end, towards functional limitations, and moving to disability- characterised by difficulties with ADLs at the other [198, 200, 208].

Intrinsic physical capability is assessed by how well an individual performs actions such as gripping or walking [211]. Commonly, physical performance on tests of grip strength, walking speed, chair rise speed, or standing balance are used separately or as a composite score to indicate an individual's physical capability in a standardised environment.[205, 212, 213]. Standardised physical performance tests are valued for being an objective measure of physical capability at a single point in time, although motivation or a one-off illness or injury could feasibly play a part [214]. Scoring performance on a continuous scale allows the detection of incremental changes, possibly even before individuals themselves notice loss of function [205, 209, 211-213].

The complementary measure of self-reported functional limitations assesses an individual's perception of difficulties performing physical actions such as gripping or walking in their usual environment [215]. Self-report functional limitations are subjective; an individual's perception of their ability may be better or worse than

their objective ability [208, 216]. An individual's judgement of their own function relies not only on their present ability but draws in their recent performance, their need or desire to perform a task, and facilitation by home-adaptions [217]. Self-reported categorical functional limitations (i.e. responses = yes, or no) are a more blunt assessment than continuous physical performance scores, although the clinical significance of loss of function to the individual is clear [205]. Together the measures of physical performance scores and self-reported functional limitations reflect the social model of disability; capturing how the same intrinsic physical capability may manifest in quite a different lived experience person-to-person depending on environmental conditions and personal responses [198].

Measurement of ADLs exist at the negative end of the spectrum of physical capability. Disability is captured through self-report of difficulties performing basic daily activities such as preparing a meal, washing, dressing, and feeding oneself [198, 200]. They are more likely to emerge in association with worsening performance scores, and increasing functional limitations [218]. However, as suggested earlier in this chapter, disability is fluid [199]. Difficulties performing ADLs can be temporary in response to illness or change in social circumstance and respond to support.

Together the specific characteristics of physical performance tests, self-report functional limitations and ADLs form a comprehensive picture of physical capability with predictive value for living independently, quality-of life, and mortality [211, 217, 218]. Mastery may be a useful psychological response in controlling the interplay between physical impairment and the environment described above [198]. The following sections discuss available evidence for associations between mastery and physical capability.

1.4.3 Potential pathways between mastery and physical capability

A number of studies have shown evidence of an association between mastery and indicators along the spectrum of physical capability. Longitudinal and cross-sectional evidence suggests that individuals with higher mastery have better scores on performance tests of walking speed [77], grip strength [65, 66], and composite performance score [219], as well as fewer functional limitations [32,

65, 220, 221]. Slower development of ADL difficulties over 2-8 years has also been differentiated by higher baseline mastery in older adults [34, 36, 222, 223]. Even in clinical populations of frail older adults, those with high mastery at baseline report less progression in ADLs over time than those with low mastery [36, 224].

This small body of literature has several limitations which this thesis will address (see section 1.4.7). Most importantly, although evidence suggests that individuals with higher mastery in early old age have better intrinsic physical capability and are more able to maintain their independence for ADLs over time, the mechanism is relatively unexplained. As introduced in section 1.2, individuals who feel more in control, that is have higher mastery, may perceive any physical changes as preventable or modifiable and take behavioural action accordingly [61-63, 225]. Pearlin also proposed that people with lower mastery are more likely than those with high mastery to be frightened by their circumstances [31, 76, 77]. Inaction linked to fear of poor physical capability is a risk factor for decline in physical capability in older age [88-90]. Mastery and physical capability may also share contextual determinants which explain them both. The following sections examine these theories in more detail before outlining how this thesis will test them.

1.4.4 Proposed behavioural pathway

The role of health behaviours in maintaining physical capability in early older age has previously been established in the NSHD [226-229]. Individuals with higher mastery may take behavioural action to protect their physical capability; health behaviours may then explain associations between mastery and better physical capability.

Greater leisure-time physical activity (LTPA) in individuals with higher mastery may contribute to associations between mastery and physical capability. Associations between LTPA and physical capability are thought to be explained by physical activity contributing to factors which influence physical capability, such as, aerobic power, muscle quality, and strong bones and joints [205, 226, 227, 230]. Longitudinal evidence indicates that the greater likelihood of people

with higher mastery reporting more frequent LTPA contributes to better physical performance scores and fewer functional limitations [46, 65, 66].

Smoking status may also be implicated in the pathway between mastery and physical capability. Smoking compromises respiratory and cardiovascular function, contributes to increased body mass, and risk of arthritis and diabetes, and ultimately limits physical capability [231-233]. Several cross-sectional North American studies have shown mastery to be proportionally higher in non-smokers relative to ex-smokers and current smokers [69, 70]. No studies have tested whether smoking contributes to an association between mastery and physical capability, although theories of smoking cessation implicate wider constructs of perceived control such as autonomy in controlling smoking behaviour [234].

It is also conceivable that people with higher mastery have better physical capability because they maintain a healthier body mass index (BMI) [23, 67, 68]. Weight gains are associated with poorer muscle quality in older age, compromised energy and joints, and higher risk of chronic physical conditions and depressive symptoms [53, 235, 236]. Associations between heavier BMI and worse physical performance, more functional limitations and greater difficulties with ADLs have been reported in the NSHD [227, 237, 238]. One study demonstrated that a composite indicator of weight (waist to hip ratio, BMI, HDL to total cholesterol ratio, triglycerides, and glucose) partially attenuated the association between low mastery and decline in physical capability over time [223].

1.4.5 Proposed psychological pathway

In addition to evidence for a behavioural pathway between mastery and physical capability, positive psychological processes have been implicated as a mechanism of mastery (see section1.2.2) [31, 76, 77, 88-90]. Research indicates that individuals with lower mastery appraise stressors more fearfully [31, 80, 81], and are less likely to actively confront challenges, than those with higher mastery [22, 120]. Consequently, the concern is that individuals with lower mastery, regardless of their intrinsic physical capability, may underestimate their physical capability or the likelihood of falling. Fear of falling is common in older age,

whether falls have been experienced or not [59, 239, 240]. It has been shown that low confidence explained by a fearful appraisal of physical capability reduces physical performance [241]. Underestimation of physical capability is also associated with a sharper decline in functional limitations over time, explained by fear-linked inaction and restricted movements [34, 86-90].

No studies have examined the potential pathway of negative psychological processes operating between lower mastery and poorer physical capability. There is some basis for this in mastery literature. Several cross-sectional studies indicate that individuals with higher mastery are less fearful of the potential consequences of poor physical capability, such as falling, and less likely to restrict their movements, whether they have good physical capability or not [77, 225, 239, 242]. A less fearful appraisal of physical capability in individuals with higher mastery may explain associations between higher baseline mastery and, slower decline in physical capability, and higher chance of maintaining independent living over some years [33, 49, 242, 243]. Fear due to perceiving oneself as unable to globally manage life circumstances, i.e. low mastery, may contribute incrementally to physical decline over time.

1.4.6 Effect modification between physical capability and disability

A further mechanism by which mastery could contribute to physical capability is through its role as an effect modifier of worsening mental and physical outcomes [6, 27, 50, 51, 244]. Physical capability and disability are multidimensional [198]; the WHO recognises that an individual may have poor physical capability, but due to their perseverance, positive state of mind, or adaptions to their method, they may still not feel that they have difficulty performing their ADLs [59, 198, 209, 245]. For example, Kivinen et al. [208] showed that although tests of physical performance strongly predicted the risk of functional limitations, more than a third of individuals in the poorest performance quartile self-reported good capability. Individuals with disability and higher mastery are less likely to experience functional limitations during periods of poor physical capability as they make adaptions or use mobility aids [246].

Although it is plausible that mastery may be a buffer between physical capability and disability in older age, there is conflicting evidence. Of four studies published (using the same two Dutch-based cohorts), only one reported that individuals with high mastery had fewer ADL difficulties than predicted from their walking speed performance, compared to those with the same walking speed and low mastery [190]. However, the proposed role of mastery as an effect modifier between measures of physical capability and disability was not seen in the other similar studies [33, 34, 247]. This evidence suggests the need for further investigation to clarify whether mastery is a personal resource which can help people optimise their physical capability in early old age [198, 208-210]. One aspect to address when extending this evidence base is to investigate whether associations between mastery and physical capability can be generalised outside of the Netherlands to Britain.

1.4.7 Summary and limitations of the literature

The sections above outlined how mastery may be associated with physical capability. The literature justifies further study of the association between mastery and physical capability and exploration of the behavioural and psychological pathways involved using data from the NSHD (described in section 1.3.4.1).

The rich measures available in the NSHD provide opportunity to simultaneously test associations between mastery and both physical performance and functional limitations. This may help understand if individuals with higher mastery inflate their appraisal of independence or pay less attention to their physical restrictions. One relevant example is a study in which diabetics with higher mastery reported greater recommended-care-practices in the past six months but no difference in their three-month glucose. This would indicate that mastery predicted a self-reported difference but not an objective health advantage [248]. No research has explored a similar disconnect in mastery and physical capability; that is, whether, despite people with higher mastery self-reporting fewer functional limitations, their objectively measured physical performance in the same study is not associated with mastery. This thesis will examine whether there is a difference in the magnitude of the association between mastery and both objective measures

of physical performance and self-reported functional limitations within the same population.

Several studies discussed above did not control for potential confounders. It is unclear if associations between mastery and physical capability may be explained by their shared determinants. Poor physical capability disproportionately affects women and people with lower socioeconomic position; factors which also explain differences in mastery [94, 200, 249, 250]. The education, economic and legal restrictions historically placed on women in British society may explain consistent findings across age groups and cohorts that women have lower mastery than men [24, 45, 94, 101, 102, 123, 149, 251, 252].

The presence of chronic physical health conditions may also bias associations reported between mastery and physical capability. As outlined earlier, chronic health conditions such as such as diabetes, cardiovascular disease, arthritis, and respiratory symptoms are more common in those with low mastery, [5, 47, 81, 186] and they are recognised to contribute to lower physical capability [24, 205, 227, 235]. Gaining a clear picture of associations between mastery and physical capability is further complicated by the contribution of symptoms of depression such as motivation and concentration [253, 254].

This thesis is able to account for a wider range of potential confounders, informed by initial analysis of correlates of mastery across the life in the NSHD, together with physical capability literature. People do not suddenly become old or ill in the same way that they do not suddenly have very high or low mastery [199]. To fully understand the current presentation of how mastery relates to physical capability and disability, a life course approach is needed. Investigation of the association between mastery and physical capability will be extended by first assessing the predictors of mastery in this group of British adults in early old age. In addition to generating valuable insights into the subjective self-concept of mastery, this analysis may help to identify relevant confounders of the association between mastery and physical capability.

No studies have investigated more than one potential mediator between mastery and physical capability. Evidence suggests that individuals with higher mastery engage in multiple healthy behaviours, such as not smoking, more frequent LTPA and maintain a healthy BMI. Those studies have been limited to indicators of health behaviours rather than psychological factors. It appears that people with higher mastery are less restricted by fear in their range of activity. This thesis attempts to address the complex mechanism of mastery by investigating the explanatory effect of a range of indicators of health behaviours in addition to the psychological indicator of fear-of falling and related activity restriction.

No studies have examined the relationship between mastery and physical capability in a British population. One single British study investigating the association between an item of perceived control and physical capability signals the need for more research. The statement, “I control my own life”, was not an effect modifier between physical capability and disability in the English Longitudinal Study of Ageing (ELSA), whereas it was in matched American study members [192]. Reiterating the earlier summary of gaps to address in studies of mastery (section 1.3.4), it is necessary to validate between cultures before drawing generalisations about the usefulness of mastery. Many studies have noted discrepancies in patterns of findings pertaining to mastery between cultures [40, 138, 188-191].

The NSHD lacks access to longitudinal data on mastery and future physical capability but investigating cross-sectional explanatory pathways between mastery and physical capability in the NSHD will extend the current literature and build a foundation for future longitudinal assessment in this cohort.

1.5 Structure of thesis

This chapter defined mastery and exposures potentially associated with it across a lifetime. It defined physical capability and disability in early old age and explored how mastery might be associated with them. The dataset used in this thesis, the NSHD, was described in section 1.3.4.1. Based on literature introduced in sections 1.3 and 1.4, the conceptual framework shown in figure 1.2 was developed.

The following analytical chapters (3-6) will each present a section of the conceptual framework to test. Each analytical chapter begins by expanding discussion of relevant literature presented in chapter 1, followed by the specific rationale and hypotheses, methods, results and discussion.

Chapters 3 and 4 use a life course approach to closely examine pathways from across the life to mastery in early old age. Chapter 3 examines associations between early environment exposures and mastery and chapter 4 extends the investigation to exposures from across adult life. Chapters 5 and 6 consider how mastery is related to physical capability. Specifically, chapter 5 tests the behavioural and psychological processes hypothesised to explain associations between mastery and physical capability. Chapter 6 tests the role of mastery as a potential modifier between physical capability and disability. Chapter 7 draws together the findings from each chapter and interprets insights into mastery in early old age, within the context of this thesis' methodological strengths and limitations. Public health implications and recommendations for future research will be addressed.

The following chapter (2) begins by outlining the aim, objectives and hypotheses of this thesis. The NSHD will be described in more detail along with an introduction to the measures and analytical strategies used throughout the thesis.

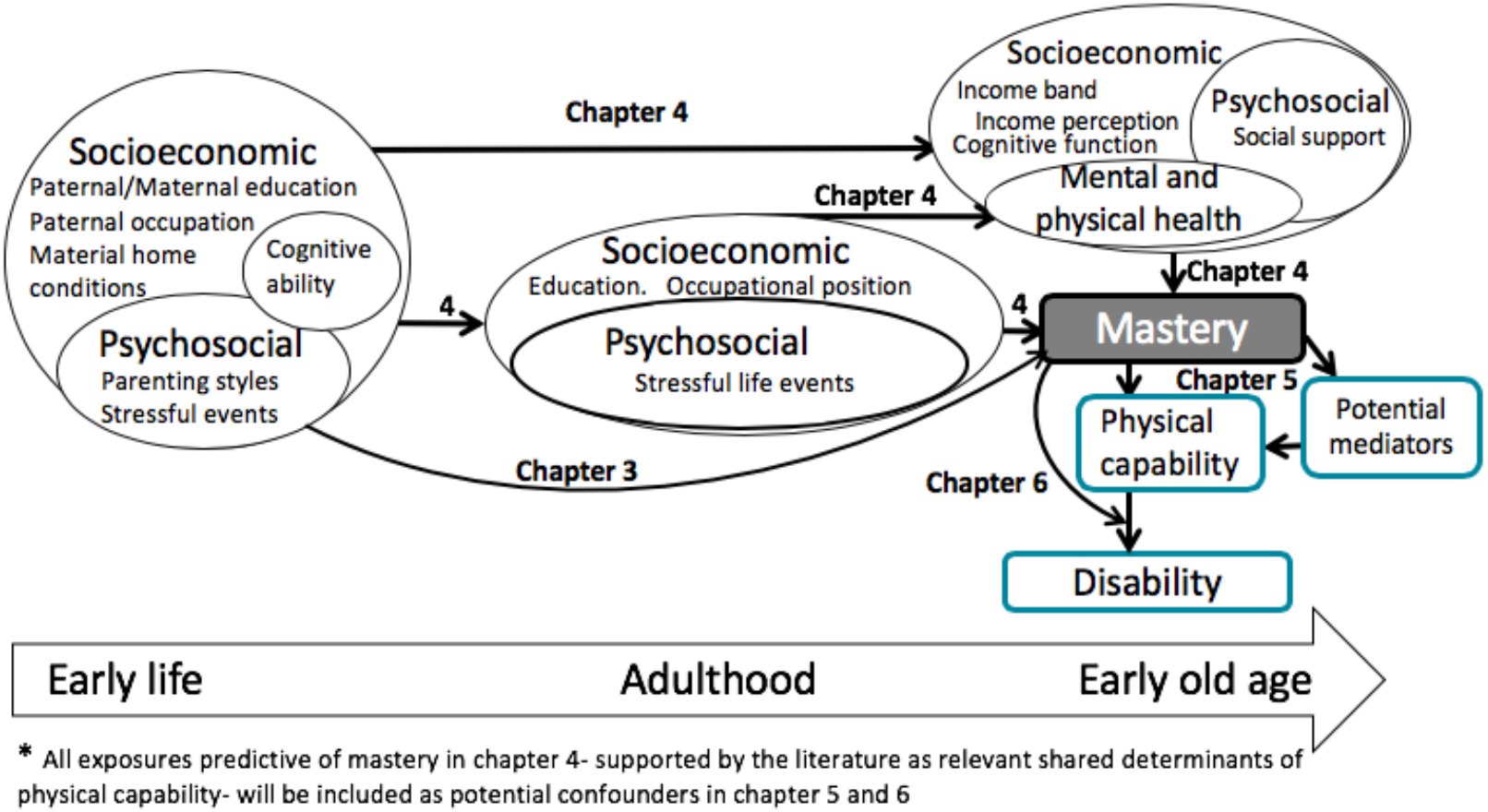

Figure 1.2 Conceptual model theorising pathways of association between life course exposures and mastery; and associations between mastery and physical capability in early old age. Overlapping circles depict potential co-occurrence of exposure

2 DATA AND ANALYTICAL STRATEGY

Building on the literature presented in the previous chapter, this chapter introduces the aim, objectives, and hypotheses of this thesis (section 2.1). The cohort used to test these hypotheses- the MRC NSHD- is described in more detail, including discussion of the representativeness of the sample and the strategy for dealing with missing data (section 2.2). The variables used throughout this thesis are described (section 2.3) along with an introduction to the general analytical strategies (section 2.4). Subsequent chapters address the rationale and methodology of specific strategies.

2.1 Aim, objectives and hypotheses

The overall aim of this thesis was to investigate the life course influences of mastery in early old age and its association with physical capability in the MRC National Survey of Health and Development (NSHD).

The specific objectives of this thesis are:

i) To test the direct and indirect associations between multiple indicators of the early (age 0-16) socioeconomic and psychosocial environment and mastery at age 68-9 (Chapter 3).

ii) To test the direct and indirect associations between multiple indicators of socioeconomic and psychosocial environment across adulthood and mastery at age 68-9 (Chapter 4).

iii) To assess if associations between socioeconomic and psychosocial exposures across life and mastery at age 68-9 are independent of each other, and contemporaneous cognitive function, chronic health conditions and mental health (Chapter 4).

iv) To investigate cross-sectional associations between mastery and physical capability (objective nurse-assessed physical performance, and self-reported functional limitations) at age 69-70 (Chapter 5).

v) To test if associations between mastery and physical capability at age 69-70 are explained by potential explanatory variables of health behaviours or psychological processes, or potential confounders identified from literature and chapter 4 (Chapter 5).

vi) To test mastery's role as an effect modifier between physical performance and a) functional limitations and b) activities of daily living (ADLS) at age 69-70 (Chapter 6).

2.1.1 Life course influences on mastery: hypotheses relating to objectives i-iii (chapters 3 and 4)

It is hypothesised that greater socioeconomic advantage - i.e. higher occupational position, education, income band and income perception (in the early environment where possible and adulthood) - will be positively associated with mastery aged 68-9. These associations are hypothesised to be independent of cognitive function in the early environment and in early old age. This hypothesis was informed by literature outlined in chapter 1 as higher education, income, occupational position and financial perception at various times of life have been reported in association with higher mastery [94, 119, 122, 123, 128].

It is also hypothesised that the higher the number of SLEs (in the early environment and adulthood), the lower the mastery of adult study members, independent of socioeconomic exposures at all times. As no previous studies have examined early SLEs as a predictor of adult mastery, this hypothesis was based on evidence of inverse associations between adult SLEs and mastery [149, 251, 255], with support that early SLEs remain associated with other indicators of health and wellbeing into older age [154, 158, 256].

Perceived parenting is expected to be associated with adult mastery, independent of other early environment and adult exposures, in the following hypothesised directions. Higher perceived parental support will be associated with higher mastery and higher perceived parental psychological and behavioural control will be associated with lower mastery. Evidence of positive associations between supportive parenting and adolescent mastery [145, 162, 163] informed the hypothesis on parental support. There is little evidence on the association

between perceived parental behavioural or psychological control and mastery, however each of these types of parenting may limit mastery [167] .

It is predicted that greater positive social support in early old age will be associated with higher mastery and greater negative social support associated with lower mastery, independent of socioeconomic exposures. These specific measures of social support have not previously been investigated in association with mastery, however previous literature suggests that better positive social support, and fewer negative social interactions are associated with higher mastery [146, 257, 258].

It is predicted that greater cognitive function, fewer depressive symptoms, and no diagnosis of chronic health conditions (respiratory problems, osteoarthritis, cardiovascular disease and diabetes) will be associated with higher mastery at age 68-9 [5, 24, 121, 186]. These measures will be correlated with socioeconomic and psychosocial disadvantages, yet in simultaneous adjustment, associations between socioeconomic and psychosocial indicators and mastery will remain.

2.1.2 Associations between mastery and physical capability - hypotheses relating to objective iv (chapter 5)

It is hypothesised that greater mastery will be associated with better composite physical performance and fewer functional limitations aged 69-70. Findings using the composite score of physical performance and total functional limitations and the component items are not expected to differ. This hypothesis was informed by evidence for a positive association between mastery and physical performance on nurse-assessed tests of composite and individual performance, and an inverse association between mastery and functional limitations [66, 219]. Not all previous literature has adjusted analysis for sex, occupational position, height, chronic health conditions (cardiovascular diseases, respiratory difficulties, osteoarthritis and diabetes) and depressive symptoms, but it is expected that mastery will explain additional variance in physical capability independently of these shared determinants.

2.1.3 Potential mediators of the association between mastery and physical capability- hypotheses relating to objective v (chapter 5)

It is hypothesised that differences in physical capability according to levels of mastery will be partly explained by differences in smoking status, leisure time physical activity (LTPA), body mass index (BMI) and fear of falling and related activity restriction. There is some evidence implicating both health behaviours, and psychological processes such as fear-induced activity restriction, in the positive association between mastery and physical capability [66, 77].

2.1.4 Mastery as an effect modifier between physical capability and disability- hypotheses relating to objective vi (chapter 6)

There is mixed evidence as to the role of mastery as a moderator of pathways between physical capability and disability [33, 259]. However, it is hypothesised that lower levels of physical performance will be associated with greater functional limitations, and both lower physical performance and greater functional limitations will both be associated with more severe difficulties with activities of daily living (ADLs). These associations will be weaker in those with higher mastery, independently of sex, occupational position, height, chronic health conditions (cardiovascular diseases, respiratory difficulties, osteoarthritis and diabetes), and depressive symptoms.

2.2 Introduction to the MRC National Survey of Health and Development data and participants

Analysis was conducted using the MRC National Survey of Health and Development (NSHD). NSHD study members have provided data since their birth, making it possible to study lifelong and contemporaneous correlates of mastery in later life. The NSHD began as a maternity survey of 16695 births that occurred between March 3 to March 9 1946 in England, Wales and Scotland. For follow up, a nationally representative birth cohort of 5362 was selected from all single births to married women with husbands in non-manual and agricultural employment, and one in four in manual occupations [193, 194]. The study members have been followed up to 24 times throughout their life. In childhood,

data were collected from study members' mothers, mostly through face-to-face interviews, and health visitors, with teachers providing data once they had started school. Follow-ups occurred approximately every 2 years in childhood. After the age of 15, study members began to report their own data through questionnaire and in later years through nurse home visits. The main data collections in adult life were at 26, 36, 43, 53 and 60-64 and 68-70 years [260, 261].

In the 24th and most recent follow-up, a postal questionnaire at age 68-9 (which included mastery assessment) followed by a home visit at age 69-70 (2014-2015) (which included physical capability assessment) provided data for a total of 2638 study members, 1978 of whom completed both the postal questionnaire and home visit. This represents 93.7% of the target sample (n=2924) as depicted in figure 2.1. No attempt was made to contact the remaining 2420 study members: 957 (18%) were known to have died, 620 (12%) had previously withdrawn from the study, 448 (8%) had emigrated and were no longer in contact with the study, and 395 (7%) had been untraceable for more than five years. This most recent data collection is the first wave of the NSHD to capture mastery.

While the NSHD has high rates of study member retention across life (figure 2.1), a concern of all longitudinal studies is that attrition may affect the representativeness of the study. Previous work suggests the sex, employment and occupational position profiles of NSHD study members who participated at age 60-64 years were broadly similar to the English post-war population at age 60-64, although the NSHD appear to be a healthier group [195]. It is also important to consider whether attrition may affect the estimates produced in analyses. Important exposures such as SEP disadvantage and poor physical functioning are risks for attrition in cohort studies including the NSHD [195, 262, 263]. A benefit of using the NSHD is that data from previous waves allows some quantification of factors which predict missingness.

Being in a non-manual occupation, having higher educational attainment, higher early cognitive ability, and fewer adult chronic health conditions were strongly associated with higher participation rates in the latest wave (age 68-70 years)

studied in this thesis [261]. Later in this chapter (section 2.4), the predictors of inclusion in analytical samples in this thesis are discussed along with the extent to which missing data might bias associations.

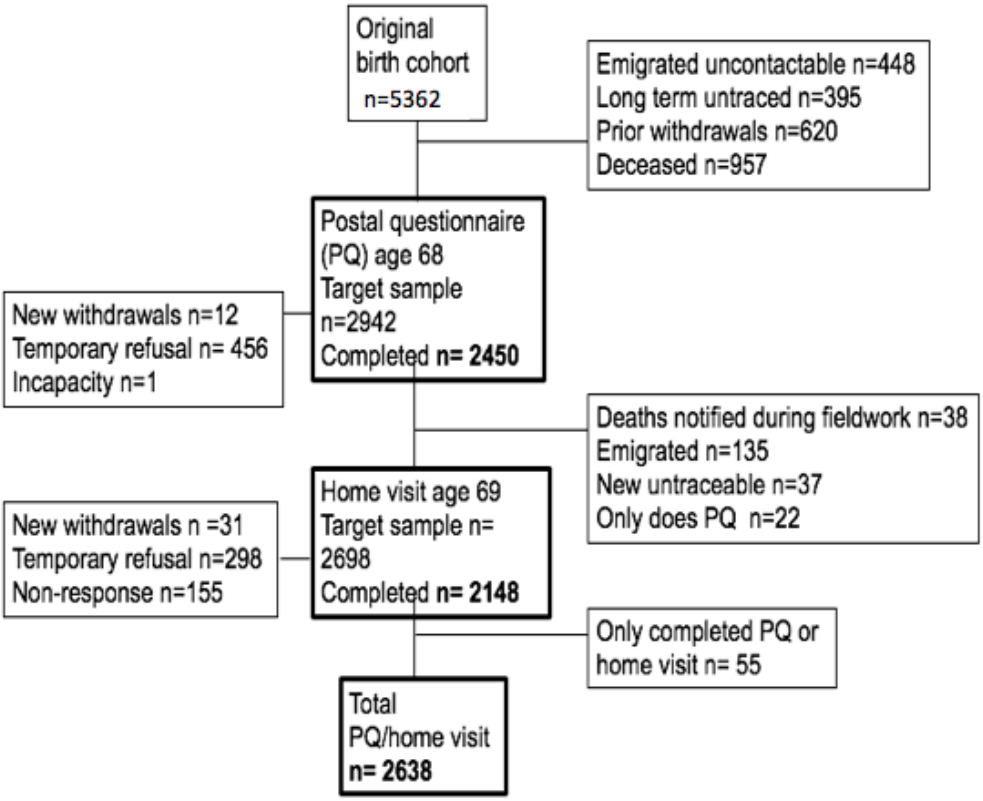

Figure 2.1 Target samples and responses from postal questionnaire and home visit at age 68-70. Figure adapted from Kuh et al. [261]

2.3 Measures

Below, the mastery questionnaire is described, followed by a description of exposures tested in association with mastery in chapters 3 and 4. Finally, the physical capability and disability measures, potential explanatory variables and potential confounders used in chapters 5 and 6 are described.

2.3.1 Mastery

Mastery was assessed in 2014 when the study members were aged 68-9. It was assessed by postal questionnaire using the self-report 7 item personal mastery scale[22]. Each item is responded to on a four-point Likert scale ranging from "strongly disagree" to "strongly agree". A list of items can be found in table 2.1. Two are positive statements and five are negative statements thus are reverse coded; a high score indicates high mastery. Items are summed to create a scale from 7-28.

Table 2.1 Pearlin Personal Mastery Scale

The following are statements that people use to describe themselves. Think about how well the following statements describe you. Please circle one number in each row that best describes how strongly you agree or disagree with the statement.
1 What happens to me in the future mostly depends on me.
2 I can do just about anything I really set my mind to.
3 *There is really no way I can solve some of the problems I have.
4 *Sometimes I feel that I'm being pushed around in life.
5 * I have little control over the things that happen to me.
6 * I often feel helpless in dealing with the problems of life.
7 * There is little I can do to change many of the important things in my life.
*items reverse coded

2.3.2 Early environment socioeconomic exposures

2.3.2.1 Paternal education; Maternal education

Both parents' educations were assessed when the NSHD study members were six years old. Study members' mothers reported what level of school they and their husband attended, and what education or vocational training they obtained after leaving school. There were eight original categories of education which were collapsed into 4 categories. The re-coding is described in Table 2.2.

Table 2.2 Paternal education; Maternal education coding

Recoding	Original categories
1 Primary only	
2 Below secondary	More than primary but no qualification
3 Secondary	Primary and tech or course diploma/ primary and professional degree, diploma/secondary only/secondary and no diploma
4 Degree/diploma	Secondary and tech or course diploma/ secondary and professional degree, diploma

2.3.2.2 Paternal occupational position

Father's occupation when the study members were aged four (or ages 11 or 15 if missing) was grouped according to the British Registrar General's Occupational Classification: (I Professional, II Managerial/technical, III Skilled non-manual, IV Skilled manual, V Partly skilled, VI Unskilled).

2.3.2.3 Material home conditions

Information on material home conditions was collected during mothers' interviews when the study members were 4 years. As in previous studies, a score (0-5) for material home conditions was derived by allocating 1 point for each of: dwelling in very good repair, dwelling built since 1919, ownership of home, not sharing a bed, and no more than 1.5 people per room of the house [264].

2.3.2.4 Cognitive ability

The inclusion of cognitive ability was to assess its contribution to the pathway between early socioeconomic indicators and mastery. At age 15, study members completed three cognitive tests: the Alice Heim (AH4) test of fluid intelligence, the Watts-Vernon reading test, and a study-specific test of mathematical ability [265]. An overall cognitive score was created as the sum of each standardised test score. This was standardized to the analytical sample (mean of 0, SD of 1). As in previous NSHD analysis, study members with missing data were included where possible (n=165) by using their scores on comparable examinations of global cognition at ages 11 or 8 [266].

2.3.3 Early environment psychosocial exposures

2.3.3.1 Stressful life events

Nine discrete stressful events reported between 0 and 16 years were scored as not experienced (0) or experienced (1) and summed to create a cumulative score of early stressful life events (SLEs) experienced (listed in table 2.3). A higher score reflects the experience of more events. Age 16 was used as the cut off point for the end of the early environment, although some exposures were not measured up to that point in the NSHD.

Table 2.3 Early environment stressful life events

	Coding Notes
Maternal separation from study member before the age of 6	Mother report; yes if >28 days [158]
Parental divorce before the age of 16 Parental death before the age of 16	Mother report; Caregiver report
Parental serious illness before 16	Mother report
Serious illness and injury 0- 5 years Serious illness and injury 6-10 years Serious illness and injury 11- 15 years	Hospitalisation >28days; from parental report, school, medical, and hospital records
Residential move by age 15 Change of school by age 13	Collected at each wave; for any reason

2.3.3.2 Perceived parenting

At age 43, study members retrospectively reported on their relationships with their mother and father before the age of 16. The Parental Bonding Instrument (PBI) is a 24-item questionnaire answered on a four-point Likert scale (see table 2.4). Previous factor analysis in this cohort found three parenting dimensions [168]. These are referred to as perceived parental support (12 items, e.g. 'Was affectionate to me'), perceived parental psychological control (5 items, e.g. 'Tried to make me dependent on him/her'), and perceived parental behavioural control (7 items, e.g. 'Let me go out as often as I wanted' (reverse coded)). Data on relationship with mother and father were combined using their mean score, with information on only one parent used if the other was missing.

Table 2.4 Parental Bonding Instrument
Perceived parental support
Appeared to understand my problems and worries
Spoke to me with a warm and friendly voice
Helped me as much as I needed
Was affectionate to me
Seemed to understand what I needed or wanted
Enjoyed talking things over
Talked to me often
Praised me
Frequently smiled at me
Could make me feel better when I was upset
Made me feel I wasn't wanted
Let me do those things I liked doing
Perceived parental behavioural control
Let me decide things for myself
Liked me to make my own decisions
Gave me as much freedom as I wanted
Let me dress in any way I pleased
Let me go out as often as I wanted
Let me do those things I liked doing
Wanted me to grow up
Perceived parental psychological control
Invaded my privacy
Was overprotective of me
Tried to control everything I did
Felt I could not look after myself unless she/he was around
Tried to make me dependent on her/him

2.3.4 Adult environment socioeconomic exposures

2.3.4.1 Education

This measure captures the highest educational qualification study members had attained by age 26. Data is grouped into categories of no qualifications, ordinary secondary (GCSEs or equivalent), advanced secondary (A levels), and degree level equivalent and higher.

2.3.4.2 Occupational position

Study members were grouped according to their own occupational position at age 53 (or age 43 or 36 if missing at age 53). Occupations were coded according to the British Registrar General's Classification of Occupations [267] into six categories of occupational position (I Professional, II Managerial/technical, III Skilled non manual, IV Skilled manual, V Partly skilled, VI Unskilled). Concurrent occupational position was not used because the large majority of study members had retired from their main job.

2.3.4.3 Income band

During the 2014 nurse home visit (age 68), study members were asked, "Which of the letters on the show card represents your total net household income?" The bands were: A) Less than £6,000, B) £6,000 - £7,999, C) £8,000 - £9,999, D) £10,000 - £11,999, E) £12,000 - £14,999, F) £15,000 - £16,999, G) £18,000 - £20,999, H) £21,000 - £23,999, I) £24,000 - £26,999, J) £27,000 - £29,999, K) £30,000 - £39,000, L) £40,000 – £79,000, M) £80,000 or more.

2.3.4.4 Income perception

In the self-completed postal questionnaire at age 68-9, study members were asked how well they perceived that they managed financially. Three response categories were available: "hard to manage", "managing fairly well" and "managing comfortably".

2.3.4.5 Cognitive function

The inclusion of adult cognitive function was to assess its contribution to the pathway between lifetime socioeconomic indicators and mastery. Cognitive function was ascertained at age 69 using the ACE-III, Addenbrooke's Cognitive Examination third edition. This is a screen-implemented test of cognitive state, administered by iPad; where this was not possible, a paper version was used. It has five domains: attention and orientation (scored 0–18), verbal fluency (0–14), memory (0–26), language (0–26) and visuospatial function (0–16) with a maximum total score of 100. It has recently been demonstrated in the NSHD to measure normal cognitive ageing and be influenced by early cognitive function [118].

2.3.5 Adult environment psychosocial exposures

2.3.5.1 Stressful life events (SLEs)

The study members reported incidence of SLEs in the previous 12 months using a checklist at ages 36, 43, 53, and 60-64 by self-completed postal questionnaire. In addition to the checklist, data were available on sibling death before age 26 (last reported), offspring dying before study member age 36 (last reported), and occurrence of divorce, separation or widowhood by 68-9 based on records of their marital history. These events were added to the list of SLEs.

Responses were dichotomised so that experiencing one event in a wave was scored as 1 point, and no experience of that event at that wave was scored as 0 points. If the study member indicated in their responses that they did not experience an event because it was not applicable to them (for example, they could not have a family crisis because they had no family), they were assigned 0. Variables were summed to form an adult SLE score. A higher score indicates a higher number of stressful events. The total count ranges from 0-32, with 32 being the highest number of events possible. Details of the items used can be found in table 2.5.

Table 2.5. Adult stressful life event items	
Age	Event
26	Sibling death <26 years
36	Family crisis
	Friend/relative ill
	Friend/relative died
	Friend/relative divorced
	Robbery
43	Spouse/partner disagreement
	Friend/relative died
	Lost contact with friend/relative ill
	Moved house
	Spouse/partner accident or illness
	Difficulties with children
	Robbery
53	Spouse/partner disagreement
	Spousal/partner accident or illness
	Friend/relative ill
	Friend/relative died
	Friend/relative disagreement/ betrayal
	Lost contact with friend/relative ill
	Moved house
	Difficulties with children
	Robbery
60-64	Spouse/partner disagreement
	Spousal/partner accident or illness
	Friend/relative ill
	Friend/relative died
	Friend/relative disagreement/ betrayal
	Lost contact with friend/relative ill
	Moved house
	Difficulties with children
	Robbery
68-9	Divorced, separated or widowed

2.3.5.2 Social support

The positive and negative aspects of the study member's closest relationship were captured through an adapted version of the Close Person's Questionnaire [268] in the postal questionnaire at age 68-9. Study members were asked to nominate the person they had felt closest to in the last 12 months and respond to six follow-up questions (in table 2.6) about the quality of that relationship. Previous confirmatory factor analysis using this measure in the NSHD found two dimensions of social support: positive support (three items) and negative support

(three items) [269]. For each dimension, the three items and responses involved were summed with equal weights creating scores from 0 to 9.

Table 2.6. Close Person's Questionnaire

Positive support	**Negative support**
Did this person make you feel good about yourself?	Did talking to this person make things worse
Did you share interests, hobbies	Would you have liked to have confided more in this person,
Did you confide in this person,	Did this person give you worries, problems and stress

Response options: 0= not at all, 1= a little, 2= quite a lot/a great deal.

2.3.6 Health variables

2.3.6.1 Depressive symptoms

Symptoms of anxiety and depression were ascertained by self-completed questionnaire using the 28-item General Health Questionnaire (GHQ-28) [270] during nurse visits at ages 53, 60-64 and 68-70. The GHQ-28 contains four sub-scales: somatic symptoms, anxiety and insomnia, social dysfunction and severe depression. Each item requires study members to answer if they have recently experienced a range of symptoms 'much more than usual', 'rather more than usual', 'no more than usual' or 'not at all'. Each item was scored from 0-3 and summed to create a total ranging from 0 – 84. A higher score indicates higher psychological distress. The GHQ-28 had a skewed distribution in this sample and was, therefore, log-transformed. A list of all 28 questions can be found in Table 2.7. In this thesis, the GHQ-28 data is referred to as depressive symptoms.

Table 2.7. 28-item General Health Questionnaire	
Have you recently:	
1. Been feeling perfectly well and in good health?	15. Been managing to keep yourself busy and occupied?
2. Been feeling in need of a good tonic?	16. Been taking longer over the things you do?
3. Been feeling run down and out of sorts?	17. Felt on the whole you were doing things well?
4. Felt that you are ill?	18. Been satisfied with the way you've carried out your task?
5. Been getting any pains in your head?	19. Felt that you are playing a useful part in things?
6. Been getting a feeling of tightness or pressure in your head?	20. Felt capable of making decisions about things?
7. Been having hot or cold spells?	21. Been able to enjoy your normal day-to-day activities?
8. Lost much sleep over worry?	22. Been thinking of yourself as a worthless person?
9. Had difficulty in staying asleep once you are off?	23. Felt that life is entirely hopeless?
10. Felt constantly under strain?	24. Felt that life isn't worth living?
11. Been getting edgy and bad-tempered?	25. Thought of the possibility that you might make away with yourself?
12. Been getting scared or panicky for no good reason?	26. Found at times you couldn't do anything because your nerves were too bad?
13. Found everything getting on top of you?	27. Found yourself wishing you were dead and away from it all?
14. Been feeling nervous and strung-up all the time?	28. Found that the idea of taking your own life kept coming into your mind?
Response options: 0=Much worse than usual, 1=Worse than usual, 2=Same as usual and 3=Better than usual	

2.3.6.2 Chronic health conditions

Four chronic physical health conditions were included: cardiovascular diseases, respiratory symptoms, osteoarthritis and diabetes. Study members were categorised as having cardiovascular disease if they had ever been diagnosed by a doctor with any of the following: heart failure, myocardial infarction (MI), angina or stroke. At age 68-9, study members were asked whether they had ever been told by a doctor that they had heart failure (congestive cardiac failure), and if they had been diagnosed with angina, myocardial infarction (MI), or stroke since the previous data collection (age 60-64). Data from previous sweeps (ages 36, 53 and 60-64) were used to identify those ever diagnosed with angina and MI, and those ever diagnosed with stroke. These items were summed to create a

binary variable describing study members who had no doctor-diagnosed cardiovascular disease and those who had experienced at least one cardiac diagnosis.

Respiratory symptoms were assessed using the UK Medical Research Council's standardised questionnaire [271]. The presence of respiratory symptoms is based on report of one or more of the following at age 68: a wheezy chest most days or nights for at least three months; usually bringing up phlegm or coughing most days for at least three months each year; or consulted a doctor more than once for a chest illness in the past three years). At age 68-9, study members were asked whether they had been diagnosed with osteoarthritis since the previous data collection (age 60-64). At this time, they were also asked if they had been diagnosed with diabetes since the previous data collection (age 60-64). Data from previous sweeps (ages 36, 53 and 60-64) were used to identify those ever diagnosed with diabetes.

2.3.7 Physical capability and disability outcomes

The following indicators of physical capability (physical performance and functional limitations) and disability (difficulties with ADLs) at age 69-70 were modelled as outcome variables in chapters 5 and 6 with mastery at age 68-9 as the exposure.

2.3.7.1 Individual and composite physical performance variables

Performance-based physical capability is a composite score based on four objective tests undertaken during nurse home visits at age 69-70: grip strength, chair rise speed, walking speed and standing balance time. Trained nurses conducted these tests using standardised protocols. The individual tests are described below. The composite score of physical capability was created using the method previously devised for use in the NSHD [201, 212] and is described after the individual measures below.

2.3.7.2 Grip strength (kilograms)

To measure grip strength (in kilograms), study members were asked to squeeze the handle of a Jamar Digital Plus handgrip dynamometer in a seated position, with the arm resting on the arm of the chair. Grip strength was tested four times (twice in each hand) with the maximum grip strength achieved used in analysis for this thesis. Higher scores represent stronger grip strength.

2.3.7.3 Chair rises (stands/minute)

Study members were asked to perform 10 cycles of rising from a chair until standing fully erect and then sitting down again with arms folded across the chest. Times in milliseconds were recorded with a stopwatch along with the number of rises achieved. Some study members who were unable or unwilling to do 10 rises did 5 rises instead (n=39). The number of rises is divided by the time taken to complete them such that higher chair rise speed scores represent the best performance.

2.3.7.4 Walking speed (metres/seconds)

Study members were asked to walk over 8ft (2.44m) from a standing start at normal pace whilst measured by a nurse using a stop watch. Study members were asked to complete the walking test twice and the fastest time (in milliseconds) was used for analysis. The time taken to complete the test was converted to speed (m/s).

2.3.7.5 Standing balance (seconds)

Study members were asked to stand with their eyes closed on their preferred leg with their arms folded and the other leg raised off the ground, for as long as they could. The longest time in milliseconds (up to a maximum of 30 seconds) for which they could maintain this position was timed using a stopwatch. Higher scores represent better balance. Due to the skewed distribution of balance times, balance was log-transformed and all estimates are presented as percent difference in balance time. For descriptive statistics, the median (Q1-Q3) balance scores were reported and non-parametric statistics were used to model data.

2.3.7.6 Study members unable to perform test for health reasons

For all physical performance tests, it was recorded whether study members were willing and able to perform the test. If they were not willing or able, the reason was recorded. Study members unable to perform the tests for health reasons (n =27 for grip strength, 107 for chair rises, 133 for standing balance, 42 walking speed) were considered conceptually similar to those with poor performance and as such, their exclusion from analyses could introduce bias. Therefore for analysis of individual performance items, these study members were assigned an imputed value of the mean of the bottom sex-specific fifth on the assumption that these participants were likely to have values within the lowest fifth of observed values [272].

2.3.7.7 Composite physical performance score

Composite physical capability score was created using the method previously devised for the NSHD [201, 212]. Each physical performance score was rescaled to 0 (low performance) to 1 (high performance) to give all measures equal weight when summed. Chair rise speed using the equation speed divided by 54.99, where 54.99 was the 99th percentile of speed. Persons taking longer than 54.99 seconds were assigned that value. Balance was rescaled by dividing the total time that a one-legged stand was maintained by the maximum possible time (30 seconds). Rescaled walking speed was calculated using the equation speed divided by 2.10, where 2.10 was the 99th percentile of speed. Persons taking longer than 2.10 seconds were assigned that value. Grip strength was adjusted for body size by dividing strength (kg) by height (cm). Grip strength was divided by its sex-specific 99th percentile value (0.341 kg/cm for men and 0.235 kg/cm for women), with persons having values greater than these being assigned these values. For all test scores, persons unable to complete the test due to health reasons (including for the balance test for those unable to keep their eyes closed) were assigned 0. The four rescaled scores were summed to an aggregate score of 0-4.

2.3.7.8 Functional limitations

During the nurse home visit at age 69-70, study members were asked to report whether they had any difficulty performing six tasks (table 2.8).

Table 2.8 Functional limitation items.

Items start: Do you have any difficulty?	Responses available
1 '..holding, gripping or turning things'	0= No, 1= Some, 2= A lot.
2 '..using your arms to reach/stretch for things'	
3 '..bending down and straightening up even when holding onto something'	0= no, 1= yes.
4 '..keeping your balance'	
5 '..walking up and down a flight of 12 stairs'	0=no, 1= yes, 2= unable to walk.
6 '..walking for a quarter of a mile on the level'	

Responses available to the questions were not consistent between each functional limitation (see table 2.8). Therefore, as previously in NSHD studies, items in which a third response was available were collapsed into binary outcomes (0= no difficulties, 1= difficulties) [211]. Total functional limitations is a sum of the items study members reported (1) any difficulty completing [46]. Higher scores represent a greater number of functional limitations.

2.3.7.9 Activities of daily living (ADLs)

During the nurse home visit at age 69-70, study members were asked to report whether they had difficulty performing eight ADLs (table 2.9) and the level of difficulty was assessed with a follow up question, “Can you do X without aids or personal help?”.

Table 2.9 Activity of Daily Living items age 69-70.

Each item starts ‘Do you have any difficulty with’: The follow up question asks: Can you do __ without aids or personal help?”. Responses= yes/no.
1 Getting around indoors
2 Bathing and/or showering
3 Getting in and out of a chair
4 Getting in and out of bed
5 Dressing and undressing
6 Using the toilet
7 Washing hands and face
8 Feeding yourself (including cutting food

ADL difficulty was categorised into 4 levels: i. no difficulty ii. some difficulty, iii. need mobility aids, iv. Need mobility aids and personal care. Study members were coded as having some difficulty if they reported difficulty on an item, yet, did not have more severe difficulties on any other items. They were coded as needing aids if they had reported that need for any item, yet, had not reported further difficulty level. They were coded as needing aids and/or personal help if they had answered personal help for any item or answered needs aids and personal help. The remaining study members who were free of all levels of difficulty on all items answered were coded as having “No difficulties”. Four individuals had responded as having no difficulties for 7 of 8 ADLs but were missing information on the eighth; they were included in the no difficulties category. Twelve study members had done a handwritten questionnaire and although they had answered that they

had at least some difficulty, they were missing data on severity and thus, were excluded from analysis.

2.3.8 Potential explanatory variables

An explanatory variable is defined as a variable which at least partially explains how an exposure affects the outcome variable [273]. The mastery and physical capability literature outlined in chapter 1 (section 1.4) suggests four possible explanatory variables on that pathway: smoking, leisure time physical activity (LTPA), body mass index (BMI) and fear of falling and related restriction. In chapter 5, the following procedure was used to indicate their explanatory value. First, descriptive statistics confirmed the hypothesised relationship between the potential explanatory variables, mastery and physical capability. Regression analyses were used to estimate the associations between mastery and physical capability, between mastery and the potential mediators, and between those potential explanatory variables and physical capability. The change in magnitude of the regression coefficient between mastery and physical capability after inclusion of the potential explanatory variables and confounders indicated the explanatory contribution of the former.

2.3.8.1 Smoking status

At age 68-9, study members self-reported their smoking status on the postal questionnaire. They were categorised as an ex-smoker, having never smoked or being a current smoker. Current smokers were those who smoked at least one cigarette a day for 12 months or more. This variable was checked against reports at earlier waves of data collection (from ages 20, 25, 31, 36, 43, 53 and 60-64) and updated accordingly.

2.3.8.2 Body mass index (BMI)

During the home visit, height (cm) and weight (kg) were measured by nurses using standard protocols to derive BMI (kg/m^2) at age 69-70.

2.3.8.3 Leisure time physical activity (LTPA)

At age 68-9, study members were asked to report by postal questionnaire whether or not they had taken part in any sports, or vigorous activities or exercises, like badminton, swimming, yoga, conditioning exercises, floor-based exercises, dancing, hill-walking or jogging, in their spare time, in the past 4 weeks. If so, they were asked on how many occasions they had done these activities. They were classed as inactive if they reported no participation, moderately active if they participated one to four times a month, or regularly active if they reported taking part five or more times in physical activity per month.

2.3.8.4 Fear of falling and related activity restriction

Study members were asked to report by postal questionnaire at age 68-9, “In the past 12 months did you worry about falling down?” (responses available = yes or no). If they answered yes, then they were then asked whether this fear restricted their activities. Response options were “No, “Yes, a little”, “Yes a lot”. A composite of these two variables was created with four categories: 0= no fear of falling, 1= fear and no activity restriction 2= fear with mild activity restriction (those who answered “yes, a little”), and 3= fear with severe activity restriction (those who answered “yes, a lot”).

2.3.9 Potential confounders

To account for potential confounding between mastery and physical capability (chapters 5 and 6), variables recognised to be associated with both but not hypothesised to be on the causal pathway between them- were identified a-priori. Literature reviewed in chapter 1 highlighted sex, occupational position, chronic health conditions, and depressive symptoms to be potential confounders between mastery and physical capability. Associations between these potential confounders and mastery were confirmed in chapter 3 and 4 and with physical capability in chapters 5 and 6.

Measurement of these variables were described earlier in this chapter. Occupational position was described in section 2.3.4.2. The four chronic health conditions of cardiovascular diseases, respiratory symptoms, osteoarthritis and diabetes were described in section 2.3.6.2. Depressive symptoms using the GHQ-28 [270] were described in section 2.3.6.1

In addition, height was identified a-priori as an exposure to account for in analyses. Although not formally a confounder due to no available evidence suggesting height could pattern mastery, it is necessary to account for in physical capability analyses. Taller people tend to have more muscle to enable grip strength, longer limbs to enable walking stride, and a better centre of balance [264, 274]. Height (cm) was measured by trained research nurses during the home visit at age 69-70.

2.4 Analyses

Below, the approach to analysis shared across chapters is described. Each set of analyses are described in detail in each relevant chapter.

2.4.1 Analytical sample

The analytical sample in this thesis are study members with data available on mastery and one early environment and adult exposure (i.e. paternal education and adult occupational position) for chapter 3-4 (n=2038), and for chapter 5-6 those with complete data on mastery and physical capability and activities of daily living (ADLs) (n= 1727). The latter analytical sample (n=1727) is smaller than that for chapters 3-4 (n=2038) largely due to the need to restrict the sample to those with valid observations for composite physical capability score (n=1951) in the home visit at age 69-70. A greater number of study members completed the questionnaire for all seven activities of daily living (observations for individual limitations ranged n= 2183-2190), similar to the number of study members with valid observations for functional limitations (n= 2188). There were no material differences in mean mastery score between study members with complete data for physical performance, functional limitations, or ADLs, or compared to those included in the final analytical sample.

Appendix A (page 254) presents the missing data for each analytical sample in this thesis. Multiple imputation by chained equations was used to maintain statistical power and minimise biased estimates due to missing data. Each imputation model included all relevant outcomes and covariates that might predict missingness more accurately [275] although analysis for each chapter was limited to the subsample with complete outcome and exposure data. Each imputation model ran 60 cycles; for each analytical sample, 60 complete datasets were generated, and estimates were combined with Rubin's rules. For comparison, analyses were also run on samples with complete cases and these results are presented in Appendix B (table B3 to B6, pages 255-260).

For the analytical sample of chapter 3 and 4, paternal education and own occupational position were selected as the exposure. One of the assumptions of MICE is that data are missing at random (MAR). Individuals with missing observations on mastery, father's education and own occupational position (n=1040) were more likely to be male (p=0.004), have early SLEs (p<0.001), and higher mother's education (p<0.001). For the analytical sample of chapter 5 and 6, those missing covariate data (n=303) were less likely to report frequent LTPA (p<0.001), more likely to report restricting their activities due to fear of falling (p<0.001), more likely to have diabetes (p<0.001) or cardiovascular disease (p<0.001), and were more likely to have a lower occupational position (p<0.001). Otherwise all complete cases were similar to their respective main analytical groups. Analyses based on complete cases did not materially differ in direction or magnitude of effects from those presented in the following main chapters.

2.4.2 Descriptive analyses

All continuous variables were checked for normality and outliers using histograms, and summary statistics of means, standard deviations, medians and interquartile ranges. If variables had a skewed distribution, they were log-transformed. Categorical variables were presented as frequencies and percentages. Descriptive results are described in the relevant chapters.

2.4.3 Regression modelling

Regression models were the main statistical method used to test associations in this thesis. Non-linearity was assessed using inclusion of a quadratic term in regression models. Due to the concern of loss of statistical power associated with categorising variables, variables were modelled continuously unless they were categorical by nature. Likelihood ratio tests suggested that there was no statistical difference between a model in which the indicator (e.g. paternal occupational class) was modelled continuously and one in which the indicator was modelled categorically. Formal testing of sex-interactions in all regression models accounted for the possibility that associations may differ by sex. If sex interaction terms were significant at $p<0.10$ were found and likelihood ratio tests indicated that inclusion of the interaction was a better fit, findings were sex-stratified.

Linear regression models were used to test associations between early and adult exposures and mastery, modelled continuously, at age 68-9. Linear regression was also used to model associations between mastery and individual and composite physical performance test scores at age 69-70. Poisson regression was used when the outcome was an ordinal variable, such as, composite functional limitations. Logistic regression was used when the outcome being examined was binary, for example, individual functional limitations (yes/no). Multinomial logistic regression was used for non-ordered categorical outcomes (e.g. smoking status= current, never, ex-smoker) and ordered logistic regression was used to test associations with ordered categorical variables (e.g. fear of falling= no fear, fear, fear and mild activity restriction, fear and severe activity restriction).

Associations were described using unstandardized regression coefficients, odds ratios, incidence risk ratios, relative risk ratios, and 95% confidence intervals. Standardised regression coefficients were used in chapters 3, 4 and 6 to examine effect sizes. The coefficients for models with individual standing balance as the outcome (presented in relevant supplementary material) represents percentage differences in balance score due to being log transformed because of skew. The analyses were conducted in STATA version 13 (StataCorp 2015).

2.5 Summary and next chapter

The data described in the sections above will be used to investigate the life course determinants of mastery in early old age and its association with physical capability of study members from the MRC National Survey of Health and Development (NSHD). The following chapter begins the analyses carried out across chapters 3-6.

3 ASSOCIATIONS BETWEEN THE EARLY ENVIRONMENT AND MASTERY IN EARLY OLD AGE

The aim of this chapter was to investigate the contribution of early socioeconomic and psychosocial processes to mastery in early old age. The objective was to examine whether parental education, paternal occupation, material home conditions, stressful life events, and perceived parenting before the age of 16 are each separately associated with mastery at 68-9 years.

As established in chapter 1 (section 1.1.1), mastery is a self-concept reflecting perceived control. The majority of research into factors associated with high mastery in adulthood has tested temporal circumstances or factors from the recent past. However, it has been suggested that mastery is accumulated over a life time [92-94] and is not only informed by the intensity of the current circumstances individuals need to control, but also by their prior impression of themselves as someone who has managed their own life [94]. Circumstances in early life may contribute to whether or not individuals perceive that they can manage current circumstances. This chapter aims to clarify whether early environmental exposures are associated with mastery in early old age. It also aims to isolate which type of socioeconomic or psychosocial early environmental exposures are associated with mastery. Findings from this chapter will inform the analysis in chapter 4 investigating associations between experiences from across the whole life time and mastery in early old age. Together the aim is to further insights on how mastery is accumulated across the life course.

3.1 Introduction

3.1.1 Background to testing the early environment and mastery in early old age

As introduced in, Chapter 1 (section 1.3), several plausible mechanisms propose how the early environment continues to contribute to mastery in early old age. The first mechanism describes that early life is a key developmental period for

mastery. Self-concepts, of which mastery is one, are seen as starting their development in the early family environment [155]. Theories of child development describe an “internal working model” of the self being gradually built upon both how others communicate that we are seen, and how we respond to external events [17, 159, 276, 277]. Longitudinal studies demonstrate a substantial growth in mastery year-by-year from childhood to early adulthood; with disparities in mastery visible by the end of adolescence [101-103]. Some adolescents with lower mastery at that point in life may not get the opportunity to catch up with their higher mastery counterparts.

A strong self-concept of mastery in adolescence may carry across life to early old age in several ways. Firstly, through a feedback loop protecting from mastery loss over time. Higher mastery is expected to influence individual’s appraisal of the manageability of their circumstances while unmanageable circumstances are associated with loss of mastery [27, 28]. By extension, individuals with strong early mastery could experience the same future difficulties as those with lower mastery, but experience them as less unmanageable, and therefore not experience the expected loss in mastery [92, 93]. In this way, high mastery in adolescence carries over into adult life regardless of adult factors associated with mastery loss.

Another feedback loop is that mastery has been demonstrated in association with an increased likelihood of future beneficial circumstances. The available evidence suggests that adolescents with higher mastery are more likely to stay on in school, to achieve higher education, to earn a higher income, and have better social relationships, net of earlier exposures linked to these factors and the initial mastery [6, 8, 103, 107, 157, 278]. As described in chapter 1 (sections 1.33 and 1.34), these adult factors are associated with greater mastery beliefs, potentially lasting into early old age. The conclusion is that individuals who feel in control are able to effectively manage their lives; a self-fulfilling prophesy to even higher mastery by early old age.

It is complex untangling whether early life factors are directly associated with mastery in early old age; part of an accumulative effect of linked factors across life; or only the first in a chain of exposures of which it is the later factors relevant to mastery in later life. Relevant early exposures such as advantaged family socioeconomic position (SEP), supportive parental relationships, and general stability (fewer SLEs), have been identified as repeating themselves in corresponding circumstances across life [117, 151, 173-176]. Analyses in chapter 4 will extend analysis in chapter 3 by attempting to understand these pathways across life.

3.1.2 Identifying pathways between the early environment and mastery

In addition to understanding whether early life contributes to mastery in early old age, this thesis is interested in understanding what type of experiences may explain differences in mastery. As chapter 1 established (section 1.3.2.1 and section 1.3.3.3), factors contributing to mastery can be broadly grouped into two pathways: of socioeconomic and psychosocial processes. Within each group each exposure is theorised to make its own contribution to mastery.

The theories regarding early socioeconomic exposures and mastery are grounded in Pearlin et al.'s assertion that more resources and more status in society encourage people to feel more in control [107]. Pearlin suggested that restrictions in family material conditions are internalised in children alongside perceived social evaluations of their parental occupational position [97, 98]. Qualitative research supports that young people are aware of socially graded perceptions of their family position from an early age [279, 280]. Another proposal is that educated parents model to their offspring how to process and solve challenges; thereby teaching them the skills to manage their life [105, 106].

In terms of the early psychosocial environment, theories of early development focus on parent-child interactions as the origins of the child's self-concept [161]. In recent decades, the characterisation of three different dimensions of parenting shown to have influence across the life have extended Baumrind's classic work on parenting typologies [158, 170, 281, 282]. Parental support refers to responsiveness to the child, and providing guidance and encouragement to

manage their circumstances independently [167]. Two groups of parental control behaviours exist: behavioural control and psychological control. Parental behavioural control refers to regulating children's behaviour in accordance with family or social standards, through monitoring, punishment and reward [167]. Some behavioural control is believed to be beneficial for child development, in as much as it teaches predictability and competence [283]. However, an excessive requirement for behavioural conformity has been linked to lower self-confidence in adolescence and poor long term outcomes [169, 170]. Psychological control refers to attempts to keep the child mentally and emotionally dependent on parents [166, 167]. Techniques such as inducing guilt, instilling anxiety and undermining confidence are used to pressure individuals to think and feel in particular ways [171] and ultimately may restrict their sense that they control their own life.

It should be considered that these groups of early psychosocial and socioeconomic exposures may overlap and contribute, partly, or wholly, to how another factor is associated with mastery. For example, higher exposure to disadvantage in material home conditions may increase the frequency of early SLEs, such as parental divorce, illness and death [256]. Parents who have the time and resources to gain more education, and provide more comfortable material home conditions, may have more time and fewer pressures on their capacity to provide supportive autonomy-granting parenting [179-181]. This is supported by an early Pearlin study observing that American and Italian fathers in low-autonomy jobs were less likely to value mastery-like attriibutes of self-direction in their children [284].

The next sections examine the available evidence attempting to understand, whether and how, early life factors contribute to mastery in early old age.

3.1.3 Background literature: Associations between the early environment and mastery in adulthood

Studies available testing the contributions of early life to mastery in early old age are sparse. Four studies have tested associations between the earlier

environment and measurements of perceived control at any stage of adulthood. One British study found that the indicators of early environment tested were not associated with perceived control statements in members of the 1970 British Birth Cohort at age 30 [178]; unlike several adult exposures tested. The study member's maternal education, paternal occupation, material home conditions score and maternal parenting attitudes (captured between 0 and 10) were not associated with mastery-like statements at 30. It is not clear whether these early socioeconomic and psychosocial factors were never relevant to perceived control, or the association had faded over time. Complicating conclusions, in two large US cohorts, one in midlife and one in later life, maternal but not paternal education was associated with an extended 12 item version of the Pearlin mastery scale [45]. A third large US study found parental education was positively associated with perceived control statements for study members under, but not over, the age of 45 [105]. Finally, in a study of Japanese adults (aged 25-51) testing the Pearlin mastery scale, an association between recalled early economic status and mastery only existed for women [285].

There are several reasons why the available evidence was unable to reach a consensus on associations between early environmental exposures and adult mastery. First, only one study tested the Pearlin mastery scale as the outcome; the others varying in their perceived control items. No studies have tested whether mastery is measuring the same self-concept as more generic control statements. If the control statements used in these studies do reflect mastery, the conclusion as to whether any earlier life experiences are associated with mastery in adulthood is unclear. The only early exposure consistently tested was parent education, but it was not consistent which parent's education was being tested. The study from Japan emphasises the need to consider the cultural context on research into self-concepts as the authors speculated that the sex difference was specific to Japan. These intriguing differences make clear the need for more research into whether early environment exposures are associated with mastery well into adulthood.

Without very little available literature to base assessments of pathways between early life and mastery in early old age it is useful to examine the adolescent literature. Five studies have tested the association between multiple indicators of

early socioeconomic environment and mastery in adolescence, and four between psychosocial indicators and mastery in adolescence. The majority of studies come from Iowa or the wider area of Minnesota in the 1990s [101, 106, 144, 163], and two are national US from the late 1970s [102, 162]. Findings are discussed in the following sections.

3.1.4 Literature review: The early socioeconomic environment and mastery in adolescence

Studies have tested whether indicators of early life socioeconomic position such as composite family SEP score, material home conditions and parental education are associated with mastery growth in adolescence.

Two studies testing composite SEP scores did not show associations between early SEP and mastery in 15 year olds, in a USA Midwest [101] and a nationally representative USA cohort [162]. However, in the Midwest study, by the age of 18, differences in mastery associated with family SEP (material home conditions and parent education) had emerged, whereas none had been visible at age 15. Adolescents from a higher SEP household had a sharper growth in their mastery since the age of 15. Both studies tested the interplay between socioeconomic and psychosocial earlier life exposures. Lower family SEP co-occurred with lower parental support, explaining a small part of associations between supportive parenting and mastery.

In considering the contribution of separate indicators of early SEP, it appears that advantage or disadvantage in material home conditions by itself is not associated with adolescent mastery. Only one study directly tested associations between household income and mastery. Household income had no association with mastery in adolescents with a mean age of 17 in a large (n=8247) nationally representative US study in 1979, or with mastery growth over a 13 year period [102]. There was no information about whether the families could manage on this indicator of material home conditions or how it affected their relationships.

A small study of 377 white Iowans (US Midwest) [144] (age 12-14) did not test material home conditions but considered pressure on material home conditions as an explanatory pathway of family conflict. This study reported no association between parent-reported pressure on material home conditions (e.g. difficulty paying bills, buying necessities) and mastery, nor between adolescent reported pressure and mastery. However, adolescents who reported parental arguments or parental distress regarding material home conditions, and those experiencing parent-child conflict related to it, were more likely to experience a decrease in mastery over two years [144]. An additional study from the same Iowan sample reported that the association between pressure on material home conditions and decreases in adolescent mastery a year later was mediated by parents providing less support and warmth and more behavioural control [145].

Another Iowan study emphasised the potential for parent education, as well as material home conditions to potentially co-occur with psychosocial earlier life circumstances. Mean parent education was associated with mastery growth over three measurements between the ages of 13-19 [106]. This was partially mediated by observations of inter-family member problem-solving interactions, listening, and shared decision-making. Lewis et al. [102] supported positive associations between maternal education and higher adolescent mastery, independent of adolescent self-reported cognitive ability, but did not test for a contribution of psychosocial factors.

Due to heterogeneous measures and inconsistent multivariate adjustment, it is hard to isolate which conditions are most relevant to mastery and how they operate. Overall, evidence of early socioeconomic environment and adolescent mastery repeatedly point to a contribution of psychosocial factors such as impaired family relationships and distress. The next section reviews the evidence directly exploring the role of the early psychosocial environment for mastery.

3.1.5 Literature review: The early psychosocial environment and mastery in adolescence

Four prospective studies have tested associations between dimensions of supportive or autonomy-granting parenting and adolescent mastery [101]. In both

the aforementioned large nationally representative US survey of adolescents, and the three smaller Iowan samples better parental support was associated with a steeper rate of mastery growth between the ages of 12-18[162], 12-16 [145], and yearly growth between 15 and 31 [163]. The three studies used different measures of parental support: all reflected encouragement with autonomy, and affection, and two measures additionally reflected parental behavioural standard setting [145, 162]. No studies have yet tested associations between the three separate dimensions of parental support and autonomy-granting: parental support, psychological control and behavioural control.

As chapter 1 introduced, experiencing SLEs may undermine an individual's perception that they are in control of their own life [94]. Only one published mastery study tested SLEs during earlier life, but did not test whether they co-occurred with early socioeconomic circumstances or parenting styles [103]. Shanahan and Bauer found that of 777 US young people surveyed, higher recollections of SLEs between ages 14 and 21 (e.g. partner loss and parental separation) were associated with a slower growth in mastery over that same period than for those recalling fewer events. While mastery was collected at several waves, participants in this study were reporting on SLEs experienced in the previous five years rather than the events being prospectively collected. It is possible that memory or cognitive biases played more of a role than the actual experience of the SLE on mastery.

Several of the studies cited above extended tests of associations between early life psychosocial exposures and mastery into early adulthood but not beyond. Despite these studies using similar Midwest cohorts in the 1990s there was no consensus if associations between early life and mastery persisted beyond adolescence. One study indicated that parental support was associated with mastery at age 15, but not at age 18 [101]. A second study indicated that parenting style became less important in later teens but was associated with more proximal exposures of partner support, which was then associated with increases in mastery into their mid twenties. For SLEs, there was some sex differences;

adolescent SLEs were associated with mastery up to the age of 27 for girls, but for boys [103].

Previous NSHD data suggests the potential for certain early SLEs to have long lasting effects into adulthood. There is evidence that parental divorce, parental death, maternal separation, childhood illness, and changing schools, in early life, are all associated in some way with poor psychological health in adulthood [158, 182]. Literature has long supported evidence of associations between an accumulation of SLEs in early life and an increased risk of poor mental health or wellbeing in adulthood [151, 183].

3.1.6 Literature discussion and summary

As summarised in this chapter, there is little evidence testing whether early life exposures are associated with mastery in adulthood. However, the adolescent literature provides a starting point for investigation as to which early environmental exposures could be associated with mastery into adulthood.

This literature suggests that material home conditions on their own might not be associated with adolescent mastery. However, there may be an association when parenting styles are impaired by those conditions [145], while parent education might have some direct association with adolescent mastery [102, 106]. No studies tested maternal and paternal education separately in association with adolescent mastery despite evidence suggesting a difference relevant to mastery [45]. Associations between parental occupation position and mastery have not been tested.

Limited evidence suggests that the early psychosocial environment plays a role in adolescent mastery, although more work needs to be done to differentiate between parental support, parental psychological control and behavioural control and replicate findings of early SLEs. Apart from the need to add to this body of literature, there are several other gaps which need addressing in the current thesis.

Inconsistent statistical adjustment makes it hard to conclude which earlier environmental exposures were associated with mastery and how they were operating. Only two studies testing associations between earlier life socioeconomic exposures and mastery controlled for cognitive ability. One study reported a positive association between school test scores and mastery [102]. The other study controlled for self-reported academic ability but did not report on its association with mastery, or how or whether its inclusion changed an association between early SEP and adolescent mastery[101]. As discussed in chapter 1 (section 1.3), higher cognitive ability, which may be associated with mastery [102], is influenced by educated parents who understand how to achieve at school [117, 175].

The one study testing earlier life discrete SLEs rather than chronic strains such as disadvantages in material home conditions did not control for indicators of earlier socioeonomic environment. Psychosocial risk factors such as SLEs and poor parenting quality have been shown to co-occur with socioeconomic disadvantage [145, 162, 179, 286]. For example, looking at NSHD evidence, families experiencing the early environment SLE of divorce were more likely to have compromised material home conditions, and more likely to experience further SLEs [113, 256]. Socioeconomic disadvantage may also strain parents and parenting quality. For example, Pearlin [284] found that fathers who were closely supervised at work, had less autonomy, were occupationally dissatisfied, and thus were more likely to report frequent irritation with their children and less affection than middle class fathers. They were also more likely to value a parenting style of behavioural control. Further studies need to analyse multiple early environmental exposures in isolation, and simultaneously, to better understand the pathway between exposure and mastery.

All of the studies that tested associations between early environmental exposures and scores on the Pearlin mastery questionnaire are American. Several studies have pointed to the potential for antecedents of mastery to differ across cultures [138, 188, 192]. Within this US literature, only two of the studies included a nationally representative sample; the remaining samples were agricultural

dwelling white Iowans with a lower mean family income than the national average and potentially limited education or work opportunities. Again, inconsistent consideration of other indicators of early environment, such as parent education, adolescent cognitive ability, education or future opportunities, makes it challenging to understand what factors underlie low mastery.

This thesis addresses the major evidence of associations between early life factors and mastery beyond the third decade. The literature highlighted that antecedents of mastery or the mechanism may change over the years. Several studies reported that earlier exposures relevant to mastery in earlier adolescence were no longer associated with mastery at the end of adolescence or early adulthood [101, 103, 163]. Testing the exposures in the conceptual model (figure 3.1), this chapter aims to build on the interesting evidence presented so far by increasing understanding of whether associations exist between the earlier environment and mastery in early old age.

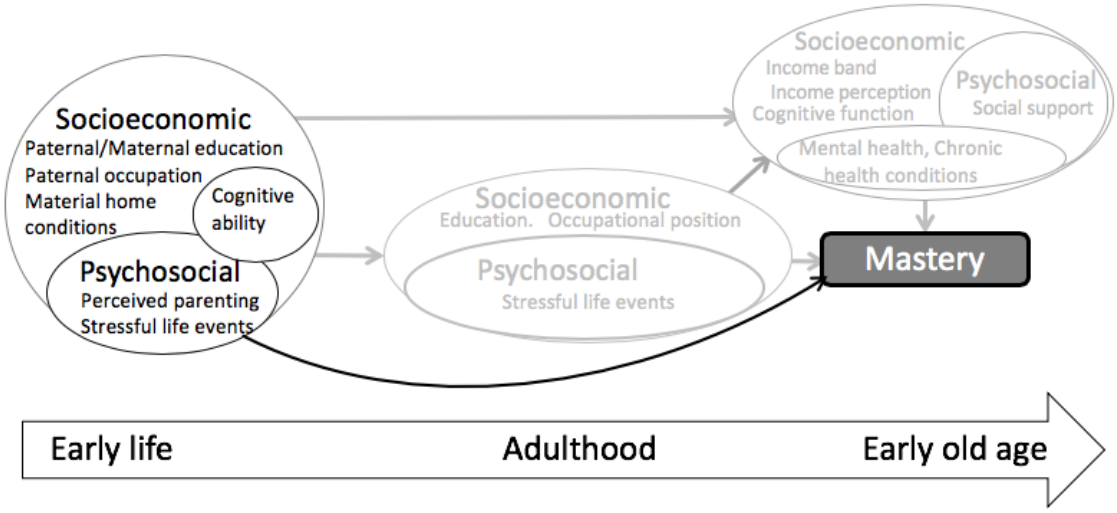

Figure 3.1. Conceptual model theorising pathways of associations between early exposures and mastery in early old age**;** greyed out pathways tested in the following chapter (4). Note: overlapping circles depict potential co-occurrence of exposures.

3.2 Analysis plan

The analysis in this chapter tested objective 1 (chapter 2; section 2.1): to test the direct and indirect associations between multiple indicators of the early

socioeconomic and psychosocial environment (age 0-16) with mastery at age 68-9.

It was hypothesised that more advantaged early socioeconomic environment (higher maternal education, paternal education, paternal occupation, and material home conditions score) would be positively associated with mastery in British adults in early old age. While it was hypothesised that these indicators of early socioeconomic environment would co-occur, independent associations were expected between each individual socioeconomic exposure and mastery. It was hypothesised that early cognitive ability would be at least a partial mediator between earlier life socioeconomic environment and mastery in early old age.

It was hypothesised that better perceived parental support and more autonomy-granting from parents, along with fewer SLEs, would be more likely in higher socioeconomic environment, and would at least partly explain associations between earlier socioeconomic environment and mastery in early old age. Higher parental support and fewer SLEs were hypothesised to be associated with higher mastery in early old age, with inverse associations hypothesised between parental psychological control, parental behavioural control, and mastery.

3.2.1 Analytical sample

The analytical sample in this chapter was restricted to those with complete data on mastery at age 68-9 (n=2038). To maintain statistical power and minimise the bias introduced by missing information, multiple imputation by chained equations was used (process described in chapter 2, section 2.4.1) to impute missing exposures under the assumption that data were missing at random. The main associations in the maximum available sample with complete data were compared with sensitivity analyses to those run on imputed data sets.

3.2.2 Descriptive analyses

Early socioeconomic and psychosocial environment

Descriptive data were used to assess the early environment of study members with complete mastery data at age 68-9. Proportions, or mean scores and standard deviations (SD) were presented to describe categorical and continuous exposures, respectively. Early socioeconomic environment was measured separately by: father's and mother's education (collected at age 6), father's occupation, and material home conditions at 4 years. Early psychosocial environment was measured by three dimensions of perceived parenting regarding support and autonomy-granting before the age of 16 (perceived parental support, psychological control and behavioural control), and a count of SLEs occurring before the age of 15. Cognitive ability was indicated by overall score on four cognitive tests at age 15. All variables were described in detail in chapter 2 (section 2.3). Descriptive statistics for the early environment were presented stratified by sex. Sex differences were checked using chi-squared tests for proportions, and one-way ANOVAs for mean scores.

To examine if the multiple early exposures co-occur, pairs of exposures were examined in cross-tabulations of frequencies. Associations between them were examined using chi-squared tests. For this purpose, the three continuous perceived parenting variables were broken into quartiles. The count of SLEs, which as described in chapter 2 (section 2.3.3.1) has a range of 0-10, was collapsed into five groups (0, 1, 2, 3, 4+ SLEs) due to small numbers experiencing more than four events. Likelihood ratio tests indicated that it was appropriate to model SLEs as a linear term.

Mastery across the early socioeconomic and psychosocial environment

The characteristics of mastery were assessed descriptively by presenting the mean, range and standard deviation (SD) for men and women with complete mastery data at age 68-9. Sex-stratified histograms examined the distribution of mastery. Differences in mean mastery scores across the categorical early environmental exposures were assessed using one-way ANOVAs, and when appropriate, for trend using linear regression.

3.2.3 Regression models

Linear regression was used to analyse associations between each early environment exposure and mastery. Firstly, the mean differences in mastery at age 68-9 were estimated for each early socioeconomic and psychosocial environment exposure (models 1).

In the second step, all exposures reflecting the domain of early socioeconomic environment were entered into a mutually adjusted model (model 2). This model was re-run with adjustment for early cognitive ability (model 3).

Next, all exposures reflecting the domain of early psychosocial environment were mutually adjusted within a linear regression model (model 2).

Finally, all early environment exposures statistically significant at the 10% level were entered into a fully adjusted model to consider together (model 4).

Formal investigation of sex-interactions (at the 10% level) in the basic model were non-significant and thus, there was no need for stratification by sex. All analysis was adjusted for sex.

3.3 Results

3.3.1 Descriptive statistics for mastery

The distribution of mastery of the study members with complete data at age 68-9 is shown in Figure 3.2. The average mastery score was 22.1 (SD=3.6, range 8-28). Men had one point higher mean mastery (22.6, SD=3.5, range = 11-28) than women (21.6, SD= 3.5, range = 8-28) ($p < 0.01$).

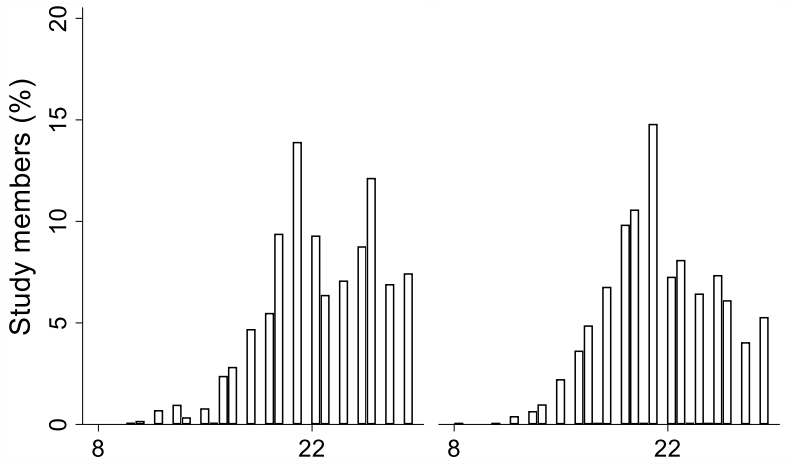

Figure 3.2. Distribution of mastery scores at age 68-9 in 2038 study members with complete data (left side female n=1009, right side male n= 1029).

3.3.2 Description of early socioeconomic environment and mastery

The early socioeconomic environment for those who provided mastery scores aged 68-9 is presented in table 3.1. The most commonly reported family occupational position was skilled-manual, with fewer than 10% of fathers in the highest, professional class. The majority of parents were not educated beyond secondary school. The majority of households had material home conditions rated to be above a reasonable standard of living. Cross-tabulations of frequencies indicated co-occurring early socioeconomic disadvantage (table 3.5). Fathers with the lowest education were more likely to be married to mothers with the same, have unskilled or manual occupations, and have poorer material home conditions. Those scoring lower in all socioeconomic exposure had lower early cognitive ability.

Table 3.1. Descriptive characteristics of early socioeconomic environment of study members with complete mastery data by sex [a]

	Men n=1128		Women n= 1209		
	N	(%)	N	(%)	P-value for sex difference[b]
Paternal education					0.1
Primary only	500	50.2	587	55.0	
Below secondary	155	15.5	134	12.5	
Secondary	234	23.5	224	20.9	
Degree/diploma	106	10.6	122	11.4	
Maternal education					0.5
Primary only	574	57.0	644	59.9	
Below secondary	162	16.1	153	14.2	
Secondary	202	20.0	205	19.0	
Degree/diploma	68	6.7	72	6.7	
Paternal Occupational position					0.4
Unskilled	58	5.4	52	4.5	
Partly skilled	160	14.9	211	18.4	
Skilled manual	334	31.1	341	29.8	
Skilled non-manual	191	17.8	200	17.5	
Managerial/technical	245	22.8	252	22.0	
Professional	85	7.9	87	7.6	
Material home conditions					0.5
0 Worst	14	1.6	10	1.0	
1	50	5.7	63	6.6	
2	102	11.6	118	12.4	
3	247	28.2	263	27.7	
4	292	33.4	286	30.1	
5 Best	169	19.3	208	21.9	

Note: Study members are those with data for each individual measure+ mastery at age 68-9 (maximum n =2337). [a] Total numbers vary due to missing data.

One-way ANOVAs suggested that for males, paternal education, paternal occupation, and maternal education were all associated with a non-linear positive gradient in mean mastery (table 3.2). That is, it was the mid-level rather than the highest educated parents or managerial/professional grade fathers associated with highest mean mastery in study members. There was no difference in mean mastery by material home conditions. For women, there were no statistically significant differences in mastery by any indicator of their early socioeconomic environment.

Table 3.2. Mean mastery score according to socioeconomic childhood environment in study members with complete mastery data [a]

	Men Mean mastery score (SD)	*P-value Difference in mean*[b]	Women Mean mastery scores (SD)	*P-value Difference in mean*[v]
Paternal education		0.02		0.9
Primary only	22.0(3.7)		21.4(3.6)	
Below secondary	22.7(3.4)		21.5(3.4)	
Secondary	23.0(3.5)		21.5(3.6)	
Degree/diploma	22.6(3.5)		21.6(3.3)	
P for trend[c]	0.02		0.6	
Paternal education				
Primary only	22.4(3.6)	0.1	21.4(3.6)	0.9
Below secondary	23.2(3.4)		21.4(3.4)	
Secondary	22.2(3.4)		21.5(3.4)	
Degree/diploma	22.1(4.0)		21.1(3.1)	
P-value for trend[c]	0.06		0.7	
Paternal occupational position				
Unskilled	21.7(3.9	0.04	21.2(3.4)	0.9
Partly skilled	22.0(3.8		21.5(3.5	
Skilled manual	22.3(3.8		21.2(3.53	
Skilled non manual	23.1(3.2		21.52(3.6	
Managerial/technical	22.6(3.4		21.4(3.6	
Professional	22.5(3.5		21.4(3.5)	
P-value for trend[c]	0.01		0.6	
Material home conditions				
0 Worst	22.9(3.3	0.8	21.4(3.3)	0.9
1	22.9(3.7		21.3(3.7)	
2	22.3(3.6		21.6(3.4)	
3	22.2(3.7		21.4(3.5)	
4	22.6(3.5)		21.4(3.7)	
5 Best	22.5(3.7)		21.6(3.3)	
P-value for trend[c]	0.7		0.8	

Note: Study members are those with data for each individual measure+ mastery at age 68-9 (maximum n =2337). [a] Total numbers vary due to missing data. [b]*P*= differences in mean tested using one-way ANOVA. [c]Test of trend using linear regression.

3.3.3 Description of early psychosocial environment and mastery

The early psychosocial environment for those who provided mastery scores aged 68-9 is presented in table 3.3. It was uncommon for study members to experience more than two SLEs in their early environment. Women perceived that they had experienced higher parental support, and higher psychologically and behaviourally controlling parenting than men. Cross-tabulations of frequencies showed that SLEs were more frequent in environments with higher perceived parent behavioural control (table 3.5). Parents perceived as high in

behavioural control were more likely to be parents perceived high in psychological control and low parental support. Study members with higher perceptions of parental support had higher mean mastery. Higher perceived psychological and behavioural control, and more SLEs, were each associated with lower mean mastery (table 3.4).

Table 3.3. Descriptive characteristics of early psychosocial environment of study members with complete mastery data by sex [a]

	Men n=1128		Women n= 1209		
	N	%/ mean (SD)/ median (IQR)	N	%/mean(SD)/ median (IQR)	P-value sex difference
Stressful events (0-10) (%)					0.03
0-	155	15.0	140	12.7	
1-	334	32.4	409	37.1	
2-	318	30.8	553	31.0	
3-	138	13.4	125	11.3	
4+	85	8.25	86	7.8	
Perceived parenting					
Psychological control; mean (SD)	1008	8.8 (2.8)	1080	9.2 (2.9)	<0.001
Median (min, max)		8.5 (5,20)		9 (5,19)	
Behavioural control; mean (SD)	1006	14.2 (3.6)	1067	15.0 (4.0)	<0.001
Median (min, max)		14.0 (7,26)		14.5 (7,28)	
Parental support; mean (SD)	1014	23.1 (5.6)	1094	24.0 (6.4)	<0.001
Median (min, max)		23.5 (1,33)		25.0 (1,33)	

Note: Study members are those with data for each individual measure+ mastery at age 68-9 (maximum n =2337). [a] Total numbers vary due to missing data.

Table 3.4. Mean mastery score according to early psychosocial environment in study members with complete mastery data [a]

	Men Mean(SD)	*P-value Difference in mean*[b]	Women Mean(SD)	*P-value Difference in mean*[b]
Parental support quartiles		0.1		0.04
Low 0	22.2(3.9		20.9 (3.7)	
20-	22.4(3.5)		21.2 (3.5)	
24-	22.6(3.5)		21.5(3.5)	
High 28.5-	23.0(3.7)		21.8(3.3)	
P-value for trend[c]	<0.01		<0.01	
Parental psychological control quartiles				
Low 5 -	23.1(3.9)	<0.001	21.9(3.4)	<0.001
6.5-	22.8(3.4)		21.7(3.5)	
9-	22.4(3.3)		21.2(3.5)	
High 11-	21.7(3.9)		20.9(3.5)	
P-value for trend[c]	<0.001		<0.001	
Parental behavioural control quartiles				
Low 7-	22.8(3.7	0.3	21.5(3.5)	0.9
12-	22.2(3.7		21.5(3.4	
14.5-	22.7(3.3)		21.3(3.4	
High 17-	22.3(3.9		21.4(3.6	
P-value for trend[c]	0.44		0.65	
Stressful life events (0-10)				
0	22.6(3.6)	0.1	21.8(3.4)	0.2
1	22.8(3.4)		21.5(3.5)	
2	22.3(3.6)		21.5(3.5)	
3	22.1(3.6)		21.5(3.7)	
4+	22.1(3.9)		20.7(3.3)	
P-value for trend[c]	<0.001		0.03	

Note: Study members are those with data for each individual measure+ mastery at age 68-9 (maximum n =2337). [b]*P value* = differences in mean tested using one-way ANOVAS. [c]P value = Test of trend using linear regression.

3.3.4 Interplay between early socioeconomic and psychosocial exposures

Cross-tabulations between exposures across the early environment provided some evidence that indicators of early socioeconomic disadvantage co-occurred with indicators of early poor psychosocial environment (table 3.5). Study members whose parents had lower education reported higher perceived behavioural control from their parents, yet no differences in perceived parental support, psychological control or SLEs. Study members with fathers in unskilled or manual occupational positions reported higher perceived behavioural control. Those with higher ratings of material home conditions experienced fewer SLEs and reported higher parental support than those with lower-rated material home conditions.

Table 3.5. Summary table of cross-tabulations between multiple indicators of early environment using chi-squared tests of association

	1.	2.	3.	4.	5.	6.	7.	8.
1. Paternal education								
2. Maternal education	→							
3. Paternal occupational position	→	→						
4. Material home conditions	→	→	→					
5. Psychological control	-	-	-	-				
6. Behavioural control	←	←	←	-	→			
7. Parental Support	-	-	-	→	←	←		
8. Stressful life events	-	-	-	←	-	-	-	

Notes: Study members are those with data for each pair of measures+ mastery (maximum n =2337). Arrows represent an association between pairs of exposures tested by chi-squared tests

→ a positive association, ← an inverse association. - no association

3.3.5 Main findings: Associations between early socioeconomic exposures and mastery

Table 3.6 shows the results of sex-adjusted regression analysis between each early socioeconomic exposure and mastery at age 68-9. Paternal education and paternal occupational position were non-linearly positively associated with mastery (Table 3.6, models M1). Study members born to secondary educated fathers had mean mastery scores 0.5 (95% CI 0.1, 0.8) higher than those born to fathers with only primary education. Those from households headed by fathers in skilled non-manual occupations had 0.5 (95% CI 0.1, 0.9) higher mastery scores on average than those from skilled-manual households. Maternal education and material home conditions did not appear to be associated with mastery. A one standard deviation increase in early cognitive test score was associated with a 0.3 (95 % CI 0.1, 0.4) higher mastery score.

In a model considering all markers of early socioeconomic position simultaneously, the positive associations of mid-level paternal education and occupational position with mastery did not change (Table 3.6, model M2). An inverse association emerged between maternal education and mastery. The different directions of effects on mastery of maternal education, paternal education and paternal occupation is surprising given the descriptive suggestion that the three circumstances co-occur.

When this model was adjusted for early cognitive ability (model 3), the inverse association between maternal education and mastery strengthened in magnitude. Associations between paternal education and mastery, and paternal occupation and mastery, were attenuated.

Table 3.6 Associations between multiple dimensions of early socioeconomic environment and mastery, from multiple linear regression models

	Models 1[a], sex-adjusted	Model M2[b], mutually adjusted	Model M3[c], + cognitive ability
	Unstandardised regression coefficients (95% CI)	Unstandardised regression coefficients (95% CI)	Unstandardised regression coefficients (95% CI)
Paternal education			
Primary (*reference)*	0.00	0.00	0.00
Below secondary	0.38 (-0.08,0.84)	0.30 (-0.20, 0.79)	0.21 (-0.29, 0.71)
Secondary	0.47(0.09, 0.85)*	0.47 (0.00, 0.94)**	0.38 (-0.08, 0.85)
Degree/diploma	0.31(-0.18, 0.82)	0.50(-0.19, 1.18)	0.34(-0.35, 1.02)
Maternal education			
Primary (*reference)*	0.00	0.00	0.00
Below secondary	0.37 (-0.08, 0.81)	0.14 (-0.33, 0.61)	0.07 (-0.40, 0.54)
Secondary	-0.01 (-0.41, 0.38)	-0.40 (-0.87, -0.06)**	-0.50 (-0.97, -0.03)*
Degree/diploma	-0.24 (-0.86, 0.38)	-0.71 (-1.42, -0.00)*	-0.82(-1.53, -0.11)*
Paternal occupational position			
Unskilled	-0.31 (-1.03, 0.41)	-0.31 (-1.03, 0.42)	-0.23 (-0.96, 0.49)
Partly skilled	0.02 (-0.48, 0.44)	0.01 (-0.45, 0.46)	0.02 (-0.43, 0.49)
Skilled manual (*reference*)	0.00	0.00	0.00
Skilled non-manual	0.54 (0.10, 0.99)*	0.48(-0.00, 0.97)**	0.39 (-0.09, 0.88)
Managerial/technical	0.30 (-0.11, 0.71)	0.26 (-0.20, 0.75)	0.16 (-0.30, 0.62)
Professional	0.25(-0.35, 0.84)	0.20 (-0.55, 0.94)	0.10 (-0.63, 0.84)
Material home conditions			
0 Worst	0.08(-1.40, 1.55)	0.40(-1.16, 1.94)	
1	0.01(-0.74, 0.76)	0.22 (-0.61, 1.06)	
2	-0.12(-0.71, 0.47)	-0.03(-0.71, 0.64)	
3	-0.28(-0.76, 0.19)	-0.16(-0.70, 0.38)	
4	-0.07(-0.54, 0.39)	-0.15(-.64, 0.34)	
5 Best (reference)	0.00	0.00	
Cognitive ability (*per 1 SD increase)*	0.28 (0.11, 0.44)*		0.25 (0.06, 0.45)*

Based on n= 2038 study members using multiple imputation by chained equations; *= p<0.05; ** = p<0.10. Unstandardised linear regression estimates represent the mean difference in mastery scores at age 68-9 (95% Confidence Intervals).
[a] M1, each exposure included separately. [B] M2, all early socioeconomic exposures included together
[c] M3, exposures significant at p<0.10 mutually adjusted for cognitive ability

3.3.6 Main findings: Associations between early psychosocial environment and mastery

Associations between each indicator of the early psychosocial environment and mastery at age 68-9 are presented in Table 3.7. Sex-adjusted linear regression analysis showed that mean mastery scores were -0.2 (95% CI -0.3, -1.1) lower for each additional early stressful event (Table 3.7, models M1). Perceived parental support was positively associated with mastery. An inverse association between parental psychological control and mastery was found. There was no evidence of an association between parental behavioural control and mastery.

When all markers of early psychosocial environment were included simultaneously (Table 3.7, models M2), a positive association between perceived parental behavioural control and mastery emerged. In descriptive statistics perceived behavioural control had been shown to co-occur with fellow early psychosocial exposures. Testing of which indicator drove this adjustment showed that only holding perceived parental support and psychological control constant was there an association between parental behavioural control and mastery.

Table 3.7 Associations between multiple dimensions of early psychosocial environment and mastery, from multiple linear regression models

	Models M1[a], sex-adjusted	Models M2[b], fully adjusted
	Unstandardised regression coefficients (95% CI)	Unstandardised regression coefficients (95% CI)
SLEs (*per 1 event increase)*	-0.20 (-0.32,-1.08)*	-0.19 (-0.31 -0.06)*
Perceived parenting *(per 1 unit increase)*		
Parental support	0.05 (0.03, 0.08)*	0.05 (0.02, 0.08)*
Psychological control	-0.15 (-0.21, -0.10*	-0.15 (-0.21, -0.09*
Behavioural control	-0.03 (-0.07, 0.01)	0.05 (0.00, 0.11)*

Notes: Based on n= 2038 study members using multiple imputation by chained equations; * indicates p<0.05; ** = p<0.10.
Unstandardised linear regression estimates represent the mean difference in mastery scores at age 68-9 per 1 event increase for SLEs, and 1 unit increase in mean score for parenting exposures (95% Confidence Intervals).
[a]In models M1, each exposure was included separately
[b]In models M2, all early psychosocial exposures were included simultaneously

3.3.7 Main findings: Mutually adjusted associations between early environment and mastery

In a mutually adjusted model, most indicators of the early psychosocial environment remained associated with mastery (Table 3.8). Study members who had experienced fewer early SLEs, higher perceived parental support, and lower parental psychological control had higher mastery in early old age. The positive association between perceived parental behavioural control and mastery in the previous psychosocial model (Table 3.8) was removed by the addition of maternal education. Their co-occurrence had been suggested by the descriptive statistics; study members whose parents had lower education had perceived higher behavioural control from their parents, yet there were no differences in parental support, psychological control or the number of SLEs during their early life.

Early cognitive ability remained positively associated with mastery at age 68-9. The inverse association between maternal education and mastery was attenuated on adjustment for psychosocial factors. Examining the effect of adjustment by each psychosocial exposure separately did not show that a particular exposure was driving the attenuation of maternal education.

Table 3.8 Fully adjusted model showing associations between exposures from multiple domains of early environment and mastery, in linear regression models

	Model 4[a], fully adjusted Unstandardised regression coefficients (95% CI)
Maternal education	
Primary (*reference)*	0.00
Sub secondary	0.20 (-0.25, 0.65)
Secondary	-0.20 (-0.62, 0.22)
Degree/diploma	-0.48 (-1.12, 0.16)
Cognitive ability (*per SD increase)*	0.27 (0.08, 0.45)*
SLEs (*per 1 event increase)*	-0.16 (-0.29, -0.04)*
Parental support (per 1 unit increase)	0.04 (0.01,0.06)*
Psychological control (per 1 unit increase)	-0.12 (-0.18,-0.07)*
Behavioural control (per 1 unit increase)	0.05 (-0.01, 0.10)

Notes: Based on n= 2038 study members using multiple imputation by chained equations; * indicates p<0.05; ** = p<0.10.
Unstandardised linear regression estimates represent the mean difference in mastery scores at age 68-9 (95% Confidence Intervals).
[a]Multiply adjusted model including exposures significant at p<0.10 in the socioeconomic model 3 (table 3.6) and psychosocial model 2 (table 3.7).

3.4 Discussion

3.4.1 Summary of early environment and mastery findings

This chapter aimed to extend past research based on adolescent groups to examine if multiple indicators of early socioeconomic and psychosocial environment were associated with mastery at 68-9 years. Despite the passing of more than fifty years since the study members entered adulthood, there were observable variations in mastery relating to differences in early life. Sex-adjusted associations showed mastery at age 68-9 was higher in those who had fathers with mid-level socioeconomic occupations and education; lower-educated mothers; higher early cognitive ability; fewer early SLEs; and more supportive and more autonomy-granting parents.

Accounting for such comprehensive indicators of early environment allowed separation of shared and unique pathways between early circumstances and mastery in later life. Many socioeconomic circumstances overlapped with each other, with cognitive ability, and with psychosocial factors. In regression analysis only associations between psychosocial factors and mastery, and cognitive ability and mastery were unexplained by the presence of other exposures. Study members who experienced fewer SLEs before the age of 15, and those who perceived that their parents were less psychologically invasive, and more supportive of them, had higher mastery, whether or not their earlier environment was considered socioeconomically disadvantaged.

3.4.2 Early socioeconomic processes and mastery

3.4.2.1 Comparison with previous literature and explanation of findings

Summarising the pathway between separate indicators of early socioeconomic environment and adolescent mastery was challenging due to the majority of studies not accounting for comprehensive early socioeconomic indicators. In this chapter, cross-tabulations of frequencies indicated that the paternal education of study members was likely to correspond with their maternal education, paternal occupation grade and early material home conditions. Using mutually-adjusted linear regression, varying patterns of association between the multiple indicators

of early socioeconomic environment and mastery pointed to independent processes between each exposure and mastery.

3.4.2.2 Material home conditions

As described early in this chapter, previous theories about mastery have speculated that the societal evaluation of disadvantaged material home conditions may be reflected back at young people as evidence of a lack of control over their own circumstances [97, 107]. As mastery was only measured for the first time at age 68-9 in the NSHD, it was not possible to investigate whether material home conditions was associated with mastery earlier in this cohort or if the association changed. It is possible that the standard of living was less unequal in the post-war years in Britain than in America when these theories developed [196]. Without being noticeably materially disadvantaged compared to their peers, these young people may not have internalised their societal limits.

On balance, previous adolescent evidence did not indicate that material home advantage is associated with mastery. The conclusion from US studies of young people was that measures of household material conditions were not relevant to adolescent mastery unless adolescents experienced related parental distress or parental conflict. There was no NSHD measurement of whether study members experienced parental distress or conflict linked to early material home conditions. This information would advance comparison of the current finding with the available literature from US studies of adolescents in the late 1970s and 1990s [102, 162, 163].

3.4.2.3 Parental education

As described earlier in this chapter (section 3.1.2), it has been proposed educated parents can contribute to their offspring's mastery development through parent-to-child modelling of effective problem-solving skills [105-107]. The findings of this chapter reinforce this theory; the association between paternal education and mastery at age 68-9 was attenuated after adjustment for early cognitive ability. As previous socioeconomic research has suggested, fathers with more education

may be more likely to provide a home environment which encourages schooling and improves cognitive ability [175, 287]. The implication is that development of cognitive processes in the early environment supports a trajectory toward greater adult mastery.

In contrast to these findings, previous studies testing mean parental education, and a composite of parent education and income, showed remaining residual associations with adolescent mastery, after adjusting for cognitive test score [102], and self-reported cognitive ability [101]. Among other methodological differences, neither of these measures is the same as those used in the NSHD; it is hard to directly compare the results. It is possible that in the NSHD, parent education may have residual associations with mastery if tested in adolescence, thus indicating an additional process connecting parental education and mastery. After a greater number of years, the potential role of early cognitive ability in providing further opportunities to develop mastery is hypothesised to have surpassed any other residual contribution of paternal education to mastery.

Additionally, neither maternal nor paternal education demonstrated the expected positive dose-response association with mastery documented in the available adolescent studies [101, 102, 106]. Analyses in the current chapter showed that study members whose fathers were educated to secondary school level had higher mastery than those whose fathers had no education. However, there was no additional difference for having a further educated father. It is possible that few parents educated highly in the 1940s meant that associations were not visible.

Controlling for paternal education and occupation constant, study members whose mothers were more highly educated had lower mastery. This is inconsistent with the one study testing the contribution of maternal education to adolescent mastery. Moilanen et al. found no evidence of an association between a composite measure of maternal education and income, and adolescent mastery [162]. Putatively, the present finding may reflect a period effect of the mothers of the 1946 birth cohort study being denied career opportunities consistent with their education [288]. It is possible that maternal awareness of societal restrictions on their own autonomy and control abilities was transmitted to their offspring. However, more detailed measures are lacking with which to explore this

hypothesised pathway further. The descriptive statistics indicated that highly educated mothers were perceived as less supportive and more controlling of their children, this may have attenuated the association between higher maternal education and lower study member mastery.

3.4.2.4 Paternal occupation

Research ethnographies of families in the 50s and 70s emphasised how fathers in lower autonomy jobs (lower occupational position) prioritised obedience to authority in their children rather than autonomy [284, 289]. Based on this sparse evidence, along with adult mastery research, it was expected that mastery would be higher for each increase in paternal occupational grade. Surprisingly, study members whose fathers had worked in skilled non-manual jobs had the highest mastery, rather than those raised in households in the highest occupational position as expected. A previous study of Ryff's environmental mastery in female NSHD study members at age 43 showed the same pattern [290]. This study was not taken into account when reviewing the mastery literature as environmental mastery is different to personal mastery (see chapter 1, section 1.1.2). It is also possible that there would have been a linear positive association between paternal occupation and mastery but smaller numbers of study members in the NSHD whose fathers were working in the higher occupational grades meant that a lack of power reduced the significance of this association.

Like the non-linear association between paternal education and mastery, the association between paternal occupation and mastery was attenuated by early cognitive ability. As previously discussed, early cognitive ability is malleable to environmental influences. Parents working in occupations requiring more education have been demonstrated to encourage their children to engage with their own education [117, 157]; thus, cognitive development is hypothesised to be the mechanism between early paternal socioeconomic position and mastery.

3.4.2.5 Overall comparison with previous socioeconomic studies

As a whole, this chapter's analyses suggest that a more advantaged early socioeconomic environment may contribute to mastery in early old age through a context in which other relevant exposures are more likely. This assessment is consistent with literature in which outcomes between low SEP and high SEP children are explained, at least in part, by socioeconomic advantage placing fewer restrictions on parent-child interactions and children's cognitive development [162, 179, 284]. These findings imply that in isolation, early socioeconomic advantages are not enough itself to promote mastery.

3.4.3 Early psychosocial process and mastery

3.4.3.1 Comparison with previous literature and explanation of findings

Literature reviewed earlier in this chapter had pointed toward the importance of psychosocial processes in the development of mastery in adolescence. In this chapter, the findings suggested that similar psychosocial processes contributed to mastery in early old age.

3.4.3.2 Perceived parental support

The current findings build on evidence of the long-term value of parents who respond to their children with appropriate support, guidance and care [167]. Consistent with previous literature, perceptions of more supportive parenting was associated with higher mastery at age 68-9, independent of early socioeconomic indicators [101, 145, 162, 163]. Parental support may give children the confidence and competencies to manage challenges themselves, whatever their socioeconomic resources. Unlike previous mastery and adolescent literature, the current analysis did not suggest that low parental support in the early environment was more likely in families experiencing socioeconomic disadvantage [106, 145, 179]. Chapter 4 extends investigation of how perceived supportive parenting may be associated with adult mastery by exploring how it relates to adult exposures.

3.4.3.3 Perceived behavioural control

Previous literature indicated that high parental requirements for behavioural conformity is linked to lower self-confidence in adolescence and poorer long-term outcomes [167, 169, 170, 283]. Expanding this to mastery, the current analyses indicate an association between higher perceived behavioural control and lower mastery in early old age, although this association was not independent of other parenting types.

3.4.3.4 Perceived psychological control

Perceived parental psychological control had not previously been investigated in association with mastery. Findings of inverse associations between perceived psychologically controlling parenting and mastery at age 68-9 were not explained by lower perceived parental support or earlier SLEs. Parents who encourage mental over-dependence in their children may limit their chances to develop decision-making skills and a sense of competence [291]. The following chapter examines how adult exposures may contribute to the pathway between perceived psychological control and mastery in early old age.

3.4.3.5 Stressful life events

In support of previous adolescent evidence, experiencing a greater number of stressful life events (SLEs) before the age of 15 was directly associated with lower mastery in early old age [103]. As these SLEs were not closely correlated with the early socioeconomic environment or perceived parenting, it is unlikely that those processes explain how SLEs are associated with mastery. The detrimental effect of SLEs across life on mastery is a central tenet of Pearlin's work [94]. He hypothesises that experiencing events which are hard to manage undermines the degree to which a person could feel in control of their own circumstances. The following chapter explores how SLEs in earlier life may explain differences in mastery due to a pathway of risk of further SLEs in adult life [113, 256].

3.4.4 Methodological considerations

The main methodological issues in this thesis will be drawn together in the discussion chapter (chapter 7). Methodological issues relevant to this chapter are considered below.

Parenting styles that the study members perceived that they had experienced before the age of 16 were recalled when study members were aged 43. No similar prospective information was collected during earlier life. Further, the parental bonding instrument (PBI) captures the study members' perception of how their parents behaved to them; without checking it with parental or observer reports. These issues raise the possibility of selective recall of parent-child interactions biasing the associations reported in this chapter. For example, study members with low mastery at age 43 may have more negatively rated their parents, creating an overestimation of the size of the association between perceived parenting and mastery. However, several pieces of evidence validate the use of the PBI to capture study members reports of parenting after childhood. For example, grown-up siblings strongly agree on their recollections of parenting using the PBI [292], while recollections of parenting also appear stable over a 20-year period [293].

Another methodological issue relevant to the current analysis is the coding of early environment SLEs. The events, ranging in gravity from parental bereavement to moving to a new house, were chosen without knowledge of whether they were stressful for the individual at the time. The measure was based on studies finding that an accumulation of stressful events in childhood rather than just one or two regardless of type, substantially increases the risk of poor psychological development [294, 295].

An advantage of the NSHD data is that the prospectively measured data spans such a long period of time. Nonetheless, this does mean that some indicators of the early environment may have changed shortly before or after they were measured. For example, Douglas (p41) reported that more than a third of study members' fathers moved above or below their original occupational position within the first decade of the study [112]. Uncaptured changes in occupational position may have influenced financial resources, social status, family

relationships, cognitive ability, and study member mastery. It is possible that such potential measurement invariance obscured the estimation of associations between the study members' social background and mastery in early old age.

3.5 Conclusion and next chapter

This chapter suggests that the early environment plays a role in how much individuals in early old age perceive themselves to be in control of their own lives. A positive early environment may explain why some adults continue to feel mastery in early old age, despite experiencing challenges expected to be associated with lower mastery (investigated in chapter 4).

Independent pathways between several early life exposures and mastery existed. Study members who had experienced fewer SLEs, and perceived that their parents granted them more psychological autonomy and gave more support had higher mastery in early old age. This was independent of socioeconomic position, which itself did not remain associated with mastery. The following chapter (chapter 4) will explore whether early psychosocial exposures are associated with mastery directly, or through further pathways to adult experiences.

The following chapter (chapter 4) takes a life course perspective in examining the interplay between earlier life exposures and experiences from across adulthood, and associations with mastery in early old age. Early SLEs, parental autonomy-granting and support, and cognitive ability have plausible links to circumstances across adult life that are subsequently associated with adult mastery. Extending the analysis of chapter 3 will contribute to understanding processes across life that encourage mastery. Understanding the lifelong contributions to mastery in NSHD study members at age 68-9 in chapter 4 will further inform analysis of the relationship between mastery and physical capability in chapters 5 and 6.

4. ASSOCIATIONS BETWEEN EXPOSURES FROM ACROSS LIFE AND MASTERY IN EARLY OLD AGE

The aim of this chapter was to build upon findings from chapter 3 to investigate potentially life-long processes underlying mastery. The objectives were to test how adult socioeconomic exposures (including education, occupational position and income indictors) may each uniquely be associated with mastery; while assessing separate pathways from adult psychosocial exposures (SLEs, social support), and early environment factors.

As established in chapter 1, mastery is a self-concept indicating the extent to which an individual perceives that they can manage their own life. It is thought to be based not only on how manageable current circumstances objectively are, but the individual's prior concept of themselves as someone who managed their own life [92-94]. Chapter 3 identified associations between several early environment exposures and mastery at age 68-9, despite more than five decades passing since study members reached adulthood. Perceptions of more supportive parenting, less psychologically invasive parenting, and fewer early stressful life events were implicated in higher mastery in early old age. Chapter 4 begins by investigating whether multiple socioeconomic and psychosocial exposures from across adult life, including current circumstances, each directly contribute to mastery in early old age. This chapter goes on to build on the findings of chapter 3 to examine how early life factors and adult socioeconomic and psychosocial exposures may operate together to explain differences in mastery in early old age. The aim is that conclusions from this chapter will advance understanding into the processes between circumstances across life and a good sense of mastery over current circumstances, whatever they may be, in early old age.

4.1 Introduction

4.1.1 Theoretical background behind the adult environment and mastery

Findings of positive associations between mastery and, the maintenance of physical capability, independence, and longevity during older age, suggest the need for more research into how people entering older age can feel in control of their circumstances [8, 33, 77]. There has been a substantial amount of research into the antecedents of mastery, yet conclusions are not clear. This section reiterates the theory as to which individuals are expected to have higher mastery; highlighting where more evidence is needed.

Pearlin and colleagues suggest that people who are experiencing disruptive circumstances are less likely to report high mastery [94]. Early old age is a period associated with many anticipated life changes which could be experienced as hard-to-manage [153]. For example, retirement-linked changes in occupation and income; aging-related increases in chronic health conditions; the onset of caring responsibilities, and bereavement, within interpersonal relationships. Associations between each of these circumstances and low mastery suggest that some individuals in early old age may be particularly vulnerable to low mastery [31, 134, 149, 296]. Yet as noted in the introduction the same circumstances may be perceived as manageable or unmanageable to different individuals. One or two studies have reported strong mean mastery and even increases in mastery in older cohorts [297-299]. Factors such as the individual's existing mastery or alternative support systems [94, 131] may suppress the saliency of an objectively hard-to-manage situation to mastery.

Both an individual's perception of their circumstances and the circumstances themselves may relate to prior factors. Primarily, mastery literature has not been able to measure factors much preceding the measure of mastery, let alone the early environment. Chapter 3 described theories suggesting that a strong sense of mastery in early life might both influence later exposures positively linked to mastery, and, the perception of circumstances as manageable. In that case, an

individual with a favourable earlier environment may retain strong mastery throughout hard-to-manage adult circumstances.

Associations between the earlier environment and adult mastery may also be explained by exposures connecting across life. In the NSHD it has been shown that socioeconomic background is associated with primary education attainment, net of the original cognitive ability of the child, then higher education opportunities net of earlier attainment, and earning disparity into adulthood, net of education opportunities [174, 175, 300, 301]. Psychosocial exposures are similarly linked across life. Early SLEs and parental psychological control and low support are associated with a greater likelihood of adult SLEs and disruption of later social relationships, as well as poorer socioeconomic outcomes [133, 151, 163, 165, 176, 177]. This chapter aims to understand how experiences from across life integrate and contribute to pathways associated with stronger mastery, whether or not individuals are challenged in early old age.

4.1.2 Literature review: socioeconomic pathways to mastery

As detailed in chapter 1 (section 1.3.2), adult socioeconomic position (SEP) is the core set of circumstances suggested to develop and maintain mastery; through the shared reflection of status, and unique processes inherent to separate socioeconomic indicators [75, 92, 94, 98, 104]. The following section presents a brief review of the available literature to inform investigation of whether and how adult socioeconomic factors are associated with mastery. Of the available evidence seven studies have tested the association between indicators of adult socioeconomic environment and mastery. The data comes from Canadian and American surveys.

4.1.2.1 Evidence for associations between education and mastery

As discussed in chapter 1 (section 1.3.2.2), education is theorised to develop problem-solving competencies which contribute to a greater ability to manage circumstances [105]. Education may also operate through facilitating a higher occupational position and more income; themselves theorised to contribute to mastery [92, 122, 123, 128, 258]. Six available studies have tested associations

between education and mastery alongside fellow indicators of socioeconomic position to make inferences on the processes involved.

Positive associations between education and mastery have been reported in working age adults, net of income and occupational position [46, 92, 94, 122, 123, 128, 129, 258, 302]. In contrast, no associations between education and mastery, net of income or past occupational position, have been identified in retirement age cohorts [46, 94, 129]. Greater recency of education to younger cohorts may explain the difference in findings. All studies used North American cohorts thus disallowing study of cultural differences in the meaning of education for mastery. Unreported bivariate associations leave it unclear whether pathways from education to income or pre-retirement occupational position contributed to differing patterns between education and mastery. Several more North American studies not accounting for income or previous occupation when testing associations between education and mastery in retirement age cohorts have reported positive associations.[25, 46] Potentially stronger pathways from education to greater income or past occupation in older cohorts explain different findings between age groups.

4.1.2.2 Evidence for associations between occupation position and mastery

In two available cohorts of North American working-age adults it was reported that those in managerial and professional occupations have higher mastery than those in lower-grade occupations. The cross-sectional associations were completely explained by several characteristics of higher-grade positions; schedule control, job autonomy, enriching work, and higher income [122, 123]. Unlike with education and mastery, the available evidence suggests the association between occupational position and mastery persists into retirement age, net of education and accumulated wealth [94]. As bivariate associations were unreported in the former studies it is not clear how large the role of higher income was in explaining the association between higher occupational position and mastery in working-age adults. The classic Whitehall studies suggest that job characteristics of low schedule control and task autonomy are key to poor outcomes associated with low control at work [30].

4.1.2.3 Evidence for associations between income and mastery

As discussed in chapter 1 (section 1.3.2.4) income is thought to contribute to mastery because money buys a certain degree of control through the fulfilment of needs and providing more choice over circumstances [127, 133]. As with available evidence of associations between education and mastery, the reports of associations between indicators of income and mastery are inconsistent. Three cross-sectional studies found income bands linearly positively associated with mastery in working age Americans, net of education and occupation level [45, 122, 128]. Whereas, in older US adults, income was not associated with mastery (simultaneously adjusting for education and previous occupation) [94]. Lachman et al. (1998)[37] reported associations between income and mastery in older US adults but noted substantial within-income-group differences: many low income participants had high mastery and vice versa. On the basis of this evidence additional processes contribute to mastery in older adults.

The perception of income may explain differences in patterns of associations between income and mastery. Adolescent mastery studies reported in the previous chapter (3), indicated that low (family) income in itself was not associated with mastery; feeling 'under pressure financially' was the explanatory process. In the adult mastery literature the one available study demonstrated positive associations between self-reported financial 'security' and mastery; net of the remaining association between objective income and mastery [122].

4.1.3 Literature review: Adult psychosocial environment and mastery

This chapter continues the work introduced in chapter 1 of identifying psychosocial processes contributing to mastery. Individuals disadvantaged by the structural socioeconomic barriers described in above sections, or associated health inequalities, need to be supported to gain mastery beliefs through other processes [12]. In order to inform the test of whether and how the adult psychosocial environment is associated with mastery in early old age, this section presents a review of the relevant adult literature. Ten studies have assessed associations between psychosocial exposures and mastery, such as social support and stressful life events (SLEs). The predominately North American available literature is reviewed in below.

4.1.3.1 Evidence for associations between social support and mastery

Chapter 1 established that social support can provide 'instrumental' practical help to manage circumstances, or positive social support, described as "the sharing of confidences and interests, and degree of self-esteem held within an individual's closest relationship" [31, 268, 303]. In the absence of stressful circumstances, or without instrumental support, social constructionists posit that an individual's closest relationship can itself give individuals "the confidence and self-assurance that helps them feel in control of their lives" [303]. The implication is that social support is a psychological resource which helps people feel more in control of challenges and therefore facilitates mastery. A bi-directional process between social support and mastery is not excluded; as shown in one short study testing the relationship [304]. However, longitudinal data supports that those with more social support do not lose mastery to the same extent when experiencing a stressor such as unemployment, as those with lower social support [134].

Several small cross-sectional studies suggest that both higher instrumental and positive social support differentiate people who have higher mastery despite experiencing a range of disruptive circumstances [135-137, 139]. Based on the studies published there is no indication that differences in the nature of support produce different associations between mastery and social support; as some areas of health research have documented [305].

The social support and mastery literature has not consistently accounted for contextual factors which may suppress or invert the association between higher social support and mastery; for example, socioeconomic disadvantage, SLEs, or chronic health problems. The one study reporting that social support was associated with lower mastery, used a cohort of elderly Singaporean adults [147]. The difference in pattern of findings may be due to the measurement of social support including family instrumental support with daily living as well as positive social support. Being near completely dependent on others for support to live may undermine mastery in a way that positive social support does not for groups of more independent individuals [306, 307].

This Singaporean study above is but one of the published studies assessing social support and mastery limited to American populations. Its findings may also contrast from the US research due to differences in culture, values, or societal structure being reflected in differences in how mastery is developed and maintained [138, 188].

Close relationships can be characterised by both warmth and conflict yet little evidence exists testing associations between negative social support in close relationships and mastery [268]. In the case of negative social support, strain and conflict are linked to low self-esteem in the receiver which could contribute to a person feeling unable to manage their circumstances [308]. Negative interactions, such as relatives and friends making too many demands, and being too critical, have been linked with lower mastery [257]. Loss in positive social support and chronic low positive support has also been demonstrated in association with a decrease in mastery over a four year period in older Americans [25]. Although these findings are promising, negative social support within one's closest relationship has yet to be tested as a contributing factor for low mastery.

4.1.3.2 Evidence for associations between SLEs and mastery

In chapter 3 the findings implied that an accumulation of SLEs in the early environment were associated with mastery in early old age. It is a central tenet of mastery theory that a single SLE is a risk for low mastery. Discrete SLEs such as bereavement, family illness and rifts, divorce, moving house and robbery, can cause substantial upheaval; plausibly reminding the recipient that they do not control their own life. The gap in research is that few studies have tested the persistence of associations between accumulated SLEs over a lifetime and mastery.

The available literature is limited to four North American studies. Two reporting associations between change in SLEs and decreases in mastery over four years; two reporting a cross-sectional association between a higher number of recent SLEs and lower mastery [94, 149, 150, 251]. In the four-year studies, although mastery was measured at two timepoints, change in SLEs from baseline was recalled at the end, which raises concerns of recall bias contingent on current

mastery. That is, individuals with current higher mastery may be more likely to forget the occurrence of SLEs. Still, the evidence for increasingly lower mastery associated with each accumulated SLE is supported by the wider SLE literature. Studies report that with each additional SLE there is an associated increase in poor psychological outcomes increases [133, 151].

The four studies cited have not consistently tested processes between accumulated SLEs and lower mastery. One suggestion in mastery literature is that it is the circumstances in which SLEs are most numerous which contribute to lower mastery rather than a higher frequency of SLEs. That, is, SLEs have been shown to co-occur with relevant socioeconomic and psychosocial exposures; for example, low income, or close relationships [75, 133, 150, 152, 153]. The explanation for associations between SLEs and mastery could also travel in the other direction: SLEs disrupting daily life through producing or exacerbating economic strain, or placing a burden on social support [134].

Testing of a wider range of potentially co-occurring exposures, and testing changes in the effect size of associations between SLEs and mastery may clarify the processes involved. Of the four studies available, three simultaneously included at least one of, income, education, or past occupational position; reporting that associations between more SLEs and lower mastery were independent of socioeconomic circumstances [94, 149, 150]. One of the studies also noted that the association between higher SLEs and mastery was independent of social support [150]. Overall this evidence gives some support that psychosocial exposures such as SLEs and social support contribute to mastery independently of each other, and of the structural socioeconomic barriers described in the above sections [12]. However, more evidence, and an extension into clarifying the processes between SLEs and mastery is required.

4.1.4 Literature discussion and summary

The available literature suggests grounds for higher education, occupational position, income and income perception being positively associated with mastery in early old age. It also suggests associations between fewer SLEs and mastery,

and better social support and mastery. As mentioned in the previous sections there are several limitations of the existing literature which this chapter builds on in testing the contributions of exposures across life to mastery in early old age.

The large majority of available evidence is cross-sectional using retrospectively captured measures; thus, limiting testing of chains of exposures toward mastery. Without temporality having been established the explanation of associations between, for example SEP exposures from different periods of life, and mastery is less clear. Longitudinal studies have not been consistently able to investigate whether or how the earlier environment plays a role in processes explaining mastery in early old age.

No studies consistently account for potential overlap between the socioeconomic and psychosocial environment to isolate processes contributing to mastery. The findings from chapter 3 offered mixed support for overlapping psychosocial and socioeconomic environments explaining their respective associations with mastery. NSHD study members with lower ratings of early material home conditions had experienced more early SLEs and recollections of poorer parental care and support, but other early socioeconomic and psychosocial exposures were no more than weakly correlated. Yet, as described there is still the potential for associations between socioeconomic exposures and mastery being partly explained by psychosocial processes and vice versa [94].

The available literature has not consistently accounted for other processes contributing to associations between socioeconomic circumstances and mastery in early old age. As indicated in chapter 1, physical conditions such as cardiovascular disease, diabetes, respiratory problems, and arthritis, and mental health problems such as depressive symptoms, are unevenly distributed in low SEP and more commonly reported with low mastery [5, 47, 81, 186, 254, 309].

Studies testing associations between adult indicators of SEP and mastery have largely not investigated potential cognitive processes. In chapter 3 associations between paternal socioeconomic indicators and mastery were attenuated by adolescent cognitive function; suggesting a role for cognitive processes between SEP and mastery. Chapter 1 introduced that higher cognitive function, which

research suggests can be influenced by SEP, may allow people to manage their circumstances better, therefore have higher mastery; yet there is little evidence testing this pathway [117, 118].

The majority of studies published into antecedents of mastery are from the US. As chapter 1 established, there are some cross-cultural differences in mastery [42, 138, 188], which may explain inconsistent findings regarding social support and mastery.[147] British adults in early old age differ from their North American counterparts in socioeconomic and psychosocial resources, and in their mastery.[192] As such previous international findings need testing in a British population.

Using a life course framework, supported by multiple waves of data collections this chapter will build upon available literature and the findings of chapter 3 to test pathways to mastery across a whole lifetime (see figure 4.1). As depicted in figure 4.1 this chapter will test whether education, occupational position, income, and income perception are related to mastery in British adults in early old age. It will also test whether current positive and negative social support, and SLEs accumulated across adulthood, are associated with mastery in this group. Testing these associations simultaneously along with early environmental exposures suggested by chapter 3, accounting for current chronic physical conditions, depressive symptoms, and cognitive function, allows this chapter to further the discussion of what processes people use to feel in control of their own lives.

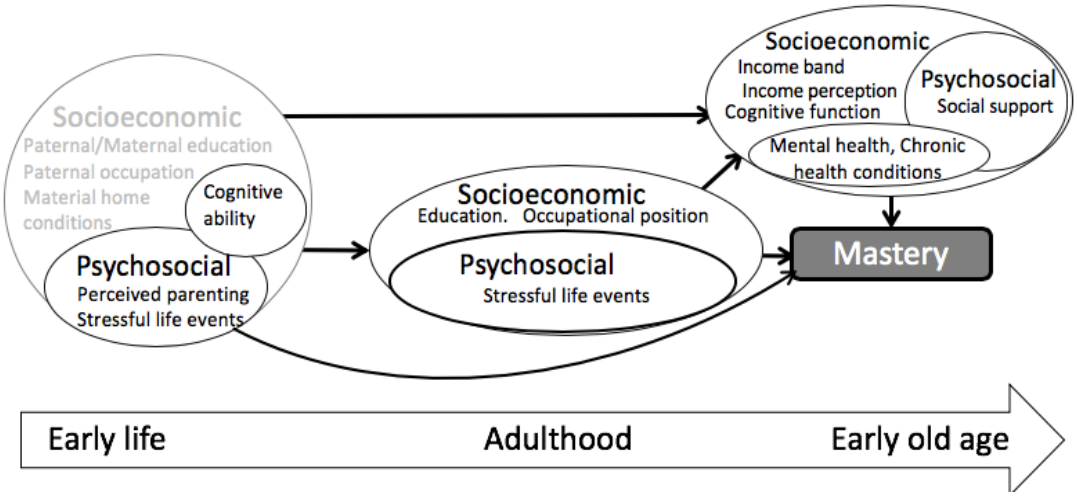

Figure 4.1 Conceptual model theorising pathways of association between exposures across life and mastery in early old age**;** greyed out circles indicate exposures removed in the preceding chapter (3). Note: overlapping circles depict potential co-occurrence of exposures

4.2. Analysis plan

The analysis in this chapter tested objectives ii and iii (chapter 2; section 2.1): To test the direct and indirect associations between multiple indicators of socioeconomic and psychosocial environment across adulthood with mastery at age 68-9; and to assess whether associations between exposures across life and mastery at age 68-9 are independent of each other, contemporaneous cognitive function, chronic health conditions and mental health (depressive symptoms).

It was hypothesised that greater socioeconomic advantage- i.e. higher occupational position, education, income band and income perception will be positively associated with mastery aged 68-9.

It was hypothesised that the higher the number of SLEs across adulthood, the lower the mastery of adult study members, independent of socioeconomic exposures. It was hypothesised that greater positive social support in early old age will be associated with higher mastery and greater negative social support associated with lower mastery, independent of socioeconomic exposures.

It was hypothesised that greater cognitive function, fewer depressive symptoms, and no diagnosis of chronic health conditions (respiratory problems, osteoarthritis, cardiovascular disease and diabetes) will be associated with higher mastery at age 68-9. It was hypothesised that indicators of the adulthood socioeconomic and psychosocial environment would correlate with these contemporaneous factors, yet independent socioeconomic and psychosocial associations were expected with mastery.

It was hypothesised that associations between early environment factors demonstrated in chapter 3 (perceived parental support, perceived parental

psychological control, early SLEs, and early cognitive ability) and mastery would remain following simultaneous adjustment for exposures across life.

4.2.1 Analytical sample

As in chapter 4, the analytical sample in this chapter was restricted to those NSHD participants with complete data on mastery at age 68-9 (n=2038). Multiple imputation by chained equations was used (process described in chapter 2; section 2.4.1) to impute missing exposures under the assumption that data was missing at random. The main associations in the maximum available sample with complete data were compared using sensitivity analyses to those run on imputed data sets. Regression estimates from models fit using multiply imputed data were similar in magnitude and direction to analysis using only complete cases, therefore the latter was not presented.

4.2.2 Descriptive analyses

To assess the lifetime socioeconomic and psychosocial environment of study members with complete mastery data at age 68-9, data were presented using proportions, or mean scores and standard deviations (SD) (to describe categorical and continuous exposures respectively). Chi-squared tests investigated sex differences for proportions, and one-way ANOVAs for mean scores. The coding of all exposures was described in chapter 2 (section 2.3).

Indicators of the adult socioeconomic environment were education by age 26, own occupational position at 53, total net household income band, and income perception (of how well the study member manages financially) reported at age 68-9. Cognitive function was captured at age 69-70 by overall score on Addenbrooke's Cognitive Examination (ACE-III). Indicators of the adult psychosocial environment were total SLEs between ages 26 and 68-9, and negative and positive social support from their closest reported person at the age of 68-9. The exposures reflecting health conditions at age 68-9 were depressive symptoms and four chronic health conditions. Depressive symptoms were reported at age 68-9 using the 28-item General Health Questionnaire (GHQ-28).

Chronic health conditions were diagnosis of any cardiovascular diseases, or diabetes, between age 36 and 68-9, respiratory symptoms in the past three years, and diagnosis of osteoarthritis between 60-64 and 68-9.

To assess the extent to which adult exposures co-occur within and across respective socioeconomic and psychosocial environments, associations between pairs were examined using chi-squared tests. For this purpose, all continuous variables were categorised into quartiles. Chi-squared tests were further used to describe the relationship between adult exposures and early environment exposures taken forward for investigation from chapter 3. Interactions between sex and each adult variable were formally tested but there was no evidence of this (at the 10% level) so all analyses were sex-adjusted.

4.2.3 Regression models

Sex-adjusted linear regression was used to analyse associations between each adult exposure and mastery at age 68-9. First, mean differences in mastery were estimated for each adult exposure considered one at a time. Next, adult exposures reflecting the adult socioeconomic environment (education achievement at age 26, occupational position at age 53, income band and income perception age 68-9) were entered into a mutually adjusted model. In the next step, the socioeconomic model was adjusted for adult cognitive function at age 69-70. All adult psychosocial environment exposures were mutually adjusted within a separate linear regression model (SLEs between age 26 and 68-9; positive and negative social support age 68-9). After that adjustment in socioeconomic and psychosocial groupings, exposures remaining statistically significant at the 10% level in each were entered together in a fully adjusted model to consider adult environment as a whole in relation to mastery.

Next, the early environment exposures taken forward from chapter 3 were mutually adjusted in a model with the remaining adult exposures. These early environment exposures were early SLEs, perceived parental support and psychological control, and cognitive ability. Finally, all statistically significant exposures were adjusted for current mental health and chronic health conditions.

4.3 Results

4.3.1 Description of adult socioeconomic environment and mastery

Table 4.1 presents the adult socioeconomic environment for those providing mastery scores. It was uncommon to be educated further than A-level equivalent. At age 53 most study members were grouped within mid-level occupational tiers (managerial/technical and skilled non-manual occupations). Around two thirds (67%) of study members described their income perception as comfortable at age 68-9. Overall men had received more education than women, had held higher occupational positions, and were in a higher household income band; yet no there was no difference in income perception at age 68-9. The average cognitive score measured by the Addenbrooke's Cognitive Examination III (ACE-III) at age 69 was 91.51 (SD 6.0). As expected the socioeconomic exposures were interrelated. That is, cross-tabulations of frequencies demonstrated that study members with higher education were also more likely those with higher occupational position, household income band and income perception (table 4.7).

Assessing differences in mean mastery by each adult socioeconomic indicator supported evidence of socioeconomic disparities in mastery (section 4.1.2). For occupational position at age 53, and income perception, and household income band at age 68-9 there was an approximate difference of 2 units in mean mastery between the bottom and top categories. Far smaller differences in mean mastery between education levels were observed along with a non-linear pattern; mastery being highest for those with A-level or equivalent rather than further education.

Table 4.1 Descriptive characteristics of adult socioeconomic environment of study members with complete mastery data by sex [a]

Exposure	Men n=1128		Women n= 1209		
	n	%/ median (IQR)/mean (SD	**n**	% or mean (SD)/ median (IQR)	*P-value* [b]
Education (%)					
No qualifications	347	32.4	350	30.5	<0.01
Below secondary school	59	5.5	105	9.1	
O-level	159	14.8	312	27.2	
A level or equivalent	315	29.4	300	26.2	
Degree or higher	188	17.6	78	6.8	
Occupational position (%)					<0.01
Unskilled	25	2.2	53	4.4	
Partly skilled	78	7.0	154	12.9	
Skilled manual	263	23.7	93	7.8	
Skilled non manual	115	10.3	439	36.8	
Managerial/technical	476	42.9	427	35.7	
Professional	152	13.7	27	2.2	
Income perception (%)					0.29
Hard to manage	34	3.7	46	4.7	
Managing fairly well	267	29.3	297	30.7	
Managing comfortably	610	66.9	623	64.4	
Income band quartiles (%)					
1 = < 6,000 to 11,999	136	15.7	232	26.0	<0.01
2= 12,000 to 20,999	230	26.5	242	27.1	
3= 21,000 to 29,999	172	19.9	157	17.6	
4 =30,000 to 80, 000	325	37.6	260	29.1	
Cognitive function; mean(SD)	747	91.6 (5.5)	809	92.0 (5.8)	0.17
Median (min, max)		93 (53,100		93 (59,100)	

Note: Study members are those with data for each measure+ mastery at age 68-9 (maximum n =2337). [a] Total numbers vary due to missing data. [b]*sex differences* = chi-squared tests for categorical, one-way anovas for continuous variables.

Table 4.2 Mean mastery according to indicators of adult socioeconomic environment in study members with complete mastery data by sex [a]

	Men: Mean (SD)	P value [b]	Women Mean (SD)	P value [b]
Education		<0.01		<0.01
No qualifications	22.1 (3.4)		21.1 (3.7)	
Below secondary school	22.4 (3.4)		21.6 (3.7)	
O-level	22.7 (3.5)		21.3 (3.4)	
A level or equivalent	22.9 (3.8)		21.8 (3.4)	
Degree or higher	22.6 (3.7)		21.1 (3.2)	
P value [c]	<0.05		0.07	
Occupational position		<0.01		<0.01
Unskilled	20.6 (4.2)		20.6 (3.2)	
Partly skilled	22.6 (3.7)		20.6 (3.4)	
Skilled manual	22.1 (3.7)		20.7 (3.7)	
Skilled non manual	22.6 (3.5)		21.3 (3.5)	
Managerial/technical	22.7 (3.4)		21.9 (3.8)	
Professional	22.7 (3.4)		22.6 (3.2)	
P value [c]	<0.05		<0.01	
Income perception		<0.01		<0.01
Hard to manage	20.3 (3.5)		20.1 (3.7)	
Managing fairly well	21.4 (3.5)		20.9 (3.4)	
Managing comfortably	22.3 (3.5)		21.8 (3.5)	
P value [c]	<0.01		<0.01	
Income band quartile		<0.01		<0.01
1 (lowest)= < 6,000 to 11,999	21.3 (3.5)		20.9 (3.4)	
2= 12,000 to 20,999	22.1 (3.5)		21.1 (3.2)	
3= 21,000 to 29,999	22.4 (3.6)		21.4 (3.6)	
4 (highest)= 30,000 to 80, 000	23.1 (3.4)		22.1 (3.5)	
P value [c]	<0.01		<0.01	

Note: Study members are those with data for each individual measure+ mastery (maximum n =2337). [a] Total numbers vary due to missing data. [b] *P value* = differences in mean using one-way ANOVA. [c] P value = Test of trend using linear regression.

4.3.2 Description of adult psychosocial environment and mastery in early old age

The adult psychosocial environment for those who provided mastery scores aged 68-9 is presented in table 4.3. Out of a possible 35 SLEs across adulthood 98% of study members had experienced at least one event; the median being five. It was uncommon to have experienced more than 11 SLEs (2.6% study members reported more than 11). Women reported more than men. More women reported

low positive social support from their closest person than men, yet no differences in negative social support. For just over two thirds of study members (67%) the person closest to them at age 68-9 was a source of mid to high level positive social support but for 24.8% their closest person was rated as providing the most negative social support.

Cross-tabs of frequencies indicated that in the adult psychosocial environment there was slightly less overlap than between adult socioeconomic indicators (table 4.7) Positive social support from the closest person was inversely related to negative social support as expected. Frequency of SLEs did not differ by positive social support but SLEs were substantially higher with worse negative social support ($p < 0.001$).

Table 4.3 Adult psychosocial characteristics of study members with complete mastery data[a]

Exposure	**n**	Men n=1128	**n**	Women n= 1209	*P value*[b]
Stressful events (range 0-35) (%)					
0-2	81	17.7	81	10.9	0.02
3	86	13.0	95	12.8	
4	96	14.5	105	14.2	
5	102	15.4	103	13.9	
6	91	13.8	101	13.6	
7-8	93	14.1	134	18.1	
9-22	74	11.2	120	16.2	
Median (min, max)		5 (0,15)		5 (0,22)	
Positive social support; mean (SD)	1100	6.4 (1.9)	1172	6.1 (1.9)	0.01
Median (min, max)		7 (1,9)		6 (1,9)	
Negative social support; mean (SD)	1091	1.6 (1.5)	1169	1.7 (1.5)	0.23
Median (min, max)		1 (0,9)		1 (0,9)	

Note: Study members are those with data for each individual measure+ mastery at age 68-9 (maximum n =2337). [a] Total numbers vary due to missing data. [b] = sex difference using chi-squared tests for categorical exposures and one-way anovas for continuous variables

Table 4.4 Mean mastery according to indicators of adult psychosocial environment in study members with complete mastery data by sex [a]

Stressful events (range 0-35) (%)	Men Mean (SD)	P value [b]	Women Mean (SD)	P value [b]
0-2	22.6 (3.6)	<0.001	22.3 (3.3)	0.01
3	22.1 (3.4)		22.0 (3.4)	
4	22.1 (3.4)		21.6 (3.3)	
5	21.2 (3.6)		21.7 (3.3)	
6	20.7 (3.6)		20.9 (3.7)	
7-8	19.9 (3.6)		20.1 (3.6)	
9-22	19.8 (3.5)		19.5 (3.5)	
P value [c]	<0.001		0.03	
Positive social support (quartiles)		<0.001		<0.001
Low 0-	20.3 (3.6)		20.0 (3.6)	
Low mid 5-	21.4 (3.3)		21.2 (3.3)	
Mid 6-	22.1 (3.4)		22.5 (3.4)	
High (best) 8-9	23.3 (3.4)		23.1 (3.4)	
P value [c]	<0.001		<0.001	
Negative social support (quartiles				
Low 0-	23.5 (3.6)	<0.001	23.2 (3.4)	<0.01
Low mid 1-	22.1 (3.3)		22.0 (3.6)	
Mid 3-	20.5 (3.4)		20.1 (3.3)	
High (worst) 4-9	20.1 (3.4)		20.0 (3.6)	
P value [c]	<0.01		<0.01	

Note: Study members are those with data for each individual measure+ mastery (maximum n =2337). [a] Total numbers vary due to missing data. [b] *P value* = differences in mean using one-way ANOVA. [c] P value = Test of trend using linear regression.

4.3.3 Description of chronic health conditions and depressive symptoms

Table 4.5 describes the chronic health conditions and mental health of the study members, by sex. Women reported slightly higher depressive symptoms than men (mean 16.5 vs 14.1). The majority of study members did not report having each chronic health condition. More men had cardiovascular disease and diabetes, while more women had osteoarthritis. There were no sex differences in prevalence of respiratory difficulties. Examining cross-tabulations between pairs of variables indicated that study members with more socioeconomic advantage were less likely to have been diagnosed with chronic health conditions (table 4.7).

Overall mean mastery was appreciably lower for study members with chronic health conditions relative to those without that diagnosis (table 4.6). For men there was little difference in mastery whether or not they had been diagnosed with diabetes.

Table 4.5 Adult mental and physical health of study members with complete mastery data by sex [a]

	Men	n	Women	N	P [b]
Depressive symptoms; Mean (SD)	14.1(7.4)	901	16.5(8.2)	951	<0.01
Median (min, max)	12(0,82)		14(1,62)		
Cardiovascular disease (% yes)	16.0	181/1121	9.1	103/1204	<0.01
Respiratory difficulties (% yes)	23.9	249/1039	21.8	247/1131	0.22
Osteoarthritis (% yes)	16.2	151/ 930	25.8	261/991	<0.01
Diabetes (% yes)	13.6	154/ 1126	10.0	110/1206	<0.01

Note: Study members are those with data for each individual measure+ mastery at age 68-9(maximum n =2337). [a] Total numbers vary due to missing data. [b] = sex difference tested using chi-squared tests for categorical exposures and one-way anovas for continuous variables

Table 4.6 Mean mastery according to indicators of adult chronic health conditions in study members with complete mastery data by sex [a]

	Men Mean (SD)	P value [b]	Women Mean (SD)	P value [b]
Cardiovascular disease		<0.001		<0.001
Yes	21.5 (3.4)		20.5(3.5)	
No	22.7 (3.4)		21.5(3.4)	
Respiratory difficulties		<0.001		<0.001
Yes	20.9 (3.8)		20.7(3.8)	
No	22.2 (3.5)		21.7(3.5)	
Osteoarthritis				
Yes	21.9 (3.6)	<0.001	21.1 (3.5)	0.03
No	22.8(3.5)		21.6 (3.7)	
Diabetes				
Yes	22.1(3.7)	0.11	20.5 (3.5)	0.01
No	22.9(3.5)		21.1 (3.5)	

Note: Study members are those with data for each individual measure+ mastery (maximum n =2337). [a] Total numbers vary due to missing data. [b] *P value* = differences in mean using one-way ANOVA.

4.3.4 Interplay between socioeconomic and psychosocial factors from across the early environment to early old age

Using cross-tabulations of frequencies between pairs of variables it was assessed how factors relevant to mastery co-occurred (table 4.7). Consistent with findings from the early environment reported in chapter 3 some indicators of adult socioeconomic advantage overlapped with indicators of adult psychosocial advantage. Current positive social support was positively associated with income band, income perception, education and occupational position (p=0.03 to 0.04). Study members with higher occupational position (p=0.03) and the highest income perception (p=0.003) reported fewest adult SLEs.

Returning to the early environment, study members who had perceived their parents as most psychologically controlling had the most negative social support aged 68-9 (p=0.08), and lowest occupational position age 53 (p=0.03). In chapter 3 it had been reported that perceived parental support was highest for study members with the lowest perceived parental psychological control. Parental support had been highest for those with the most comfortably rated early material home conditions but it was not related to any adult socioeconomic factors. Study members with the highest perceived parental support reported the least negative and the most positive social support from their closest person at age 68-9 (p= 0.07, p<0.001). Early SLEs were not related to any circumstance examined.

Table 4.7. Summary table of cross-tabulations between multiple indicators of early environment using chi-squared tests of association

	1.	2.	3.	4.	5.	6.	7.	8.	9	10
1. Education		→	→	→	-	→	-	-	-	-
2. Occupational position	→		→	→	←	→	-	-	-	-
3. Income band	→	→		→		→	-	-	-	-
4. Income perception	→	→	→		←	→	-	-	-	-
5. Adult SLEs	-	←	-	←		-	→		-	-
6. Positive social support	→	→	→	→	-		←	-	-	-
7. Negative social support	-	-	-		→	←		-	-	-
8. Early SLEs	-	-	-	-	-	-	-		-	-
9 Parental support	-	-	-	-	-	→	←	-		←
10.Psychological control	-	←	-	-	-	-	→	-	←	

Notes: Study members are those with data for each pair of measures+ mastery (maximum n =2337). Arrows represent an association between pairs of exposures tested by chi-squared tests. The icons → represent a positive association, ← an inverse association., and - denotes no association

4.3.5 Main findings: Associations between adult socioeconomic exposures and mastery

In sex-adjusted models, all adult socioeconomic exposures were associated with mastery at age 68-9 at the 10 % level of statistical significance (Table 4.8, Models 1). Consistent with bivariate associations between paternal socioeconomic position and study member mastery reported in chapter 3, there was a non-linear association between their own education and mastery. Those educated to A level or equivalent had higher mastery than graduates, both relative to no qualifications. This is a similar pattern to the association between paternal education and mastery found in chapter 3. Unlike for paternal occupational position in chapter 3, own occupational advantage was linearly positively associated with mastery, as was income band. Less favourable income perception was associated with lower mastery. Adult cognitive function was positively associated with mastery at the same age.

In the mutually adjusted model considering all markers of adult socioeconomic environment the association between education and mastery was substantially attenuated in magnitude and did not retain statistical significance. There was some attenuation of the association between adult occupational position and mastery such that higher mastery in the skilled non-manual group did not retain statistical significance. Introducing adult cognitive function to the mutually adjusted socioeconomic environment model removed the positive association between adult cognitive function and mastery. This is contrasts to chapter 3 where the association between early cognitive function and mastery was maintained in an adjusted socioeconomic model, whereas, associations between paternal SEP indicators and mastery were fully attenuated.

Table 4.8. Associations between adult socioeconomic environment and mastery, from linear regression models

	Models 1[a], sex-adjusted	Model M2[b], mutually adjusted	Model M3[c], + cognitive function
	Unstandardised regression coefficients (95% CI)	Unstandardised regression coefficients (95% CI)	Unstandardised regression coefficients (95% CI)
Education			
No qualifications (reference)	0.00	0.00	
Below secondary	0.46(-0.15,1.07	0.20 (-0.42,0.810	
O level	0.40(-0.02, 0.81	-0.07(-0.51,0.38)	
A level equivalent	0.80 (0.41,1.18)*	0.11 (-0.34,0.55)	
Degree	0.63 (0.12,1.13*	-0.37 (-0.98,0.24	
Occupational position			
Unskilled	-1.93(-2.71,-1.07)*	-1.51(-2.37,-0.64)*	-1.36(-2.23,-0.52)*
Partly skilled	-0.92(-1.44,-0.41)*	-.64(-1.19, -0.08)*	-0.53(-1.09,0.01)*
Skilled manual	-0.91(-1.34,-0.47)*	-.65(-1.15, -0.16)*	-0.54(-1.02,-0.08)*
Skilled non manual	-0.45(-0.84,-0.06)*	-.29(-0.72 0.11)	-0.26(-0.70,0.13
Managerial/ technical (reference)	0.00	0.00	0.00
Professional	-0.03(-0.61,0.55)	-.04(-0.64,0.55)	-0.17(-0.63,0.42
Income perception			
Hard to manage	-1.68-9(-2.48, -0.88*	-1.28 (-2.11, -0.46)*	-1.28 (-2.10, -0.46)*
Manage fairly well	-0.83(-1.18, -0.47)*	-0.57 (-0.94, -0.20*	-0.57 (-0.94, -0.20*
Managing comfortably (reference)	0.00	0.00	0.00
Income band (per 1 band increase)	0.16(0.11, 0.21)*	0.08 (0.04,0.17)*	0.07 (0.01, 0.13)*
Cognitive function (per 1 unit increase)	0.05(0.03, 0.08)*		0.02(-0.01, 0.05)

Notes: Based on n = 2038 study members using multiple imputation. * indicates p<0.05. ** p<.010. Unstandardised linear regression estimates represent the mean difference in mastery scores at age 68-9 (95% Confidence Intervals).

[a]Models 1, each exposure included separately (sex-adjusted bivariate analysis).

[b]Models 2, exposures mutually adjusted within their socioeconomic domain

[c]Model 3, socioeconomic exposures significant at p<.10 in model 2 adjusted for adult cognitive function

4.3.6 Main findings: Associations between adult psychosocial exposures and mastery

In bivariate sex-adjusted models, all adult psychosocial exposures were associated with mastery in early old age, at the 10% level of significance (Table 4.9, Models 1). As the SLE count increased by one, mean mastery scores decreased by -0.15 (95% CI -0.21, -0.10). Greater positive social support was associated with higher mean mastery (β 0.47, 95% CI 0.40, 0.55), while negative social support was inversely associated with mastery (-0.70 (95% CI -0.80, -0.64). When SLEs and both types of social support were included simultaneously these associations were minimally attenuated.

Table 4.9 Associations between adult psychosocial environment and mastery, from multiple linear regression model

	Models M1[a], sex-adjusted	Models M2[b], mutually adjusted
	Unstandardised regression coefficients (95% CI)	Unstandardised regression coefficients (95% CI)
SLEs (per 1 event increase)	-0.15 (0.21,-0.09)*	-0.15 (-0.13,-0.02)*
Positive social support (per 1 unit increase	0.47 (0.40, 0.55)*	0.33 (0.25, 0.41)*
Negative social support (per 1 unit increase	-0.70 (-0.80, -0.60)*	-0.58 (-0.63, -0.43*

Notes: Based on n = 2038 study members using multiple imputation. * indicates p<0.05. ** p<.010. Unstandardised linear regression estimates represent the mean difference in mastery scores at age 68-9 (95% Confidence Intervals).
[a]Models 1, each exposure included separately (sex-adjusted bivariate analysis).
[b]Models 2, mutually adjusted

4.3.7 Main findings: Mutually adjusted associations between exposures from across adulthood and mastery

Next it was examined whether associations between adult socioeconomic exposures and mastery were independent of the contribution of adult psychosocial exposures, and vice versa. Statistically significant exposures shown earlier in separate adult socioeconomic and psychosocial models were tested simultaneously in association with mastery (Table 4.10, model 4).

The positive association between adult occupational position and mastery was not explained by the previously described co-occurrence of occupational position with both positive support and fewer adult SLEs (section 4.3.2). The positive association between income perception and mastery was maintained, although the association between income band and mastery was attenuated from significance after adjustment for positive social support.

The inverse association between adult SLEs and mastery was partially attenuated by inclusion of income perception. The associations between both indicators of social support and mastery were not explained by adjustment for socioeconomic exposures. When the remaining adult exposures were simultaneously adjusted for chronic health conditions and depressive symptoms the inverse association between adult SLEs and mastery was removed (Table 4.10, model 5). Attenuation appeared to be driven by the addition of depressive symptoms although mastery was also lower in those with cardiovascular disease, respiratory symptoms, and diabetes.

Table.4.10 Multiply adjusted associations between exposures from across adulthood, and mastery in early old age, from linear regression models

	Models 4, mutually adjusted[a]	Model 5, + health conditions[b]
	Unstandardised linear regression estimates (95% CI).	Unstandardised linear regression estimates (95% CI).
Socioeconomic environment:		
Occupational position		
Unskilled	-1.44(-2.23,-0.64)*	-1.25 (-2.23,-0.64)*
Partly skilled	-0.60(-1.10,0.09)*	-0.47 (-0.96,0.02**
Skilled manual	-0.80 (-1.24,-0.36)*	-0.60 (-1.24,-0.36)*
Skilled non manual	-0.31(-0.61,0.06	-0.28(-0.61,0.06
Managerial (reference)	0.00	0.00
Professional	-0.22(-0.82,0.32	-0.31 (-0.82, 0.21)
Income band (per 1 band increase)	0.02 (-0.00, 0.04)	
Income perception		
Manage comfortably (reference)	0.00	0.00
Hard to manage	-1.29 (-1.78, -0.19)*	-0.65 (-1.43, -0.13)*
Manage fairly well	-0.44(-0.07, -0.05)*	-0.18(-0.53, 0.15)
Psychosocial environment:		
SLEs (per 1 event)	-0.06 (-0.11,-0.00)**	-0.01(0.08, 0.05)
Positive social support (per 1 unit)	0.38 (0.26, 0.41)*	0.26(0.19, 0.36)*
Negative social support (per 1 unit)	-0.55 (-0.64, -0.44)*	-0.43(-0.53, -0.33)*
Current health conditions:		
Depressive symptoms (*per SD)*		-1.93(-2.30, -1.58)*
CVD (ref diagnosis)		-0.60(-1.01, -0.18)*
Respiratory symptoms (ref diag.)		-.04(-0.74, -0.08)*
Osteoarthritis (ref diagnosis)		-0.26(-0.61, 0.09)**
Diabetes (ref diagnosis)		-0.34(-0.76, -0.03)**

Notes: Based on n = 2038 study members using MICE. * indicates p<0.05. ** p<.010. Unstandardised linear regression estimates represent the mean difference in mastery scores at age 68-9 (95% Confidence Intervals).
[a]Model 4, exposures significant at p<0.10 in model 3.
[b]Model 5 exposures significant at p<0.10 in model 4 + curent health conditions

4.3.8 Mutually adjusted associations between exposures from the early environment throughout adulthood, and mastery in early old age

The associations between the earlier environment and mastery presented in chapter 3 may be partly explained by associations with adult factors presented in this chapter (table 4.11). Early SLEs, early cognitive ability, perceived parental support and psychological control were included in a linear regression model with the adult exposures previously significant at the 10% level (table 4.10).

The final model of chapter 3 (section 3.3.7, table 3.8) presented an inverse association between parental psychological control and mastery in early old age (β -0.12 (95% CI -0.18, -0.07)). This was only partially attenuated by simultaneous adjustment with adult exposures. There was similar attenuation of the effect size between early SLEs and mastery from -0.16 (95% CI -0.29, -0.04) to -0.10 (95% CI -0.22, -0.02).

Associations reported in chapter 3 (section 3.3.7, table 3.8) between perceived parental support and mastery, and early cognitive ability and mastery, were attenuated by adult factors (table 4.11). To understand which exposures drove this additional analysis was conducted. The effect size of the positive association of parental support with adult mastery was reduced to zero by adult positive social support and removed from significance. Income perception, and, separately adult occupational position, were implicated in removing the previously reported positive association between early cognitive ability and adult mastery. Largely, associations between the remaining indicators of adult environment and mastery were only slightly attenuated by inclusion of early environment factors. The association between osteoarthritis and mastery was no longer statistically significant.

The standardised (beta) regression estimates allowed comparison of effect sizes of associations presented in the fully adjusted model. The largest effect sizes were for associations between contemporaneous adult exposures and mastery. For example, for a one standard deviation increase in depressive symptoms, mastery was an estimated -0.25 standard deviation lower. For a one standard deviation increase in adult negative social support, mastery was an estimated -0.20 standard deviation lower. There was a 0.14 standard deviation increase in mastery per 1 standard deviation increase in adult positive support. The effect sizes for the remaining associations were far smaller.

Table 4.11 Multiply adjusted associations between exposures from the early environment throughout adulthood, and mastery in early old age, from linear regression models

	Model 6 + early environment [c]	
	Unstandardised linear regression estimates (95% CI).	Standardised regression estimates
Adult socioeconomic environment		
Occupational position		
Unskilled	-1.31 (-2.11, -0.51)*	-0.03
Partly skilled	-0.57 (-1.07, -0.07)*	-0.01
Skilled manual	-0.69 (-1.13, -0.25)*	-0.02
Skilled non manual	-0.35 (-0.71, -0.02)**	-0.06
Managerial (reference)	0.00	0.00
Professional	-0.30(-0.83, 0.23)	-0.03
Income perception		
Manage comfortably (reference)	0.00	
Hard to manage	-1.07(-1.87, -0.27)*	-0.02
Manage fairly well	-0.32 (-0.67, 0.03)	-0.01
Adult psychosocial environment		
Positive social support (per 1 unit)	0.25(0.17, 0.33)*	0.14
Negative social support (per 1 unit)	-0.42(-0.52, -0.33)*	-0.20
Current health conditions:		
Depressive symptoms (*per SD)*	-1.95(-2.31, -1.60)*	-0.25
CVD (ref diagnosis)	-0.44(-0.78, -0.11)*	-0.05
Respiratory symptoms (ref diagnosis)	-0.65(-1.06, -0.24)*	-0.06
Osteoarthritis (ref diagnosis)	-0.31(-0.69, 0.06	-0.03
Diabetes (ref diagnosis)	-0.48(-.94, -0.02)*	-0.06
Early environment		
Cognitive ability (per 1 SD increase)	-0.08(-0.28, 0.11)	0.00
SLEs (per 1 event increase)	-0.10(-0.22,0.02) **	-0.02
Parental support (per 1 unit increase)	0.01(-0.12, 0.03)	-0.02
Psychological control (per 1 unit inc.)	-0.07(-0.12, -0.02)*	-0.03

Notes: Based on n = 2038 study members using MICE. * indicates p<0.05. ** p<.010. Unstandardised linear regression estimates represent the mean difference in mastery scores at age 68-9 (95% Confidence Intervals).

[c] Model 6 adjusted for all adult and early exposures significant at p<0.10 in previous models.

4.4. Discussion

4.4.1 Summary of findings

This study used prospectively measured longitudinal data to integrate previous findings that experiences from across the whole of life contribute to mastery [94, 105]. Associations between contemporaneous exposures and mastery were the most substantial, yet exposures from across life right back to the earlier environment were associated with mastery in these British adults in early old age.

There were promising findings regarding exposures associated with higher mastery, despite a context of hard-to-manage circumstances. As expected mastery was higher in those in higher occupational positions by late-midlife, and in those with current better mental health and without chronic health conditions. Most of the predictor variables were inter-related, hence the use of multivariable modelling; however, associations were also observed between psychosocial exposures unrelated to occupational position and health. Of the earlier environment exposures: associations between fewer SLEs and mastery, and weaker perceptions of psychologically controlling parenting and mastery, were not explained by trajectories into adulthood. In adulthood, the psychosocial indicators of lower negative support as well as more positive support from the study members' closest person had associations with mastery unrelated to co-occurring socioeconomic or health disadvantages.

4.4.2 Pathways between the adult socioeconomic environment and mastery

These findings support previous mainly North American evidence that multiple dimensions of adult socioeconomic advantage have distinct pathways to mastery [94, 122, 123, 258].

The association between education by the age of 26 and mastery at age 68-9 appeared to be explained by the trajectory between education and higher occupation by 53, and indicators of income at age 68-9. This supports the North

American evidence into education and mastery in older people [94, 129, 302]. Earlier in this chapter it was speculated that previous mixed findings between education and mastery were due to the age of cohorts being studied; therefore differences in proximity of education. These findings suggest that for British adults in early old age the link between education and mastery is through higher education facilitating greater occupational position and income.

Although the study members had largely retired, residual associations between their previous occupational position and mastery were consistent with the three North American studies presented earlier in this chapter [94, 122, 123]. In the current chapter analysis showed that study members who had worked in unskilled positions had more than one point lower mastery than those who had worked in higher managerial positions. Pearlin et al. (2005) theorised that associations between occupation and mastery may be explained by an internalised attribution of high status and power [97, 130]. However, this meaning has not been formally tested. As discussed in chapter 1, repeated experiences of autonomy or schedule control during work have been shown to be key to explaining differences in many health outcomes [30]. The current chapter suggests that occupations recognised as being characterised by autonomy or schedule control may have visible associations with mastery even years after retirement.

As in the available North American research, income band, and income perception were related to each other and fellow SEP exposures yet residual associations suggested different processes between each income indicator and mastery [122, 123]. As in a previous study into predictors of mastery in early old age Americans[310], it appeared that better positive social support was more likely for those with higher income, and this explained associations between income and mastery at this age. Although study members with more comfortable income perception also reported better positive social support, there was no evidence for social support explaining the association between income perception and mastery.

The findings in this chapter did not suggest that positive associations between adult indicators of SEP and mastery in early old age were explained by cognitive

processes. This was in contrast to findings in chapter 3 suggesting that higher cognitive ability in earlier life explained paternal socioeconomic associations with mastery. Both the positive association of earlier cognitive ability, and that of adult cognitive function with adult mastery were fully attenuated on adjustment for indicators of adult income and occupational position.

4.4.3 Pathways between the adult psychosocial environment and mastery

One aim of this chapter was to identify psychosocial processes contributing to a good sense of mastery, net of structural socioeconomic barriers. From the available evidence it appeared that this study is the first to investigate how both positive and negative support from a person's closest relationship is associated with mastery. As with the early environment exposures in chapter 3, associations between these adult psychosocial indicators and mastery were not explained by indicators of adult SEP. Net of occupation and income, study members whose closest person made them feel good about themselves and shared their confidences and interests, had higher mastery. Unrelated to socioeconomic advantage- feeling a high level of worry and stress from one's closest person and lacking the ability to confide in them- was associated with lower mastery in early old age.

The measure of adult SLEs captured events reported over a substantially longer time period than the previous 12 months used in other studies [94, 149, 251]. In this analysis there was not a higher frequency of SLEs reported by study members with less advantaged SEP. The inverse association between an accumulation of SLEs between age 26 and 60-64 and mastery at age 68-9 was independent of socioeconomic processes. More SLEs across life were associated with stronger symptoms of depression in early old age which was what explained the association between SLEs and mastery.

4.4.4 Earlier life environment

Chapter 3 suggested that even in early old age, early circumstances theorised to provide the foundation for self-concepts [17, 155, 159, 276, 277] are associated

with mastery in early old age. The analysis in this chapter investigated the links between circumstances across life and how they may operate together across a long time to explain differences in mastery in early old age.

Some indicators of the early environment were related to relevant adult factors. Study members who perceived their parents as being more psychologically controlling were those reporting the most negative social support in early old age. Supportive relationships also appeared to track across life; those with perceived supportive parents in their early environment reported the least negative and the most positive social support from their closest person at age 68-9.

A trajectory of negative interpersonal relationships did not explain the association between perceived parental psychological control and lower mastery in early old age. In contrast the association between perceived parental support and mastery was explained by higher contemporaneous adult positive support. These data extend findings described in chapter 3; in a North American adolescent cohort supportive partners in early adulthood supplanted the original association between supportive parents and mastery in adolescence [163].

As outlined earlier in this chapter, early life SLEs have been widely linked to a higher frequency of adult SLEs and other poor socioeconomic and psychosocial adult outcomes [133, 151, 176, 177]. However, in analysis in this chapter, early SLEs were not correlated with any adulthood exposures tested. A higher frequency of SLEs in early life remained associated with lower mastery in early old age. These findings suggest that earlier SLEs are an additional process contributing to mastery, separate to lifetime socioeconomic disadvantages and current challenges in adulthood.

4.4.5 Methodological considerations

The main methodological issues of analysis in this thesis will be drawn together in the discussion chapter (chapter 7). Several methodological issues relevant to this chapter are considered below.

One methodological concern is that the measure of net household income band does not account for the number of people living in the house on that income. A fellow British cohort study, the English Longitudinal Study of Ageing captures variation in income perhaps more accurately by creating “household equivalence” (income/ persons in household). This method was not possible in the current study as in the NSHD income is categorised into such wide income bands study members in the same band could receive the same household equivalence score when one has a net household income of 40,000 and one of 79,000. It was hoped that the income perception variable would capture the lived financial experience of the study members.

Although measuring SLEs is one the simplest approach to measuring stress, it comes with many methodological challenges.[311] The assumption of cumulative totals of SLE is that different types of events have characteristics in common that determine the nature and extent of their impact.[154] Cumulative totals do not take account of the frequency, duration or intensity of each event. A method which would take intensity into account is to ask study members to rate the stress, or to have the researchers assign their own *a priori* scores. However, the same pattern of results have been found using both weighted life event scores and simple frequency count of events to predict severity of stress response. [312]

Chapter 4 comprehensively drew together the range of exposures across the life emphasised in theory and previous evidence to be relevant to mastery. This was facilitated by the use of a life course framework and many years of rich data held in the NSHD. However, it is likely that there are many more factors across the life which may give an even more granular consideration as to how individuals have more or less mastery; and could be supported in improving their mastery.

A limitation of the data used in this chapter is the lack of measures of mastery earlier in life. This restricts the ability to consider the potential for bi-directional associations across life. That is, as described in chapter 3 (3.11), and earlier in this chapter (4.1.1), a strong sense of mastery in early life might influence later exposures which this chapter has highlighted are positively associated with

mastery in early old age. For example, one study of 971 Canadian high schoolers found that those who with higher mastery at age 18 were more likely to go on to complete a university degree[313]. The degree itself was not associated with increases in mastery over the following 25 years, but may have shown more long term effects through occupational opportunities if these had been studied. Another of the few studies examining these very complex trajectories showed that higher adolescent mastery was associated with stronger social support in their early twenties[163]. It is plausible that individuals experiencing growth in mastery may develop the impression that they can manage future opportunities such as higher education therefore they pursue them, or give them the confidence to seek and maintain good quality social support. Following this line of thought, associations between later life exposures and mastery may be at least partly explained by earlier mastery itself. However, very few studies have had the data available to reinforce these findings, to test this theory on individuals past middle age, or to attempt to separate out the relative pathways.

4.5 Conclusion and next chapter

Chapter 3 and 4 identified multiple exposures across the whole of a person's life which appear to be associated with higher mastery in early old age. This supports theory about mastery reiterated earlier in this chapter; that mastery is an integration of not only individuals current circumstances, but experiences spanning back across adult life and to the earlier environment [92, 93, 255]. The findings emphasise the psychosocial processes appearing to contribute to mastery. Regardless of indicators of socioeconomic position at any point, study members who grew up in environments with fewer SLEs to manage, and who did not recall their parents invading their mental autonomy (psychological control), had higher mastery in early old age. Furthermore, regardless of exposures associated with lower mastery earlier in life and into older age, having a close person who listens and shows support was associated with a higher sense of mastery.

The current findings are useful as mastery has consistently been conceptualised as a protective resource for individuals experiencing a range of challenges. Evidence supports that people with higher mastery appear to have better health

and wellbeing outcomes than those with low mastery, net of their challenging situation or established SEP related health-benefits. However, it is currently far from certain how mastery is associated with health and wellbeing. Chapters 5 and 6 move on from considering which exposures across life are associated with mastery, to investigating how mastery is associated with health and wellbeing in early old age. Concentrating on one aspect of health and wellbeing, chapters 5 and 6 will test whether and how mastery may be associated with physical capability in early old age.

5. MASTERY AND PHYSICAL CAPABILITY: EXPLAINING THE ASSOCIATION

The aim of this chapter was to explore how mastery relates to physical capability. The objectives were to test cross-sectional associations between mastery and physical capability at age 69-70 in the MRC National Survey of Health and Development; and to test if associations are explained by the potential mediators of health-related behaviours or a psychological indicator of fear of falling and related activity restriction, independent of potential confounders.

Consistent with WHO policy that perceived control should be investigated to tackle health inequalities [12], previous research has demonstrated positive associations between mastery and long-term physical functioning, quality life in older age, and longevity [5, 8, 33]. This chapter and chapter 6 build on that evidence to investigate why individuals with higher mastery appear to have better intrinsic physical capability; a broad assessment of functioning important to people in mid and later life [198]. Past literature indicates several explanations of how individuals with higher mastery are those who are more physical capable in early old age, independent of factors which differentiate both high mastery (reported in chapter 4) and physical capability [64, 314]. Chapter 1 (section 1.2) described the proposed mechanism that individuals with higher mastery are more likely to pro-actively attempt to manage their own physical capability through health behaviours. Mastery has also been framed as a more positive psychological state of mind which protects older people from losing their mobility due to fear or worries about their physical capability. This chapter first examines if mastery is associated with physical capability, and then investigates if indicators of health behaviours or more positive psychological state explain potential associations.

5.1 Introduction

As summarised in chapter 1 (section 1.4.1), physical capability is an important area to examine when considering mastery in early old age. In addition to

maintenance of physical capability being a public health priority [54, 201-205], it is recognised that psychological factors such as mastery could play a role in physical capability. Encouraging mastery may help to maintain independence and physical functioning in early old age [198, 210]. While it is accepted that physical capability has started to decline in early old age [205-207, 250] substantial variations in age-related decline have been noted [209, 315]. This data has established heterogeneity in ageing, such that older adults do not experience the same degree of decline in physical capability; this is similar to how adults report different levels of mastery (chapters 3 and 4).

Intrinsic physical capability is measured by two complementary measures in this thesis: how well an individual performs on standardised physical tests [205, 212, 213], and functional limitations the individual reports in their usual environment [215]. A number of studies have demonstrated an association between mastery and both physical performance tests and functional limitations [32, 65, 66, 77, 219-221]. However, evidence to date has not satisfactorily explained how mastery contributes to physical capability.

5.1.1 Potential explanatory pathways between mastery and physical capability

As introduced in chapter 1 (section 1.4.3), it is theorised that individuals who feel more in control perceive any physical changes as preventable or modifiable and so are more likely to engage in health behaviours which influence their physical capability [61-63, 225]. Health behaviours such as frequent leisure time physical activity (LTPA), not smoking, and maintaining a healthy body mass index (BMI) have been implicated in better physical capability, as detailed in chapter 1 (section 1.4.4). The available mastery evidence reports that those with higher mastery are more likely to exhibit all three of these indicators of health behaviour: to not smoke, to exercise, and to have a healthier body size [23, 46, 65-70, 223].

The second proposed pathway between mastery and physical capability is through more positive psychological processes. Pearlin proposed that people with lower mastery are more likely than those with high mastery to feel negative

or even frightened by their circumstances than those with lower mastery [31, 76, 77]. Underestimation of physical capability in individuals entering older age may contribute to inaction or restricted movements and consequently lower physical capability [34, 86-90]. Several cross-sectional studies indicate that individuals with higher mastery are more positive about their physical capability, less fearful of falling, independent of their intrinsic physical capability, and thus are less likely to restrict their movements, [77, 225, 242].

The following sections review the evidence supporting associations between mastery and physical capability and proposed explanatory pathways.

5.1.2 Evidence of associations between mastery and physical performance

As cited in chapter 1, four studies have tested an association between mastery and objectively measured physical performance. Together this literature has examined physical performance using tests of grip strength, walking speed, and overall composite score from tests of chair rise speed, walking speed and standing balance time. Each standardised performance-based test and the composite score has been validated as capturing intrinsic capability [213, 316]. None of the findings are from the UK, but from the US (Health and Retirement Study) [46, 65, 220], Australia (PATH through Life study) [66], and the Invecchiare inChianti study based in rural Italy [77, 219].

Two cross-sectional studies reported positive associations between higher mastery and better grip strength [65], and higher mastery and better performance on four walking tests (increasing speed, walking around obstacles, walking on a narrow path, and walking whilst engaged in a cognitive verbal task) [77]. Two longitudinal studies have reported associations between higher baseline mastery and smaller decreases in composite performance score (across tests of chair rise speed, standing balance time and walking speed) over six years [219] and grip strength over 8 years [66, 219]. One study reported the same pattern of findings in a subset of those with good baseline physical capability (no ADL disabilities and the highest quartile of composite performance scores at baseline. This suggests that even in those with no discernible differences in physical capability at baseline, those with lower mastery at baseline were more likely to develop

poorer physical capability over time [219]. Taken together these studies suggest that individuals with higher mastery in early old age have better physical capability, measured by performance on individual tests of grip strength, walking speed and overall composite test scores.

5.1.3 Evidence toward associations between mastery and functional limitations

Self-reported functional limitations capture how they perceive that they perform actions such as walking, gripping, and balancing, within their daily life [250]. Higher functional limitation scores are associated with lower self-reported physical capability. As introduced in chapter 1, two studies have reported associations between mastery and self-reported functional limitations, both using the large nationally representative US sample of the Health and Retirement study (HRS) [46, 220]. Infurna and Mayer [46] tested a bi-directional association between mastery and functional limitations over four years. Lower baseline mastery was associated with an increase in functional limitations and higher baseline functional limitations were associated with loss in mastery over that time. Drewerlies [220] reported that study members with higher mastery at baseline were those more likely to have fewer functional limitations measured six years later. Together this evidence indicates that in US adults from the HRS, those with higher mastery appear to maintain their physical capability over time.

5.1.4 Evidence supporting potential explanatory pathways between mastery and physical capability.

As established in chapter 1, there are few studies testing potential mediators between mastery and any indicators of physical functioning [314] The current chapter analyses builds upon available evidence supporting a basis for explanatory pathways between mastery and physical capability.

There is some evidence suggesting that individuals with higher mastery are those more likely to report indicators of positive health behaviours (more frequent

leisure time physical activity, not smoking, and healthier body size) recognised to influence physical capability in older age [226-229].

As chapter 1 (section 1.4.4) outlined, three studies have investigated physical activity as a potential explanatory variable between mastery and physical capability. Two studies report that self-reported general frequency of physical activity partly mediates the positive association between mastery and grip strength test score [65, 66]. In another study, self-reported vigorous exercise was only very minimally a mediator between findings of higher mastery and fewer functional limitations over four years [46]. The difference in effect size may be due to the physical activities included. The first two studies included mild to moderate exertion of routine chores such as vacuuming and laundry in their exercise scores, whereas the third study limited the measure to vigorous leisure-time physical activity (LTPA). The difference in size of contribution of physical activity between mastery and physical capability could also be attributable to differences between standardised tests of grip strength and self-reported functional limitations [209]. However, overall individuals with higher mastery are more likely to engage in physical activity, and this at least partially explains why those individuals have better physical capability. More evidence testing the explanatory role of leisure time physical activity (LTPA), rather than mild to moderate exertion, may clarify whether mastery acts through a pathway of health behaviours.

An indicator of health behaviours that may operate between mastery and physical capability is body mass index (BMI), which is recognised as a contributor to physical capability. As described in chapter 1, there is sparse cross-sectional evidence that people with lower mastery have a higher BMI or other indicators of weight [67]. Longitudinal evidence allows greater confidence that higher mastery at baseline is associated with smaller increase in indicators of growing weight over time, and that people who maintain their weight feel more in control as a result [68].

There is only one study available testing any indicator of weight as a line of investigation between mastery and physical capability. This Taiwanese study demonstrated that a composite measure of multi-system physiological

dysregulation including indicators of weight (waist to hip ratio, BMI, HDL to total cholesterol ratio, triglycerides, and glucose) partially attenuated the association between low mastery and decline in physical capability over time [223]. Conclusions from this prospective study are limited by cohort size (n= 487) and a complex aggregate potential mediator. It is not clear what the explanatory process was which appeared to contribute to the effect of baseline mastery. In addition, several studies have indicated that conclusions about mastery generated from Asian cohorts do not generalise to non-Asian populations [191, 317]. Testing BMI as a potential explanatory variable between mastery and physical capability in a representative British cohort such as the NSHD may clarify the role of BMI.

No other indicators of health behaviours have been examined as potential mediators of the association between mastery and physical capability, although some evidence highlights a potential role for smoking behaviour. As outlined in chapter 1 (section 1.4.4), evidence of associations between lower mastery and likelihood of being a smoker is available [67, 69, 70] in small non-British studies. As the smoking variables measured did not account for smoking history, the direction of these cross-sectional associations is therefore even more uncertain. However, as smoking is an established influence on physical capability, it is plausible that people with higher mastery are more likely to control their health given that smoking may contribute to associations between higher mastery and better physical capability.

No studies have examined psychological processes between mastery and physical capability although there is evidence suggesting that indicators of psychological processes such as fear of falling and related activity restriction are a promising focus. As chapter 1 (section 1.4.5) explained, fear of falling and activity avoidance is common in older people and a concern for functional decline [89, 241, 318]. Several cross-sectional studies based outside of Britain report that in adults older than the NSHD study members (over 70 years), mastery is lower in those who are more fearful of the consequences of poorer physical capability, such as falling, and are more likely to restrict their movements, independent of

their intrinsic physical capability [77, 225, 239, 242]. In contrast, one study reported that higher mastery was not associated with differentiating low and high fear of falling and activity avoidance, once a range of mental health indicators, chronic conditions, and demographic variables were simultaneously accounted for [318]. It is unclear which exposure explained the different pattern of findings in this study. Notably, the small sample was restricted to individuals over 70 years who reported any fear of falling. It is possible that mastery is more useful as a personal response in overcoming more mild challenges. Examining fear of falling and associated activity restriction in a population just entering older age and with a range of intrinsic physical capability will allow more sensitive detection of potential psychological processes related to mastery.

5.1.5 Summary of evidence and gaps to be addressed in the current study

As summarised above, there is some evidence available on associations between mastery and physical capability. The following paragraphs identify specific gaps to be addressed in this body of research and explain how the current chapter builds on available evidence.

There is wide heterogeneity in the physical capability outcome measures examined by studies in this area. Mixed findings could be attributable to the differences in measures used to assess physical capability; over a small number of studies, there is not a clear pattern. Of the four published mastery and physical performance papers, three rely on single differing individual performance tests [65, 66, 77], and only one has used a composite measure [219]. Overall performance score is considered to be most useful for clinical assessment of physical capability as it captures variation in functioning across the whole spectrum of ability [205]. Consistent with previous work in the NSHD, an extensively validated composite measure of physical performance [212, 319] is presented in this chapter along with total functional limitations [250]. Use of the composite measure of physical performance in this thesis, including standing balance score, extends previous research and ensures that physical capability is comprehensively captured. Figures using the individual performance scores and individual functional limitations are not formally proposed as outcome measures but differences in individual components may be useful so are presented in tables

in supplementary material. Similarities or differences in patterns of association may clarify the mixed literature and elucidate drivers of the main associations between mastery and composite measures [316].

The measure of functional limitations tested in this chapter will extend findings from the two outlined studies presenting associations between mastery and functional limitations [46, 220]. Those studies use a measure of functional limitations (e.g. walking and climbing stairs) with additional items indicating difficulties with instrumental activities of daily living (IADLs) such as managing money and taking medications. Combining actions with activities changes the conclusions of the findings from associations between mastery and physical capability to that between mastery and disability [198], which will be explored in chapter 6. The current chapter investigates whether mastery is associated with poor physical capability before it has manifested as problems likely to comprise autonomy and independent living. Although the samples of the Health and Retirement Study (HRS) and the NSHD are similarly aged (HRS mean age is 68), someone reporting difficulties in the HRS measure of functional limitations (with IADLs such as taking medications) is likely to be more restricted than those reporting functional limitations using the measure tested in the NSHD.

There is very little evidence formally testing the contribution of potential explanatory variables between mastery and physical capability, or indeed, any health outcome [5, 314]. The current chapter extends the literature by considering the potential contribution of the health behaviours of smoking status, and BMI, and the psychological indicator of fear of falling and related activity restriction (fear of falling). This chapter builds on the available evidence on leisure time physical activity (LTPA) as an explanatory variable between mastery and physical capability, rather than routine mild to moderate physical activity such as housework, as included in two of three previous published studies. In addition, including several potential mediators together in one model produces a more realistic experience of real life in which multiple health behaviours and psychological processes act together.

To extend previous conclusions on whether and how mastery is associated with physical capability, potential confounders not consistently accounted for in previous work will be addressed. For example, as explained in chapter 1, female sex, socioeconomic disadvantage, chronic health conditions and poor mental health linked with both physical capability and mastery may have biased estimation of associations between the two variables. All six of the studies reviewed above adjusted analysis of the association between mastery and physical capability for education yet not occupational position. As chapter 4 reported, in study members from this British birth cohort, it is occupational position not education which analyses should consider at age 68-70.

Given physical capability literature and findings in chapter 4, chronic medical health conditions and depressive symptoms are also implicated as potential confounders between mastery and physical capability. Only two of the available physical performance studies and the two functional limitations studies controlled for self-reported medical conditions (cardiovascular problems, arthritis, diabetes, and lung problems) [46, 220] Two of these controlled for self-reported depressive symptoms, and one for self-reported emotional and nervous problems. Chronic health conditions and poor mental health are potential confounders on the proposed pathway between mastery and physical capability such as smoking, physical inactivity, BMI, and fear-linked activity restriction [24, 48, 94, 200, 227, 249, 250, 253].

In addition, previously unmeasured variables which impact measures of physical capability may have influenced findings of previous associations between mastery and physical capability. In the published studies, only one study controlled for height. Although this is not formally a confounder as no studies have examined whether mastery correlates with height, height is an important contributor to performance on physical tests such as walking speed and chair rise speed [229].

No studies have examined both physical performance and functional limitations as complementary physical capability outcomes in the same study of mastery. Utilising both measures allows their relative characteristics to advance speculation on whether mastery has objectively measurable benefits to health or

merely people with higher mastery report that they are healthier. Performance-based measures such as tests of standing balance, walking speed, grip strength, and chair rise speed assess the ability to perform that action in a standard environment. Self-reported questions on functional limitations complement this by assessing the individual's perception of how well they can perform those same actions in their daily environment. As discussed in chapter 1, there is far more research available linking mastery to self-reported indicators of health, than that available testing associations between mastery and objective outcomes, such as body size, hormones, or arterial calcification. Opening the investigation to whether mastery is simultaneously associated with both objectively visible differences in physical capability and differences perceivable to the individual themselves in their daily lives may allow further insights into how mastery is associated with health more broadly.

Associations between mastery and physical capability have not yet been tested in a British population. Evidence from chapter 3 and 4 suggested that several patterns of associations between socioeconomic indicators and mastery in this British cohort were different to those reported in international studies. Findings regarding associations between mastery and physical capability from US and European countries must therefore also be confirmed in this UK birth cohort. As reported in chapter 1, the UK differs slightly from the US and European countries in which associations between mastery and physical capability have been shown [46, 65, 190]. Physical capability appears to be generally higher in the UK than the US, but lower than in Italy, Germany, and the Netherlands (countries reporting tests of associations between mastery and physical capability) [320, 321]. Differences across countries reinforce that findings regarding mastery and physical capability in one country should be examined the UK before suggestions are made to inform UK public health policy.

A final note regarding the direction of the association between mastery and physical capability. As emphasised by the bi-directional testing in one study reviewed earlier [46], and the findings of chapter 4, health conditions contribute to mastery, as well as mastery explaining additional variance in health outcomes.

The measure of mastery in the NSHD only exists at the most recent wave at age 68-9. Therefore, like several of the reviewed studies, analysis in the current chapter is cross-sectional. As in the study from Milaneschi, Bandinelli et al. [219] the analysis presented in this chapter was repeated on a subset of those with good physical capability (no functional limitations and the highest quartile of composite physical performance scores at the previous wave of data collection (age 64)). This process was intended to address concerns of findings between mastery and physical capability being explained by previous differences in physical capability explaining variance in current mastery.

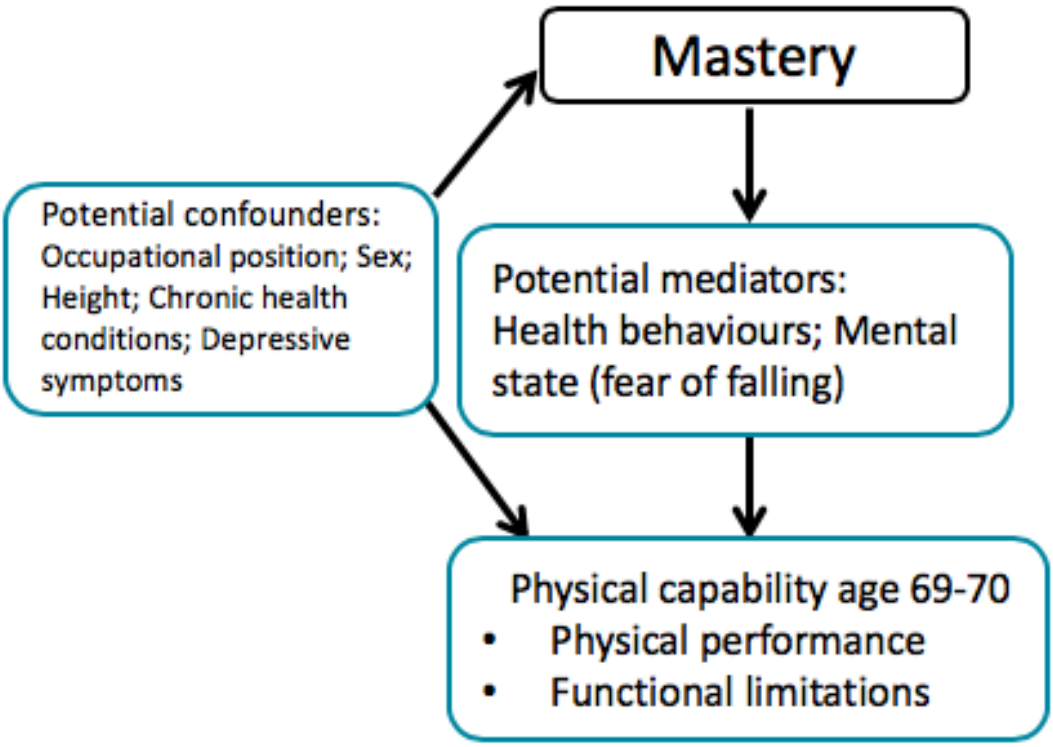

Figure 5.1 Conceptual model theorising pathways of association between mastery and physical capability

5.2 Analysis plan

The analysis in this chapter relates to research objectives iv-v described in the methods chapter (chapter 2; section 2.1): to investigate the cross-sectional association between mastery and physical capability at age 69-70 (both nurse-assessed physical performance and self-reported functional limitations); and to assess whether these associations are explained by potential explanatory

variables of indicators of health behaviours or fear of falling and related activity restriction.

It was hypothesised that greater mastery will be associated with better composite physical performance and fewer functional limitations aged 69-70. It was hypothesised that differences in physical capability according to levels of mastery will be partly explained by differences in smoking status, leisure time physical activity (LTPA), body mass index (BMI) and fear of falling and related activity restriction, net of potential confounders.

As suggested in the introduction, potential confounders were selected a-priori on the basis of findings from chapter 4 and physical capability literature described in chapter 1 (section 1.4.1). The potential confounders were occupational position, height, chronic health conditions (cardiovascular diseases (CVD), respiratory difficulties, osteoarthritis and diabetes) and depressive symptoms.

5.2.1 Analytical sample

The analytical sample in this chapter was restricted to study members with complete data on mastery at age 68 who also provided data on at least one of the physical performance measures or the functional limitations score at age 69-70 (n= 1727). Those participants with missing data on covariates were included by using multiple imputation by chained equations. Further details of which are described in chapter 2 (section 2.4.1). The main associations in the maximum available sample with complete data were compared with sensitivity analyses to those run on imputed data.

5.2.2 Descriptive analyses

Physical performance and functional limitations were checked for normality using histograms. The overall physical capability of the sample was assessed using the mean, range and standard deviation of composite physical performance score, and the proportion of study members with either no or 1-6 functional limitations.

Associations between, i) the potential confounders and physical capability, ii) the potential mediators and physical capability, and iii) mastery and the potential mediators were presented using descriptive statistics. Differences in mean physical performance by categories of covariates were tested by one-way ANOVAS. Chi-squared tests examined differences in the proportion of study members with functional limitations by categories of potential mediators. For the descriptive statistics, BMI was categorised into clinical categories of underweight, normal, overweight, obese and severely obese (reference), and mastery into quartiles.

To formally test the trend of mean physical performance over gradients of covariates, linear regression was used, and for functional limitations logistic regression. To assess how mean mastery varies in line with the potential mediators, differences in mean mastery within each categorical variable were tested with one-way ANOVAS and for trend using regression models. Findings in chapter 4 had already confirmed that mastery varied across the potential confounders of occupational position, chronic physical health conditions and depressive symptoms so this analysis was not repeated.

5.2.3 Regression models

No evidence of non-linearity was found from regression models tested using inclusion of a quadratic term, therefore, mastery, physical performance, and functional limitations were modelled continuously as exposures. Formal testing of sex-interactions at the 10 % level of statistical significance indicated that analysis would be sex-adjusted, aside for the functional limitation of difficulty balancing which was stratified by sex.

The next steps examined whether there was an association between mastery and physical capability, first in sex-adjusted analysis, and then independent of the potential confounders. Linear regression was used to estimate the mean difference in physical performance for a unit change in mastery. Poisson regression was used to estimate the incident rate ratio of functional limitations for a unit change in mastery.

Regression analysis was used to confirm the relationship between mastery and the potential mediating variables and those variables and physical capability. Multinomial logistic regression was used to estimate the odds of smoking status for a unit change in mastery. Ordered logistic regressions repeated this for odds of LTPA and fear of falling, and with linear regression for BMI as the outcome. Physical performance, and functional limitations according to levels of i) smoking, ii) LTPA, iii) BMI, and iv) fear of falling were estimated using linear regression, and Poisson regression, respectively.

Finally, regression models examining the mean difference in physical performance and functional limitations for a unit change in mastery were repeated adjusting for potential mediating variables significant at the 10% level in the previous steps of the analysis. The impact of each potential mediator was assessed in turn after adjustment for potential confounders, and finally fully adjusted. The change in magnitude of the regression coefficient between mastery and physical capability after inclusion of the potential mediators and confounders indicated the explanatory value of the potential mediators. These models were repeated for individual performance tests and individual functional limitations (presented in Appendix B, page 255 to 261). Parametric regression models, using the paramed test in Stata, were used to estimate whether the statistical criteria for mediation were met.

Several steps were taken to further the conclusions possible from these findings. To compare the relative explanatory contribution of each potential mediator, the standardized regression coefficients were additionally presented. The potential mediators were also considered in groups with the potential confounders i) sex, height ii) occupational class iii) chronic health conditions iv) health behaviours v) psychological processes (fear of falling and depressive symptoms). The focus here is understanding whether associations between mastery and physical capability are driven most substantially by indicators of health behaviours, an indicator of psychological processes, or potentially confounding health or socioeconomic inequalities.

Additionally, the analysis between mastery and each composite physical capability indicator was repeated for a sensitivity analysis in a subset of study members restricted to those with good physical capability at age 60-64; this includes those with no functional limitations and a composite performance score of the highest quartile.

5.3 Results.

5.3.1 Characteristics of physical capability

The normal distribution of composite physical performance score is shown in Figure 5.2. Men had slightly higher mean physical performance on a scale with a potential range of 0-4 than women (1.8 compared to 1.6: p<0.001). The sex difference was consistent for all individual performance measures (figure B1, Appendix B, page 255. As figure 5.2 depicts, the distribution of functional limitations was positively skewed; in men and women, the largest proportion had no functional limitations. More men reported no limitations at all (64.0%) than women (38.4%). There were no sex differences for two single limitations: 'using your arms to reach or stretch' and 'walking 1/4 mile on the level'. The most common limitation (31%) was 'holding, gripping and turning things' (Table B1, Appendix B, page 255)

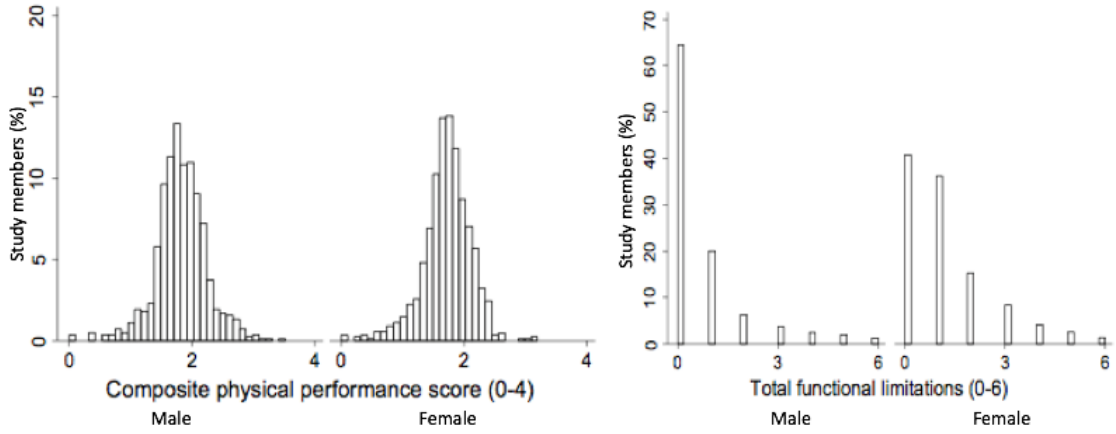

Figure 5.2. Distribution of sex-stratified 1) physical performance scores (0-4); 2) prevalence of any functional limitations (0-6) in study members with complete data on mastery and physical capability at age 68-70.

5.3.2 Descriptive pathway between mastery and physical capability

5.3.2.1 Assessing physical capability by the potential confounders

Differences in physical performance and functional limitations by potential confounders were assessed using one-way ANOVAS and chi-squared tests (table 5.1) Occupational advantage was positively associated with physical performance; inversely with functional limitations. Study members without chronic health conditions had better physical performance and fewer functional limitations than those with those conditions. Findings were replicated for individual measures of physical performance and individual functional limitations; albeit no differences in standing balance relative to respiratory difficulties (Appendix B: Table B3, page 258; Table B5, Page 259). Together with evidence from chapter 4 (4.3.6) and previous literature, the findings reinforce occupational position and chronic health conditions as potential confounders between mastery and physical capability.

Table 5.1. Characteristics of compositive physical capability in study members with complete mastery and physical capability data[1]

	Physical performance (0-4)	Functional limitations (Yes= 1-6)	
Exposure	Mean(SD)	No (%)	Yes (%)
Total	1.7 (0.4)	50.9	49.0
Men	1.8 (0.4)	64.0	35.9
Women	1.6 (0.4)	38.4	61.5
P[a]	<0.001	<0.001	
Occupational position			
I Professional	1.9 (0.3)	67.8	32.2
II Managerial/tech	1.8 (0.4)	53.4	46.5
III Skilled(NM)	1.7 (0.3)	44.7	55.2
IIIM Skilled manual	1.6 (0.4)	51.6	48.3
IV Partly skilled	1.6 (0.4)	44.5	55.4
V Unskilled	1.5 (0.6)	40.8	59.1
P [a]	<0.001	<0.001	
CVD			
Yes	1.60 (.48	53.1	46.8
No	1.77 (0.41)	34.8	65.1
P [a]	<0.001	<0.001	
Respiratory difficulties			
Yes	1.6 (.46	54.9	45.1
No	1.8 (0.38)	40.1	59.8
P [a]	<0.001	<0.001	
Osteoarthritis			
Yes	1.6 (0.47)	57.7	42.2
No	1.7 (0.39)	25.7	74.3
P [a]	<0.001	<0.001	
Diabetes			
Yes	1.5 (0.46)	52.	47.6
No	1.7 (0.41)	39.8	60.1
P [a]	<0.001	<0.001	

Note: Study members include those with data for each individual measure + mastery + physical capability at age 69-70 (maximum n= 1727). [1]Total numbers vary due to missing data. [a] P describes overall test of association. [b] P describes test of trend using linear regression

5.3.2.2 Assessing physical capability by the potential mediators.

Descriptive statistics presented in table 5.2 support investigation of the indicators of health behaviours of smoking status, LTPA and BMI, and the psychological indicator fear of falling as potential mediators between mastery and physical capability. Current smokers had lower physical performance than non-smokers and ex-smokers, although there was little difference in prevalence of functional limitations between ex and current smokers. Physical performance was higher, and functional limitations lower among those who reported greater levels of participation in LTPA. Obese and severely obese study members had lower physical performance and a greater prevalence of functional limitations than those at a normal BMI. Most patterns were not different when examining individual physical test scores although smokers did not differ from non-smokers in their grip strength or standing balance (Appendix B: table B4, page 258). Unlike findings for total functional limitations, only study members reporting difficulties 'holding, gripping and turning things' did not differ from those with no difficulties on smoking status (Appendix B : table B6, page 260).

5.3.2.3 Assessing mastery across the potential mediators.

The descriptive statistics (table 5.2) indicate that mastery was higher in study members with better health behaviour indicators and lower fear of falling. Like with total functional limitations, and individual grip strength, the difference in mastery by smoking status did not obtain statistical significance.

Table 5.2. Physical capability and mastery across potential mediators in study members with complete data[a]

	Physical performance (score 0-4)		Functional limitations (no 0, yes 1-6)		Mastery
Exposure	N	Mean(SD)	No (%)	Yes (%)	Mean(SD)
Total		1.7 (0.4)	50.9	49.0	
Men	830	1.8 (0.4)	64.0	35.9	22.7(3.4)
Women	897	1.6 (0.4)	38.4	61.5	21.5(3.5)
P [b]		<0.01	<0.01		<0.01
Smoking					
Current	123	1.6 (0.4)	50.2	49.7	21.8 (3.2)
Ex	978	1.7 (0.4)	50.8	49.1	22.6 (3.6)
Never	506	1.8 (0.1)	53.2	46.7	22.3 (3.6)
P [b]		<0.01	0.58		0.09
LTPA					
Inactive	910	1.6 (0.4)	45.9	54.0	22.2 (3.7)
Moderate	217	1.8 (0.3)	53.6	46.3	22.7(3.3)
Regular	476	1.8 (0.4)	62.2	37.7	22.9 (3.4)
P [c]		<0.01	<0.01		<0.01
BMI kg/cm					
Underweight <18	8	1.6(0.5)	45.4	54.5	23.6 (2.5)
Normal 18-	493	1.8(0.4)	56.8	43.1	22.8(3.3)
Overweight 26-	716	1.8(0.4)	55.6	44.3	22.8(3.6)
Obese 30-	361	1.7(0.4)	45.4	54.5	22.5(3.2)
Severely obese 35+	143	1.5(0.4)	25.5	74.4	22.4(3.3)
P [c]		<0.01	<0.01		<0.05
Fear of falling					
None	1259	1.8 (0.7)	57.7	42.2	22.7 (3.4)
Fear	135	1.6 (0.3)	32.6	67.3	21.6 (3.5)
+ mild restriction	159	1.4 (0.4)	26.4	73.5	20.5 (4.0)
+ severe restriction	25	1.1 (0.5)	7.1	92.8	15.6 (3.6)
P [c]		<0.01	< 0.01		<0.01

Note: Study members are those with data for each individual measure+ mastery and physical capability outcome at age 69-70 (maximum n= 1727). [a] Total numbers vary due to missing data. [b] P value describes overall test of association. [c] P value describes test of trend using linear regression

5.3.3 Main findings: Associations between mastery and physical performance

In sex-adjusted linear regression models, mastery was positively associated with physical performance (Table 5.3, M1). Descriptive statistics had indicated shared differences in physical performance and mastery by potential confounders, yet a

residual association between mastery and physical performance remained after adjustment for these variables. The standardised coefficient of 0.22 represents a small to medium effect size [322] The fully adjusted unstandardized regression coefficient of an increase in physical performance score of 0.02 (0.01, 0.02) for every 1SD increase in mastery, is equivalent to a difference of 10% of a standard deviation in physical performance (based on physical performance score SD = 0.42). Investigation of the association between mastery and individual performance tests did not suggest that a specific individual performance score was driving the association (Appendix B: Table B7, page 261).

Table 5.3. Associations between mastery and physical capability outcomes in separate analyses at age 69-70

	Physical performance		Functional limitations
	Unstandardised regression coefficient (95% CI)	Standardised regression coefficient	Incident Rate Ratio (95% CI)
M1 Mastery +sex	0.03 (0.02, 0.03)	0.22	0.90 (0.88, 0.91)
M2 Mastery + confounders	0.02 (0.02, 0.03)	0.13	0.96 (0.94, 0.97)

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Unstandardised regression estimates represent mean difference in physical performance scores at age 69=70 using linear regression models. Incident rate ratios represent the incidence of functional limitations per unit increase in mastery using poisson regression models. M1 sex adjusted. M2 + adjusted for occupational position, height, chronic health conditions and depressive symptoms.

5.3.4 Main findings: Associations between mastery and functional limitations

An association between mastery and fewer functional limitations was also present. In sex-adjusted Poisson regression, each 1 point increase in mastery was associated with a 10% (IRR 0.90 95% CI 0.88, 0. 91) lower incidence of functional limitations (Table 5.3, M1). Inclusion of confounders only partially attenuated the effect size. There was no suggestion that a specific limitation was driving the association (Appendix B: Table B8, page 261).

5.3.5 Main findings: Mastery and potential mediating variables

Before testing pathways between mastery and physical capability, sex-adjusted regression models confirmed each potential mediator was associated with mastery. Sex-adjusted multinomial regression did not indicate differences in smoking by mastery (Table 5.4). Mastery was positively associated with more frequent LTPA, and lower fear of falling, in sex-adjusted ordered logistic regression (Table 5.5, M1), and with lower BMI in sex-adjusted linear regression. Associations were minimally attenuated by adjustment for potential confounders.

Table 5.4.Associations between mastery and smoking, in multinomial regression

	Current smoker n= 228 Relative risk ratio (95% CI)	Never smoker n= 1454 Relative risk ratio (95% CI)	Ex smoker n= 746 Relative risk ratio (95% CI)
M1 Mastery + sex adjusted	Reference	1.02 (0.99, 1.04)	1.05 (0.99, 1.12)
M2 Mastery + confounders	Reference	1.01 (0.99, 1.04)	1.05 (0.99, 1.12)

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Relative risk ratios represent the risk of smoking per 1 unit increase in mastery from multinomial regression models. M1 sex adjusted. M2 + adjusted for occupational position, height, chronic health conditions and depressive symptoms.

Table 5.5. Associations between mastery and LTPA, BMI, and fear of falling

	LTPA Inactive Moderate Regular	BMI (1kg/m^2)	No fear of falling Fear + mild restriction + severe restriction
	Odds ratio (95 % CI)	Unstandardised regression coefficient (95 % CI)	Odds ratio (95 % CI)
M1 Mastery + sex adjusted	1.07 (1.05, 1.09)	-0.10 (-0.10, -0.03)	0.84 (0.82, 0.87)
M2 Mastery + confounders	1.06 (1.03, 1.09)	-0.09 (-0.12, -0.02)	0.84 (0.81, 0.87)

Based on n= 1727 study members using MICE; Odds ratios represent the odds of each frequency of LTPA, and level of fear of falling per 1 unit increase in mastery using ordered logistic regression. Unstandardised regression estimates represent mean difference in BMI per 1 unit increase in mastery using linear regression. M2 adjusted for occupational position, height, chronic health conditions and depressive symptoms.

5.3.6 Main findings: Potential mediators and physical performance

Regression models generally supported descriptive statistics that physical capability was higher in study members with indicators of healthier behaviours and with lower fear of falling (table 5.6). In sex-adjusted linear regression, ex-smokers, and never smokers had correspondingly higher mean physical performance than current smokers. Each increasing frequency of LTPA was associated with additionally higher mean physical performance. Every additional 1kg/m^2 increase in BMI was associated with a 0.02 lower mean physical performance score. Increasing severity of fear of falling was inversely associated with physical performance. The association between smoking and physical performance was removed by adjustment for potential confounders.

Table 5.6. Associations between potential mediating variables and physical performance at age 69-70

	Model 1 + sex-adjusted	Model 2 + confounders
	Unstandardised linear regression estimates (95% CI)	Unstandardised linear regression estimates (95%CI)
Smoking		
Current (reference)	0.00	0.00
Ex-smoker	0.10 (0.03, 0.17)	0.06 (-0.01, 0.13)
Never smoked	0.14 (0.07, 0.22)	0.08 (-0.00, 0.15)
LTPA		
Inactive (reference)	0.00	0.00
Moderate	0.17(0.03,0.31)	0.11 (0.06,0.17)
Regular	0.25 (0.15,0.36)	0.15 (0.08,0.17)
BMI (per 1kg/m^2)	-0.02 (-0.02 to -0.01)	-0.01 (-0.02 to -0.01)
Fear of falling		
None (reference)	0.00	0.00
+ no restriction	-0.12 (-0.18,-0.04)	-0.09 (-0.16,-0.02)
+ mild restriction	-0.32 (-0.39,-0.26)	-0.25 (-0.31,-0.19)
+severe restriction	-0.66 (-0.80,-0.52)	-0.51 (-0.66,-0.37)

Based on n= 1727 study members using multiple imputation by chained equations; Unstandardised linear regression estimates represent the mean difference in physical performance scores at age 69-70. M1 adjusted for sex. M2 + occupational position, height, chronic health conditions, depressive symptoms.

5.3.7 Main findings: Potential mediators and functional limitations

Next, the use of each potential mediator was checked though sex-adjusted Poisson regression assessing the relationship of each to functional limitations. There was no association between being an ex-smoker and functional limitations

(Table 5.7), although never smoking had a 27% lower incidence of functional limitations than current smokers. Inactive study members had a 39% higher incidence of functional limitations than those reporting moderate LTPA, and approximately twice the incidence than those regularly active. BMI was positively associated with incidence of functional limitations. There was a clear gradient of higher functional limitations by severity of fear of falling. Most associations were only partly attenuated by the potential confounders. The association between never smoking and functional limitations was removed, and as smoking had also not been associated with mastery or physical performance (Table 5.4 and 5.6) it was removed from further analysis.

Table 5.7. Associations between potential mediators and functional limitations

	Model 1 + sex-adjusted	Model 2 + confounders
	Incidence rate ratio (95% CI)	Incidence rate ratio (95% CI)
Smoking		
Current (reference)	0.00	0.00
Ex-smoker	0.95 (0.82, 1.10)	0.90 (0.75, 1.10)
Never smoked	0.73 (0.62, 0.87)	0.87 (0.71, 1.06)
LTPA		
Inactive (reference)	0.00	0.00
Moderate	0.61 (0.52, 0.70)	0.74 (0.62, 0.87)
Regular	0.49 (0.43, 0.55)	0.67 (0.59, 0.76)
BMI (per 1kg/m2)	1.06 (1.05, 1.07)	1.03 1.03, 1.04)
Fear of falling		
None (reference)	0.00	0.00
Fear	1.74 (1.50, 2.03)	1.49 (1.27, 1.76)
+ mild restriction	2.59 (2.31, 2.92)	1.78 (1.56, 2.04)
+ severe restriction	4.84 (4.09, 5.73)	2.40 (1.92, 2.95)

Based on n= 1727 study members using multiple imputation by chained equations; Incident rate ratios represent the incidence of count of functional limitations at age 69-70. M1 adjusted for sex. M2 + occupational position, height, chronic health conditions, depressive symptoms.

5.3.8 Main findings: Explaining the association between mastery and physical performance

A series of regression analyses addressed the final stage of mediation analysis. That is, the difference in association between mastery and physical capability after separate inclusion of the potential mediators of (M3) LTPA, (M4) BMI, and (M5) fear of falling (Table 5.8). As reported earlier, for every 1 SD increase in mastery there was an increase of 0.02 (95% CI 0.01, 0.02) in physical performance score in linear regression models adjusted for sex and potential confounders. Following that adjustment, inclusion of each potential mediator separately did not alter the size of the positive linear regression coefficient between mastery and physical performance. Comparison of the standardized regression coefficients showed that BMI and fear of falling did partially reduce the effect size of the association between mastery and physical performance. As reported earlier in descriptive statistics, study members who reported a higher frequency of LTPA had higher mean mastery, and higher mean physical performance scores, yet regression analysis did not indicate that LTPA explained any of the association between mastery and physical performance. Simultaneously adjustment for every potential mediator together with the potential confounders did attenuate the association further.

Table 5.8. Summary associations between mastery and physical capability

	Physical performance		Functional limitations
	Unstandardised regression coefficient (95% CI)	Standardised regression coefficient	Incident Rate Ratio (95% CI)
M1 Mastery +sex adjusted	0.03 (0.02, 0.03)	0.22	0.90 (0.88, 0.91)
M2 Mastery + confounders	0.02 (0.02, 0.03)	0.13	0.96 (0.94, 0.97)
M3 + LTPA	0.02 (0.01, 0.02)	0.13	0.96 (0.95, 0.98)
M4 + BMI	0.02 (0.01, 0.02)	0.12	0.96 (0.94, 0.97)
M5 + Fear of falling	0.02 (0.01, 0.02)	0.10	0.97 (0.96, 0.99)
M6 + mutually adjusted	0.01 (0.01, 0.02)	0.10	0.98 (0.96, 0.99)

Based on n= 1727 study members using multiple imputation by chained equations; Unstandardised linear regression estimates represent the mean difference in physical performance scores per 1 unit increase in mastery at age 69-70. Incident Rate Ratios represent the incidence of functional limitations per 1 unit increase in mastery. M1 adjusted for sex. M2 + occupational position, height, chronic health conditions, depressive symptoms.

The overall pattern of findings was consistent for associations between mastery and individual scores of chair rise speed, grip strength and standing balance. The association between mastery and walking speed was removed once fear of falling was added to the model (Appendix B: Table B7, page 261).

5.3.9 Main findings: Explaining the association between mastery and functional limitations

The same steps of analysis were repeated for the association between mastery and functional limitations (Table 5.8). As previously reported, in sex-adjusted Poisson regression models, each 1 point increase in mastery was associated with a 10% (IRR 0.90 95% CI 0.88, 0. 91) lower incidence of functional limitations. Inclusion of the potential mediators implicated different processes between mastery and functional limitations compared to those between mastery and physical performance. After adjustment for potential confounders, the lower incidence of functional limitations per unit increase in mastery was not attenuated by the inclusion of LTPA, or separately BMI. It was partly attenuated by the addition of fear of falling. Accounting for fear of falling reduced the risk of increase in functional limitations per unit increase in mastery by 1%.

Slight differences emerged when the above models were repeated with individual functional limitations as separate outcomes (Appendix B: Table B8, page 261). Fear of falling entirely explained associations between mastery and all functional limitations, apart from ‘walking ¼ mile on a level’, and for men, ‘keeping balance’. Inclusion of both LTPA and BMI in separate models fully attenuated the association between mastery and lower odds of limitations with ‘holding, gripping, or turning things’.

5.3.10 Extending analysis: adjustment for grouped covariates

Adjustment for potential confounders weakened the bivariate association between mastery and physical capability. Adjusting for grouped covariates extended interpretation of factors driving each pathway (Table 5.9). The size of the association between mastery and physical performance was not attenuated

by adjustment for occupational position. Adjusting for grouped chronic health conditions, and separately, grouped health behaviours, partially attenuated the association between mastery and physical performance. Stronger attenuation of the association between mastery and physical performance by grouped psychological indicators (depressive symptoms with fear of falling) implicated psychological processes, such as fear of falling and related activity restriction.

The presence of different explanatory pathways between mastery and functional limitations was reinforced by the inclusion of grouped covariates. Without adjustment for occupational position, indicators of health behaviours weakened the size of the association between mastery and functional limitations. Unlike for physical performance, addition of grouped psychological indicators only minimally attenuated the association between mastery and functional limitations.

Table 5.9 Associations between mastery and physical capability, with grouped adjustment.

	Physical performance		Functional limitations
	Unstandardised regression coefficient (95% CI)	Standardised regression coefficient	Incident Rate Ratio (95% CI)
M1 Mastery +sex, height	0.03 (0.02, 0.03)	0.22	0.90 (0.88, 0.91)
M2 + occupational position	0.03 (0.02, 0.03)	0.22	0.96 (0.94, 0.97)
M3 + chronic health conditions	0.02 (0.02, 0.03)	0.18	0.91 (0.90, 0.93)
M4 +health behaviour indicators	0.02 (0.01, 0.02)	0.14	0.95 (0.93, 0.97)
M5 + psychological indicators	0.01 (0.01, 0.03)	0.11	0.91 (0.90, 0.93)

Based on n= 1727 study members using MICE; Unstandardised linear regression estimates represent the mean difference in physical performance scores per 1 unit increase in mastery at age 69-70. Incident rate ratios represent the incidence of functional limitations per 1 unit increase in mastery. Each sex-adjusted association between mastery and physical capability, adjusted separately by grouped covariates: M4 =LTPA, BMI. M5 = fear of falling and depressive symptoms.

5.3.11 Checking the statistical criteria for mediation analysis

The paramed command in Stata was used to perform additional mediation analyses based on the same models as described above (tables 5.10 – 5.11). The estimated total effect produced by this test was equivalent to the estimate

reported in table 5.8 for the association between mastery and physical capability, after accounting for potential confounders. As above (table 5.8) the addition of LTPA did not add explanatory value to the model between mastery and physical performance. This was indicated by the natural indirect effect (nie) for changing the value of LTPA (nie= 0.00 (95% CI -0.00, 0.00) which did not obtain statistical significance (p=0.35). Similarly, nor did the natural indirect effect for the addition of BMI (p=0.77). There was the suggestion of a small indirect explanatory pathway between mastery and physical performance through the psychological indicator of fear of falling and activity restriction (p=0.03). This supports the interpretation of findings in table 5.9 of a contribution of psychological processes between mastery and physical performance.

Repeating these models with functional limitations as the outcome also produced support for the testing of explanatory variables in the previous sections (table 5.11). There was a small additional indirect effect of fear of falling and activity restriction between the effect of mastery and functional limitations (p= 0.03). Whereas the natural indirect effects for LTPA and BMI were not consistent with mediation.

Overall these causal mediation analyses using parametric regression models suggest that the main cross-sectional analyses showing a small explanatory role for fear of falling between mastery and physical capability are consistent with mediation.

Table 5.10 Additional mediation analysis between mastery and physical performance + potential confounders using parametric regression models

	Total effect (95% CI)	Natural direct effect (95% CI)	Natural indirect effect (95% CI)
Mastery + LTPA	0.02 (0.01, 0.02)	0.01 (0.01,0.02)	0.00 (-0.00, 0.00)
Mastery + BMI	0.02 (0.01, 0.02)	0.01 (0.01,0.02)	0.00 (-0.01, 0.01)
Mastery + Fear of falling	0.02 (0.01, 0.03)	0.01 (0.01,0.02)	0.01 (0.00, 0.01)

Based on n= 1727 study members using multiple imputation by chained equations; Parametric regression model estimates represent the direct and indirect difference in physical performance scores per 1 unit increase at age 69-70. Potential confounders= occupational position, height, chronic health conditions, depressive symptoms.

Table 5.11 Additional mediation analysis between mastery and functional limitations + potential confounders using parametric regression models

	Total effect (95% CI)	Natural direct effect (95% CI)	Natural indirect effect (95% CI)
Mastery + LTPA	0.96 (0.94, 0.97)	0.96 (0.94,0.97)	1.00 (0.99, 1.01)
Mastery + BMI	0.98 (0.01, 0.02)	0.98 (0.96,1.00)	1.00 (0.99, 1.01)
Mastery + Fear of falling	0.97 (0.96, 0.99)	0.97 (0.96,0.99)	0.98 (0.97, 0.99)

Based on n= 1727 study members using multiple imputation by chained equations; Parametric regression model estimates represent the direct and indirect difference in functional limitations per 1 unit increase at age 69-70. Potential confounders= occupational position, height, chronic health conditions, depressive symptoms.

5.3.12 Extending analysis: in a physically capable sub-group

To obtain further insight into the association between mastery and physical performance, the analyses were repeated in a subset of study members with no functional limitations and the highest quartile of composite performance scores at the previous wave of data collection at age 60-64 (n=299). Again, there was a positive association between mastery and physical performance and an inverse association between mastery and functional limitations (table 5.12). Independent of the contribution of prior physical capability to mastery and physical capability in early old age, current mastery maintains an association with physical capability.

Table 5.12. Summary associations between mastery and physical capability at age 69-70 in a subset of 299 with good physical capability at age 60-64[a].

	Physical performance	Functional limitations
	Unstandardised regression coefficient (95% CI)	Incident Rate Ratio (95% CI)
M1 Mastery +sex adjusted	0.02 (0.01, 0.03)	0.92 (0.87, 0.97)
M2 Mastery + confounders	0.02 (0.01, 0.03)	0.95 (0.89, 1.00)

[a] Based on n= 299 study members with complete data on mastery, physical capability and covariates at age 69-70, with 0 functional limitations and the highest quartile of performance score (scoring 3-4/4) at age 60-64; Unstandardised linear regression estimates represent the mean difference in physical performance scores per 1 unit increase in mastery at age 69-70. Incident Rate Ratios represent the incidence of functional limitations per 1 unit increase in mastery. M1 adjusted for sex. M2 + occupational position, height, chronic health conditions, depressive symptoms.

5.4 Discussion

5.4.1 Summary of findings

The findings of this chapter suggest that people with higher mastery perform better on objective standardised physical tests, and perform similar actions better in their daily life, than people with lower mastery. The findings extend evidence of associations between higher mastery and better physical capability from US, Italian and Australian samples to a British population [65, 66, 77, 219]. These findings further extended previous evidence of associations between mastery and physical capability by using both a more comprehensive assessment of objective physical functioning (a composite score from tests of chair rise speed, standing balance and walking speed, with additionally grip strength performance) and, in the same study, self-reported functional limitations.

Indicators of psychological processes (i.e. lower fear of falling and fear related activity restriction) explain a small part of the association between higher mastery and better physical capability, however much of the association between mastery and physical capability was unexplained.

Previous findings from this birth cohort suggest that the current findings are potentially valuable for older people. In the NSHD between ages 53 and 60-64 years, it has been shown that a 1 SD increase in physical performance score is associated with a HR of all-cause mortality of 0.52 [201]. Therefore the 0.1 SD increase in performance score associated with a 1 SD increase in mastery seen in this study could reflect a 6% lower mortality rate (HR of 0.94 (95% CI 0.92, 0.95).

5.4.2 Explaining the association between mastery and physical capability

After identifying an association between higher mastery and both higher levels of nurse-assessed physical performance and fewer self-reported functional

limitations at age 69-70, the aim was to investigate potential pathways between mastery and physical capability.

No available evidence has previously tested smoking behaviour as a potential mediator between mastery and physical capability. Investigation of smoking as a potential mediator in this chapter was based on evidence established in chapter 1 that those with lower mastery are more likely to smoke than those with higher mastery [69, 70]. A large amount of evidence recognises links between smoking and lower physical capability [231-233]. In this chapter, analyses did not suggest an association between mastery and smoking, or between smoking and physical capability once potential confounders had been accounted for.

The contribution of BMI to associations between mastery and physical capability had not previously been tested. Consistent with the literature, BMI was higher in those with higher mastery and higher physical performance, and lower in those with higher functional limitations [23, 67, 68, 223, 227]. There was no evidence that lower BMI explained associations between higher mastery and better composite physical performance or fewer functional limitations. Examining associations between mastery and the individual measures indicated that BMI at least partly explained the association between mastery and better performance on grip strength and chair rise speed tests, and lower odds of limitations in 'holding, gripping, turning things' and 'bending down and straightening up'.

Although more frequent LTPA was associated with higher mastery, better physical performance, and fewer functional limitations, LTPA did not explain the association between mastery and overall physical capability. However, the positive association between mastery and grip strength, and mastery and lower odds of 'holding, gripping, turning things' was reduced after adjusting for LTPA. This supports the previously available evidence reporting that self-reported moderate to vigorous physical activity explained the association between mastery and grip strength test score, and mastery and functional limitations [46, 65, 66]. LTPA also partly explained the association between mastery and quicker chair rise speed, and fully attenuated the inverse association between mastery and limitations in, 'using arms to reach or stretch', and for women, difficulties with balancing.

No evidence has previously examined factors indicating psychological processes between mastery and physical capability. Fear of falling and related activity restriction was lower in those with higher mastery and partially explained the association between mastery and functional limitations, independent of the potential confounders. Inclusion of fear of falling did not reduce the magnitude of the unstandardized linear regression coefficient between mastery and physical performance, independent of the confounders, yet comparison of the standardised effect size indicated that it made a small additional contribution. The grouped inclusion of both psychological factors (fewer depressive symptoms and less fear of falling together) explained some of the effect size between mastery and physical capability. The same patterns of association for individual physical capability items supported the implication that fear-linked psychological processes explained part of the association between mastery and physical performance

The findings of this chapter suggest a more psychologically rooted pathway than a proactive health behaviour pathway between mastery and physical capability. Reinforcing Dutch and Italian evidence, NSHD study members with low mastery appear to appraise their physical capability more fearfully and are more likely to report this fear restricting their activities [77, 318]. Low confidence in physical capability has been shown to both contribute to poorer physical performance scores and a more rapid decline in physical capability over time [34, 86-90, 241]. Individuals with lower mastery may be more likely to underestimate their physical capability or their likelihood of falling, regardless of their intrinsic physical capability.

5.4.3 Methodological considerations

A strength of this study is that physical capability was measured using both nurse-assessed physical performance scores and self-reported functional limitations. This suggested that mastery is associated with underlying physical capability, independent of an individual's perception of their capability. Performance-based measures may be able to gauge a level of physical capability higher or lower than

the functional limitations which individuals report they experience in their own environment.

The major limitation of this work is that findings are based on a cross-sectional design. It should be noted that the direction between these associations is likely to be reciprocal [46]. At this relatively young age and good level of physical capability, functional limitations may be a key driver of activity restriction, which evidence suggests contributes to functional decline and low mastery. People with high physical capability could report feeling more in control of their lives because they feel physically able, rather than maintaining their physical capability because they feel they can control their lives. Associations between mastery and physical capability were consistent in a subset of NSHD study members with good physical capability (no functional limitations and the highest quartile of composite physical performance scores) at age 60-64. Although these findings infer that mastery explained an additional variance in physical capability at age 69-70 than the effect of prior physical capability at age 60-64, causality cannot be attributed. Longitudinal research investigating change in mastery in relation to change in physical capability is warranted in future waves of the NSHD.

The potential confounders considered were chosen based on findings from chapter 4 confirming that they are relevant to mastery in the NSHD, and previous NSHD literature that they contribute to physical capability. Multiple potential confounders were considered in this analysis but there still may have been residual confounding by unobserved factors.

One methodological consideration is if those with higher mastery are more motivated to perform better on physical tests than people with lower mastery. It is plausible that these individuals are pushing themselves to walk faster, balance longer, grip harder, and get up from a chair more quickly. Whilst it is not possible to answer this question, the composite measure of performance has been extensively validated as predictive of the pre-clinical stage of disability [212, 319]. This suggests that people with higher mastery have better underlying physical capability although the exact temporal direction of the findings cannot be confirmed.

The multiple mediators tested in this chapter enable informed discussion of the underlying associations between mastery and physical capability. Yet, future work could enhance the measures further. It is possible that the measures of leisure-time physical activity and smoking did not capture the behaviours as precisely as is possible. Objective measures of energy expenditure, not available in this wave of study, may provide a more accurate assessment of physical activity. Measurement of smoking behaviour could also be improved in future work to consider when ex-smokers quit, although recall error of the smoking variable was considered. The variable accounted for smoking (at least one cigarette a day) in the past year or more and was checked against reports at earlier waves of data collection (from ages 20, 25, 31, 36, 43, 53 and 60-64) and updated accordingly. This is important given people may report themselves as never smokers rather than ex smokers when they have previously recorded themselves as smokers. Fear of falling and related activity restriction was self-reported via questionnaire, although this method has been shown to be more reliable than face to face data collection for reporting of fear of falling [323].

5.5 Conclusions and next chapter

As established in chapter 1 (section 1.2.1), the perpetuating theory of how mastery is associated with any indicator of health is that people who feel in control act accordingly to improve their circumstances [61-63, 134]. However, there is very little evidence formally investigating health behaviours or proposed psychological pathways [5, 64, 314]. Results of this chapter suggest that health behaviours were better in those with higher mastery. They were also more frequently recorded in individuals with higher occupational position and with fewer chronic diseases. After accounting for these potential confounders, indicators of health behaviours did not contribute to explaining why individuals with mastery have better physical capability. Lower fear of falling and fear related activity restriction in people with higher mastery appeared to contribute a very small additional effect to higher physical capability. This finding warrants further investigation of a psychological pathway between mastery and indicators of health such as physical capability in early old age.

The findings in this chapter are promising in that they indicate that even in early old age adults, when individuals remain at a relatively good level of physical capability, differences in mastery can distinguish between how they perform tasks in a standardised and a home environment. The following chapter (6) extends these findings further by investigating whether mastery is also associated with disability (i.e. difficulties with activities of daily living). In chapter 6, mastery will be modelled as an effect modifier between physical capability and disability. After findings in this chapter implied that adults in early old age with more mastery have a more positive psychological state in terms of ageing (with regard to physical capability), the already established literature indicating that mastery is an effect modifier may be extended into its maintenance of independence in older age.

6 THE MODIFYING EFFECT OF MASTERY ON THE ASSOCIATION BETWEEN PHYSICAL CAPABILITY AND DISABILITY

The aim of this chapter was to examine whether mastery is an effect modifier of the associations between physical performance, functional limitations and activities of daily living.

Chapters 3-5 have investigated factors across the life associated with mastery, and associations between mastery and physical capability in early old age. Findings from chapters 3-4 emphasised the contribution of psychological resources to mastery in early old age; suggesting that those with low SEP or poor health can have high mastery despite relatively harder-to-manage circumstances. As introduced in chapter 1, one goal for the WHO is to increase knowledge of perceived control constructs, such as mastery, in order to empower people with few tangible resources to maintain their health, wellbeing, and independence [13, 198, 199]. Chapter 5 extended evidence of mastery as a personal resource associated with physical functioning; even at a relatively good level of physical capability, differences in mastery distinguished between how individuals performed on physical tests and how they experienced the same actions used in their independent home life. The findings suggested that psychological processes may explain how mastery is associated with better physical capability. Chapter 6 extends these findings by investigating if mastery, as an effect modifier, weakens the association between physical capability and disability in this British cohort in early old age.

6.1 Introduction

This chapter builds on the findings in chapter 5 that mastery is associated with physical capability to test whether mastery can also be an effect modifier of the association between physical capability and disability. Specifically, it will test if mastery is associated with better independent physical functioning than would be expected, even for adults in early old age with poor physical capability. As the

literature in chapter 1 explored, mastery has long been framed as a coping mechanism, a psychological resource which can differentiate people in the same challenging circumstances whose health and wellbeing is likely to be protected [6, 20, 27, 50, 51, 83]. During later life when changes such as the onset of decline in physical capability are more likely to occur [54, 205], mastery may be associated with better physical capability than expected.

6.1.1 Background to modification between physical capability and disability

As in chapter 5, the spectrum of physical capability is a useful set of measures to investigate whether mastery is a protective psychological resource. Literature presented in chapter 1 (section 1.4.1) established that where people sit on the continuum between physical capability and disability is the result of a personal and dynamic interaction between their physical impairment, their environmental support, and personal responses [198, 208, 209]. The negative end of that continuum is disability, which can be measured by difficulties in activities required for independent living such as preparing a meal or washing oneself. If physical performance declines beyond a certain threshold, which can happen during the ageing process, an individual may experience more difficulties with functional limitations, and with activities of daily living (ADLs) [198, 208, 209, 324]. Personal responses such as motivation and confidence, or environmental support such as home-adaptions, may support individuals with physical impairment to perform ADLs, thus increasing their physical capability [59, 198, 209, 245]. Mastery may be a personal resource that can minimise the association between physical capability and disability in early old age.

6.1.2 Background to mastery as an effect modifier between physical capability and disability

The findings in chapter 5 help to explain how mastery could be an effect modifier of the association between physical capability and disability. Pearlin suggested that those with high mastery perceive difficult circumstances as less fear-inducing or worrying than do those with lower mastery [31, 76, 77, 88-90]. In chapter 5, higher fear of falling and related activity restriction, along with depressive symptoms in those with low mastery, partially contributed to the positive

association between higher mastery and better physical capability. Building on those findings, it is hypothesized that people with higher mastery may have fewer ADL difficulties than their physical performance or functional limitations suggest, because they do not let age-related fears impact their independent actions or activities in their daily life. For example, it has been shown that older adults with higher mastery are more likely to carry on independent living (through a higher likelihood of using mobility devices) when they develop functional limitations, than those with low mastery [246]. An individual may have poor balance, speed or grip, but because they feel in control of their own circumstances, they persist in attempting actions or activities based on those capabilities, which can positively contribute to the maintenance of physical capability.

6.1.3 Literature on mastery as an effect modifier between physical capability and disability

As summarised in chapter 1, despite substantial literature reporting mastery as an effect modifier for a range of challenges, there are only three studies specifically examining mastery as an effect modifier between physical capability and disability [33, 34, 190, 247]. The exposure test of physical capability is inconsistent between the studies but all three used a composite of IADL/ADL difficulties to capture the outcome of disability. IADLs are tasks involving cognition more overtly (e.g. managing money, or shopping) therefore indicate more complex disability than ADLs.

The available evidence comes from two Dutch cohorts, and one comparison of Dutch with Moroccans and Turks living in the Netherlands. They provided conflicting evidence as to whether higher mastery weakens the association between poor physical capability and disability. Within the Longitudinal Amsterdam Study of Ageing (LASA) [190], Dutch study members and immigrant Turkish study members with slower walking speed were less likely to report IADL/ADL difficulties if they had higher mastery, than those with lower mastery. For the Moroccan immigrant study members in the group, there was no effect modification by mastery between their walking speed and IADL/ADL difficulties. The proportion of Moroccans with ADLs/IADLs was lower than the other samples,

and the sample itself was smaller and more male (n = 199, male 62%, compared to Turkish n = 255, 55% and Dutch samples n=928, 47%). It is possible that there were not enough Moroccan study members with IADL/ADL difficulties to have sufficient power to distinguish differences by mastery. The analyses were also unadjusted; it is possible that taking sex, or other potential confounders into account would have clarified an association.

In contrast, the two other Dutch studies suggested that mastery did not change the association between physical capability and disability. In an older sample from LASA, there was no evidence of mastery modification on the association between baseline physical performance and development of ADLs/IADLs over three years [33]. This study captured a broader assessment of physical performance (composite walking speed, chair rise speed, standing balance time, and putting on a cardigan time) than single walking speed. Unlike in the previous study, the analysis was sex adjusted. There was also no evidence that mastery was an effect modifier for the likelihood of IADL/ADL difficulties per physical performance score in a cross-sectional Dutch cohort of older adults [34]. Physical performance was assessed using a composite of an endurance walking test, a test of hamstring and lower back flexibility, and a test of shoulder joint flexibility. Findings were presented fully adjusted for chronic health conditions; it is not clear whether an interaction was present if chronic health conditions were not included.

Age-related differences may have played a role in the different patterns of findings. The two Dutch studies [34] reporting no evidence of mastery interaction are roughly a decade older (mean age 70) than the Dutch sample [190] reporting mastery to be an effect modifier between physical capability and disability. Differences due to diverse tests of physical performance, functional limitations and ADLs deserve examination. As introduced in the introduction (section 1.3.), the culture of the sample may influence the antecedents or outcomes associated with mastery. There were differences in the role of mastery as an effect modifier between Dutch and Turkish, and Moroccan immigrant study members living in the Netherlands [190]. A study using one perceived control item rather than the mastery questionnaire also reported mixed findings between older Americans (HRS cohort) and members of the English Longitudinal Study of Ageing (ELSA) [192].

6.1.4 Summary of evidence and gaps to be addressed in the current study

In summary, there were only three studies available testing an interaction between mastery, physical performance and disability. There is a need for more research to understand the role of mastery as an effect modifier more generally as well as of the association between physical capability and disability. Inconsistencies in findings of previous literature may reflect a number of issues which necessitate more research. Different measures of physical capability as the exposure between studies make it harder to compare findings. This thesis extends previous literature by considering differences in the spectrum of normal functioning rather than just using scores from one or two performance tests. The assessment produced by the short physical performance battery (SPPB) used in chapter 5 and 6, described more fully in chapter 2 (section 2.3), may be sensitive to decline in capability before it is even noticed by the individuals themselves [209, 324].

Inconsistent use of potential confounders in previous studies examining the role of mastery as an effect modifier between physical capability and disability also needs to be addressed. The findings from chapters 3 & 4, together with established literature on physical capability, point to the shared role of potential confounders when interpreting the interaction of mastery on physical capability and disability. Chapter 5 reinforced that although mastery contributes to physical capability, independent occupational position, chronic health conditions and depressive symptoms may inflate the effect size.

There are no studies investigating if mastery is an effect modifier of the association between physical performance and functional limitations, or of the association between functional limitations and ADLs. Building on the findings of previous work whilst addressing the gaps, this chapter will examine whether mastery modifies both the experience of actions (functional limitations) and the activities (ADLs) needed for maximum physical capability (see figure 6.1).

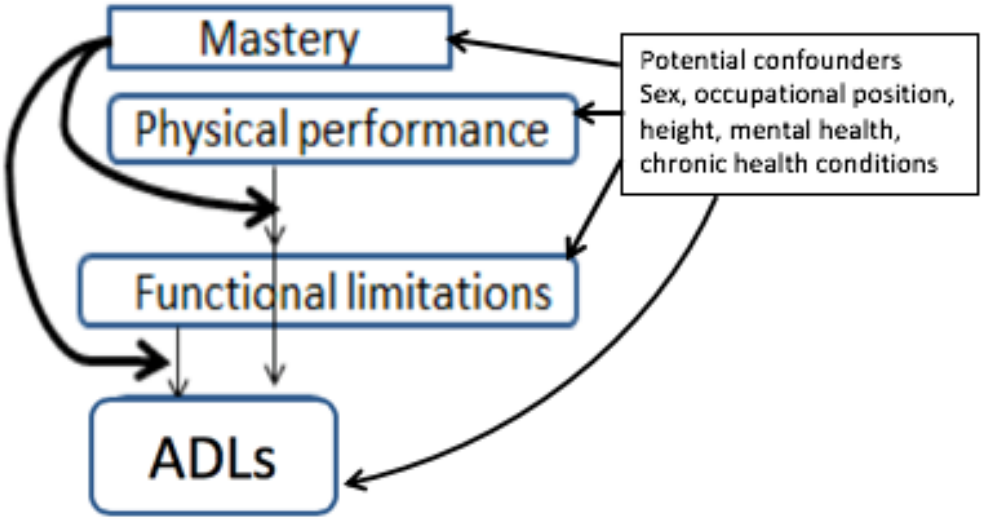

Figure 6.1 Conceptual model theorising pathways of association between physical capability and ADLs with mastery as an effect modifier

6.2 Analysis plan

The analysis in this chapter relates to research objective vi described in detail in the methods chapter (chapter 2, section 2.1): to examine the association between physical performance and functional limitations, and between both these variables and ADLs; and investigate whether mastery modifies the associations.

For the first section of results, it was hypothesised that lower levels of physical performance will be associated with higher prevalence of functional limitations. The association between physical performance and functional limitations is expected to be weaker in those with higher mastery. In the second section of results, it was hypothesised that lower levels of physical performance and greater functional limitations will both be associated with increasing level of difficulties with ADLs. This association will be weaker in those with higher mastery.

Consistent with chapter 5, potential confounders were selected a-priori. The potential confounders were occupational position, height, chronic health conditions (cardiovascular diseases, respiratory difficulties, osteoarthritis and diabetes) and depressive symptoms.

6.2.1 Analytical sample

The analytical sample used throughout in this chapter was restricted to study members with complete data on mastery at age 68-9 who also provided data on at least one of the physical performance measures or the functional limitations score at age 69-70 (n= 1727). Those participants with missing data on covariates were included by using multiple imputation by chained equations. Further details of which are described in chapter 2 (section 2.4.1). The main associations in the maximum available sample with complete data were compared with sensitivity analyses to those run on imputed data sets.

6.2.2 Descriptive analyses

Descriptive statistics were first presented to identify whether there is an association between functional limitations and physical performance. In the descriptive statistics, physical performance and mastery were examined by tertiles. Chi-squared tests assessed whether the proportion of study members with functional limitations differed by physical performance tertile.

As with descriptive analyses for physical performance and functional limitations in chapter 5, this chapter reports the proportion of ADLs in this sample in addition to their distribution over the potential confounding variables. Chi-squared tests assessed the relationship of the exposures (physical performance and functional limitations) and the potential modifier (mastery) to the prevalence of ADL difficulties in this sample. To formally test the gradient in ADL difficulties across physical performance and mastery tertiles, and functional limitations, ordinal logistic regression was used.

6.2.3 Regression models

The second stage of the analysis for each objective used sex-adjusted regression models to test the associations between each exposure and outcome, before including adjustment for potential confounders. As in chapter 5, these were occupational position, height, chronic health conditions (cardiovascular diseases,

respiratory difficulties, osteoarthritis and diabetes) and depressive symptoms. For each model, sex interactions were formally tested; no evidence was found. Physical performance, as well as functional limitations, and mastery, were modelled continuously after formal testing for deviation from linearity.

Poisson regression estimated the association between physical performance and count of functional limitations by calculating incident rate ratios of functional limitations for a unit change in physical performance. To test the modifying effects of mastery on this association, a term representing the interaction between physical performance and mastery (and their main effects) was introduced. The hypothesis of effect modification was supported if the interaction terms were statistically significant, while accounting for main effects.

To estimate whether there was an association between physical performance and ADLs, ordinal logistic regression was used to estimate the odds of difficulties with ADLs for each unit increase in physical performance, before adding a term representing the interaction between physical performance and mastery (and their main effects). Before using ordinal logistic regression for this analysis the Brandt Test of Parallel Regression Assumption was used to check that the proportional odds assumption was not violated. The Brandt test was not significant, suggesting that the use of ordinal logistic regression for this analysis was appropriate.

When estimating the interaction where evidence of a significant interaction at the 10 % level of statistical significance was found this was interpreted further. The magnitude of the regression estimates between exposure and outcome were compared across pre-specified mastery tertiles.

6.3 Results

6.3.1 The modifying effect of mastery on the association between physical performance and functional limitations

This first section of the results reports investigation of the association between physical performance and functional limitations, and potential effect modification by mastery.

6.3.1.1 Descriptive relationship between physical performance and functional limitations

The figures in table 6.1 support evidence cited in the introduction of this chapter that physical performance is inversely correlated with functional limitations ($p<0.001$). Of those in the lowest physical performance tertile, 19% of study members had 4-6 functional limitations, compared to only 2% of those in the mid tertile and 0.6% of those in the highest tertile.

Table 6.1. Prevalence of functional limitations by physical performance tertile

Physical performance tertiles	n	Functional limitations (proportion of sample %) 0	1	2	3	4-6
1 Low (range 0-1.54)	483	26	25	17	12	19
2 Mid (1.55- 1.99)	518	55	31	8	4	2
3 High (2.00- 3.41)	423	69	24	6	1	1
P-value [a]		<0.001				

Note: Study members are those with data for each individual measure+ mastery and physical capability outcome at age 69-70 (maximum n =1727). [a] P value describes overall test of association.

6.3.1.2 Association between physical performance and functional limitations

Sex-adjusted Poisson regression confirmed the descriptive analyses that physical performance was strongly inversely associated with functional limitations. Each 1 point increase in physical performance was associated with a 76% decrease in number of functional limitations (IRR 0.24 (95% CI 0.22, 0.26), table 6.2) Adjustment for the potential confounders attenuated this rate by 11% (IRR 0.35 (0.30, 0.38). This pattern of association was consistent for each

performance item and total and individual functional limitations (Appendix C: Table C1, page 262).

Table 6.2 Association between physical performance and functional limitations

	Model 1, sex adjusted	Model 2, covariate adjusted
	IRR (95% CI)	IRR (95% CI)
Physical performance	0.24 (0.21, 0.26)	0.35 (0.30, 0.38)

Notes: Based on n= 1727 study members using multiple imputation by chained equations; incident rate ratios represent the incidence of functional limitations per I unit increase in physical performance score at age 69-70 using poisson regression models. M1 sex adjusted. M2 + adjusted for occupational position, height, depressive symptoms, chronic health conditions

6.3.1.3 Effect modification of mastery between physical performance and functional limitations

To test for effect modification between physical performance and mastery, whilst accounting for their main effects on functional limitations, the interaction was tested (Table 6.3). The significant interaction (p-value from test of mastery x physical performance interaction=0.009) indicated that mastery modifies the association between physical performance and incidence of functional limitations.

Table 6.3 Interaction between mastery and its effect on physical performance and functional limitations from poisson regression models

	Model 1, sex adjusted	Model 2 covariate adjusted
	Incident rate ratios (95% CI)	Incident rate ratios (95% CI)
Physical performance	0.67 (0.40, 1.16)	0.67 (0.40, 1.16)
Mastery	1.01 (0.97, 1.05)	1.03 (0.99, 1.06)
Mastery x physical performance	0.96 (0.93, 0.99)	0.97 (0.94, 0.99)
P-value for interaction	0.009	0.007

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Incident rate ratios represent the incidence of functional limitations per unit increase in mastery score or physical performance score using poisson regression models. M1 sex adjusted. M2 + adjusted for occupational position, height, depressive symptoms, chronic health conditions

Table 6.4 presents stratification of the association between physical performance and incidence of functional limitations, by mastery tertile. The association between higher physical performance and fewer self-reported functional limitations was stronger in those with higher mastery. For each 1 point increase in physical performance measured, study members in the bottom third of mastery had 72% lower reports of functional limitations (IRR 0.28 (95% CI 0.24, 0.33). Whereas for those in the middle and top third of mastery each 1 point increase in physical performance was associated with an additional 8% fewer functional limitations (IRR 0.20 (95% CI 0.5, 0.25). This suggests that the lived experience of poorer physical capability (i.e. more self-reported functional limitations than would be expected from one's intrinsic physical capability score) was more pronounced for those with lower mastery, compared to those with higher mastery.

Table 6.4 Associations between physical performance and functional limitations, stratified by mastery tertile

	N	Model 1, sex adjusted	Model 2, covariate adjusted
Mastery tertile		Incident rate ratio (95% CI)	Incident rate ratio (95% CI)
Low (8-19)	483	0.28 (0.24, 0.33)	0.36 (0.31, 0.42)
Mid (20-23)	518	0.20 (0.16, 0.25)	0.26 (0.19, 0.33)
High (24-28)	423	0.20 (0.15, 0.25)	0.36 (0.23, 0.42)
P-value for interaction		0.009	0.007

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Incident rate ratios represent the incidence of functional limitations per unit increase in physical performance at age 69-70, using poisson regression. M2 adjusted for occupational position, height, depressive symptoms, chronic health conditions

Mastery did not moderate associations between any individual performance items and individual functional limitations (Appendix C, Table C2, page 263). Although there was a reasonable sample size with complete data for analysis using each performance test and functional limitation, there was less variability in individual functional limitations than overall. Descriptive statistics from chapter 5 indicated that although approximately half of all study members reported at least one functional limitation, the range over individual items is far less (10% to 30%). Thus, analysis may have been unable to detect variations in functional limitations per mastery and physical performance interaction.

6.3.2 The modifying effect of mastery on the association between physical performance, functional limitations and activities of daily living (ADLS)

This second section of the results reports investigation of the associations between physical performance and functional limitations and difficulties with ADLS, and the potential effect modification of mastery on those associations.

6.3.2.1 Characteristics of ADL difficulty in this cohort

The prevalence of ADL difficulties in study members with complete mastery and physical capability and disability data at age 69-70 is presented in tables 6.5 and 6.6. Study members were grouped by level of ADL difficulty if they reported that level of difficulty with at least one of the eight activities (coding described in chapter 2 (section 2.3)). The majority of study members (88.5%) did not report any ADL difficulty at all. The most common activity to report difficulty completing independently was bathing and/or showering for which only 6.8% of study members had difficulties. These figures raise the possibility of a ceiling effect in the self-reported measures although as the study members are not yet in later older age, this is to be expected.

Table 6.5. Prevalence of each individual ADL item in study members with complete data[a]

	n	Proportion of study members (%)			
		No difficulties	Difficulties	Uses aids	Uses aids and/or personal care
Getting around indoors	1725	97.7	0.9	0.9	0.5
Bathing and/or showering	1726	93.2	3.7	1.7	1.4
Getting in and out of a chair	1726	95.1	3.2	0.7	1.0
Getting in and out of bed	1727	96.0	2.5	0.6	0.9
Dressing and undressing	1727	96.3	1.6	0.4	1.7
Using the toilet	1727	98.5	0.5	0.8	0.3
Washing hands and face	1727	99.4	0.5	0.0	0.1
Feeding self (incl. cutting food)	1725	98.8	0.8	0.1	0.3

Note: Study members are those with data for each individual measure+ mastery and physical capability and disability at age 69-70 (maximum n =1727). [a] Total numbers vary due to missing data.

The distribution of ADL difficulties across the potential confounders emphasises the value of extending previous evidence to consider these factors (table 6.6). Fewer men reported any level of difficulty than women which reiterates the need to address previous research gaps by considering sex differences. Severity level of ADL difficulty was inversely associated with occupational advantage. Study members with each chronic health condition reported more difficulties with ADLs.

Table 6.6. Prevalence of difficulties with ADLs across covariates in study members with complete data[1]

		Proportion of study members (%)			
	N	None N= 1548	Difficulties N= 100	Uses aids N= 37	Uses aids and personal care N= 42
Men	926	91.1	4.5	1.13	3.2
Women	987	86.1	7.4	3.4	2.9
P value [a]		<0.001			
Occupational Position					
I Professional	148	94.3	4.5	0.0	1.1
II Managerial/tech	698	91.8	4.1	1.9	1.9
III Skilled(NM)	423	86.4	9.1	2.4	1.9
IIIM Skilled manual	241	85.4	6.9	2.1	5.4
IV Partly skilled	164	84.9	5.6	5.1	4.2
V Unskilled	46	76.3	5.5	4.1	13.8
P-value [a]		<0.001			
P-value [b]		<0.001			
Cardiovascular disease					
No	1509	90.5	5.1	2.2	2.0
Yes	217	75.2	12.1	2.5	9.9
P-value [a]		<0.001			
Respiratory difficulties					
No	1242	91.2	5.2	1.7	1.6
Yes	357	82.6	8.2	3.2	5.7
P-value [a]		<0.001			
Osteoarthritis					
No	1363	91.4	4.1	1.8	2.6
Yes	363	78.2	12.7	4.3	4.7
P-value [a]		<0.001			
Diabetes					
No	1550	895	5.7	2.3	2.4
Yes	177	81.7	8.1	2.4	7.6
P-value [a]		<0.001			

Note: Study members are those with data for each individual measure + mastery + physical capability and disability at age 69-70 (maximum n= 1727). [1] Total numbers vary due to missing data. [a] Test of association using chi-squared test. [b] Test of trend using ordinal logistic regression

6.3.2.2 Descriptive relationship between physical capability and ADLs

The results in table 6.7 support research cited earlier in this chapter that physical performance is inversely correlated with ADL difficulties ($p<0.001$), and functional limitations are positively associated with severity of ADL difficulties ($p <0.001$). Individuals in the highest physical performance tertile were more likely to have no difficulties with ADLs (97.8% vs 93.8% in middle tertile and 74.9% in the lowest tertile). In study members with no functional limitations, 98.3% also reported no difficulties with ADLs, whereas in those with 4-6 limitations only 26.0% did not report difficulties, while 28.9% needed aids and/or personal care for at least one ADL. The descriptive statistics support previous studies that indicate that ADL difficulties vary by mastery; as mastery increased from the lowest quartile to the highest study members free of ADL disability increased by 13% ($p<0.001$).

Table 6.7. Prevalence of difficulties with ADLs across mastery, functional limitations, and physical performance at age 69-70

	Proportion of study members (%)			
	None	Difficulty	Uses aids	Uses aids and personal care
Physical performance tertiles				
Low (0- 1.54)	74.9	11.0	5.8	8.1
Mid (1.55- 1.99)	93.8	4.6	0.7	0.7
High (2.00- 3.41)	97.8	1.8	0.1	0.1
P-value [a]	<0.001			
P-value [b]	<0.001			
Functional limitations				
0	98.3	1.4	0.09	0.0
1	94.7	3.9	0.72	0.5
2	78.5	14.7	3.33	3.3
3	75.0	17.1	2.34	5.4
4-6	26.0	23.6	21.30	28.9
P-value [a]	<0.001			
P-value [b]	<0.001			
Mastery tertiles				
Low (8-19)	81.0	9.7	4.6	4.6
Mid (20-23)	92.8	4.0	1.4	1.7
High (24-28)	94.3	4.0	0.5	1.0
P-value [a]	<0.001			
P-value [b]	<0.001			

Note: Study members are those with data for each individual measure+ mastery and physical capability and disability (maximum n =1727). [1] Total numbers vary due to missing data. [a] Test of association using chi-squared test.[b] Test of trend using ordinal logistic regression

6.3.2.3 Association between physical capability and ADLs

Regression analysis confirmed descriptive findings that physical capability was associated with ADLs (table 6.8). In sex-adjusted ordinal logistic regression models, each 1 point increase in physical performance was associated with a lower likelihood (OR 0.03 (95% CI 0.01, 0.05)) of higher severity of ADL difficulty. Each 1 point increase in functional limitations was associated with 2.75 higher odds (95% CI 2.43, 3.11) of higher ADL severity. These associations were maintained on adjustment for the potential confounders (attenuated to OR 0.05 (95% CI 0.03, 0.08) and OR 2.50 (95% CI 2.17, 2.88) respectively).

Table 6.8 Associations between physical capability and difficulties with ADLs

	Model 1, sex adjusted	Model 2, covariate adjusted
	OR (95% CI)	OR (95% CI)
Physical performance	0.03 (0.01, 0.05)	0.05 (0.03, 0.08)
Functional limitations	2.75 (2.43, 3.11)	2.50 (2.17, 2.88)

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Odds Ratio represent the likelihood of each additional severity level of ADL difficulties per I unit increase in exposure (modelled continuously) using ordinal logistic regression. M2 + occupational position, height, chronic health conditions, and depressive symptoms.

6.3.2.4 Effect modification of mastery between physical capability and ADLs

To assess effect modification between physical performance and mastery, while accounting for their main effects on ADLs, the interaction term was included (Table 6.9). This interaction was not significant (p=0.7). The main effects indicated that when physical performance was included in the model, higher mastery was associated with lower odds of ADL difficulties. There was no evidence that increases in mastery changed the association between physical performance and odds of ADL difficulties.

Table 6.9. Interaction between mastery and its effect on physical performance and ADLs at age 69 -70 from ordinal logistic regression models

	Activities of daily living (4 levels of severity) No difficulties Difficulties Difficulties + uses aids Difficulties + uses aids and/or personal care	
	Model 1, sex adjusted	Model 2,+ covariates
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Physical performance	0.02 (0.00, 0.27)	0.01 (0.00, 0.16)
Mastery	0.88 (0.74, 1.04)	0.84 (0.70, 1.01)
Mastery x physical performance	1.03 (0.90, 1.15)	1.07(0.95, 1.21)
P-value for interaction	0.7	0.2

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Odds Ratio represent the likelihood of each additional severity level of ADL difficulties per I unit increase in exposure (modelled continuously) using ordinal logistic regression. M2 + adjusted for occupational position, height, depressive symptoms, chronic health conditions

Table 6.10 shows the test of interaction between mastery and functional limitations on odds of ADLs. Accounting for the main effect of functional limitations on ADLs, mastery was positively associated with lower odds of ADL difficulty. There was no evidence that odds of additional ADL difficulty per functional limitation differed by change in mastery (p=0.7). These findings were consistent for individual physical performance and functional limitation items (Appendix C: Table C4, page 265; Table C5, page 266).

Table 6.10. Interaction between mastery and its effect on functional limitations and ADLs at age 69 -70 from ordinal logistic regression models

	Activities of daily living (4 levels of severity) No difficulties Some difficulties Difficulties + uses aids Difficulties + uses aids and/or personal care	
	Model 1, sex adjusted	Model 2, covariate adjusted
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Functional limitations	3.02 (1.64, 5.59)	3.45 (1.83, 6.50)
Mastery	0.96 (0.88, 1.05)	0.98 (0.90, 1.08)
Mastery x functional limitations	0.99 (0.94, 1.04)	0 .98 (0.95,1.01)
P-value for interaction	0.7	0.3

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Odds Ratio represent the likelihood of each additional severity level of ADL difficulties per I unit increase in exposure (modelled continuously) using ordinal logistic regression. M2 + adjusted for occupational position, height, depressive symptoms, chronic health conditions

6.4 Discussion

6.4.1 Summary of findings

The main findings of this chapter indicated that the association between physical performance and incidence of functional limitations was modified by mastery. Individuals with poorer physical performance reported more functional limitations. However, for individuals with higher mastery scores, this association was weaker compared to those with low mastery scores. The findings infer that people who feel more in control are less likely to have the functional limitations that their physical performance score suggests. There was no evidence that the association between physical performance and ADLs, and functional limitations and ADLs were different at any level of mastery.

6.4.2 Explaining the findings

As emphasised earlier in this chapter, mastery may have a role as a psychological resource used by individuals coping better than expected with many areas of poor health or challenges [6, 27, 50, 51, 244]. Although previous studies had not formally tested an interaction of mastery on the association between any physical performance test and functional limitations, there was supporting literature. Prior mastery in older adults has been reported as higher in those who go on to recover from functional limitations and who have a slower rate of physical capability decline over time [246]. In the previous chapter (5), there was no evidence of indicators of health behaviours explaining why mastery was associated with physical capability but there was some indication of psychological processes underlying the association. Within the context of the literature, the findings regarding physical performance, functional limitations and mastery suggest that mastery may be one of the personal resources suggested by the WHO to contribute to the dynamic process of disability [59, 198, 209, 245].

Conversely, there was no evidence of effect modification of mastery on the association between either physical performance or functional limitations and ADLs. This supports the evidence cited earlier in this chapter of two Dutch studies

of older age adults (33, 34); mastery did not modify the association between composite physical performance scores and a composite of IADLS/ADLS. It was expected that mastery would have been an effect modifier for a measure of disability focused on ADLs rather than the more advanced and complex measure of disability represented by ADLs/IADLs. However, difficulties with ADLs may still represent a more severe degree of physical impairment that is harder to modify by perceived control. Both of these analyses, although cross-sectional, represent steps further along the spectrum of physical decline than between physical performance and functional limitations. In addition, there were very few members of the sample at age 69-70 with ADL difficulties in whom to test differences which would have reduced power.

6.4.3 Methodological considerations

The following chapter (7) presents the overall methodological strengths and limitations of this thesis, while strengths specific to chapter 6 are outlined below.

Despite a strong theoretical model implying a trajectory from the development of physical performance impairment to functional limitations to ADL difficulties [205-207, 209], both disability and mastery are bi-directional and dynamic [24, 33, 46, 325]. It is possible that experiencing more functional limitations contributes to low mastery, rather than as hypothesised, an individual with higher mastery has fewer functional limitations than one would expect given their level of physical impairment. The cross-sectional model examined in chapter 6 lacks the scope to speculate the direction of the effect.

As highlighted in the previous section, the age and good physical capability of the study sample, and those used in previous research, may reduce the scope for differences in disability to be detected by mastery. Functional limitations were reported by 49% of the sample whereas only 11% of study members had any ADL difficulty. It may not have been possible to detect variations associated with mastery and physical capability in individuals with ADL difficulties whereas there were enough functional limitations present to notice differences associated with mastery.

This chapter added to the literature in this area by using both composite physical performance scores and assessing whether associations with particular tests were driving the interaction. The findings of the current chapter study report that in this population, mastery does not modify the likelihood of functional limitations for any particular physical performance score. As discussed in chapter 1, mastery is a general perception of control, and in these early old aged adults, there may not be an association unique to localised aspects of physical capability.

6.4.4 Conclusion and next chapter

This chapter reported findings that mastery modified associations between physical performance and self-reported functional limitations. People with higher mastery had a lower incidence of the expected functional limitations for their given physical performance, than people with lower mastery. This effect was not explained by potential confounders shown in previous chapters to contribute to mastery, and from previous NSHD research, to physical capability. There was no evidence that high mastery interacted with the association between both indicators of physical capability and ADL difficulties.

The following chapter (7) summarises the main findings of this thesis. It provides insights into both exposures across life associated with mastery in early old age, and whether and why mastery is associated with physical capability and disability in early old age. After placing the findings in context with their strengths and weaknesses, their implications are discussed and followed by recommendations for future investigation.

7 DISCUSSION

7.1 Summary of main findings

This thesis used a life course perspective to test the processes across life by which British adults may feel more or less in control in early old age, and how their sense of mastery may relate to their physical capability. It aimed to address important gaps in the current understanding of mastery, identified with an extensive literature review.

No previous study used a long running birth cohort to test whether mastery is an integration of multiple processes spanning the life course or limited to more proximal factors. In this sample of British adults in early old age, there were multiple associations between current and proximal conditions and mastery. For example, current socioeconomic advantage (income and income perception), better social support were associated with higher mastery and current poor mental health and chronic health conditions were associated with lower mastery. Associations between more distal exposures and current mastery were explained by pathways to the current circumstances. For example, the association between accumulation of SLEs across adulthood and lower mastery in early old age was explained by the presence of greater depressive symptoms.

Consistent with mastery theory introduced in chapter 1 (section 1.3), current conditions were not the only exposures informing mastery in early old age. Data from nearly seventy years of this birth cohort emphasised that independent of current and adult circumstances, associations between earlier factors and mastery remain; study members who reported higher parental psychological control or more stressful life events in their early environment had a lower sense of mastery over their own life at age 68-9.

There was also evidence for separate socioeconomic and psychosocial processes spanning the life course toward mastery in early old age. For example, higher perceived parental support in the early environment was associated with better positive support in early old age, which was subsequently associated with a stronger sense of mastery. Findings in chapter 3 indicated that cognitive

processes explained associations between paternal socioeconomic advantage and mastery, with associations between early cognitive processes and higher mastery explained by links to higher adult occupational position and income at age 68-9 (chapter 4). Moreover, education appeared to contribute to mastery through facilitating greater occupational position and income in early old age rather than adult cognitive processes.

In addition, there was some interplay between socioeconomic and psychosocial pathways of associations and mastery. As in a previous study into predictors of mastery in early old age Americans [310], it appeared that better social support was more common in those with higher income and that social support explained associations between income and mastery at this age. In earlier life, there was also some co-occurrence of socioeconomic and psychosocial pathways. The unexpected association between higher maternal education and lower mastery appeared to be explained by the contribution of more highly educated mothers being perceived as more controlling and less supportive in study members' earlier lives. The identification of multiple potential processes between factors across the life and mastery fit within the aim of the WHO [13] introduced in chapter 1: to highlight factors associated with sense of control regardless of current hard-to-manage circumstances.

The second broad area of research gaps that this thesis aimed to address was understanding mastery, health and resiliency. Although evidence suggests that people with higher mastery are healthier, live longer lives, and are more resilient to challenges than those with lower mastery, little evidence has explored why that might be. To investigate this, associations between mastery and physical capability were tested. Higher mastery was associated with better physical performance on objective tests and fewer self-reported functional limitations, independent of potential confounders identified in the first half of the thesis.

Findings inferred that psychological processes contributed to the association between mastery and physical capability rather than proactive health behaviours such as frequent leisure time physical activity (LTPA). A psychological

mechanism of mastery was again inferred by the final set of analyses in chapter 6. For study members with higher mastery, the likelihood of functional limitations was lower than predicted from their physical performance score. These key findings, as well as other findings from this thesis are discussed in greater detail in this chapter. The next sections outline the 6 objectives of this thesis.

7.1.1 Objective i: The early environment and mastery in early old age

To test the direct and indirect associations between multiple indicators of the early (age 0-16) socioeconomic and psychosocial environment with mastery (Chapter 3)

The findings in chapter 3 did not support the hypothesis that greater early socioeconomic advantage would be positively associated with mastery in early old age, independent of potentially co-occurring psychosocial factors and cognitive ability. There was no dose-response relationship between any indicator of earlier socioeconomic advantage and mastery. However, study members whose fathers had intermediate levels of education, whose fathers worked in mid-level occupations, and whose mothers had relatively lower levels of education had the highest mastery at age 68-9. Greater early cognitive ability explained associations between father's education and mastery, and occupational position and mastery in early old age. The unexpected inverse association between maternal education and mastery was later fully explained by overlapping psychosocial factors.

Several psychosocial exposures from the early environment were associated with mastery. As hypothesised, study members who had experienced fewer early stressful events and had more autonomy-granting from parents (i.e. higher supportive parenting, lower psychological control) had higher mastery in early old age. A positive association between parental behavioural control and mastery emerged when controlling for parental psychological control and parental support. Maternal education attenuated the significance of the association between parental behavioural control and mastery. Parental behavioural control was recalled as stronger in households where mothers had relatively lower

education. Mothers with lower educations were also those whose offspring had higher mastery.

7.1.2 Objectives ii and iii: Life course influences on mastery

To test associations between multiple indicators of the socioeconomic and psychosocial adult environment and mastery, along with early environment measures reported in chapter 3 (Chapter 4).

Chapter 4 tested which adult life experiences were associated with mastery at age 68-9. As expected, different pathways were implicated between each of the four separate indicators of adult socioeconomic advantage and higher mastery in early old age. The association between higher education and mastery was explained by more proximal indicators of SEP (i.e. advantaged occupational position, and current income band and financial perception). The association between current income band and mastery was explained by positive social support being better for those with higher income. Higher occupational position and income perception remained positively associated with mastery.

It was expected that separate to SEP disadvantage and current health conditions there would be associations between adult psychosocial experiences and mastery. As expected, having a chronic medical condition (apart from osteoarthritis) was associated with lower mastery. Worse negative social support and lower positive support were associated with lower mastery regardless of SEP or health conditions. Worse depressive symptoms explained the association between more SLEs across adult life and lower mastery at age 68-9.

First, separate models focused on early environment factors and models focusing on adult environment factors, which were then included in combined models. These findings supported the hypothesis that differences in the early environment can have long lasting associations with mastery, separate from adult trajectories indicative of more or less control. Associations between lower perceived parental psychological control, fewer early SLEs, and higher mastery were not explained by pathways in adulthood. The association between greater parental support and

mastery appeared to be driven by variations in current positive social support. The association between early cognitive ability and mastery was completely explained by a more advantageous later socioeconomic trajectory.

7.1.3 Objective iv: Mastery and physical capability

To investigate cross-sectional associations between mastery and physical capability at age 69-70 (Chapter 5).

The cross-sectional findings presented in chapter 5 supported the hypothesis that study members with higher mastery performed better on standardised physical performance tests administered by nurses and reported fewer functional limitations in their daily life. Associations between mastery and better physical capability remained after inclusion of the potential confounders of sex, occupational position, chronic physical health conditions and depressive symptoms, as informed by both findings in previous chapters and previous literature.

7.1.4 Objective v: Potential mediators between mastery and physical capability.

To test whether associations between mastery and physical capability at age 69-70 are explained by potential explanatory variables of indicators of health behaviours and psychological processes, or potential confounders identified from literature and chapter 4 (Chapter 5).

It was hypothesised that indicators of health behaviours (leisure time physical activity, smoking, and BMI) in study members with higher mastery would explain part of the association between mastery and physical capability. Preliminary analysis did not implicate smoking status as an indicator of health behaviours to test between mastery and physical capability. Mastery was associated with more frequent leisure time physical activity (LTPA) and healthier body mass index (BMI). However, there was little evidence that these indicators of health behaviours contributed to associations between higher mastery and better physical capability. It was also hypothesised that the association between

mastery and physical capability would partially be explained by psychological processes. There was some evidence that an indicator of psychological processes (lower fear of falling and related activity restriction) explained a small part of the association between mastery and better physical capability.

7.1.5 Objective vi: Mastery as an effect modifier

To test mastery's role as an effect modifier between physical performance and a) functional limitations and b) activities of daily living (ADLS) at age 69-70 (Chapter 6)

As expected, a lower physical performance score was associated with a greater number of self-reported functional limitations. Lower physical performance score and greater functional limitations were associated with more difficulties with activities of daily living (ADLs). The effect modification hypothesis was partially supported as the association between physical performance and functional limitations was weaker among those with higher mastery.

7.2 Explanations of findings

The next sections summarise processes from across the life suggested to explain the findings from chapters 3 and 4 and indicate how people in early old age may feel more or less in control of their circumstances (sections 7.2.1 to. 7.2.4.). Following this, sections 7.25 to 7.2.6 summarise the explanations of evidence in chapters 5 and 6 regarding higher mastery and greater physical capability in early old age.

7.2.1 Current circumstances and mastery in early older age

Mastery is defined as a self-concept indicating the extent to which an individual perceives that they can manage their own life [94]. Being with current circumstances, findings in chapter 4 reinforce that factors which are hard to control and factors which make daily life harder to control may play a role in mastery. Chapter 4 supports evidence that financial pressure, chronic health conditions, and depressive symptoms are associated with low mastery [31, 134,

149, 186, 296]. Chronic health conditions such as cardiovascular disease, diabetes, and respiratory symptoms require time and effort for appointments, lifestyle changes and health-worries and can make it physically challenging to carry out a daily routine. Not being able to manage financially can impact lifestyle worries and daily routines if each requirement has to hinge on the most affordable option. Depressive symptoms are inherently the feeling of being overwhelmed and can make daily life harder to cope with [309].

7.2.2 The integration of factors across life into mastery in early older age

Evidence suggests pathways to mastery can occur across life, independent of current circumstances. This thesis was able to integrate examination of current contributions to mastery with those much earlier in adult life, right back to the earliest environment [131, 298].

7.2.2.1 Accumulation of mastery across life

There was evidence that mastery is an accumulation of factors across life, as well as a response to current circumstances. The linear association between SLEs across adulthood and mastery in early older age implied that each additional SLE was associated with an additionally lower mastery score. Each additional SLE could be a repeated and cumulative reminder that the individual does not control their own life.

Other non-contemporaneous factors were associated with mastery in early old age. For example, an association remained between occupational position captured at age 53 and mastery at age 68-9, independent of current cognitive, financial and health indicators. Although the NSHD study members are largely retired, it is possible that repeated experiences of being in control in the workplace accumulated a sense of mastery carried over into early old age.

7.2.2.2 Lasting associations between early life factors and mastery in early old age

Factors from the early environment can also have lasting associations with mastery in early old age. Early life may be a sensitive period for psychological

development in which many patterns of thought, for example control expectancies, are thought to be established [21, 155]. Unlike other early life factors in the models, associations of both higher psychological control and more SLEs with lower mastery were not explained by including concurrent or adult factors in the model. Both parental psychological control and SLEs in early life may contribute to a long-lasting sense of helplessness and negative expectations with regard to mastery.

7.2.2.3 Trajectories between factors across life and mastery

The findings also suggested that lifelong trajectories in certain domains may contribute to mastery in early old age. For example, associations between indicators of higher paternal SEP and greater mastery at age 68-9 were attenuated by greater earlier cognitive ability; cognitive ability was thought to be encouraged by parents with higher education [117, 118, 157]. Higher mastery in study members who had scored more highly on cognitive tests in childhood was explained higher adulthood occupational positions (chapter 4). Another example of a life-long trajectory to mastery is that the pathway between perceived parental support in the early environment and later mastery appeared to be mediated by links to adult positive social support. Many studies support theories that healthy parental relationships teach young people to form supportive close relationships in adulthood [159, 163, 167], and social support is an important resource facilitating control beliefs in early old age.

7.2.3 Suggested socioeconomic processes

Grouping exposures in this thesis into socioeconomic environment and psychosocial environment allows suggestion of the types of processes underlying greater mastery in early old age.

Apart from material home conditions in the early environment, all indicators of socioeconomic position across the life were, to varying extents, associated with mastery in early old age. As reported in chapter 1, the commonality that Pearlin and colleagues proposed to underlie associations between indicators of SEP and

mastery is the internalisation of societal status [20, 94, 97, 98]. Rosenberg and Pearlin used social comparison theory to explain that those who perceive that they are judged to be in a lower strata in society will feel lower in confidence and ability themselves [98]. Additionally, the analyses in this thesis attempted to separate out the potentially unique processes between each of the multiple co-occurring indicators of SEP, and mastery.

The findings of this thesis emphasised the contribution of early socioeconomic environment to later mastery through its association with cognitive processes and elements of parent-child interactions. As outlined earlier in chapter 7, attenuation of associations between each of paternal education and paternal occupation with mastery by early cognitive ability reflects NSHD evidence that more parents with higher SEP are likely to encourage engagement with learning and the development of cognition [112, 113, 175, 287]. In chapter 4, the association between early cognitive ability and mastery was not explained by later education, occupation, or income implying that early cognitive processes contribute to mastery beyond enabling further socioeconomic opportunities to develop mastery.

Unexpectedly, the findings suggested that more educated mothers have offspring with lower control beliefs than those with less education. This inverse association was attenuated by more highly educated mothers being perceived as less supportive and more psychologically controlling. Women with high levels of education may have felt dissatisfaction with their daily life, as they may have fulfilled traditional roles in the home (in the 1940s and 1950s) rather than being able to work in an occupational role suitable to their education. This could have had consequences for the study member; with the mother's lack of control over their own life being reflected into how they raised their own child.

As established in chapter 1 (section 1.3.2.2), education is theorised to be associated with mastery through the development of problem-solving competencies. In this thesis, evidence suggested that education (captured by age 26) was associated with mastery in early older age through its facilitation of more proximal indicators of SEP such as mid-life occupational level and current income. In contrast, a residual association between occupational level and

mastery, after accounting for later higher income and mental and physical health conditions, suggested a persistent association between occupation and mastery. In previous literature in working adults, workplace characteristics such as schedule control and autonomy were identified as key to associations between managerial and professional occupations and higher mastery [122, 123]. Speculatively, an accumulation of years of schedule control and autonomy may have visible associations with mastery, even years after retirement.

Findings from chapter 3 and 4 are consistent with previous evidence and suggest that higher income is not independently associated with higher mastery. The findings emphasise key processes operating between objective income and mastery; perception of financial strain and its potential to affect interpersonal support play a role. The association between higher income band and higher mastery at age 68-9 was explained by positive social support being more frequent for those in higher income bands. This reflects findings from the adolescent literature that family interpersonal relationships impacted by financial strain mediate the association between indicators of poor family material circumstances and lower mastery. Consistent with adolescent mastery literature, in chapter 3, no association was shown between early material home conditions and mastery in early old age. NSHD did not assess family financial pressure and family relationship strain; further research is needed to assess if associations between early life financial pressure and relationship strain extend beyond adolescent mastery to later in life. In chapter 4 it remained that study members who reported that they could not manage on their income at age 68-9 had far lower mastery at that time than those who felt that they managed comfortably with their income.

7.2.4 Suggested psychosocial processes

The role of psychosocial experiences in contributing to mastery, distinct from socioeconomic disadvantage, was explored in chapters 3 and 4. An early study from Pearlin et al. suggested that higher control parenting was more likely in families headed by fathers with relatively lower education and occupational positions [284]. However, the association between perceived parental psychological control in adolescence and mastery was not explained by early

socioeconomic conditions. Parental psychological control is defined as a covert form of control that potentially stifles development of the child's autonomous sense of self through psychological intrusion and emotional manipulation [291]. Although perceived parental psychological control may have links to other later life factors not accounted for by this thesis, an early limit on mental autonomy may also have lifelong implications for mastery.

An accumulation of stressful life events (SLEs) in the early environment was associated with lower mastery in early old age. As the prospectively measured SLEs were not closely correlated with the early socioeconomic environment or perceived parenting, it is unlikely that those potential pathways explain how SLEs are associated with mastery. Early environment SLEs were also not related to any adult circumstance examined.

There were income differences in two indicators of adult psychosocial circumstances: positive social support and accumulated SLEs. Positive social support was greater in higher income bands as suggested by previous mastery literature [146], but was also directly associated with higher mastery. Speculatively, having a close person who helps one feel more positive and shares confidences and interests may be a useful resource for someone with low financial resources. This finding may be useful for future work under the WHO's goal to maximise individual control available despite unequally distributed access to power or resources [12]. There was no evidence of socioeconomic differences in negative social support. It is plausible that for individuals of all socioeconomic positions, negative social support behaviours, such as creating problems, making problems worse, or not providing support at all, can restrict the ability of an individual to manage their life.

Pearlin et al. theorised that in addition to low financial resources being associated with lower mastery, low income can be more detrimental for those with low mastery as it is associated with more numerous SLEs [94]. However, in this thesis, financial processes were not implicated between SLEs and mastery. Depressive symptoms, which include hopelessness and preoccupation with difficult circumstances, explained the association between more SLEs throughout adulthood and lower mastery at age 68-9. Taken together, these findings indicate

multiple psychosocial and socioeconomic processes between experiences right across life and a good sense of control over current circumstances, whatever they may be, in early old age.

7.2.5 Pathways between mastery and physical capability

Mastery has long been suggested to play a role in health and wellbeing with little attempt to investigate how it might operate [6, 8, 47-49, 64]. In addition to understanding how to encourage mastery, this thesis aimed to extend evidence of possible processes acting between mastery and physical capability. The NSHD has both standardised physical performance tests and subjective self-report measures of physical capability. This allowed novel investigation of whether there are differences in objective physical capability or in subjective experiences of these physical abilities depending on their mastery score.

In chapter 5, mastery was associated with better performance on objective tests of physical capability as well as a better experience of physical capability in everyday life. The measure of self-reported functional limitations used is a valid assessment of physical capability and is strongly correlated with physical performance score [209, 250, 324]. Nevertheless, the consistent association with both outcomes reduces concern that self-reported measures could be disproportionately impacted by individuals of different mastery levels (e.g. people with higher mastery may think that they have better physical capability than those with lower mastery). Rather, standardised nurse-assessments of physical performance indicated that people with higher mastery do objectively perform better than people with low mastery.

Chapter 5 investigated factors which may explain the association between mastery and physical capability. As expected, higher levels of mastery and physical capability amongst those with occupational advantage, better mental health and fewer chronic health conditions explained some of the association between mastery and physical capability. After adjustment, there was no evidence that health behaviour indicators explained the remaining association between mastery and physical capability [226-229]. This was surprising as there

is evidence that people with higher mastery engage in more healthy behaviours than people with low mastery and these behaviours contribute to physical capability. Although little evidence has tested a proactive health behaviour pathway, literature discussing potential adaptive benefits of mastery consistently emphasises theory that individuals with higher mastery change or increase their health behaviours to maintain or improve their health [61-64]. Given the lack of evidence found in this thesis, further analyses is needed to help support or refute this theory.

Study members with higher mastery did engage in more LTPA, and, had a lower mean BMI than those with lower mastery, but these indicators did not explain why they had better physical capability. The association between mastery and functional limitations was partially attenuated by fear of falling and related activity restriction. A comparison of models with different adjustments showed that depressive symptoms had the largest impact on the association between mastery and physical performance. These findings may relate to fear of falling and related activity restriction marking a broader constellation of psychological processes associated with mastery.

7.2.6 Mastery as a moderator of physical capability

Chapter 6 suggested that mastery was an effect modifier of the association between physical performance and functional limitations. Individuals with poorer physical performance reported more functional limitations. However, for individuals with higher mastery scores, this association was weaker than for those with low mastery scores. Evidence from chapter 5, consistent with mastery theory, suggests that ageing adults with higher mastery are those who are less restricted by anxiety, worry and fear [31, 80, 81]. These negative psychological processes, common in individuals with low mastery, may be barriers for continuing daily activities in their home. These are actions that, according to their physical performance tests, they are objectively capable of. This potential explanation is supported by two studies showing that older adults with higher mastery were more likely to carry on independent living in early old age than those with low mastery, whether or not they had functional limitations or difficulties with ADLs [33, 246].

There was no evidence that associations between either physical performance or functional limitations and ADLs differed by mastery level. Difficulties in ADLs, such as washing, cooking and bathing, represent steps further along the pathway of physical disability than between physical performance and functional limitations. Given the age of the sample (68-9),there were very few members of the sample with ADL difficulties in whom to test differences. The next wave of the NSHD data collection will capture mastery, physical capability and disability in study members into at least their mid-seventies. A larger proportion of individuals with disability may aid investigation of whether some individuals have better ability in ADLs than expected; and whether mastery is an effect modifier of those associations.

7.3 Generalisability

This thesis examined which life time experiences contribute to mastery in early old age. These findings are generalisable to older people who have grown up and aged through a similar time period. The post-war period in Britain was a very particular time; potentially a unique context in which lasting associations between early life and mastery in early old age were facilitated. Effects associated with mastery may differ by birth cohort. The opportunities themselves relevant to mastery can vary over time; which may relate to differences in mastery characteristic of certain cohorts. For example, there is variation over time in educational attainment and the societal meaning of variability in this. Relevant to younger populations, the removal of free university tuition and the lasting effects of the austerity government may undermine the advantages of education to mastery, without sufficient occupational prospect to go on to. The small number and heterogeneous methods of studies investigating mastery make it difficult to discern patterns or trends across time [24, 187, 243].

Moreover, findings on mastery may also not generalise well across ages. The resources which help or hinder people to feel in control may differ depending on the life stage of the individual. Several studies have shown that, amongst different age groups, there are some differences in factors associated with mastery as well as in how mastery contributes to health. For example, studies assessing

associations between mastery and indicators of cardiovascular disease in young healthy populations report weaker effect sizes of mastery than in older groups [5]. It is possible that in earlier life there are minimal differences in people's health or in physical capability, and advantages of mastery may not be relevant. However, no studies have been published assessing associations between mastery and physical capability in populations earlier than mid-life to test whether the conclusions of this thesis are generalisable.

As chapter 1 described, there is evidence for differences in findings regarding mastery across countries. There are very few studies on mastery using UK populations with which to make meaningful comparisons. Furthermore the NSHD is limited to a White British population. Given cross-cultural differences in mastery, it is possible that the findings of this thesis are not generalisable outside of the UK or to a diverse population. Reiterating studies cited in chapter 1, North American, Dutch, and Swedish literature have reported differences in the predictors and effects of mastery depending on measures of ethnicity and cultural experiences [40, 138, 188-191].

7.4 Strengths

The use of this birth cohort made it possible for the first time to study associations between prospectively captured life experiences and mastery over nearly seventy years. Most previous research on this topic has been cross-sectional, relying on recall of past experiences, or using very short time frames. It is also the first to investigate factors associated with mastery in a British cohort. Research into mastery has been focused in North America, the Netherlands and Germany. A very small number of UK studies have examined one item of the mastery scale over shorter time frames, but a single item is unlikely to accurately capture such a complex self-concept as mastery.

The rich data available in the MRC National Survey of Health and Development contributes to the novel findings in this thesis. The use of multiple indicators of both the socioeconomic and psychosocial environment allowed more detailed investigation of which aspects of life are relevant to mastery and how they may operate. Testing of different indicators of SEP from birth until early old age

allowed analysis of pathways across life; from family background to indicators which people perceive that they have achieved themselves. Considering different aspects of social relationships across the life course within the same group of people also allowed understanding of how those relationships are related to each other and mastery. For example, no published study has examined the early life antecedents of the relationship between current social support and mastery or considered the negative aspects of social relationships such as negative social support and mastery.

The current assessment of the association between mastery and physical capability is the first in a UK population, and one of small number of studies worldwide. Of these studies, few have attempted to understand the mechanisms through which mastery could be associated with physical capability. The analysis in chapter 5 and 6 was the first study to separate multiple explanatory processes of the complex relationship between mastery and physical capability. This approach helps to clarify understanding of how mastery is related to health. The implication of fear of falling and related activity restriction within a possibly broader constellation of psychological processes associated with mastery is a promising novel route for further research. All three different indicators of health behaviours (smoking, physical activity, BMI) were not implicated as explanatory processes operating between mastery and physical capability in early old age. This understanding may help guide researchers investigating mastery and behavioural health such as HIV prevention [61] and chronic disease management[326] into testing more relevant control constructs.

The quality of the data increases the likelihood of meaningful conclusions from the analysis in this thesis. As the majority of the variables were prospectively captured, recall bias is reduced. For example, frequent capturing of SLEs across many ages limits the possibility that study members with lower mastery may retain stronger memories of past SLEs than those with higher mastery. The accuracy of the SLE measure was enhanced by being able to use four waves of SLEs checklists, augmented with official records of events such as bereavement and divorce. The repeated data also limits the likelihood of measurement error

as the accuracy of the variable can be checked and updated accordingly using information from past waves. For example, it is important to consider whether study members with lower mastery had lower physical capability because of prior poor health. The likelihood of accurately capturing poor health from mid-life onwards is increased by data from previous sweeps being used to update the chronic health condition measures at age 69-70.

7.5 Limitations

The specific limitations of each set of analysis have been discussed in the relevant chapter. The limitations common to all analyses in this thesis are discussed below.

The investigation of the nature of the relationship between mastery and physical capability was limited to cross-sectional data. It is possible that the findings of this thesis reflect a reverse association that study members with better physical capability feel that they are more in control of their own circumstances. This thesis was not able to test if the relationship between mastery and physical capability is bi-directional [46] rather than one of reverse causation. Nevertheless, as discussed in chapter 1, there is longitudinal evidence that mastery contributes to physical capability outcomes over years of study [8, 34, 36, 223]. Further work could assess the bidirectional association to better understand the mechanism of association.

Within NSHD, the first assessment of mastery (with the Pearlin scale) was at the most recent wave of data collection at age 68-9. Therefore, it was not possible to estimate mastery in the study members prior to measuring relevant factors, to assess for example whether mastery changed after education, SLEs, or chronic health conditions. This thesis was also unable to test whether mastery was the antecedent to indicators of health behaviours or fear of falling and related activity restriction, which were themselves proposed to account for variance in physical capability. It was also unable to observe whether mastery contributed to modifying the association between physical capability and disability over any period of time. Future work using NSHD data should test whether mastery at age 68-9 explains variance in physical capability at the next data collection, and

whether this is independent of the initial relationship between mastery and physical capability reported in this study. The analysis could further be replicated with information accounting for changes in health behaviours and fear of falling.

Missing data in longitudinal studies can bias estimates of the relationship of interest. Low mastery is associated with premature mortality over time, independent of chronic diseases [6, 8, 47]. It may be that NSHD study members who would have had the lowest mastery had deceased prior to data collection at age 68-9. Therefore, this study may not be reflecting differences in mastery in the general population. Checking for potential bias indicated that study members missing mastery data at age 68-9 were more likely to have had higher early environment SLEs, and to have lower adult occupational position (section 2.4.1) This pattern of missing data may have led to associations between early environment SLEs and mastery, and adult occupational position and mastery being underestimated. Analysis using multiple imputed data sets were compared to analysis based on complete cases in sensitivity analyses. In general, no differences were observed, implying that bias was not introduced to the estimates due to missing data.

This thesis can only make implications about variables included in the models. The nature of secondary data means that the analysis is constrained to the measures available. It is likely that the relationships between factors across life and mastery and between mastery and physical capability are complicated and not driven by one factor. The breadth of NSHD data allowed this thesis to consider a wider range of explanatory pathways between mastery and physical capability than available research. However, other factors may mediate or confound the association between mastery and physical capability. The potential for residual confounding (due to imprecise measurement of confounders included and other confounders not included), bias, or even chance needs to be considered.

7.6 Implications for policy and practice

The findings from this thesis underscore several themes repeatedly suggested by NSHD data over the years [327]. Firstly, that elements of childhood circumstances have a lasting association with our health and wellbeing [158, 168, 286]. In this current work the finding of an association between higher perceived parental psychological control in earlier life and lower mastery many years later progresses the existing field of work on the long-term importance of behavioural control and parental support for child development and long-term mental wellbeing[167]. It appears particularly timely to emphasise to policy makers the implication that parental psychological control may be detrimental to one's own self concept of control in the long-term. Sociologists have documented a trend towards increasingly intensive parenting in recent years [328]. Time diary data reflects a progression to parent-child enrichment and monitoring activities intended to be deterministic in an individual's development and future, rather than encouragement to play independently as in years gone by [329]. As described in chapter 3 (section 3.1.2), examples of perceived psychological control include not allowing children to make their own decisions or hold thoughts different to their parents, and generally fostering dependence. New cultural norms such as 'helicopter parenting'- defined as hovering and anxiously monitoring, and 'snow-plough parenting' -clearing even minor hassles or obstacles from a child's way, may at their outer limits step into parental psychological control. The child is not able to develop skills to trust their own decision-making, to learn that it is possible (and how) to recover from mistakes, or deviate from their parents' world view. With the current finding supporting previous theory that parental psychological control restricts the development of an independent sense of self [167, 283], public health policy makers may wish to communicate to families the importance of parental autonomy-granting for their offspring.

There may also be a role for policy to attempt to reduce economic and other pressures on parents and young people which could strengthen the early development of mastery. Historic studies into parental values and styles, such as those cited in chapter 3 showed a socioeconomic split in how parents prioritise independence and autonomous thought (section 3.1.4). Parents from lower SEP households reported that they taught obedience to authority in their children while wealthier and more educated parents promoted independent thinking and autonomy in their offspring [284, 289]. Over the decades the difference in these

findings (as measured in repeated surveys) has narrowed and now there are no socioeconomic differences. Parents across socioeconomic strata now report prizing hard work and discipline rather than independence and autonomous thought[329]. The 2008 economic recession and stiffer competition for jobs and introduction of fees in UK higher education is thought to be one element shaping more controlling parenting [328, 329]. Parents are thought to be too anxious about their children's future to allow them to make their own choices and potentially financially damaging mistakes. Policies to reduce economic pressures or increase opportunities and options for young people may foster less controlling family dynamics and therefore a stronger sense of mastery in offspring.

The findings of this thesis also indicate factors in adult life that could be targeted by policy makers to improve mastery. The MRC National Survey of Health and Development (NSHD) data has long demonstrated a socioeconomic gradient in health and wellbeing [327]. The current findings suggested that higher past occupational level was related to higher mastery in these largely retired older adults. Policies designed to allow more control at work despite occupational level, and the provision of more support to individuals struggling financially may improve mastery; with expected benefits to multiple health outcomes. At the same time policies could address social aspects of life associated with mastery. Despite established socioeconomic inequalities relating to mastery, the overarching impression of this thesis is the value to individuals of their psychosocial resources and perception. Even without reducing structural disparities, national policies which allow more time, space, and free activities to encourage early family attachments and later social support, may bring lifelong benefits.

Finally, in addition to potential intervention targets for increasing mastery, this thesis could have clinical impact in furthering understanding of the role of psychological processes such as mastery in maintaining and improving physical capability. The finding of the contribution of fear of falling and activity restriction between low mastery and poorer physical capability (chapter 5), and the difference by mastery level of likelihood of functional limitations per physical capability score (chapter 6) implicate the involvement of psychological processes

in maintaining physical capability in older age. Psychological processes such as mastery should not be neglected from the current tools clinicians and social care providers use to support older people to maintain physical capability, and by extension their independence and quality of life.

7.7. Future work

As introduced in chapter 1, there are very few studies investigating mastery in a British population. Findings in this study should be replicated using data from British populations to establish whether the findings are generalisable to the British population. Adding the mastery scale to future waves of all the British birth cohorts would guide inference on the generalisability of these findings to younger cohorts and in more ethnically diverse British groups than the NSHD.

To extend the conclusions from this thesis of what factors from across life contribute to mastery, future data collection could capture mastery regularly across life. While a number of studies support the findings of this thesis regarding which exposures contribute to mastery in early old age (chapters 3 and 4), few have been able to study whether mastery changes in association with these factors. The studies which have are largely adolescent studies over no more than one decade of life. Studies measuring mastery at regular collection waves, and accounting for multiple factors and pathways between them, could shed more light on the reciprocal relationship between exposures across the life and mastery in early old age.

Studies testing prospectively measured early life exposures such as parenting, SLEs, and material home conditions associated with adolescent mastery (see chapter 3) have not conducted follow ups on their cohorts who would now be in early midlife [162]. The early environment exposures tested in chapters 3 and 4 of this thesis were based on evidence from those adolescent mastery studies. Findings of associations between parental psychological control, parental support, SLEs and mastery at age 68-9 were taken to imply that these associations had remained since adolescence. Conducting follow ups on the Iowan and National US cohorts reviewed in chapter 3 who would now be in early

midlife may allow further insights into whether and how early parenting, SLEs, and socioeconomic factors are associated with later life mastery.

Future explanation of the association between mastery and physical capability could be improved by extending work separating physical capability into objective tests and self-reported measures. For example, it would be informative to measure whether mastery is associated with underlying physical differences such as muscle fibres, blood flow, and lung function. This line of investigation may reinforce whether mastery is associated with physical differences or the experience of physical differences. Both aspect of physical capability (objective performance and subjective perception of capability) are important, understanding differences between the two may help suggest how mastery operates.

Stepping away from a behavioural or psychological pathway, it was not possible in this thesis to explore the role of biological markers of stress (chapter 1 section 1.2.2) in addition to indicators of behavioural and psychological processes. Measures of markers of stress such as cortisol were not available at age 68-9. As discussed in chapter 1, there is some evidence that higher mastery is associated with a less intense physiological response to stressors, as demonstrated by more stable cortisol, heart rate, and noradrenaline reactivity, and a healthier allostatic load in stressful conditions [26, 28, 80-83]. It is possible that use of biomarkers would improve understanding of the relationship between mastery and physical functioning. It has been theorised that feeling more in control protects people from becoming physically stressed during objectively hard-to-manage circumstances demands [71-74]. Mental control may protect people from stress-related physiological wear and tear on the physical structures underlying physical functioning [79].

A different approach in future work would be to supplement this quantitative data with qualitative analysis of what factors study members themselves report are important to feel in control of their life. There has been no qualitative work published on mastery. It may yield fresh understanding on how some people have

high mastery despite lacking in socioeconomic resources, and greater insight into whether and how mastery is associated with maintaining physical capability in older age.

7.8 Conclusion

Personal mastery as an adaptive psychological resource has been studied for nearly fifty years, and more recently around the globe [22, 39-43, 61, 188]. Despite a substantial literature in both the antecedents of mastery and associations between mastery and a range of physical and mental health outcomes, there are many gaps in knowledge about mastery and its fellow perceived control indicators [64, 314].

This thesis examined the literature as a whole and attempted to extend insights into differences in mastery, its mechanisms and its potential implications in early old age. There continues to be a public health need for work integrating and extending knowledge on the meaning of mastery. The public health benefit of mastery, and the wider context of perceived control, have been consistently demonstrated and proposed as a tool in addressing health inequalities [13].

The findings of this thesis have important implications for governments not to neglect policies that encourage the levelling of structural socioeconomic inequalities in society. Although the associations between family socioeconomic background and mastery may be overcome by interventions targeting supportive parenting or early cognitive development, there are clear and persistent differences in mastery by adult socioeconomic indicators. Although the wider literature and the findings of chapter 6 support the use of mastery as an effect modifier, psychological resources such as mastery could partially absolve differences in multiple health and wellbeing indicators that result from inequalities in education, occupational position and income.

Equally, the findings of this thesis are promising for public health goals to attempt to empower people affected by hugely complex and stressful social conditions [13]. Although adolescence has been suggested as a sensitive period for mastery development [21], from which young people with low mastery compared to their

peers have a persistent disadvantage [92, 93], this is untested. Adults who have not overcome the effects of early SLEs, or low support or high psychological control parenting, may benefit from psychological therapy to empower them. The findings of this thesis sustain a huge literature in indicating the long term potential benefit for public health interventions to support parents in establishing circumstances conducive to supportive, autonomy encouraging parenting [55, 145, 162, 163, 168-170, 286]. The findings are a reminder of the benefit and the harm of social relationships to feelings of control at any age.

As well as suggesting a number of pathways amenable to increasing mastery, the findings of this thesis lay the foundation for further interpretation of how mastery may operate on physical functioning. Recent unsuccessful investigations into mastery as a tool for changing health behaviours linked to very serious public health concerns such as HIV infection [61] or chronic disease management[326] may be avoided in future with more support *against* mastery operating along a behavioural pathway, as suggested by this thesis.

This thesis has added to the evidence base on the complex psychological self-concept of mastery. Given the important findings on factors across life associated with mastery and subsequent associations between mastery and physical capability, this thesis has demonstrated the public health value of mastery in physical health in the ageing process. It has extended insights about mastery that will make it easier for future investigations to build collective knowledge even further while individuals learn how to feel in control of their own lives.

REFERENCES

[1] E. J. Langer and J. Rodin, "The effects of choice and enhanced personal responsibility for the aged: a field experiment in an institutional setting," *J Pers Soc Psychol. ,* vol. 2, pp. 191-8, 1976.

[2] J. B. Rotter, "Generalised expectancies for internal versus external control of reinforcement " *Psychological Monographs: General and Applied,* vol. 80, no. 1, 1966.

[3] D. H. Shapiro, C. E. Schwartz, and J. A. Astin, "Controlling ourselves, controlling our world. Psychology's role in understanding positive and negative consequences of seeking and gaining control.," *The American psychologist.,* vol. 51, pp. 1213–123, 1996.

[4] J. Drewelies, W. J. Chopik, C. A. Hoppmann, J. Smith, and D. Gerstorf, "Linked Lives: Dyadic Associations of Mastery Beliefs With Health (Behavior) and Health (Behavior) Change Among Older Partners," (in eng), *J Gerontol B Psychol Sci Soc Sci,* May 26 2016, doi: 10.1093/geronb/gbw058.

[5] S. K. Roepke and I. Grant, "Toward a more complete understanding of the effects of personal mastery on cardiometabolic health," (in eng), *Health Psychol,* Research Support, N.I.H., Extramural Review vol. 30, no. 5, pp. 615-32, Sep 2011, doi: 10.1037/a0023480.

[6] C. Turino, B. Chapman, P, S. Agrigoroaei, F. J. Infurna, and M. E. Lachman, "Perceived Control Reduces Mortality Risk at Low, Not High, Education Levels," *Health Psychol.,* vol. 33(8), no. 8, pp. 883–890, 2014.

[7] L. I. Pearlin and C. Schooler, "The Structure of Coping," *Journal of Health and Social Behavior,* vol. 19, no. 1, pp. 2-21, 1978.

[8] F. J. Infurna, N. Ram, and D. Gerstorf, "Level and change in perceived control predict 19-year mortality: findings from the Americans' changing lives study," (in eng), *Dev Psychol,* vol. 49, no. 10, pp. 1833-47, Oct 2013, doi: 10.1037/a0031041.

[9] J. Rodin, "Personal control throughout the life course," in *Implications of the life span perspective for social psychology*, R. Abeles Ed.: NJ: Erbaulm, 1986, pp. 103-120.

[10] M. M. Baltes and P. B. Baltes, "The Psychology of Control and Ageing," ed: Hillsdale, NJ: Erbaulm, 1986.

[11] A. Antonovsky, "Health, Stress and Coping," ed. San Francisco: Josey Basse, 1979.

[12] The World Health Organisation. Wellbeing. *Review of social determinants and the health divide in the WHO European Region. Final report*. (2020).

[13] W. H. Organisation. *Health 2020: The European Policy for Health and Wellbeing. Review of social determinants and the health divide in the WHO European Region. Final report*. (2020).

[14] E. A. Skinner, "A guide to constructs of control," *Journal of Personality and Social and Personality Psycholo g y,* vol. 71, pp. 549-570, 1996.

[15] J. Heckhausen, C. Wrosch, and R. Schulz, "A motivational theory of life-span development," (in eng), *Psychol Rev,* vol. 117, no. 1, pp. 32-60, Jan 2010, doi: 10.1037/a0017668.

[16] V. Gecas, "Self-Agency and the Life Course," in *Handbook of the Lifecourse.*, S. M. J. Mortimer J.T. Ed., no. Handbooks of Sociology and Social Research): Springer, Boston, MA, 2003.

[17] A. Bandura, "Self-efficacy: Toward a unifying theory of behavioral change," *Psychological Review,* vol. 84, pp. 191-215, 1977.

[18] B. Wheaton, "The Sociogenesis of Psychological Disorder : An Attributional Theory," *Journal of health and social behavior,* vol. 21, pp. 100-24, 1980.

[19] C. D. Ryff, "Happiness is everything, or is it? Explorations on the meaning of psychological well-being. ," *Journal of Personality and Social Psychology,,* vol. 57, pp. 1069–1081, 1989.

[20] L. I. Pearlin, "The life course and the stress process: some conceptual comparisons," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 65B, no. 2, pp. 207-15, Mar 2010, doi: 10.1093/geronb/gbp106.

[21] C. Sebastian, S. Burnett, and S. J. Blakemore, "Development of the self-concept during adolescence," (in eng), *Trends Cogn Sci,* vol. 12, no. 11, pp. 441-6, Nov 2008, doi: 10.1016/j.tics.2008.07.008.

[22] L. I. Pearlin and C. W. Radabaugh, "Economic strains and the coping functions of alcohol," (in eng), *AJS,* vol. 82, no. 3, pp. 652-663, Nov 1976, doi: 10.1086/226357.

[23] B. A. Laraia, A. M. Siega-Riz, C. Gundersen, and N. Dole, "Psychosocial factors and socioeconomic indicators are associated with household food insecurity among pregnant women," (in eng), *J Nutr,* vol. 136, no. 1, pp. 177-82, Jan 2006, doi: 10.1093/jn/136.1.177.

[24] D. J. Deeg and M. Huisman, "Cohort differences in 3-year adaptation to health problems among Dutch middle-aged, 1992-1995 and 2002-2005," (in eng), *Eur J Ageing,* vol. 7, no. 3, pp. 157-165, Sep 2010, doi: 10.1007/s10433-010-0157-1.

[25] U. A. Mitchell, J. A. Ailshire, L. L. Brown, M. E. Levine, and E. M. Crimmins, "Education and Psychosocial Functioning Among Older Adults: 4-Year Change in

Sense of Control and Hopelessness," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 73, no. 5, pp. 849-859, 06 2018, doi: 10.1093/geronb/gbw031.

[26] S. K. Roepke, B. T. Mausbach, T. L. Patterson, R. von Känel, S. Ancoli-Israel, and A. L. Harmell, "Effects of Alzheimer caregiving on allostatic load," *J Health Psychol.,* vol. 16, no. 1, pp. 58–69, 2011.

[27] S. K. Roepke *et al.*, "The moderating role of personal mastery on the relationship between caregiving status and multiple dimensions of fatigue," *International journal of geriatric psychiatry,* vol. 24, no. 12, pp. 1453-62, Dec 2009, doi: 10.1002/gps.2286.

[28] S. K. Roepke *et al.*, "Personal mastery is associated with reduced sympathetic arousal in stressed Alzheimer caregivers," (in eng), *The American journal of geriatric psychiatry : official journal of the American Association for Geriatric Psychiatry,* vol. 16, no. 4, pp. 310-7, Apr 2008, doi: 10.1097/JGP.0b013e3181662a80.

[29] T. Chandola, H. Kuper, A. Singh-Manoux, M. Bartley, and M. Marmot, "The effect of control at home on CHD events in the Whitehall II study: Gender differences in psychosocial domestic pathways to social inequalities in CHD," (in eng), *Soc Sci Med,* vol. 58, no. 8, pp. 1501-9, Apr 2004, doi: 10.1016/S0277-9536(03)00352-6.

[30] M. G. Marmot *et al.*, "Health inequalities among British civil servants: the Whitehall II study," (in eng), *Lancet,* vol. 337, no. 8754, pp. 1387-93, Jun 1991, doi: 10.1016/0140-6736(91)93068-k.

[31] L. Pearlin, "The Stress Process Revisited," in *Handbook of the Sociology of Mental Health*, P. J. C. Aneshensel C.S. Ed.: Springer, Boston, MA, 1999.

[32] L. N. Gitlin, M. Corcoran, L. Winter, A. Boyce, and W. W. Hauck, "A randomized, controlled trial of a home environmental intervention: effect on efficacy and upset in caregivers and on daily function of persons with dementia," (in eng), *Gerontologist,* vol. 41, no. 1, pp. 4-14, Feb 2001, doi: 10.1093/geront/41.1.4.

[33] R. Cooper, M. Huisman, D. Kuh, and D. J. Deeg, "Do positive psychological characteristics modify the associations of physical performance with functional decline and institutionalization? Findings from the longitudinal aging study Amsterdam," (in eng), *J Gerontol B Psychol Sci Soc Sci,* Research Support, Non-U.S. Gov't vol. 66, no. 4, pp. 468-77, Jul 2011, doi: 10.1093/geronb/gbr049.

[34] G. I. Kempen, E. van Sonderen, and J. Ormel, "The Impact of Psychological Attributes on Changes in Disability Among Low-Functioning Older Persons," *Journal of Gerontology:,* vol. 54B, no. 1, 1999.

[35] C. H. van Jaarsveld, A. V. Ranchor, R. Sanderman, J. Ormel, and G. I. Kempen, "The role of premorbid psychological attributes in short- and long-term adjustment after cardiac disease. A prospective study in the elderly in The Netherlands," (in eng), *Soc Sci Med,* vol. 60, no. 5, pp. 1035-45, Mar 2005, doi: 10.1016/j.socscimed.2004.06.037.

[36] G. I. Kempen, A. V. Ranchor, E. van Sonderen, C. H. van Jaarsveld, and R. Sanderman, "Risk and protective factors of different functional trajectories in older persons: are these the same?," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 61, no. 2, pp. P95-101, Mar 2006, doi: 10.1093/geronb/61.2.p95.

[37] M. E. Lachman and S. L. Weaver, "The Sense of Control as a Moderator of Social Class Differences in Health and Well-Being," *Journal of Personality and Social Psychology,* vol. 74, no. 3, pp. 763-773, 1998.

[38] J. Taylor, A. Jacoby, G. A. Baker, A. G. Marson, A. Ring, and M. Whitehead, "Factors predictive of resilience and vulnerability in new-onset epilepsy," (in eng), *Epilepsia,* Comparative Study Multicenter Study Randomized Controlled Trial Research Support, Non-U.S. Gov't vol. 52, no. 3, pp. 610-8, Mar 2011, doi: 10.1111/j.1528-1167.2010.02775.x.

[39] T. Togari and Y. Yonekura, "A Japanese version of the Pearlin and Schooler's Sense of Mastery Scale," (in eng), *Springerplus,* vol. 4, p. 399, 2015, doi: 10.1186/s40064-015-1186-1.

[40] J. R. Gordon, V. L. Malcarne, S. C. Roesch, R. G. Roetzheim, and K. J. Wells, "Structural Validity and Measurement Invariance of the Pearlin Mastery Scale in Spanish-Speaking Primary Care Patients," (in eng), *Eval Health Prof,* vol. 41, no. 3, pp. 393-399, 09 2018, doi: 10.1177/0163278718774942.

[41] Y.-L. Chen, P.-C. Hsiung, L. Chung, S.-C. Chen, and A.-W. Pan, "Psychometric properties of the Mastery Scale-Chinese version: Applying classical test theory and Rasch analysis," *Scandinavian Journal of Occupational Therapy,* vol. 20, no. 6, pp. 404-411, 2013.

[42] J. Clench-Aas, R. B. Nes, and L. E. Aarø, "The perceived constraints subscale of the Sense of Mastery Scale: dimensionality and measurement invariance," vol. 26, ed. Quality of life research : an international journal of quality of life aspects of treatment, care and rehabilitation, 2017, p. 127—138.

[43] M. Eklund, L.-K. Erlandsson, and P. Hagell, "Psychometric properties of a Swedish version of the Pearlin Mastery Scale in people with mental illness and healthy people," *Nordic Journal of Psychiatry,* vol. 66, no. 6, pp. 380-388, 2012.

[44] J. Mirowsky and C. E. Ross, "Eliminating Defense and Agreement Bias from Measures of the Sense of Control: A 2 X 2 Index," in *Social Psychology Quarterly,* vol. 54, ed, 1991, pp. 127-145.

[45] M. M. Ward, "Parental educational attainment and sense of control in mid- and late-adulthood," (in eng), *Dev Psychol,* Research Support, N.I.H., Intramural vol. 49, no. 7, pp. 1407-12, Jul 2013, doi: 10.1037/a0029557.

[46] F. J. Infurna and A. Mayer, "The effects of constraints and mastery on mental and physical health: Conceptual and methodological considerations," (in eng),

Psychol Aging, Research Support, N.I.H., Extramural vol. 30, no. 2, pp. 432-48, Jun 2015, doi: 10.1037/a0039050.

[47] P. G. Surtees, N. W. Wainwright, R. Luben, N. J. Wareham, S. A. Bingham, and K. T. Khaw, "Mastery is associated with cardiovascular disease mortality in men and women at apparently low risk," *Health Psychol,* vol. 29, no. 4, pp. 412-20, Jul 2010, doi: 10.1037/a0019432.

[48] I. Colman *et al.*, "Protective factors against depression during the transition from adolescence to adulthood: findings from a national Canadian cohort," (in eng), *Prev Med,* Research Support, Non-U.S. Gov't vol. 65, pp. 28-32, Aug 2014, doi: 10.1016/j.ypmed.2014.04.008.

[49] T. A. Glass, T. E. Seeman, A. R. Herzog, R. Kahn, and L. F. Berkman, "Change in productive activity in late adulthood: MacArthur studies of successful aging," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 50, no. 2, pp. S65-76, Mar 1995, doi: 10.1093/geronb/50b.2.s65.

[50] J. A. Morozink, E. M. Friedman, C. L. Coe, and C. D. Ryff, "Socioeconomic and psychosocial predictors of interleukin-6 in the MIDUS national sample," *Health Psychol,* vol. 29, no. 6, pp. 626-35, Nov 2010, doi: 10.1037/a0021360.

[51] K. Gibson, S. Rueda, S. B. Rourke, and T. A. Hart, "Mastery and Coping Moderate the Negative Effect of Acute and Chronic Stressors on Mental Health-Related Quality of Life in HIV," *AIDS patient care and STDs* vol. 25, no. 6, pp. 371-81, 2011.

[52] Age UK. "Healthy Ageing Evidence Review." http://www.ageuk.org.uk/documents/en-gb/for-professionals/health-and-wellbeing/evidence%20review%20healthy%20ageing.pdf?dtrk=true (accessed 01, 2017).

[53] World Health Organisation. "Policies and priority interventions for healthy ageing." http://www.euro.who.int/__data/assets/pdf_file/0006/161637/WHD-Policies-and-Priority-Interventions-for-Healthy-Ageing.pdf (accessed 01, 2017).

[54] S. Parsons, J. Elliott, C. Gale, and D. Kuh, "Physical capability and the advantages and disadvantages of ageing: perceptions of older age by men and women in two British cohorts," *Ageing and Society,* vol. 45, no. 3, pp. 452-47, 2014.

[55] M. Marmot, J. Allen, T. Boyce, P. Goldblatt, and J. Morrison, "HEALTH EQUITY IN ENGLAND: THE MARMOT REVIEW 10 YEARS ON," Institute of Health Equity, London, 2020.

[56] M. Marmot, J. Allen, P. Goldblatt, T. Boyce, and D. McNeish, "Fair Society Healthy Lives (The Marmot Review)," *Strategic review of health inequalities in England post-2010,*

[57] T. H. Brown and T. W. Hargrove, "Psychosocial Mechanisms Underlying Older Black Men's Health," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 73, no. 2, pp. 188-197, 01 2018, doi: 10.1093/geronb/gbx091.

[58] K. Gibson, S. Rueda, S. B. Rourke, and T. A. Hart, "Mastery and Coping Moderate the Negative Effect of Acute and Chronic Stressors on Mental Health-Related Quality of Life in HIV," *AIDS patient care and STDs,* vol. 25, no. 6, pp. 371-81, 2011.

[59] S. Dury *et al.*, "Detecting frail, older adults and identifying their strengths: results of a mixed-methods study," (in eng), *BMC Public Health,* vol. 18, no. 1, p. 191, 01 2018, doi: 10.1186/s12889-018-5088-3.

[60] G. C. o. S. D. o. Health, "Closing the gap in a generation: health equity through action on the social determinants of health," ed. World Health Organisation, Geneva, 2007.

[61] E. R. Long-Middleton, P. J. Burke, and S. H. Rankin, "Predictors of HIV Risk Reduction in Adolescent Girls," (in eng), *MCN Am J Matern Child Nurs,* vol. 44, no. 3, pp. 150-156, 2019 May/Jun 2019, doi: 10.1097/NMC.0000000000000517.

[62] R. M. Manning and R. M. Greenwood, "Recovery in homelessness: The influence of choice and mastery on physical health, psychiatric symptoms, alcohol and drug use, and community integration," (in eng), *Psychiatr Rehabil J,* vol. 42, no. 2, pp. 147-157, Jun 2019, doi: 10.1037/prj0000350.

[63] V. Timkova, I. Nagyova, S. A. Reijneveld, R. Tkacova, J. P. van Dijk, and U. Bültmann, "Social support, mastery, sleep-related problems and their association with functional status in untreated obstructive sleep apnoea patients," (in eng), *Heart Lung,* vol. 47, no. 4, pp. 371-379, 2018 Jul - Aug 2018, doi: 10.1016/j.hrtlng.2018.04.006.

[64] L. K. George, "Commentary: Embedding control beliefs in a social and cultural context," in *Personal control in social and life course contexts*, L. I. Pearlin Ed. New York: Springer, 2003.

[65] F. J. Infurna and D. Gerstorf, "Perceived control relates to better functional health and lower cardio-metabolic risk: the mediating role of physical activity," (in eng), *Health Psychol,* vol. 33, no. 1, pp. 85-94, Jan 2014, doi: 10.1037/a0030208.

[66] K. A. Sargent-Cox, P. Butterworth, and K. J. Anstey, "Role of physical activity in the relationship between mastery and functional health," (in eng), *Gerontologist,* Research Support, Non-U.S. Gov't vol. 55, no. 1, pp. 120-31, Feb 2015, doi: 10.1093/geront/gnu042.

[67] C. Paquet, L. Dube, L. Gauvin, Y. Kestens, and M. Daniel, "Sense of mastery and metabolic risk: moderating role of the local fast-food environment," (in eng), *Psychosom Med,* Comparative Study Research Support, Non-U.S. Gov't vol. 72, no. 3, pp. 324-31, Apr 2010, doi: 10.1097/PSY.0b013e3181cdf439.

[68] C. Roberts, N. Troop, F. Connan, J. Treasure, and I. C. Campbell, "The effects of stress on body weight: biological and psychological predictors of change in BMI," (in eng), *Obesity (Silver Spring),* vol. 15, no. 12, pp. 3045-55, Dec 2007, doi: 10.1038/oby.2007.363.

[69] M. Daniel, M. D. Cargo, J. Lifshay, and L. W. Green, "Cigarette smoking, mental health and social support: data from a northwestern First Nation," (in eng), *Can J Public Health,* vol. 95, no. 1, pp. 45-9, 2004 Jan-Feb 2004.

[70] L. L. Pederson, Koval, J.J, O'Connor, and K., "Are psychosocial factors related to smoking in grade-6 students? ," *Addict Behav* vol. 22, p. 169 − 81, 1997.

[71] S. Cohen, R. C. Kessler, and L. U. Gordon, "Strategies for measuring stress in studies of psychiatric and physical disorders. ," in *Measuring stress: A guide for Health and Social Scientists.* , S. Cohen, R. C. Kessler, and L. U. Gordon Eds. Oxford: Oxford University Press, 1995.

[72] E. Gatti, E. Calzolari, E. Maggioni, and M. Obrist, "Emotional ratings and skin conductance response to visual, auditory and haptic stimuli," (in eng), *Sci Data,* vol. 5, p. 180120, 06 2018, doi: 10.1038/sdata.2018.120.

[73] L. L. Brown, U. A. Mitchell, and J. A. Ailshire, "Disentangling the Stress Process: Race/Ethnic Differences in the Exposure and Appraisal of Chronic Stressors Among Older Adults," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 75, no. 3, pp. 650-660, Feb 2020, doi: 10.1093/geronb/gby072.

[74] L. I. Pearlin, " Status inequality and stress in marriage. ," *American Sociological Review,* vol. 40, no. 3, pp. 344–357, 1975.

[75] L. I. Pearlin and M. M. Skaff, "Stress and the Life Course: A Paradigmatic Alliance," *The Gerontologist,* vol. 36, no. 2, pp. 239-247, 1994.

[76] J. Koltai, A. Bierman, and S. Schieman, "Financial circumstances, mastery, and mental health: Taking unobserved time-stable influences into account," (in eng), *Soc Sci Med,* vol. 202, pp. 108-116, 04 2018, doi: 10.1016/j.socscimed.2018.01.019.

[77] N. Deshpande, E. J. Metter, S. Bandinelli, F. Lauretani, B. G. Windham, and L. Ferrucci, "Psychological, Physical and Sensory Correlates of Fear of Falling and Consequent Activity Restriction in the Elderly: The InCHIANTI Study," *Am J Phys Med Rehabil,* vol. 87, no. 5, pp. 354–362., 2008.

[78] R. S. Lazarus and S. Folkman, *Stress, Appraisal, and Coping*. New York Springer Pub. Co., 1984.

[79] M. R. Salleh, "Life event, stress and illness," (in eng), *Malays J Med Sci,* vol. 15, no. 4, pp. 9-18, Oct 2008.

[80] Z. Ma, A. Faber, and L. Dube, "Exploring women's psychoneuroendocrine responses to cancer threat: insights from a computer-based guided imagery task," (in eng), *The Canadian journal of nursing research = Revue canadienne de recherche en sciences infirmieres,* vol. 39, no. 1, pp. 98-115, Mar 2007.

[81] J. Younger, P. Finan, A. Zautra, M. Davis, and J. Reich, "Personal mastery predicts pain, stress, fatigue, and blood pressure in adults with rheumatoid arthritis," (in eng), *Psychol Health,* Randomized Controlled Trial vol. 23, no. 5, pp. 515-35, 2008, doi: 10.1080/08870440701596593.

[82] B. T. Mausbach *et al.*, "Stress-related reduction in personal mastery is associated with reduced immune cell beta2-adrenergic receptor sensitivity," (in eng), *Int Psychogeriatr,* Comparative Study Research Support, N.I.H., Extramural vol. 19, no. 5, pp. 935-46, Oct 2007, doi: 10.1017/S1041610206004364.

[83] J. J. Chiang, A. Ko, J. E. Bower, S. E. Taylor, M. R. Irwin, and A. J. Fuligni, "Stress, Psychological Resources, and HPA and Inflammatory Reactivity During Late Adolescence," (in eng), *Dev Psychopathol,* vol. 31, no. 2, pp. 699-712, 05 2019, doi: 10.1017/S0954579418000287.

[84] R. S. Lazurus, "The stress and coping paradigm," in *Fifty Years of the Research and theory of R.s. Lazarus: An Analysis of Historical and Perennial Issues*, R. S. Lazurus Ed. Lawrence Erlbaum Associates Publishers, 1998.

[85] J. M. Covino, T. W. Stern, and T. A. Stern, "Denial of cardiac illness: consequences and management," (in eng), *Prim Care Companion CNS Disord,* vol. 13, no. 5, 2011, doi: 10.4088/PCC.11f01166.

[86] M. R. Umstattd, E. McAuley, R. W. Motl, and K. S. Rosengren, "Pessimism and physical functioning in older women: influence of self-efficacy," (in eng), *J Behav Med,* vol. 30, no. 2, pp. 107-14, Apr 2007, doi: 10.1007/s10865-006-9089-9.

[87] M. F. Scheier *et al.*, "Dispositional optimism and recovery from coronary artery bypass surgery: the beneficial effects on physical and psychological well-being," (in eng), *J Pers Soc Psychol,* vol. 57, no. 6, pp. 1024-40, Dec 1989, doi: 10.1037//0022-3514.57.6.1024.

[88] T. Rantanen, "Promoting mobility in older people," (in eng), *J Prev Med Public Health,* vol. 46 Suppl 1, pp. S50-4, Jan 2013, doi: 10.3961/jpmph.2013.46.S.S50.

[89] L. Ferrucci, R. Cooper, M. Shardell, E. M. Simonsick, J. A. Schrack, and D. Kuh, "Age-Related Change in Mobility: Perspectives From Life Course Epidemiology and Geroscience," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 71, no. 9, pp. 1184-94, 09 2016, doi: 10.1093/gerona/glw043.

[90] L. DiPietro, Y. Jin, S. Talegawkar, and C. E. Matthews, "The Joint Associations of Sedentary Time and Physical Activity With Mobility Disability in Older People:

The NIH-AARP Diet and Health Study," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 73, no. 4, pp. 532-538, 03 2018, doi: 10.1093/gerona/glx122.

[91] D. Kuh, Y. Ben-Shlomo, J. Lynch, J. Hallqvist, and C. Power, "Life course epidemiology," *Journal of Epidemiology and Community Health,* vol. 57, no. 10, pp. 778-783, 2003, doi: 10.1136/jech.57.10.778.

[92] S. Schieman, "Age, Education, and the Sense of Control: A Test of the Cumulative Advantage Hypothesis," *Research on Ageing,* vol. 23, no. 2, pp. 153-178, 2001.

[93] Skaff and M, "Sense of control and health: A dynamic duo in the aging process.," in *Handbook of health psychology and aging* Aldwin, C. M, Park, C. L, Spiro, and A Eds.: New York : Guildford Press . 2007, pp. 186 – 209.

[94] L. I. Pearlin, K. Nguyen, S. Schieman, and M. A. Milkie, "The Life-Course Origins of Mastery among Older People," *Journal of Health and Social Behavior,* vol. 48, pp. 164–179, 2007.

[95] Y. Ben-Shlomo and D. Kuh, "A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives," (in eng), *Int J Epidemiol,* vol. 31, no. 2, pp. 285-93, Apr 2002.

[96] Public Health England. "Health matters: Prevention- A life course approach." https://www.gov.uk/government/publications/health-matters-life-course-approach-to-prevention/health-matters-prevention-a-life-course-approach#resources (accessed March, 2019).

[97] L. Pearlin, S. Schieman, E. Fazio, and S. Meersman, "Stress, Health, and the Life Course: Some Conceptual Perspectives," *Journal of Health and Social Behavior,* vol. 46, no. 2, pp. 205-19, 2005.

[98] M. Rosenberg and L. I. Pearlin, "Social class and self-esteem among children and adults," *American Journal of Sociology,* vol. 84, no. 1, pp. 53–77, 1978.

[99] P. S. Nurius, S. Green, P. Logan-Greene, and S. Borja, "Life course pathways of adverse childhood experiences toward adult psychological well-being: A stress process analysis," (in eng), *Child Abuse Negl,* vol. 45, pp. 143-53, Jul 2015, doi: 10.1016/j.chiabu.2015.03.008.

[100] L. Ejlskov, H. Bøggild, D. Kuh, and M. Stafford, "Social relationship adversities throughout the lifecourse and risk of loneliness in later life. ," *Ageing and Society,* 2019.

[101] C. D. Falci, "Self-Esteem and Mastery Trajectories in High School by Social Class and Gender," (in eng), *Soc Sci Res,* vol. 40, no. 2, pp. 586-601, Mar 01 2011, doi: 10.1016/j.ssresearch.2010.12.013.

[102] K. L. Lewis, C. E. Ross, and J. Mirowsky, "Establishing a Sense of Personal Control in the Transition to Adulthood," *Social Forces,* vol. 77, no. 4, pp. 1573-1599, 1999.

[103] M. J. Shanahan and D. J. Bauer, "Developmental properties of transactional models: The case of life events and mastery from adolescence to young adulthood," *Development and Psychopathology,* vol. 16, pp. 1095–1117, 2004.

[104] M. J, "Instrumentalism in the land of opportunity: Socioeconomic causes and emotional consequences," vol. 59 Ross and C. E, Eds., ed: *Social Psychology Quarterly*, 1996, pp. 322-337.

[105] J. Mirowsky and C. E. Ross, "Life Course Trajectories of Perceived Control and Their Relationship to Education," *American Journal of Sociology,,* vol. 12, no. 5, pp. 1339-1382, 2007

[106] K. J. Conger, S. T. Williams, W. M. Little, Masyn K E, and Shebloski B, "Development of Mastery during Adolescence: The Role of Family Problem Solving," *J Health Soc Behav.,* vol. 50, no. 1, pp. 99–114., 2009.

[107] C. Ross and B. Broh, "The role of self-esteem and the sense of personal control in the academic achievement process," *Sociology of Education,* vol. 73, no. 4, pp. 270–284, 2000.

[108] G. Whitty, *Making sense of education policy*. London: Paul Chapman, 2002.

[109] G. J. Duncan and J. Brooks-Gunn, Eds. *Consequences of Growing Up Poor*. New York: Russell Sage, 1997.

[110] P. Mortimore and G. Whitty, *Can school improvement overcome the effects of disadvantage? Revised edition*. London: Institute of Education, 2000.

[111] D. Ghate and N. Hazel, *Parenting in poor environments: stress, support and coping*. London: Policy Research Bureau, 2004.

[112] J. W. B. Douglas, "The Home and the School . ," ed. MacGibbon and Kee, London, 1964.

[113] M. Wadsworth, "Roots of Delinquency," in *Infancy Adolescence and Crime*, ed: Martin Robertson and Company Limited, 1979.

[114] J. Mirowsky and C. Ross, "Education, Personal Control, Lifestyle and Health: A Human Capital Hypothesis," *Research on Aging* vol. 20, no. 4, pp. 415-449, 1998.

[115] M. Rutter, "FAMILY AND SCHOOL INFLUENCES ON COGNITIVE DEVELOPMENT," *Journal of Child Psychology and Psychiatry,* vol. 26, pp. 683–704, 1985.

[116] J. Mirowsky and C. E. Ross, "Life Course Trajectories of Perceived Control and Their Relationship to Education," *American Journal of Sociology,,* vol. 12, no. 5, pp. 1339-1382, 2007.

[117] S. Hatch, L. Feinstein, B. Link, M. E. J. Wadsworth, and M. Richards, "The continuing benefits of education: adult education and midlife cognitive ability in

the British 1946 birth cohort. ," *Journal of Gerontology Series B* vol. 62, pp. 404-414, 2007.

[118] J. S. Richards M , Sizer A , et al and I, "Identifying the lifetime cognitive and socioeconomic antecedents of cognitive state: seven decades of follow-up in a British birth cohort study," *BMJ Open* vol. 9, p. e024404, 2019.

[119] C. E. Ross and J. Mirowsky, "Explaining the Social Patterns of Depression : Control and Problem Solving-or Support and Talking?," *Journal of Health and Sccial Behavior,* vol. 30, pp. 206-219, 1989.

[120] L. W. Li, M. M. Seltzer, and J. S. Greenberg, "Change in depressivesymptoms among daughter caregivers: An 18-month longitudinal study.," *Psychology & Aging,* vol. 14, pp. 206–219, 1999.

[121] R. Klaming, D. J. Veltman, and H. C. Comijs, "The impact of personality on memory function in older adults-results from the Longitudinal Aging Study Amsterdam," (in eng), *Int J Geriatr Psychiatry,* vol. 32, no. 7, pp. 798-804, 07 2017, doi: 10.1002/gps.4527.

[122] S. Schieman and A. Narisada, "In Control or Fatalistically Ruled? The Sense of Mastery among Working Canadians," *Canadian Sociological Association,* vol. 51, no. 4, pp. 343-74, 2014.

[123] S. Schieman and G. Plickert, "How knowledge is power: Education and sense of control," *Social Forces,,* vol. 87, no. 1, pp. 153-183, 2008.

[124] M. Spence, "Job Market Signalling," *Quarterly Journal of Economics,* vol. 87, pp. 355-74, 1973.

[125] J. Ferrie *Work Stress and Health: The Whitehall II Study*. London: Public and Commercial Services Union, 2004.

[126] L. I. Pearlin and M. Skaff, "Stressors and adaptation in late life.," in *Emerging issues in mental health and aging* M. Gatz Ed. American Psychological Association, 1995, pp. 97–123.

[127] C. E. Ross and J. Mirowsky, "Does medical insurance contribute to socioeconomic differentials in health?," (in eng), *Milbank Q,* vol. 78, no. 2, pp. 291-321, 151-2, 2000, doi: 10.1111/1468-0009.00171.

[128] C. A. Christie-Mizell and R. J. Erickson, "Mothers And Mastery: The Consequences Of Perceived Neighborhood Disorder," *Social Psychology Quarterly,* vol. 70, no. 4, pp. 340–365, 2007.

[129] Y. Jang, D. A. Chiriboga, G. Kim, and S. Rhew, "Perceived discrimination, sense of control, and depressive symptoms among Korean American older adults. ," *Asian American Journal of Psychology,* vol. 1, no. 2, 2010.

[130] T. Pudrovska, S. Schieman, L. I. Pearlin, and K. Nguyen, "The sense of mastery as a mediator and moderator in the association between economic hardship and health in late life," (in eng), *J Aging Health,* Research Support, N.I.H., Extramural Research Support, U.S. Gov't, P.H.S. vol. 17, no. 5, pp. 634-60, Oct 2005, doi: 10.1177/0898264305279874.

[131] Pearlin L.I and M. F. Pioli, "Personal control: some conceptual turf and future directions. ," in *Personal control in social and life course context.*, S. H. Zarit, L. I. Pearlin, and K. W. Schaie Eds. Springer, New York, 2003.

[132] S. Gerhardt, *Why Love Matters: How affection shapes a baby's brain*. Routledge, 2004.

[133] P. A. Thoits, "Stress and health: major findings and policy implications," (in eng), *J Health Soc Behav,* vol. 51 Suppl, pp. S41-53, 2010, doi: 10.1177/0022146510383499.

[134] L. I. Pearlin, M. A. Lieberman, E. G. Menaghan, and J. T. Mullan, "The stress process," *J Health Soc Behav,* vol. 22, no. 4, pp. 337-56, Dec 1981.

[135] C. Emlet, C. Shiu, H.-J. Kim, and K. Fredriksen-Goldsen, "Bouncing back: Resilience and mastery among HIV-positive older gay and bisexual men," *The Gerontologis,* vol. 57, no. 1, pp. S40-S49, 2017.

[136] M. E. Buttram, H. L. Surratt, and S. P. Kurtz, "Risk and Protective Factors Associated with Personal Mastery Among Sexual Minority African American Female Sex Workers," (in eng), *Journal of gay & lesbian social services,* vol. 26, no. 4, pp. 407-425, Oct 01 2014, doi: 10.1080/10538720.2014.956242.

[137] S. Kim and B. G. Knight, "Caregiving Subgroups Differences in the Associations Between the Resilience Resources and Life Satisfaction," (in eng), *Journal of applied gerontology : the official journal of the Southern Gerontological Society,* Sep 20 2016, doi: 10.1177/0733464816669804.

[138] K. Reini and F. Nyqvist, "Sense of mastery differences between working-age Swedish- and Finnish-speaking Finns: a population-based study," (in eng), *Scand J Public Health,* vol. 45, no. 4, pp. 404-410, Jun 2017, doi: 10.1177/1403494817696183.

[139] R. M. Carpiano and R. T. Kimbro, "Neighborhood social capital, parenting strain, and personal mastery among female primary caregivers of children," (in eng), *J Health Soc Behav,* vol. 53, no. 2, pp. 232-47, 2012, doi: 10.1177/0022146512445899.

[140] M. A. Lippold, T. Glatz, G. M. Fosco, and M. E. Feinberg, "Parental Perceived Control and Social Support: Linkages to Change in Parenting Behaviors During Early Adolescence," (in eng), *Fam Process,* vol. 57, no. 2, pp. 432-447, 06 2018, doi: 10.1111/famp.12283.

[141] A. Bengtsson-Tops, "Mastery in patients with schizophrenia living in the community: relationship to sociodemographic and clinical characteristics, needs for care and support, and social network," (in eng), *J Psychiatr Ment Health Nurs,* vol. 11, no. 3, pp. 298-304, Jun 2004, doi: 10.1111/j.1365-2850.2003.00718.x.

[142] L. I. Pearlin, C. S. Aneshensel, and A. J. LeBlanc, "The forms and mechanisms of stress proliferation: the case of AIDS caregivers," (in eng), *J Health Soc Behav,* vol. 38, no. 3, pp. 223-36, Sep 1997.

[143] E. Carr *et al.*, "The Association Between Informal Caregiving and Exit From Employment Among Older Workers: Prospective Findings From the UK Household Longitudinal Study," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 73, no. 7, pp. 1253-1262, 09 2018, doi: 10.1093/geronb/gbw156.

[144] R. D. Conger, K. J. Conger, L. S. Matthews, and G. H. Elder Jr, "Pathways of Economic Influence on Adolescent Adjustment," *American Journal of Community Psychology,* vol. 27, no. 4, pp. 519-541, 1999.

[145] J. A. Kwon and K. A. Wickrama, "Linking family economic pressure and supportive parenting to adolescent health behaviors: two developmental pathways leading to health promoting and health risk behaviors," (in eng), *J Youth Adolesc,* Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't vol. 43, no. 7, pp. 1176-90, Jul 2014, doi: 10.1007/s10964-013-0060-0.

[146] T. M. Gadalla, "Determinants, correlates and mediators of psychological distress: a longitudinal study," (in eng), *Soc Sci Med,* vol. 68, no. 12, pp. 2199-205, Jun 2009, doi: 10.1016/j.socscimed.2009.03.040.

[147] S. Ang and R. Malhotra, "Association of received social support with depressive symptoms among older males and females in Singapore: Is personal mastery an inconsistent mediator?," (in eng), *Soc Sci Med,* vol. 153, pp. 165-73, Mar 2016, doi: 10.1016/j.socscimed.2016.02.019.

[148] B. S. Dohrenwend, L. Krasnoff, A. R. Askenasy, and B. P. Dohrenwend, "The psychiatric epidemiology research interview life events scale.," in *Handbook of stress: Theoretical and clinical aspects*, L. Goldberger and S. Breznitz Eds. New York: Free Press, 1982.

[149] J. Cairney and N. Krausse, "Negative Life Events and Age-Related Decline in Mastery: Are Older Adults More Vulnerable to the Control-Eroding Effect of Stress?," *Journal of Gerontology:,* vol. 63B, no. 3, pp. S162–S170, 2008.

[150] W. R. Avison and J. Cairney, "Social structure, stress, and personal control . ," in *Societal impacts of personal control in the elderly.* , S. H. Zarit, L. I. Pearlin, and K. Warner Schaie Eds. New York (NY) : Springer, 2003 . pp. 127 – 164.

[151] M. Rutter and M. Rutter, *Developing Minds: Challenge and Continuity Across the Lifespan* New York: Basic Books, 1993.

[152] Pearlin L.I. and M. M.E., "Occupational Stress and Marital Support.," in *Stress Between Work and Family. The Springer Series on Stress and Coping.* , G. S. Eckenrode J. Ed. Springer, Boston, MA, 1990.

[153] R. Kessler, R. Price, and C. Wortman "Social Factors in Psychopathology: Stress, Social Support, and Coping Processes," *Annual Review of Psychology,* vol. 36, no. 1, pp. 531-572, 1985.

[154] S. L. Hatch, G. Mishra, M. Hotopf, P. B. Jones, and D. Kuh, "Appraisals of stressors and common mental disorder from early to mid-adulthood in the 1946 British birth cohort," *Journal of Affective Disorders,* vol. 119, no. 1, pp. 66-75, 2009.

[155] A. Flammer, "Developmental analysis of control beliefs," in *Self-Efficacy in Changing Societies*, A. Bandura Ed. Cambridge: Cambridge University Press, 1995, pp. 69-113.

[156] B. Wheaton, "The Sociogenesis of Psychological Disorder : An Attributional Theory," *Journal of Health and Social Behavior,* vol. 21, pp. 100-24, 1980.

[157] D. Lascano, G. N, H. Krahn, and M. Lachman, "Growth in Perceived Control Across 25 Years From the Late Teens to Midlife: The Role of Personal and Parents' Education," vol. 51, ed. Developmental Psychology, 2015, pp. 124–135.

[158] M. Stafford, C. R. Gale, G. Mishra, M. Richards, S. Black, and D. L. Kuh, "Childhood Environment and Mental Wellbeing at Age 60-64 Years: Prospective Evidence from the MRC National Survey of Health and Development," *PloS one,* vol. 10, no. 6, p. e0126683, 2015.

[159] J. Bowlby, "A secure base: Parent-child attachment and healthy human development," ed: Basic Books, 1988.

[160] J. Bowlby, "Attachment and Loss. VOLUME II SEPARATION ANXIETY AND ANGER ", ed: Basic books, 1973, p. 203.

[161] C. Rodgers, *Theory of Therapy, Personality and Interpersonal Relationships as Developed in the Client-centered Framework.* (*Psychology: A Study of a Science*). New York: McGraw-Hill, 1959.

[162] K. L. Moilanen and Y. L. Shen, "Mastery in middle adolescence: the contributions of socioeconomic status, maternal mastery and supportive-involved mothering," (in eng), *J Youth Adolesc,* vol. 43, no. 2, pp. 298-310, Feb 2014, doi: 10.1007/s10964-013-9951-3.

[163] F. F. Surjadi, F. O. Lorenz, K. A. Wickrama, and R. D. Conger, "Parental support, partner support, and the trajectories of mastery from adolescence to early adulthood," (in eng), *Journal of adolescence,* Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't Research Support, U.S. Gov't,

P.H.S. vol. 34, no. 4, pp. 619-28, Aug 2011, doi: 10.1016/j.adolescence.2010.10.001.

[164] I. Smits, B. Soenens, K. Luyckx, B. Duriez, M. Berzonsky, and L. Goossens, "Perceived parenting dimensions and identity styles: exploring the socialization of adolescents' processing of identity-relevant information," (in eng), *J Adolesc,* vol. 31, no. 2, pp. 151-64, Apr 2008, doi: 10.1016/j.adolescence.2007.08.007.

[165] A. Singh-Manoux, P. Fonagy, and M. Marmot, "The relationship between parenting dimensions and adult achievement: evidence from the Whitehall II Study," (in eng), *Int J Behav Med,* vol. 13, no. 4, pp. 320-9, 2006, doi: 10.1207/s15327558ijbm1304_7.

[166] D. Nelson and N. Crick, "Parental psychological control: Implications for childhood physical and relational aggression," in *Intrusive parenting: How psychological control affects children and adolescents*, B. K. Barber Ed. Washington: DC: APA. , 2002, pp. 168–189.

[167] B. K. Barber, S. L. Maughan, and J. A. Olsen, "Patterns of parenting across adolescence," *New Directions for Child and Adolescent Development,* vol. 2005, no. 108, pp. 5-16, 2005, doi: 10.1002/cd.124.

[168] F. A. Huppert, R. A. Abbott, G. B. Ploubidis, M. Richards, and D. Kuh, "Parental practices predict psychological well-being in midlife: life-course associations among women in the 1946 British birth cohort," *Psychol Med,* vol. 40, no. 9, pp. 1507-18, Sep 2010, doi: 10.1017/S0033291709991978.

[169] C. B. Gittins and C. Hunt, "Parental behavioural control in adolescence: How does it affect self-esteem and self-criticism?," (in eng), *J Adolesc,* vol. 73, pp. 26-35, Jun 2019, doi: 10.1016/j.adolescence.2019.03.004.

[170] T. O'Connor and S. Scott, "Parenting and outcomes for children," York Publishing Services Ltd, York, 2007.

[171] B. Soenens, M. Vansteenkiste, and P. Luyten, "Toward a domain-specific approach to the study of parental psychological control: distinguishing between dependency-oriented and achievement-oriented psychological control," (in eng), *J Pers,* vol. 78, no. 1, pp. 217-56, Feb 2010, doi: 10.1111/j.1467-6494.2009.00614.x.

[172] N. W. Affrunti and G. S. Ginsburg, "Maternal overcontrol and child anxiety: the mediating role of perceived competence," (in eng), *Child Psychiatry Hum Dev,* vol. 43, no. 1, pp. 102-12, Feb 2012, doi: 10.1007/s10578-011-0248-z.

[173] I School, J. Bynner. et al "The influence of context, timing, and duration of risk experiences for the passage from childhood to midadulthood. ," *Child Dev,* vol. 73, pp. 1486–504, 2002.

[174] D. Kuh, J. Head, R. Hardy, and M. Wadsworth, "The Influence of Education and Family Background on Women's Earnings in Midlife: Evidence from a British National Birth Cohort Study. ," *British Journal of Sociology of Education,* vol. 18, no. 3, pp. 385-405, 1997.

[175] D. Kuh and M. Wadsworth, "Childhood influences on adult male earnings in a longitudinal study. ," *British Journal of Sociology,* vol. 42, pp. 537-555., 1991.

[176] E. Werner and R. Smith, "Vulnerable but Invincible: A Longitudinal Study of Resilient Children and Youth . ," ed. New York: McGraw Hill, 1982.

[177] M. Manyema, S. A. Norris, and L. M. Richter, "Stress begets stress: the association of adverse childhood experiences with psychological distress in the presence of adult life stress," (in eng), *BMC Public Health,* vol. 18, no. 1, p. 835, 07 2018, doi: 10.1186/s12889-018-5767-0.

[178] E. Flouri and D. Hawkes, "Ambitious mothers--successful daughters: mothers' early expectations for children's education and children's earnings and sense of control in adult life," *Br J Educ Psychol,* vol. 78, no. Pt 3, pp. 411-33, Sep 2008, doi: 10.1348/000709907X251280.

[179] R. Conger and M. Donnellan, "An Interactionist Perspective on the Socioeconomic Context of Human Development," *Annual Review of Psychology,* vol. 58, p. 175, 2007.

[180] R. Bradley, R. Corwyn, H. McAdoo, and G. C, "The home environments of children in the United States: part I. Variations by age, ethnicity, and poverty status. ," *Child Dev.,* vol. 72, pp. 1844–67, 2002.

[181] R. M. Thomson *et al.*, "Predictors of positive and negative parenting behaviours: evidence from the ALSPAC cohort," (in eng), *BMC Pediatr,* vol. 14, p. 247, Oct 2014, doi: 10.1186/1471-2431-14-247.

[182] B. Rodgers, "Adult affective disorder and early environment," *The British Journal of Psychiatry,* vol. 157, no. 4, pp. 539-550, 1990.

[183] M. Rutter, "Psychosocial resilience and protective mechanisms," *American Journal of Orthopsychiatry,* vol. 57, pp. 316–331, 1987.

[184] I. Colman *et al.*, "Consistency in adult reporting of adverse childhood experiences," (in eng), *Psychol Med,* vol. 46, no. 3, pp. 543-9, Feb 2016, doi: 10.1017/S0033291715002032.

[185] J. C. Phelan, B. G. Link, and P. Tehranifar, "Social conditions as fundamental causes of health inequalities: theory, evidence, and policy implications," (in eng), *J Health Soc Behav,* vol. 51 Suppl, pp. S28-40, 2010, doi: 10.1177/0022146510383498.

[186] M. I. Bisschop, D. M. Kriegsman, A. T. Beekman, and D. J. Deeg, "Chronic diseases and depression: the modifying role of psychosocial resources," (in eng), *Soc Sci Med,* Research Support, Non-U.S. Gov't vol. 59, no. 4, pp. 721-33, Aug 2004, doi: 10.1016/j.socscimed.2003.11.038.

[187] L. Crowe and P. Butterworth, "The role of financial hardship, mastery and social support in the association between employment status and depression: results from an Australian longitudinal cohort study," *BMJ Open,* vol. 6, no. 5, p. e009834, May 27 2016, doi: 10.1136/bmjopen-2015-009834.

[188] Schooler and Carmi, "It's Tough to Cope in Rural Mali: Financial Coping Style, Mastery, Self Confidence, and Anxiety in a Bad and Worsening Socioeconomic Environment," in *Advances in the Conceptualization of the Stress Process: Essays in Honor of Leonard I. Pearlin*, Caplan and Leslie Eds., Diakité and Chiaka, Eds., 2010, pp. 177-188.

[189] J. Sastry and C. Ross, "Asian Ethnicity and the Sense of Personal Control. ," *Social Psychology Quarterly,* vol. 61, no. 2, pp. 101-120, 1998.

[190] Klokgeiters and Silvia, "Resilience in the Disabling Effect of Gait Speed Among Older Turkish and Moroccan Immigrants and Native Dutch," vol. 30, v. Tilburg and Theo, Eds., ed. Journal of Ageing and Health, 2018, pp. 711-737.

[191] R. A. R. Gurung, C. Dunkel-Schetter, N. Collins, C. Rini, and C. J. Hobel, "Psychosocial predictors of prenatal anxiety. ," *Journal of Social and Clinical Psychology,* vol. 24, no. 4, pp. 497–519, 2005.

[192] P. Clarke and J. Smith, "Aging in a cultural context: cross-national differences in disability and the moderating role of personal control among older adults in the United States and England," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 66, no. 4, pp. 457-67, Jul 2011, doi: 10.1093/geronb/gbr054.

[193] D. Kuh *et al.*, "Cohort profile: updating the cohort profile for the MRC National Survey of Health and Development: a new clinic-based data collection for ageing research," *International journal of epidemiology,* vol. 40, no. 1, pp. e1-e9, 2011.

[194] D. Kuh *et al.*, "Cohort profile: updating the cohort profile for the MRC National Survey of Health and Development: a new clinic-based data collection for ageing research," *International journal of epidemiology,* vol. 40, no. 1, pp. e1-9, Feb 2011, doi: 10.1093/ije/dyq231.

[195] M. Stafford *et al.*, "Using a birth cohort to study ageing: representativeness and response rates in the National Survey of Health and Development," *European journal of ageing,* vol. 10, no. 2, pp. 145-157, Jun 2013, doi: 10.1007/s10433-013-0258-8.

[196] W. M., "The imprint of time: childhood, history and adult life," ed: Oxford University Press: Oxford, 1991.

[197] M. B. Pierce *et al.*, "Clinical disorders in a post war British cohort reaching retirement: evidence from the First National Birth Cohort study," (in eng), *PLoS One,* vol. 7, no. 9, p. e44857, 2012, doi: 10.1371/journal.pone.0044857.

[198] W. H. Organization., "International Classification of Functioning, Disability, and Health: Final Draft, Full Version.," Geneva, Switzerland, 2001.

[199] W. H. Organisation, "World Report on Ageing and Health," ed. Geneva, Switzerland, 2015.

[200] Age UK, "Diversity in older age – Disability ", 2016

[201] R. Cooper, B. H. Strand, R. Hardy, K. V. Patel, and D. Kuh, "Physical capability in mid-life and survival over 13 years of follow-up: British birth cohort study," (in eng), *BMJ,* vol. 348, p. g2219, Apr 2014, doi: 10.1136/bmj.g2219.

[202] R. Cooper, D. Kuh, R. Hardy, M. R. Group, and F. a. H. S. Teams, "Objectively measured physical capability levels and mortality: systematic review and meta-analysis," (in eng), *BMJ,* vol. 341, p. c4467, Sep 2010, doi: 10.1136/bmj.c4467.

[203] T. von Soest, M. Luhmann, T. Hansen, and D. Gerstorf, "Development of loneliness in midlife and old age: Its nature and correlates," (in eng), *J Pers Soc Psychol,* vol. 118, no. 2, pp. 388-406, Feb 2020, doi: 10.1037/pspp0000219.

[204] R. Cooper *et al.*, "Objective measures of physical capability and subsequent health: a systematic review," (in eng), *Age Ageing,* vol. 40, no. 1, pp. 14-23, Jan 2011, doi: 10.1093/ageing/afq117.

[205] R. Cooper, R. Hardy, and A. Aihie Sayer, "A life course approach to physical capability. ," in *A Life Course Approach to Healthy Ageing.* , D. Kuh, R. Cooper, R. Hardy, M. Richards, and Y. Ben-Shlomo Eds. Oxford, UK: Oxford University Press, 2014, pp. 16-31.

[206] T. M. Gill, C. S. Williams, E. D. Richardson, and M. E. Tinetti, "Impairments in physical performance and cognitive status as predisposing factors for functional dependence among nondisabled older persons," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 51, no. 6, pp. M283-8, Nov 1996, doi: 10.1093/gerona/51a.6.m283.

[207] D. Kuh, Karunananthan, S., Bergman, H., Cooper, R., "A life-course approach to healthy ageing: maintaining physical capability," *Proceedings of the Nutrition Society,* vol. 73, no. 2, pp. 237-248, 2014.

[208] P. Kivinen, R. Sulkava, P. Halonen, and A. Nissinen, "Self-reported and performance-based functional status and associated factors among elderly men: the Finnish cohorts of the Seven Countries Study," (in eng), *J Clin Epidemiol,* vol. 51, no. 12, pp. 1243-52, Dec 1998, doi: 10.1016/s0895-4356(98)00115-2.

[209] L. Coman and J. Richardson, "Relationship between self-report and performance measures of function: a systematic review," (in eng), *Can J Aging,* vol. 25, no. 3, pp. 253-70, 2006, doi: 10.1353/cja.2007.0001.

[210] Government Office for Science. "Future of ageing: : emotional and personal resilience." https://www.gov.uk/government/publications/future-of-ageing-emotional-and-personal-resilience (accessed 01, 2017).

[211] E. G. Wloch, D. Kuh, and R. Cooper, "Is the Hierarchy of Loss in Functional Ability Evident in Midlife? Findings from a British Birth Cohort," (in eng), *PLoS One,* vol. 11, no. 5, p. e0155815, 2016, doi: 10.1371/journal.pone.0155815.

[212] J. M. Guralnik, S. Butterworth, M. E. Wadsworth, and D. Kuh, "Childhood socioeconomic status predicts physical functioning a half century later," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 61, no. 7, pp. 694-701, Jul 2006, doi: 10.1093/gerona/61.7.694.

[213] J. M. Guralnik, L. G. Branch, S. Cummings, and J. D. Curb, "Physical performance measures in aging research. ," *J Gerontol* vol. 44, no. 5, pp. 141-146., 1989.

[214] S. Fors, M. Thorslund, and M. G. Parker, "Do actions speak louder than words? Self-assessed and performance-based measures of physical and visual function among old people," (in eng), *Eur J Ageing,* vol. 3, no. 1, pp. 15-21, Mar 2006, doi: 10.1007/s10433-006-0021-5.

[215] J. M. Guralnik and L. Ferrucci, "Assessing the building blocks of function: utilizing measures of functional limitation. ," *Am J Prev Med* vol. 25, pp. 112-121 2003.

[216] T. A. Glass, "Conjugating the "tenses" of function: discordance among hypothetical, experimental, and enacted function in older adults," (in eng), *Gerontologist,* vol. 38, no. 1, pp. 101-12, Feb 1998, doi: 10.1093/geront/38.1.101.

[217] R. Bendayan, R. Cooper, E. G. Wloch, S. M. Hofer, A. M. Piccinin, and G. Muniz-Terrera, "Hierarchy and Speed of Loss in Physical Functioning: A Comparison Across Older U.S. and English Men and Women," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 72, no. 8, pp. 1117-1122, Aug 2017, doi: 10.1093/gerona/glw209.

[218] D. X. M. Wang, J. Yao, Y. Zirek, E. M. Reijnierse, and A. B. Maier, "Muscle mass, strength, and physical performance predicting activities of daily living: a meta-analysis," (in eng), *J Cachexia Sarcopenia Muscle,* vol. 11, no. 1, pp. 3-25, Feb 2020, doi: 10.1002/jcsm.12502.

[219] Y. Milaneschi *et al.*, "Personal mastery and lower body mobility in community-dwelling older persons: the Invecchiare in Chianti study," (in eng), *Journal of the American Geriatrics Society,* Research Support, Non-U.S. Gov't vol. 58, no. 1, pp. 98-103, Jan 2010, doi: 10.1111/j.1532-5415.2009.02611.x.

[220] J. Drewelies, W. J. Chopik, C. A. Hoppmann, J. Smith, and D. Gerstorf, "Linked Lives: Dyadic Associations of Mastery Beliefs With Health (Behavior) and Health

(Behavior) Change Among Older Partners," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 73, no. 5, pp. 787-798, 06 2018, doi: 10.1093/geronb/gbw058.

[221] L. N. Gitlin, L. Winter, and I. H. Stanley, "Compensatory Strategies: Prevalence of Use and Relationship to Physical Function and Well-Being," (in eng), *J Appl Gerontol,* vol. 36, no. 6, pp. 647-666, 06 2017, doi: 10.1177/0733464815581479.

[222] E. B. Fauth, S. H. Zarit, B. Malmberg, and B. Johansson, "Physical, Cognitive, and Psychosocial Variables From the Disablement Process Model Predict Patterns of Independence and the Transition Into Disability for the Oldest-Old," *The Gerontologist,* vol. 47, no. 5, pp. 613–624, 2007.

[223] I. C. Wu, C. A. Hsiung, I. S. Chang, M. S. Wu, Y. H. Chang, and C. C. Hsu, "Personal mastery, multisystem physiological dysregulation and risk of functional decline in older adults: A prospective study in Taiwan," (in eng), *Geriatr Gerontol Int,* Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't vol. 15, no. 6, pp. 707-14, Jun 2015, doi: 10.1111/ggi.12334.

[224] W. J. Lee, L. K. Chen, L. N. Peng, S. T. Chiou, and P. Chou, "Personal mastery attenuates the adverse effect of frailty on declines in physical function of older people: A 6-year population-based cohort study," (in eng), *Medicine (Baltimore),* vol. 95, no. 34, p. e4661, Aug 2016, doi: 10.1097/MD.0000000000004661.

[225] E. M. Simonsick, J. M. Guralnik, and L. P. Fried, "Who Walks? Factors Associated with Walking Behavior in Disabled Older Women With and Without Self-Reported Walking Difficulty.," *Journal of the American Geriatrics Society,* vol. 47, pp. 672-680, 1999.

[226] R. Dodds, D. Kuh, A. Aihie Sayer, and R. Cooper, "Physical activity levels across adult life and grip strength in early old age: updating findings from a British birth cohort," (in eng), *Age Ageing,* vol. 42, no. 6, pp. 794-8, Nov 2013, doi: 10.1093/ageing/aft124.

[227] R. Cooper, G. Muniz-Terrera, and D. Kuh, "Associations of behavioural risk factors and health status with changes in physical capability over 10 years of follow-up: the MRC National Survey of Health and Development," (in eng), *BMJ Open,* vol. 6, no. 4, p. e009962, Apr 2016, doi: 10.1136/bmjopen-2015-009962.

[228] B. H. Strand, G. Mishra, D. Kuh, J. M. Guralnik, and K. V. Patel, "Smoking history and physical performance in midlife: results from the British 1946 birth cohort," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 66, no. 1, pp. 142-9, Jan 2011, doi: 10.1093/gerona/glq199.

[229] D. Kuh, E. J. Bassey, S. Butterworth, R. Hardy, M. E. Wadsworth, and M. S. Team, "Grip strength, postural control, and functional leg power in a representative cohort of British men and women: associations with physical activity, health status, and socioeconomic conditions," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 60, no. 2, pp. 224-31, Feb 2005, doi: 10.1093/gerona/60.2.224.

[230] M. Giné-Garriga, M. Roqué-Fíguls, L. Coll-Planas, M. Sitjà-Rabert, and A. Salvà, "Physical exercise interventions for improving performance-based measures of physical function in community-dwelling, frail older adults: a systematic review and meta-analysis," (in eng), *Arch Phys Med Rehabil,* vol. 95, no. 4, pp. 753-769.e3, Apr 2014, doi: 10.1016/j.apmr.2013.11.007.

[231] B. H. Strand, R. Cooper, R. Hardy, D. Kuh, and J. Guralnik, "Lifelong socioeconomic position and physical performance in midlife: results from the British 1946 birth cohort," (in eng), *Eur J Epidemiol,* vol. 26, no. 6, pp. 475-83, Jun 2011, doi: 10.1007/s10654-011-9562-9.

[232] T. L. North *et al.*, "Effect of smoking on physical and cognitive capability in later life: a multicohort study using observational and genetic approaches," (in eng), *BMJ Open,* vol. 5, no. 12, p. e008393, Dec 2015, doi: 10.1136/bmjopen-2015-008393.

[233] I. o. Medicine, "The Effects of Tobacco Use on Health," in *Public Health Implications of Raising the Minimum Age for Purchasing Tobacco Products* S. K. Bonnie RJ, Kwan LY Ed. Washington (DC): Board on Population Health and Public Health Practice; Institute of Medicine, 2015.

[234] P. Norman, M. Conner, and R. Bell, "The theory of planned behavior and smoking cessation," (in eng), *Health Psychol,* vol. 18, no. 1, pp. 89-94, Jan 1999, doi: 10.1037//0278-6133.18.1.89.

[235] A. K. Wills *et al.*, "Life course body mass index and risk of knee osteoarthritis at the age of 53 years: evidence from the 1946 British birth cohort study," (in eng), *Ann Rheum Dis,* vol. 71, no. 5, pp. 655-60, May 2012, doi: 10.1136/ard.2011.154021.

[236] World Health Organisation, "Obesity and Overweight," N. Factsheets, Ed., ed, 2020.

[237] S. M. Pinto Pereira, B. L. De Stavola, N. T. Rogers, R. Hardy, R. Cooper, and C. Power, "Adult obesity and mid-life physical functioning in two British birth cohorts: investigating the mediating role of physical inactivity," (in eng), *Int J Epidemiol,* Mar 2020, doi: 10.1093/ije/dyaa014.

[238] R. Hardy *et al.*, "Body mass index, muscle strength and physical performance in older adults from eight cohort studies: the HALCyon programme," (in eng), *PLoS One,* vol. 8, no. 2, p. e56483, 2013, doi: 10.1371/journal.pone.0056483.

[239] G. A. Zijlstra *et al.*, "Effects of a multicomponent cognitive behavioral group intervention on fear of falling and activity avoidance in community-dwelling older adults: results of a randomized controlled trial," (in eng), *J Am Geriatr Soc,* vol. 57, no. 11, pp. 2020-8, Nov 2009, doi: 10.1111/j.1532-5415.2009.02489.x.

[240] T. A. Dorresteijn, G. A. Zijlstra, A. W. Ambergen, K. Delbaere, J. W. Vlaeyen, and G. I. Kempen, "Effectiveness of a home-based cognitive behavioral program to manage concerns about falls in community-dwelling, frail older people: results

of a randomized controlled trial," (in eng), *BMC Geriatr,* vol. 16, p. 2, Jan 2016, doi: 10.1186/s12877-015-0177-y.

[241] S. Viaje *et al.*, "The role of concern about falling on stepping performance during complex activities," (in eng), *BMC Geriatr,* vol. 19, no. 1, p. 333, Nov 2019, doi: 10.1186/s12877-019-1356-z.

[242] R. G. Curtis, T. D. Windsor, and M. A. Luszcz, "Perceived Control Moderates the Effects of Functional Limitation on Older Adults' Social Activity: Findings From the Australian Longitudinal Study of Ageing," (in eng), *J Gerontol B Psychol Sci Soc Sci,* Sep 30 2015, doi: 10.1093/geronb/gbv088.

[243] M. Nicolaisen, T. Moum, and K. Thorsen, "Mastery and Depressive Symptoms: How Does Mastery Influence the Impact of Stressors From Midlife to Old Age?," (in eng), *J Aging Health,* vol. 30, no. 7, pp. 1084-1107, 08 2018, doi: 10.1177/0898264317705782.

[244] E. Y. Chan, G. Glass, K. C. Chua, N. Ali, and W. S. Lim, "Relationship between Mastery and Caregiving Competence in Protecting against Burden, Anxiety and Depression among Caregivers of Frail Older Adults," (in eng), *J Nutr Health Aging,* vol. 22, no. 10, pp. 1238-1245, 2018, doi: 10.1007/s12603-018-1098-1.

[245] A. A. L. Kok, M. J. Henstra, N. van der Velde, D. Rhebergen, and N. M. van Schoor, "Psychosocial and Health-Related Factors Associated With Discordance Between 13-Year Trajectories of Self-Reported Functional Limitations and Performance-Based Physical Functioning in Old Age," (in eng), *J Aging Health,* p. 898264319884404, Nov 2019, doi: 10.1177/0898264319884404.

[246] K. Latham-Mintus and P. J. Clarke, "Linking Mastery Across the Life Course to Mobility Device Use in Later Life," (in eng), *J Gerontol B Psychol Sci Soc Sci,* vol. 74, no. 7, pp. 1222-1232, Sep 2019, doi: 10.1093/geronb/gbx053.

[247] E. O. Hoogendijk *et al.*, "Do psychosocial resources modify the effects of frailty on functional decline and mortality?," (in eng), *J Psychosom Res,* vol. 77, no. 6, pp. 547-51, Dec 2014, doi: 10.1016/j.jpsychores.2014.09.017.

[248] F. A. Sloan, N. A. Padron, and A. C. Platt, "Preferences, beliefs, and self-management of diabetes," (in eng), *Health services research,* Research Support, N.I.H., Extramural vol. 44, no. 3, pp. 1068-87, Jun 2009, doi: 10.1111/j.1475-6773.2009.00957.x.

[249] K. Birnie *et al.*, "Childhood socioeconomic position and objectively measured physical capability levels in adulthood: a systematic review and meta-analysis," (in eng), *PLoS One,* vol. 6, no. 1, p. e15564, Jan 2011, doi: 10.1371/journal.pone.0015564.

[250] E. T. Murray, R. Hardy, B. H. Strand, R. Cooper, J. M. Guralnik, and D. Kuh, "Gender and life course occupational social class differences in trajectories of functional limitations in midlife: findings from the 1946 British birth cohort," (in

eng), *J Gerontol A Biol Sci Med Sci,* vol. 66, no. 12, pp. 1350-9, Dec 2011, doi: 10.1093/gerona/glr139.

[251] T. D. Windsor, K. Anstey, P. Butterworth, and B. Rodgers, "Behavioral approach and behavioral inhibition as moderators of the association between negative life events and perceived control in midlife," *Personality and Individual Differences,* vol. 44, no. 5, pp. 1080-1092, 2008.

[252] A. Sørensen and B. Slagsvold, "Age, Education, and the Gender Gap in the Sense of Control," *The International Journal of Aging and Human Development,* vol. 67, no. 1, pp. 25-42, 2008, doi: 10.2190/AG.67.1.b.

[253] J. N. Houle, "Depressive Symptoms and All-Cause Mortality in a Nationally Representative Longitudinal Study With Time-Varying Covariates," *Psychosomatic Medicine* vol. 75, no. 297, 2013.

[254] R. K. Caputo, "The effects of socioeconomic status, perceived discrimination and mastery on health status in a youth cohort," (in eng), *Soc Work Health Care,* vol. 37, no. 2, pp. 17-42, 2003, doi: 10.1300/J010v37n02_02.

[255] L. I. Pearlin, K. B. Nguyen, S. Schieman, and M. A. Milkie, "The life-course origins of mastery among older people," *J Health Soc Behav,* vol. 48, no. 2, pp. 164-79, Jun 2007, doi: 10.1177/002214650704800205.

[256] I. Colman *et al.*, "Early development, stress and depression across the life course: pathways to depression in a national British birth cohort," *Psychological Medicine,* pp. 1-10, 2014.

[257] K. D. Lincoln, "Financial Strain, Negative Interactions, and Mastery: Pathways to Mental Health Among Older African Americans," (in eng), *J Black Psychol,* vol. 33, no. 4, pp. 439-462, Nov 2007, doi: 10.1177/0095798407307045.

[258] F. D. Wolinsky and T. E. Stump, "Age and the Sense of Control Among Older Adults," *Journal of Gerontology:,* vol. 51B, no. 4, pp. S217-S22O, 1996.

[259] S. S. Klokgieters, T. G. van Tilburg, D. J. H. Deeg, and M. Huisman, "Resilience in the Disabling Effect of Gait Speed Among Older Turkish and Moroccan Immigrants and Native Dutch," (in eng), *J Aging Health,* vol. 30, no. 5, pp. 711-737, 06 2018, doi: 10.1177/0898264316689324.

[260] M. Wadsworth, D. Kuh, M. Richards, and R. Hardy, "Cohort Profile: The 1946 National Birth Cohort (MRC National Survey of Health and Development)," *International journal of epidemiology,* vol. 35, no. 1, pp. 49-54, Feb 2006, doi: 10.1093/ije/dyi201.

[261] D. Kuh *et al.*, "The MRC National Survey of Health and Development reaches age 70: maintaining participation at older ages in a birth cohort study," *Eur J Epidemiol,* vol. 31, no. 11, pp. 1135-1147, Nov 2016, doi: 10.1007/s10654-016-0217-8.

[262] F. E. Matthews, M. Chatfield, C. Brayne, and M. R. C. C. F. a. A. Study, "An investigation of whether factors associated with short-term attrition change or persist over ten years: data from the Medical Research Council Cognitive Function and Ageing Study (MRC CFAS)," (in eng), *BMC Public Health,* vol. 6, p. 185, Jul 2006, doi: 10.1186/1471-2458-6-185.

[263] G. Mein, S. Johal, R. L. Grant, C. Seale, R. Ashcroft, and A. Tinker, "Predictors of two forms of attrition in a longitudinal health study involving ageing participants: an analysis based on the Whitehall II study," (in eng), *BMC Med Res Methodol,* vol. 12, p. 164, Oct 2012, doi: 10.1186/1471-2288-12-164.

[264] D. Kuh, R. Hardy, C. Langenberg, M. Richards, and M. E. Wadsworth, "Mortality in adults aged 26-54 years related to socioeconomic conditions in childhood and adulthood: post war birth cohort study," (in eng), *BMJ,* vol. 325, no. 7372, pp. 1076-80, Nov 2002, doi: 10.1136/bmj.325.7372.1076.

[265] M. Richards, B. Shipley , R. Fuhrer , and M. Wadsworth "Cognitive ability in childhood and cognitive decline in mid-life: longitudinal birth cohort study," *BMJ . ,* vol. 328, no. 7439, p. 552., 2004.

[266] R. Cooper, M. Richards, and D. Kuh, "Childhood Cognitive Ability and Age-Related Changes in Physical Capability From Midlife: Findings From a British Birth Cohort Study," (in eng), *Psychosom Med,* vol. 79, no. 7, pp. 785-791, Sep 2017, doi: 10.1097/PSY.0000000000000482.

[267] Office. of Population, "Classification of Occupations HMSO.," Censuses and Surveys, London, 1970.

[268] S. Stansfeld and M. Marmot, "Deriving a survey measure of social support: the reliability and validity of the Close Persons Questionnaire," (in eng), *Soc Sci Med,* vol. 35, no. 8, pp. 1027-35, Oct 1992, doi: 10.1016/0277-9536(92)90242-i.

[269] M. Stafford, R. Bendayan, U. Tymoszuk, and D. Kuh, "Social support from the closest person and sleep quality in later life: Evidence from a British birth cohort study," (in eng), *J Psychosom Res,* vol. 98, pp. 1-9, 07 2017, doi: 10.1016/j.jpsychores.2017.04.014.

[270] D. P. Goldberg and V. F. Hillier, "A scaled version of the General Health Questionnaire," (in eng), *Psychol Med,* vol. 9, no. 1, pp. 139-45, Feb 1979, doi: 10.1017/s0033291700021644.

[271] Medical Research Council., "Questionnaire on respiratory symptoms and instructions for interviewers. ," MRC, 1976.

[272] L. Hurst, M. Stafford, R. Cooper, R. Hardy, M. Richards, and D. Kuh, "Lifetime socioeconomic inequalities in physical and cognitive aging," (in eng), *Am J Public Health,* vol. 103, no. 9, pp. 1641-8, Sep 2013, doi: 10.2105/AJPH.2013.301240.

[273] R. M. Baron and D. A. Kenny, " The Moderator-Mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. ," *Journal of Personality and Social Psychology. 1986,* vol. 51, pp. 1173–1182, 1986.

[274] D. Kuh *et al.*, "Developmental origins of midlife grip strength: findings from a birth cohort study," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 61, no. 7, pp. 702-6, Jul 2006, doi: 10.1093/gerona/61.7.702.

[275] I. R. White, P. Royston, and A. M. Wood, "Multiple imputation using chained equations: Issues and guidance for practice," (in eng), *Stat Med,* vol. 30, no. 4, pp. 377-99, Feb 2011, doi: 10.1002/sim.4067.

[276] A. Bandura, "Social foundations of thoughtand action: A social cognitive theory.," ed: Engle-wood Cliffs, NJ: Prentice-Hall., 1986.

[277] M. Main, N. Kaplan, and J. Cassidy, "Security in infancy, childhood, and adulthood: A move to the level of representation," *Monographs of the Society for Research in Child Development,* vol. *50*, no. (1-2), pp. 66–104, 1985.

[278] R. Duniforn and G. Duncan, "Long term effects of motivation on labor market success," *Social Psychology Quarterly,* vol. 61, no. 1, pp. 33-48, 1988.

[279] H. Goretti, "The impact of poverty on young children's experience of school,"

[280] L. Sutton, N. Smith, Dearden, C., and S. Middleton, "*A child's-eye view of social difference.*," https://www.jrf.org.uk/report/childs-eye-view-social-difference ed. Joseph Rowntree Foundation, 2007.

[281] D. Baumrind, *Rearing competent children.* (*Child development today and tomorrow*). SanFrancisco: Jossey-Bass, 1989.

[282] D. Baumrind, "Current patterns of parental authority," *Developmental Psychology,* vol. 4, no. 1, pp. 1-103, 1971.

[283] B. K. Barber, "Parental psychological control: Revisiting a neglected construct . ," *Child Development,* vol. 6*7*, pp. 3296 – 3319, 1996.

[284] L. Pearlin, *CLASS CONTEXT AND FAMILY RELATIONS: A CROSS-NATIONAL STUDY*. *Boston: Little, Brown*, 1971.

[285] C. Kan, N. Kawakami, and M. Umeda, "Mediating Role of Psychological Resources on the Association Between Childhood Socioeconomic Status and Current Health in the Community Adult Population of Japan," *Int.J. Behav. Med. ,* vol. 22, pp. 764–774, 2015.

[286] R. Caleyachetty *et al.*, "Modeling Exposure to Multiple Childhood Social Risk Factors and Physical Capability and Common Affective Symptoms in Later Life," (in eng), *J Aging Health,* vol. 30, no. 3, pp. 386-407, 03 2018, doi: 10.1177/0898264316680434.

[287] J. W. B. Douglas, "Waste of talent. ," *Advancement Of Science,* vol. 564 1964.

[288] C. Dyhouse, "Students: A gendered history," ed. London and New York: Routledge, 2006.

[289] M. Kohn, "Social class and parental values," *American journal of sociology,* vol. 64, no. 4, 1959.

[290] M. Stafford, D. D, and K. D, "Educational Attainment and Women's Environmental Mastery in Midlife: Findings From a British Birth Cohort Study," vol. 82, ed. The International Journal of Aging and Human Development 2016, pp. 314–335.

[291] B. K. Barber, M. Xia, J. A. Olsen, C. A. McNeely, and K. Bose, "Feeling disrespected by parents: Refining the measurement and understanding of psychological control," *Journal of adolescence,* vol. 35, pp. 273-287, 2012.

[292] A. J. Mackinnon, A. S. Henderson, and G. Andrews, "The Parental Bonding Instrument: a measure of perceived or actual parental behavior?," *Acta Psychiatr Scand,* vol. 83, no. 2, pp. 153-9, Feb 1991.

[293] K. Wilhelm, H. Niven, G. Parker, and D. Hadzi-Pavlovic, "The stability of the Parental Bonding Instrument over a 20-year period," *Psychological medicine,* vol. 35, no. 03, pp. 387-393, 2005.

[294] R. M., "Family, area and school influences in the genesis of conduct disorders " in *Aggression and Anti-social Behavior in Childhood and Adolescence* . , L. A. Hersov, M. Berger, and D. Shaffer Eds. Oxford: Pergamon, 1978, pp. 95–113.

[295] K. Appleyard, B. Egeland, M. H. van Dulmen, and L. A. Sroufe, "When more is not better: the role of cumulative risk in child behavior outcomes," (in eng), *J Child Psychol Psychiatry,* vol. 46, no. 3, pp. 235-45, Mar 2005, doi: 10.1111/j.1469-7610.2004.00351.x.

[296] F. Nyqvist, A. Forsman, and M. Cattan, "A comparison of older workers' and retired older people's social capital and sense of mastery," *Scand J Public Health.* , vol. 41, no. 8, pp. 792-8, 2013.

[297] B. Suanet and T. G. van Tilburg, "Loneliness declines across birth cohorts: The impact of mastery and self-efficacy. ," *Psychology and Aging,* vol. *34*, no. 8, pp. 1134–1143, 2019.

[298] L. I. Pearlin, "The study of the oldest-old: some promises and puzzles," (in eng), *Int J Aging Hum Dev,* vol. 38, no. 1, pp. 91-8, 1994, doi: 10.2190/5VE2-87HW-LR0C-LFDH.

[299] E. Raeifar, A. Halkett, M. C. Lohman, and J. A. Sirey, "The Relation Between Mastery, Anticipated Stigma and Depression Among Older Adults in a Primary

Care Setting," (in eng), *J Nerv Ment Dis,* vol. 205, no. 10, pp. 801-804, 10 2017, doi: 10.1097/NMD.0000000000000686.

[300] J. W. B. Douglas and J. M. Ross, "Characteristics of delinquent boys and their homes. ," in *Genetic and Environmental Influences on Behaviour .* , J. M. Thoday and A. S. Parkes Eds. Edinburgh: Oliver and Boyd, 1968, pp. 114-127.

[301] J. W. B. Douglas, "The environmental challenge in early childhood. ," *Public Health,* vol. 78, pp. 195-202, 1964.

[302] A. Karraker, ""Feeling poor": perceived economic position and environmental mastery among older Americans," (in eng), *Journal of aging and health,* Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't vol. 26, no. 3, pp. 474-94, Apr 2014, doi: 10.1177/0898264314522296.

[303] C. E. Ross, "Marriage and the sense of control. ," *Journal of Marriage and Family,* vol. 51, pp. 831–838, 1991.

[304] B. L. Green and A. Rogers, "Determinants of Social Support Among Low-Income Mothers: A Longitudinal Analysis " *American Journal of Community Psychology,* vol. 29, no. 3, pp. 419-442, 2001.

[305] C. C. Liao, C. J. Yeh, S. H. Lee, W. C. Liao, M. Y. Liao, and M. C. Lee, "Providing instrumental social support is more beneficial to reduce mortality risk among the elderly with low educational level in Taiwan: a 12-year follow-up national longitudinal study," (in eng), *J Nutr Health Aging,* vol. 19, no. 4, pp. 447-53, Apr 2015, doi: 10.1007/s12603-014-0545-x.

[306] A. Y. Farmer and S. K. Lee, "The Effects of Parenting Stress, Perceived Mastery, and Maternal Depression on Parent–Child Interaction," *Journal of Social Service Research,* vol. 37, no. 5, pp. 516-525, 2011.

[307] G. Lee, "Kinship and Social Support of the Elderly: The Case of the United States.," *Ageing and Society,* vol. 5, no. 1, pp. 19-38, 1985.

[308] B. Lakey, T. A. T ardiff, and J. B. Drew, " Negative social interactions: Assessment and relations to social support, cognition, and psychological distress. ," *Journal of Social and Clinical Psychology,* vol. 13, no. 1, pp. 42–62, 1994.

[309] I. Colman, K. Naicker, Y. Zeng, A. Ataullahjan, A. Senthilselvan, and S. B. Patten, "Predictors of long-term prognosis of depression," *CMAJ,* vol. 183, no. 17, pp. 1969-76, Nov 22 2011, doi: 10.1503/cmaj.110676.

[310] T. M. Gadalla, "Sense of mastery, social support, and health in elderly Canadians," (in eng), *J Aging Health,* vol. 21, no. 4, pp. 581-95, Jun 2009, doi: 10.1177/0898264309333318.

[311] R. J. Turner and B. Wheaton, "Checklist measurement of stressful life events," in *Measuring stress: A guide for health and social scientists*, 1995, pp. 29-58.

[312] J. M. Currier, L. E. Jobe-Shields, and S. Phipps, "Stressful life events and posttraumatic stress symptoms in children with cancer," *Journal of traumatic stress,* vol. 22, no. 1, pp. 28-35, 2009.

[313] D. Lascano, G. N., H. Krahn, and M. Lachman, "Growth in Perceived Control Across 25 Years From the Late Teens to Midlife: The Role of Personal and Parents' Education," vol. 51, ed. Developmental Psychology, 2015, pp. 124–135.

[314] S. Robinson and Lachman. M.E., "Perceived Control and Aging: A Mini-Review and Directions for Future Research.," *Gerontology. ,* vol. 63, no. 5, pp. 435-442, 2017.

[315] V. L. Keevil *et al.*, "The physical capability of community-based men and women from a British cohort: the European Prospective Investigation into Cancer (EPIC)-Norfolk study," (in eng), *BMC Geriatr,* vol. 13, p. 93, Sep 2013, doi: 10.1186/1471-2318-13-93.

[316] A. Balachandran and J. F. Signorile, "How to Improve Reporting of the Short Physical Performance Battery Scores," (in eng), *J Gerontol A Biol Sci Med Sci,* vol. 70, no. 12, pp. 1595-6, Dec 2015, doi: 10.1093/gerona/glv161.

[317] D. B. O'Connor and M. Shimizu, "Sense of personal control, stress and coping style: A cross-cultural study.," *Stress and Health: Journal of the International Society for the Investigation of Stress,* vol. 18, no. 4, pp. 173–183, 2002.

[318] G. I. Kempen, J. C. van Haastregt, K. J. McKee, K. Delbaere, and G. A. Zijlstra, "Socio-demographic, health-related and psychosocial correlates of fear of falling and avoidance of activity in community-living older persons who avoid activity due to fear of falling," (in eng), *BMC Public Health,* vol. 9, p. 170, Jun 2009, doi: 10.1186/1471-2458-9-170.

[319] J. M. Guralnik, S. Butterworth, K. Patel, G. Mishra, and D. Kuh, "Reduced midlife physical functioning among never married and childless men: evidence from the 1946 British birth cohort study," (in eng), *Aging Clin Exp Res,* vol. 21, no. 2, pp. 174-81, Apr 2009, doi: 10.1007/bf03325226.

[320] M. Wahrendorf, J. D. Reinhardt, and J. Siegrist, "Relationships of disability with age among adults aged 50 to 85: evidence from the United States, England and continental europe," (in eng), *PLoS One,* vol. 8, no. 8, p. e71893, 2013, doi: 10.1371/journal.pone.0071893.

[321] M. Avendano, M. M. Glymour, J. Banks, and J. P. Mackenbach, "Health disadvantage in US adults aged 50 to 74 years: a comparison of the health of rich and poor Americans with that of Europeans," (in eng), *Am J Public Health,* vol. 99, no. 3, pp. 540-8, Mar 2009, doi: 10.2105/AJPH.2008.139469.

[322] J. Cohen, "A power primer," *Psychological Bulletin,* vol. 112, no. 1, 1992.

[323] L. Yardley and H. Smith, "A prospective study of the relationship between feared consequences of falling and avoidance of activity in community-living older people," (in eng), *Gerontologist,* vol. 42, no. 1, pp. 17-23, Feb 2002, doi: 10.1093/geront/42.1.17.

[324] J. M. Guralnik, L. Ferrucci, E. M. Simonsick, M. E. Salive, and R. B. Wallace, "Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability," (in eng), *N Engl J Med,* vol. 332, no. 9, pp. 556-61, Mar 1995, doi: 10.1056/NEJM199503023320902.

[325] N. Hoeymans, E. J. Feskens, G. A. van den Bos, and D. Kromhout, "Measuring functional status: cross-sectional and longitudinal associations between performance and self-report (Zutphen Elderly Study 1990-1993)," (in eng), *J Clin Epidemiol,* vol. 49, no. 10, pp. 1103-10, Oct 1996, doi: 10.1016/0895-4356(96)00210-7.

[326] L. G. Raaijmakers, M. K. Martens, A. E. Hesselink, I. de Weerdt, N. K. de Vries, and S. P. Kremers, "Mastery and perceived autonomy support are correlates of Dutch diabetes patients' self-management and quality of life," (in eng), *Patient Educ Couns,* Research Support, Non-U.S. Gov't vol. 97, no. 1, pp. 75-81, Oct 2014, doi: 10.1016/j.pec.2014.06.016.

[327] D. Kuh, R. Cooper, R. Hardy, R. Richards, and Y. Ben-Shlomo, *A life course approach to healthy ageing.* Oxford University Press, 2014.

[328] C. Faircloth, "Intensive Parenting and the Expansion of Parenting," in *Parenting Culture Studies.* . London: Palgrave Macmillan, 2014.

[329] A. Kalil, K. Ziol-Guest, R. M. Ryan, and A. Markowitz, "Changes in Income-Based Gaps in Parent Activities With Young Children From 1988 to 2012.," *<i data-aura-rendered-by="886:0" style="box-sizing: border-box; color: rgb(68, 68, 68); font-family: futura-pt, 'Helvetica Neue', Helvetica, Arial, 'Lucida Grande', sans-serif; font-size: 16.25px;">AREA Open,* vol. 2, no. 3, 2016).

APPENDIX A

Table A.1 Missing data summary of study members: with complete mastery (chapters 3-4); with complete physical capability and mastery (chapters 5-6)

Variable	Mastery age 68-9 n=2337 (chapter 3 and 4)		Mastery + Physical capability age 69-70 N= 1727 (chapter 5 and 6)	
	with data	% no data	with data	% no data
Maternal education age 6	2062	12	-	
Paternal occupation age 4	2215	5	-	
Material home conditions age 2-11	1874	20	-	
Cognitive ability age 8-15	2163	7	-	
SLEs age 0 -15	2132	9	-	
Perceived psychological control before 16 years (recalled age 43)	2087	11	-	
Perceived parental support (“)	2107	10	-	
Perceived behavioural control (“)	2072	11	-	
Education age 26	2212	5	-	
Occupational position age 53	2301	2	1720	0
Income perception age 68 -9	1876	20	-	
Income band age 68 -9	1753	25	-	
Cognitive function age 68-9	1555	33	-	
SLEs between ages 26 -68-9	1398	40	-	
Positive social support age 68-9	2271	3	-	
Negative social support 68-9	2259	3	-	
Depressive symptoms 68-9	1850	21	1691	2
Cardiovascular disease	2324	1	1726	0
Respiratory difficulties	2169	7	1599	7
Osteoarthritis	1920	18	1726	0
Diabetes	2331	0	1727	0
Smoking status age 68-9	-		1607	7
Leisure time physical activity age 68-9	-		1603	7
BMI age 69-70	-		1721	0
Fear of falling age 68-9	-		1578	9
Height age 69-70	-		1725	0
Note: Missing data patterns examined in relevant samples only				

APPENDIX B

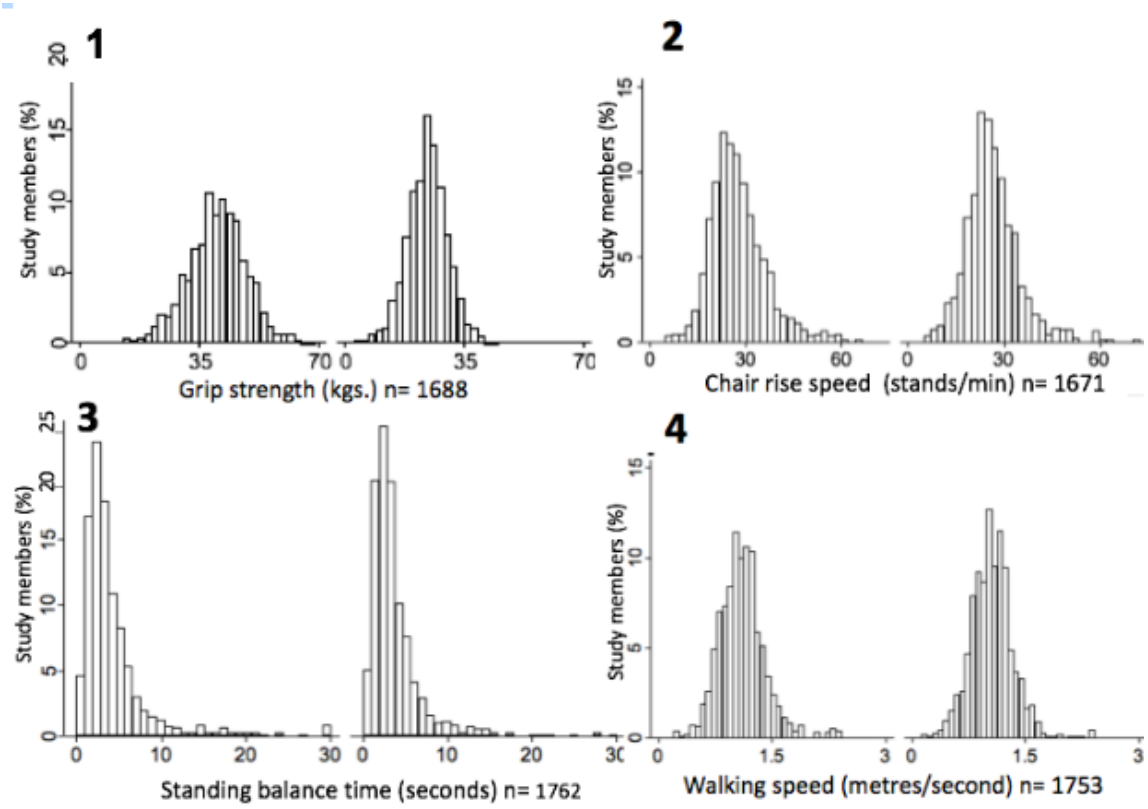

Figure B.1**.** Distribution times of sex-stratified performance scores for 1) Grip strength; 2) Chair rise; 3) Standing balance 4) Walking speed (All: left = men, right = women).

Table B.1 Proportion of study members with each individual functional limitation at age 69-70; (%) yes (limitations) or no limitations

	Gripping		Reaching		Bending		Balancing		Walking flat		Walking stairs	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Total	69	31	90	10	84	16	86	14	88	12	82	18
Men	83	17	91	9	87	13	89	11	90	10	85	15
Women	62	38	88	12	81	19	83	17	87	13	79	21
P [a]	<0.01		0.1		<0.01		<0.01		0.1		<0.01	

Note: Sample includes those with data for each individual measure + mastery + physical capability at age 69-70 (maximum n= 1727). [1]Total numbers vary due to missing data. [a] P value describes overall test of association. Percentages rounded to 0 decimal places.

Table B.2. Distribution of physical capability across mastery quartile in study members with complete data[a]				
	Low mastery Q1 = 8-19 score	Mastery Q2 =20-21 score	Mastery Q3 = 22-25	High mastery Q4 = 25-28
	Mean (std)	Mean (std)	Mean (std)	Mean (std)
Physical performance	1.65 (0.43)	1.78 (0.38)	1.80 (0.36)	1.89 (0.38)
P[b]	<0.001			
P[c]	<0.001			
Functional limitations	Proportion (%)	Proportion (%)	Proportion (%)	Proportion (%)
0	37.83	55.76	52.73	67.88
1	25.27	27.19	28.03	22.87
2	14.24	7.83	9.03	4.87
3	8.88	3.92	6.65	2.43
4-6	13.79	5.30	3.57	1.95
P[b]	<0.001			

Note: Study members include those with data for each individual measure + mastery + physical capability at age 69-70 (maximum n= 1727). [a] Total numbers vary due to missing data. Q denotes quartile. [b] P value describes overall test of association. [c] P value describes test of trend

Table B.3. Individual physical performance scores across potential confounders in study members with complete data[1]

	Chair rises(stands /min)		Standing balance (s)		Walking speed (m/s)		Grip (kg)			
	n	Total	n	Total	n	Total	n	Men	n	Women
Total	1727	26.9 (8.5)	1983	2.98 (1.91-4.36)	1981	1.08 0.29	1037	40.19 (8.5)	1066	24.07 (5.8)
Men	926	27.5 (8.6)	980	2.91 (1.91- 4.36)	954	1.10 0.30				
Women	975	26.3 (8.3)	1003	3.03 (2.02-5.00)	1027	1.05 0.28				
P[a]		<0.05		<0.05		<0.001	<0.0001			
Occupational position										
I Professional	167	29.5 (9.0)	173	3.24 (2.09- 5.43)	167	1.19 (0.29)	148	41.6 (7.5)	24	25.8 (3.8)
II Managerial/tech	762	27.2 (8.4)	801	3.15 (2.06-5.03)	762	1.10 (0.31)	431	40.9 (8.9)	404	24.8 (5.7)
III Skilled(NM)	456	26.8 (8.2)	476	2.87 (1.91- 4.15)	456	1.06 (0.27	108	39.6 (7.8)	391	23.7 (5.6)
IIIM Skilled manual	320	25.5 (8.0)	321	2.60 (1.62- 4.0)	300	1.04 (0.27)	254	38.87 (7.7)	68	23.23 (6.0)
IV Partly skilled	180	25.5 (7.6)	174	2.47 (1.79-3.97)	180	1.02 (0.28	69	39.7 (7.7)	133	23.6 (6.2)
V Unskilled	53	27.2 (11.0)	54	3.22 (1.81-4.43)	53	0.97 0.32	19	37.3 (7.5)	45	21.3 (6.9)
P[a]		<0.001		<0.0001		<0.001		<0.01		<0.001
P[b]		<0.001		<0.001		<0.001		<0.001		<0.001
CVD										
Yes	229	25.1 (9.1)	226	2.51 (1.73-4.25)	248	1.00 (0.30)	164	37.5 (9.10)	97	22.8 (6.6)
No	1671	27.1 (8.3)	1755	3.00 (2.00-4.69)	1731	1.08 (0.29)	871	40.6 (8.29)	969	24.20 (5.7)
P[a]		<0.001		<0.01		<0.0001		<0.0001		<0.05
Respiratory difficulties										
Yes	362	25.4 (8.3)	370	3.02 (2.00- 4.73)	362	1.0 (0.3)	209	39.6 (8.65)	202	23.5 (5.9)
No	1264	27.5 (8.3)	1334	2.87 (1.87-4.47)	1264	1.1 (0.2	660	40.4 (8.38)	729	24.4 (5.6)
P[a]		<0.0001		0.15		<0.0001		0.20		<0.05
Osteoarthritis										
Yes	384	25.6 (9.1)	391	2.79 (1.81-4.37)	410	1.0 (0.3	169	38.1 8.93	271	22.6 (6.0)
No	1516	27.2 (8.30)	1588	3.00 (2.00- 4.72)	1567	1.1 (0.3	867	40.5 8.36	792	24.5 (5.6)
P[a]		<0.01		<0.05		<0.001		<0.001		<0.0001
Diabetes										
Yes	191	24.3 (7.9)	199	2.47 (1.62-3.75)	203	0.9 (0.3	129	38.3 8.68	101	21.8 (5.9)
No	1705	27.1 (8.4)	1776	3.03 (2.00- 3.75)	1770	1.1 (0.3	905	40.4 8.45	961	24.3 (5.7)
P[a]		<0.0001		0.0023		<.0001		<0.005		<0.0001

Note: Study members are those with data for each individual measure + mastery + physical capability at age 69-70 (n= 1727) [1] Total numbers vary due to missing data. [a]P value tested using one-way ANOVAs (differences in balance performance with Kruskal- Wallis testing).[b]Trend of trend using linear regression.

Table B.4. Individual physical performance across potential mediators in study members with complete data[1]

	Chair rises (stands/min)		Standing balance (seconds)		Walking speed (m/s)		Grip (kg)			
Smoking	N	Total	N	Total	N	Total	N	Men	N	Women
Current	159	24.17 7.92	163	1.28 (1.00-1.60)	159	0.98 (0.27)	86	38.47 (9.16)	83	24.17 (6.)
Ex	1119	26.35 (8.88)	1183	1.35 (1.03- 1.68)	1125	1.05 (0.30)	627	40.22 (8.60)	562	23.65 (5.9)
Never	575	27.02 8.15	606	1.36 (0.98- 1.73)	580	1.09 (0.31)	254	40.19 8.19	352	24.27 (5.6)
P [a]		<0.01		0.34		<0.01		<0.01		<0.01
P [b]		< 0.01		0.26		<0.001		0.22		0.10
LTPA										
Inactive	976	25.61 7.99	1013	2.81 (1.85-4.24)	1029	1.03 0.28	535	39.40 8.50	568	23.6 6.0
Moderate	238	27.49 7.05	258	3.12 (2.18-4.96)	244	1.09 0.26	112	41.5(8.3	145	25.4 5.3
Regular	523	29.52 8.86	547	3.31 (2.15-5.44)	533	1.17 0.30	284	41.0 8.5	276	24.7 5.4
P [a]		<0.01		<0.01		<0.01		<0.01		<0.05
P [b]		<0.01		<0.01		<0.01		<0.05		<0.01
Fear of falling										
None	1337	27.53 (8.44)	1412	1.39 (1.08-1.75)	1345	1.09 (0.29)	763	40.59 (8.4)	650	24.7 (5.5)
+ no restriction	145	24.39 (6.65)	145	1.25 (1.00-1.62)	145	1.03 (0.29	41	39.72 (8.84)	107	23.8 (6.1)
+ mild restriction	176	22.72 (7.85)	186	1.12 (0.72-1.42)	176	0.94 (0.28)	49	36.36 (9.48	130	22.4 (5.6
+severe restriction	34	18.66 (6.67)	37	0.81 (0.67 - 1.38)	37	0.78 (0.21	10	34.69 (7.96	25	21.5 (7.1)
P [a]		<0.01		<0.01		<0.01		<0.01		<0.01
P [b]		<0.01		<0.01		<0.01		<0.01		<0.01
BMI kg/m^2										
Underweight -18	11	26.51(8.02	11	1.42(0.56)	11	1.03(0.33)	6	19.41(6.19)	5	35.7(8.63
Normal 18-	556	28.13(8.35)	597	1.5(0.60)	557	1.12(.29	340	24.12(5.38)	258	39.8(8.48
Overweight 26-	816	26.71(8.43)	856	1.41(0.56)	821	1.08(0.31)	400	24.54(6.08)	463	40.1(8.42
Obese 30-	430	25.258.26)	448	1.25(.52)	437	0.98(0.26)	214	23.62(5.78)	238	41.1(8.96)
Severe obese 35+	176	22.26(6.88)	184	1.05(4.9	183	0.88(0.26)	114	22.27(6.21)	72	38.5(7.13)
P a		<0.01		<0.01		<0.01		<0.01		0.09

Note: Study members are those with data for each individual measure + mastery + physical capability at age 69-70. [1] Total numbers vary due to missing data. [a] P value tested using one-way ANOVAs (differences in balance performance with Kruskal- Wallis testing).[b] Trend of trend across more than two categories using linear regression.

Table B.5. Prevalence individual functional limitations across potential confounders, in study members with complete data [1]												
	Gripping (%)		Reaching (%)		Bending (%)		Balance (%)		Walking flat (%)		Walking stairs (%)	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Total	69.3	30.6	89.6	10.3	83.20	16.80	85.91	14.09	88.1	11.8	82.0	17.97
Occupational position												
I Professional	81.92	18.06	96.1	3.9	94.3	5.6	92.66	7.34	95.4	4.52	93.7	6.21
II intermediate	71.49	28.50	91.5	8.4	86.0	14.0	87.38	12.62	91.32	8.68	84.2	15.74
III NM skilled	63.93	36.07	91.4	8.5	81.6	18.3	86.45	13.55	88.55	11.45	82.06	17.94
IIIM M skilled	71.43	28.57	87.2	12.7	79.3	20.6	86.02	13.98	82.37	17.63	78.42	21.58
IV partly skilled	61.79	38.09	80.28	19.7	75.3	24.6	76.53	23.47	84.51	15.49	76.06	23.94
V unskilled	63.89	36.11	77.78	22.2	72.2	27.7	73.61	26.39	72.22	27.78	61.97	38.03
P [a]	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
P [b]	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
Cardiovascular disease												
Yes	62.96	37.0	81.1	18.8	69.2	30.74	74.91	25.09	73.06	26.94	64.58	35.42
No	70.26	29.7	90.8	9.11	85.1	14.8	87.45	12.55	90.27	9.73	84.52	15.48
P [a]	<0.05		<0.01		<0.01		<0.01		<0.01		<0.01	
Respiratory difficulties												
Yes	62.16	37.8	83.0	16.9	78.7	21.2	77.80	22.20	80.32	19.68	73.74	26.26
No	72.12	27.8	92.7	7.23	85.8	14.2	89.19	10.81	92.07	7.93	85.11	14.89
P [a]	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
Osteoarthritis												
Yes	47.2	52.8	85.5	14.4	71.1	28.8	76.51	23.49	78.45	21.55	66.31	33.69
No	75.4	24.5	90.9	9.01	86.5	13.4	88.62	11.38	90.94	9.06	86.42	13.58
P [a]	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	<0.001
Diabetes												
Yes	67.1	32.7	82.1	17.8	70.8	29.1	73.28	26.72	78.54	21.46	66.40	33.60
No	69.6	30.3	90.6	9.36	84.7	15.2	87.51	12.49	89.36	10.64	84.01	15.99
P [a]	0.43		<0.01		<0.01		<0.01		<0.01		<0.01	

Note: Study members are those with data for each individual covariate + mastery + physical capability at age 69-70. [1] Total numbers vary due to missing data. [a] P value tested using chi-squared tests [b] Trend of trend using logistic regression

Table B.6. Prevalence individual functional limitations across each potential mediator, in study members with complete data[1]

	Gripping (%)		Reaching (%)		Bending (%)		Balance (%)		Walking flat (%)		Walking stairs (%)	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Current smoker	70.29	29.71	93.71	6.29	80.00	20.00	84.00	16.00	80.57	19.43	78.86	21.14
Ex smoker	69.53	30.47	87.51	12.49	82.60	17.40	85.39	14.61	87.76	12.24	80.80	19.20
Never Smoked	70.00	30.00	92.58	7.42	85.99	14.01	88.24	11.76	91.47	8.53	85.19	14.81
P [a]	0.97		<0.01		0.08		0.17		<0.01		<0.05	
P [b]	0.96		0.16		< 0.01		0.07		<0.01		<0.05	
LTPA												
Inactive	67.30	32.69	88.10	11.90	78.70	21.30	82.90	17.10	85.07	14.93	76.72	23.29
Moderate	68.82	31.80	94.68	5.24	89.35	10.65	88.97	11.03	94.30	5.70	87.83	12.17
Regular	75.61	24.39	93.33	6.67	92.63	7.37	92.28	7.72	95.09	4.91	91.42	8.58
Inactive	67.30	32.69	88.10	11.90	78.70	21.30	82.90	17.10	85.07	14.93	76.72	23.29
P [a]	<0.05		<0.01		<0.01		<0.01		<0.01		<0.01	
P [b]	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
Fear of falling												
None	74.74	25.26	80.6	19.32	88.44	11.56	92.16	7.84	92.64	7.36	87.56	12.44
+ no restriction	56.29	43.71	92.9	7.02	74.83	25.17	75.50	24.50	87.42	12.58	76.67	23.33
+ mild restriction	46.03	53.97	78.8	21.16	71.43	28.57	66.14	33.86	75.66	24.34	57.67	42.33
+ severe restriction	38.10	61.90	53.4	46.51	30.95	69.05	30.23	69.77	37.21	62.79	27.91	72.09
P [a]	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
P [b]	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	

Note: Study members are those with data for each individual covariate + mastery + physical capability at age 69-70 (n=1727) . [1] Total numbers vary due to missing data. [a] P value tested using chi 2 tests [b] Trend of trend using logistic regression

Table B.7 Individual linear regression models testing associations between mastery and physical performance scores					
	Grip strength (kg)		Chair rise speed (stands/ m)	Balance (s)	Walking (m/s)
	Unstandardised regression estimates (95% CI)				
	Men	Women			
M1 Mastery+ sex	0.42 (0.26, 0.57)	0.27 (0.17, 0.37)	0.42 (0.30, 0.53)	0.02(0.01, 0.02)	0.01 (0.01, 0.02)
M2+ covariates	0.33 (0.16, 0.51)	0.39 (0.24, 0.54)	0.43 (0.31, 0.54)	0.01 (0.00, 0.02)	0.01 (0.01, 0.01)
Notes: Based on n= 1727 study members using multiple imputation by chained equations; Unstandardised regression estimates represent mean difference in physical performance scores at age 69=70 using linear regression models. M1 sex adjusted. M2 + adjusted for occupational position, height, chronic health conditions and depressive symptoms.					

Table B.8. Individual logistic regression models testing associations between mastery and each functional limitation							
	Gripping	Reaching	Bending	Balancing: men	Balancing: women	Walking flat	Walking stairs
	OR(95% CI)	OR(95% CI)	OR(95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
M1 Mastery + sex	0.9(0.9,0.9)	0.8(0.8, 0.8)	0.8(0.8, 0.9)	0.7 (0.7, 0.8)	0.8 (0.8, 0.9)	0.8 (0.7, 0.8)	0.8(0.8, 0.9)
M2 Mastery + covariates	0.9(0.9, 1.0)	0.9(0.8, 0.9)	0.9(0.9, 0.9)	0.8 (0.8, 0.9)	0.9 (0.8,1.0)	0.9 (0.8, 0.9)	0.9(0.9, 0.9)
M3 + LTPA	0.9(0.9, 1.0)	0.9(0.9, 1.0)	0.9(0.9, 0.9)	0.8 (0.8, 0.9)	0.9 (0.8,1.0)	0.8 (0.8, 0.9)	0.9 (0.8, 0.9)
M4 + BMI	0.9(0.9, 1.0)	0.9(0.8, 0.9)	0.9(0.9, 1.0)	0.8 (0.8, 0.9)	0.9 (0.9,1.0)	0.9 (0.8, 0.9)	0.9(0.9,0.9)
M5 + Fear of falling	0.9(0.9, 1.0)	0.9(0.9, 1.0)	0.9(0.9, 1.0)	0.8 (0.8, 0.9)	0.98 (0.9,1.0)	0.9 (0.8,0.9)	0.9 (0.9,1.0)
M6+mutually adjusted	0.9(0.9, 1.0)	0.9(0.9, 1.0)	0.9(0.9, 1.0)	0.8(0.8, 0.9)	0.9 (0.9,1.0)	0.9(0.8, 0.9)	0.9(0.9,0.9)
Notes: Based on n= 1727 study members using MICE; Incident rate ratios represent the incidence of functional limitations per unit increase in mastery using poisson regression models. M1 sex adjusted. M2 + adjusted for occupational position, height, chronic health conditions and depressive symptoms.							

APPENDIX C

Table C.1. Association between each performance score and functional limitation

	Sex-adjusted OR (95% CI) for functional limitations					
	Gripping	Reaching	Bending	Balance	Walking flat	Walking stairs
Performance scores						
Grip strength	0.8 (0.8,0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)
Chair rises	0.9 (0.9,0.9)	0.9 (0.9, 0.9)	0.8 (0.8,0.9)	0.8 (0.8,0.9)	0.8 (0.8,0.9)	0.8 (0.8,0.9)
Standing balance	0.6 (0.5,0.7)	0.5 (0.4, 0.8)	0.4 (0.3,0.6)	0.3 (0.2, 0.4)	0.3 (0.2, 0.4)	0.3 (0.2, 0.4)
Walking speed	0.4 (0.3,0.7)	0.1 (0.1,0.3)	0.6 (0.0,0.1)	0.6 (0.0,0.1)	0.0 (0.0,0.0)	0.2 (0.1,0.4)

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Odds ratios represent the odds of limitations in each functional limitation item per 1 unit increase in physical performance score at age 69-70 using separate sex-adjusted logistic regression models.

Table C.2 Interaction between mastery and its effect on each physical performance and each functional limitation

	Sex-adjusted OR (95% CI)					
	Gripping	Reaching	Bending	Balance	Walking flat	Walking stairs
Grip strength	0.9(0.8,1.0)	0.9(0.8,1.0)	0.9(0.8,1.0)	1.0(0.9,1.0)	0.9(0.8, 1.0)	0.9(0.8, 1.0)
Mastery	1.0(0.8, 1.0)	0.8(0.7, 0.9)	0.9(0.7, 1.0)	0.9(0.9, 1.0)	0.9(0.9, 1.0)	0.9(0.8, 1.0)
Grip strength x mastery	1.0(0.9, 1.0)	1.0(0.9, 1.0)	1.0(0.9, 1.0)	0.9(0.9, 0.9)	0.9(0.9, 1.0)	0.9(0.9, 1.0)
P-value for interaction	0.3	0.7	0.9	<0.05	0.3	0.8
Chair rise speed	0.9(0.8, 1.0)	0.9(0.8, 1.1)	0.9(0.8, 1.0)	0.9(0.8, 1.1)	0.9(0.8, 1.2)	0.9(0.8, 1.0)
Mastery	0.9(0.8, 1.0)	0.8(0.7, 0.9)	0.9(0.8, 1.1)	0.8(0.8, 1.1)	1.0(0.8, 1.2)	1.0(0.8, 1.0)
Chair rise x mastery	1.0(0.9, 1.0)	1.0(0.9, 1.0)	0.9(0.9, 1.0)	0.9(0.9, 1.0)	0.9(0.9, 1.0)	0.9(0.9, 1.0)
P-value for interaction	0.3	0.2	0.8	0.8	0.1	0.1
Standing balance	0.2(0.1,0.8)	0.5(0.6,3.3)	0.4(0.8,2.1)	0.2(0.0,1.1)	0.2(0.0,1.3)	0.2(0.0,1.4)
Mastery	0.8(0.8,0.9)	0.8(0.7,0.9)	0.9(0.8,0.9)	0.8(0.7,0.9)	0.8(0.7,0.9)	0.9(0.8,0.9)
Standing balance x mastery	1.1 (0.9,1.1)	1.0 (0.9,1.1)	1.0 (0.9,1.1)	1.0 (0.9,1.1)	1.0 (0.9,1.1)	1.0(0.9,1.1)
P-value for interaction	0.1	0.7	0.8	0.5	0.5	0.8
Walking speed	0.3(0.0, 3.6)	0.0(0.0, 0.4)	0.0(0.0, 0.7)	0.2(0.0, 10.2)	0.0 (3.0,0.0)	0.0(0.0, 0.7)
Mastery	0.9(0.8,1.0)	0.7(0.6,0.8)	0.8(0.6,0.9)	0.9(0.7,1.1)	0.7(0.5,0.9)	0.8(0.7,0.9)
Walking speed x mastery	1.0(0.9, 1.2)	1.3(1.1, 1.6)	1.2(1.0, 1.4)	0.9(0.8, 1.2)	1.2(0.9, 2.3)	1.1(0.9, 1.3)
P-value for interaction	0.6	<0.05	<0.05	0.5	0.1	0.1

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Odds ratios represent the odds of limitations in each functional limitation item per 1 unit increase in physical performance score at age 69-70 using separate sex-adjusted logistic regression models. P^a = sex-adjusted test of interaction.

Table C.3 Association between each individual physical performance item, each functional limitation and difficulties with ADLs at age 69-70

	Activities of daily living (4 levels of severity) No difficulties Difficulties Difficulties + uses aids Difficulties + uses aids and/or personal care
Physical performance items	Sex adjusted OR (95% CI)
Grip strength per kg	0.90 (0.88, 0.93)
Chair rise speed per stand/minute	0.85 (0.82, 0.88)
Standing balance time per second	0.28 (0.21, 0.40)
Walking speed per m/s	0.02 (0.0, 0.05)
Functional limitations (reference, none)	
Gripping	3.84 (2.66, 5.55)
Reaching	7.49 (4.95, 11.34)
Bending	9.79 (6.80, 0.10)
Balancing	7.79 (5.36, 11.34)
Walking flat	15.42 (10.37, 22.91)
Walking stairs	14.59 (9.99, 21.31)

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Odds Ratio represent the likelihood of each additional severity level of ADL difficulties per I unit increase in exposure using ordinal logistic regression.

Table C.4. Interaction between mastery and its effect on each physical performance score and ADLs from ordinal logistic regression models

	Activities of daily living (4 levels of severity) No difficulties Difficulties Difficulties + uses aids Difficulties + uses aids and/or personal care
Physical performance items	Sex adjusted OR (95% CI)
Grip strength	0.89 (0.79, .99
Mastery	0.84 (0.72, .96
Grip strength x mastery	1.00 (0.99, 1.00)
P-value for interaction	0.6
Chair rise speed	0.94 (0.80, 1.11)
Mastery	0.96 (0.81, 1.15)
Chair rise speed x mastery	0.99 (0.98, 1.00)
P-value for interaction	0.3
Standing balance	0.32 (0.04, 2.57)
Mastery	0.86(0.77, 0.97)
Standing balance x mastery	0.99 (0 .90, 1.10)
P-value for interaction	0.9
Walking speed	0.00 (0.00, 0.18)
Mastery	0.77 (0.64, 0.94)
Walking speed x mastery	1.13 (0.92, 1.39)
P-value for interaction	0.2

Notes: Based on n= 1727 study members using multiple imputation by chained equations; Odds Ratio represent the likelihood of each additional severity level of ADL difficulties per I unit increase in exposure (modelled continuously) using ordinal logistic regression. P= sex-adjusted test of interaction.

Table C.5 Interaction between mastery and its effect on each functional limitation and ADLs from ordinal logistic regression models	
	Activities of daily living (4 levels of severity) No difficulties Difficulties Difficulties + uses aids Difficulties + uses aids and/or personal care
Functional limitations	Sex adjusted OR (95% CI)
Gripping	3.82 (0.47, 30.64)
Mastery	0 .86 (0.79,0.92)
Gripping x mastery	0 .99 (0.90, 1.10)
P-value for interaction	0.9
Reaching	18.12(1.67, 196.1)
Mastery	0 .88(0.83, 0.93)
Reaching x mastery	0.94(0.84, 1.06)
P-value for interaction	0.3
Bending	41.65(4.81, 360.54)
Mastery	0.90 (0 .84, .97)
Bending x mastery	0.92 (.83,1.02)
P-value for interaction	0.1
Balance	19.65 (2.25,171.48)
Mastery	0.89 (0.84, 0.95)
Balance x mastery	0.94 (0.85, 1.05)
P-value for interaction	0.3
Walking flat	6.25 (0.68, 56.74)
Mastery	0.86 (0.81,0.92)
Walking flat x mastery	1.03 (0.93, 1.15)
P-value for interaction	0.4
Walking stairs	35.0 (3.89, 330)
Mastery	0.91 (0.84, 0.99)
Walking stairs x mastery	0.95(0.86, 1.05)
P-value for interaction	0.3
Notes: Based on n= 1727 study members using multiple imputation by chained equations; Odds Ratio represent the likelihood of each additional severity level of ADL difficulties per reference category of exposure using ordinal logistic regression.	