WIDER BENEFITS OF LEARNING RESEARCH REPORT NO. 6

Quantitative Estimates of the Social Benefits of Learning, 2: Health (Depression and Obesity)

Leon Feinstein

Centre for Research
on the Wider
Benefits of Learning

QUANTITATIVE ESTIMATES OF THE SOCIAL BENEFITS OF LEARNING, 2: HEALTH (DEPRESSION AND OBESITY)

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Executive Summary

1. In this report, information from the latest UK national cohorts is used to estimate the magnitude of the effects of learning on two important aspects of health. The members of these two cohorts were most recently surveyed in 1999/2000 when those in the 1970 Cohort were aged 33 and those in the 1958 cohort were aged 42.
2. Education is an important risk factor for health outcomes. Some of the risk is not caused by education but related to childhood abilities, health and family background. This report, however, establishes what appear to be robust *effects* of learning on obesity and depression.
3. For example, taking into account childhood abilities, health and family background factors, it is estimated that the effect on the probability of depression for women going from no qualifications to an academic Level 1 qualification is a reduction in the likelihood of depression of between 6 and 10 percentage points. For men, the effects are weaker, although a degree benefit of 6 points is estimated for the younger sample considered.
4. The effects of learning on the probability of obesity are not strong. The primary exception is in the transition for men from no qualifications to having Level 1 academic qualifications for which the resulting benefit was a 5 point drop in the probability of obesity for the 1958 cohort and 7 points for the 1979 cohort. In addition, women in the 1958 cohort gaining Level 1 qualifications benefited with a 5 point drop in the probability of obesity.
5. There is considerable evidence that the public economic costs of depression to the UK economy are much higher than is commonly believed. A conservative estimate was made in 1993 that the cost was £3 billion per annum, based on NHS costs and the cost of lost working hours. The cost of mental ill health overall has been estimated to be 11 times this figure.
6. A similar study for obesity established a conservative public cost of £2.6 billion.
7. The effects of education on health estimated in this report have been linked to this cost information, in order to make first steps in the job of costing the health benefits of learning.
8. This requires a great number of assumptions and this level of underlying uncertainty must be borne in mind when interpreting the results of this study. These results are thought of as indicative only.
9. These assumptions are discussed in the concluding section of the text and referred to throughout the report. Key assumptions are:

i) that the estimation method deals with the main sources of bias;

ii) that there are no important age and cohort effects;

iii) that costs are well estimated and;

iv) that it is safe to ignore general equilibrium implications for the wider economy.

10. A simulation is made of the effect on health of a number of interventions. For example, an estimation is made of the economic benefit in terms of reduced risks of depression of an educational intervention that enabled 10% of women who would otherwise gain no qualifications to progress to Level 1 equivalent academic qualifications. The resulting gain is estimated to be between £6 million and £34 million per year[1]. This ignores all other benefits or personal and family costs associated with depression.

11. If all aspects of mental health were similarly affected and the intervention raised 50% of women with no qualifications to Level 1 academic qualifications, the benefit would be between £300 million per annum and nearly £1,900 million.

12. To conclude, although the estimates should not be seen as precise, the general finding that there are substantial health returns to learning is robust.

13. The findings are that the sizable differences in health observed for those with different levels of education are partially due to the effects of education and are not due solely to differences that precede or explain education. Moreover, these differences in health outcomes are important from a perspective of public finance as well as in terms of equity and wider social well-being.

[1] This range allows for a 90% confidence interval on the effect estimate.

Preface

The Centre for Research on the Wider Benefits of Learning was established in 1999 by the then Department for Education and Employment to investigate the non-pecuniary benefits that learning brings to the individual learner and to society as a whole. The wider benefits of learning represent a new and exciting topic of study. There is considerable uncertainty about the effects of learning, but a widely held belief that many aspects of life are improved by education, with considerable plausible benefits for the economy. There is, however, little evidence so far to support these hypothesised benefits and the evidence that exists is disparate, concerns widely different aspects of learning, based on different measures of learning, through different kinds of channel, in different kinds of areas.

An earlier Learning Paper from the Centre for Research on the Wider Benefits of Learning (Schuller et al., 2001) considered the benefits of learning across a very wide range of domains of potential benefit, in terms of crime, health, parenting, ageing and social cohesion. Both quantitative and qualitative evidence was reviewed in order to provide an overview of available evidence, and to suggest a conceptual framework for future investigations. This report is part of a different, though related, strand of research at the Centre, a strand whose objective is to provide and evaluate evidence on the quantifiable benefits of learning for the purposes of future spending reviews and to meet other cost–benefit requirements of the Department for Education and Skills.

This report will focus on health, describing in more detail the available robust quantitative evidence and modelling the cost implications of this evidence. The report draws on the framework provided by Schuller et al. but is more specific about the kind of evidence described. It goes further, too, in drawing out the implications of the evidence for Government spending decisions.

A sister report considers and costs the quantitative evidence for crime benefits (Feinstein, 2002). Future papers will return to the evidence investigated here and develop new evidence. Taken together, these pieces of research represent an attempt to map out the effects of learning beyond personal wage and employment returns and to estimate the magnitudes of the resulting social and personal benefits.

However, it should be emphasised that the programme of research is still at a very early stage. The analysis presented here is intended as an indication of one strand of the work being undertaken at the Centre and to show the nature of some preliminary results. Hopefully it will inspire discussion, but it should not be considered to be sufficiently robust or developed to stand without strong caveats.

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1. Introduction and caveats

In this paper, attempts are made to test whether observed associations between depression and obesity on the one hand, and academic and vocational qualifications on the other, are due to selection effects and the unobserved advantages of those that gain higher qualifications. The alternative hypothesis is that they are due to the effects of the education reflected in the qualifications or to benefits resulting in other ways from the qualifications. Attempts are made to test these hypotheses to establish whether there is evidence that the observed differences in health outcomes between those with different levels of education are due to education or not. Attempts are also made to link these estimation results to information about the social costs of poor health to provide very preliminary and broad indications of the possible health related, exchequer and social benefits of improved education.

Future analyses on this topic will consider the importance of the mediating factors that are the channels for education effects, including the relative contributions of income and family life. For now, however, in this preliminary estimation, limitations will be set to a brief sketch of econometric results, an analysis of the likely effects of education without considering the channels for the estimated relations. Future analyses will also consider in more detail the results and inferences from different estimation methods with different specifications.

A further qualification to be made is to recognise the dangers of appraisal, evaluation or cost–benefit analysis. These are discussed briefly in the introduction to the sister report to this one (Feinstein, 2002) and more intensively in an earlier Learning Paper from the Centre for Research on the Wider Benefits of Learning (Plewis & Preston, 2001). While recognising that taken out of context or misinterpreted, the search to put a monetary value on complex aspects of individuals' lives can lead to erroneous conclusions, it is important for Government spending departments to provide a guide to the potential Treasury savings resulting from policy interventions. To support these discussions with the Treasury it is helpful for departments to have some evidence based guide to the plausible bounds of policy effects. While not claiming that the results presented in this paper provide more than preliminary explorations about the effects of education on the two aspects of health considered, hopefully they also provide some initial guide as to the kinds of effects that policies undertaken by one department can have on the demands placed on another.

One final caveat is to point out that although the term 'learning' refers to an extremely broad set of potential educational experiences and interventions, this report only considers the effects of academic and vocational training reflected in the qualifications gained. This limitation is not driven by any theoretical or ethical consideration but by simple empirical necessity — the readily available data. Future work will consider the effects of broader kinds of learning including non-certified learning experiences.

It should also be pointed out that, for simplicity, the terms ‘education’, ‘schooling’ and ‘learning’ are sometimes used without clear demarcation or discussion of the precise differences in meaning except where necessary for precision. The distinctions are important but better dealt with elsewhere.

Section 2 will describe the overall picture or jigsaw puzzle of the wider benefits of learning with respect to health. Section 3 will summarise and cost the quantified evidence, i.e.; put into place the available pieces of this section of the puzzle. Section 4 presents new evidence for a robust link between education and health, and it describes the methodology. Section 5 links this evidence to estimates of the social and personal costs of ill health to provide rough and initial estimates of the costed health benefits of education.

2. The links: theory

There are a number of reasons why education and other learning interventions may have an effect on health[2]. Some of these effects are direct, through changes in behaviour or preferences; others indirect, through resulting changes in opportunities, particularly through income. This section, therefore, clarifies the links that have been hypothesised and indicates the relative strength of evidence available for each of these links.

It is important to recognise that a simple correlation between education and health may mask a number of possible effects that may not be due to education. This section, therefore, describes the possible confounding factors so as to clarify the extent to which even multivariate analyses may mislead. Section 3 provides the detailed evidence.

2.1 Channels

An important recent review (Ross & Mirowsky, 1999) concluded:

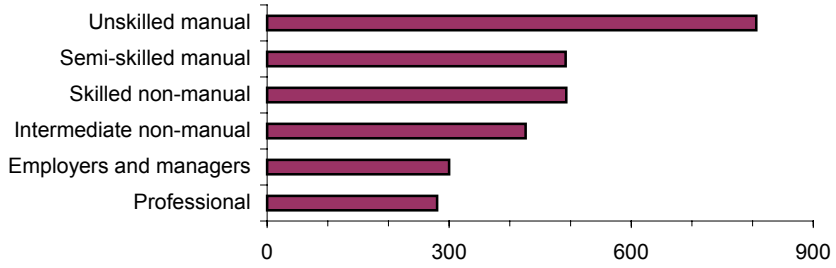
> *Educational attainment has positive effects on health. The well educated experience better health than do the poorly educated, as indicated by high levels of perceived health and physical functioning and lower levels of morbidity, mortality and disability.*

UK evidence that mortality rates are lower for people in higher social class groups is presented in the well known Acheson Report (Acheson et al., 1998) and is summarised in Figure 1[3].

[2] This section draws heavily on work undertaken by Cathie Hammond of the Centre for Research on the Wider Benefits of Learning, described in greater detail in her Learning Paper (Hammond, 2002).

[3] The graph presents mortality rates stratified by social class and not education and therefore conflates a number of important issues. However, the relation between social class and education is sufficiently strong that the graph can be taken to proxy the level of stratification in mortality by education.

Figure 1: Mortality rates per 100,000 men aged 20–64, by skill based occupational classification, England and Wales, 1991–93



Source: Acheson et al., 1998

Importantly, not only are rates much higher for those with lower educational qualifications but it is also the case that rate of decline in mortality rates is much less substantial. Whereas rates fell by 44% between 1971 and 1992 for those in the highest skill group, they fell by only 10% for those in the lowest skill group.

It is important to be clear about why there might be such associations and to indicate potential causal relations where possible. However, most of the research in this area has been based on statistical associations rather than causal models. This reflects the inherent complexity of the relations between schooling, behaviour and health outcomes. The main exception to this is the econometric work undertaken by health economists, but little has been done on UK data since the main bulk of work has considered the USA or the developing world. In each case, the implications for the UK are important but do not lend themselves well to costable outcomes. The main interest in this section, therefore, is to establish the level of quantitative evidence to support conjecture about the nature of the education–health relation.

The empirical literature suggests three channels for effects of education on health;

- economic factors, i.e. income and/or employment;
- health related behaviours and/or;
- psychosocial factors.

In addition, intergenerational factors link parental levels of education and their children's health.

Of course, these different channels are related and there are likely to be interactions between them. This means that simple associations can be hard to interpret. For example, the Health Inequalities report (Drever et al., 1997) reports that whereas the consumption of fruit in 1995 was 77% higher in grams per person in households with gross weekly

income over £570 than in households with income less than £140, consumption of fats was 29% lower. Given the relative costs of fruit and fat intakes, these figures cannot be fully explained by income constraints and presumably also reflect the effects of culture, education and personality on choices about diet and hence health. However, without analysis in a more causal vein it is not possible to determine the relative importance of each of these channels in the creation of this overall effect.

Bearing in mind this restriction on the state of current evidence, a description is given of each of these channels in turn and the evidence is considered.

2.1.1 Economic effects on health

Ross and Mirowsky (1999) consider data from a large scale US survey of those over 60 years old to look at the level of physical functioning among the elderly. Physical functioning refers to mobility and functioning on daily activities such as climbing stairs and carrying shopping. The measure has no natural metric so the quantitative findings need to be interpreted cautiously but the authors find that, on average, those who graduated from high school have a level of functioning that is roughly one third higher than those who did not, and that those with college degrees have a level of functioning roughly one third higher than those with high school diplomas but without degrees. The implication is that education is strongly and substantially associated with physical functioning in later life.

When they condition for economic factors during life they find that these associations are reduced by 50%. In other words, roughly half the education effect on disability in the third age is mediated by economic factors such as income and work conditions. The remaining 50% is mediated through other channels and is substantial. The economic factors include:

The income effect. Through its effect on income, education can be expected to raise the propensity of individuals to engage in healthy activities such as consumption of more nutritious but more expensive food, to live in better conditions and to buy better health care.

The employment effect. Through its effect on labour demand and on workplace bargaining, education raises the propensity of individuals to have reduced levels of stress from work and to perform more healthy occupations. Findings from the Whitehall studies (e.g. Marmot et al., 1991) indicate that civil servants working in higher employment grades enjoy more control over their working lives, more variety and challenge in their work and greater job satisfaction than those working in lower grades. This is associated with lower hostility levels, fewer reported difficult life events, more healthy lifestyles, and lower rates of morbidity. Since that study considered data from the mid 1980s it is

possible, however, that the relationship of seniority and stress has since changed.

However, patterns of employment in the civil service may not be representative of patterns of employment throughout the UK. In broader contexts, the effect of workplace bargaining may be very different. Indeed, analysis of the British Household Panel Study (BHPS, 1991–1997) indicates that the jobs that generally require high levels of qualifications, for example, professional/managerial roles are associated not only with high job satisfaction but also with higher levels of stress, whilst skilled workers and assembly line workers experience relatively low levels of job related stress (Rose, 2000).

2.1.2 Effects of education on health related behaviours

Health related behaviours include diet, smoking, patterns of alcohol consumption (less education is associated with abstinence and excessive drinking, but not with moderate drinking), medical compliance, obtaining medical treatment, taking regular exercise and the use of condoms and seat belts.

Analysis of the 1946 British Birth Cohort (Wadsworth et al., 1997) has suggested that men and women with qualifications at the level of A Level or above were between 30 and 60% more likely to take regular, vigorous exercise, half as likely to smoke and 20% less likely to be overweight. All these figures control for paternal occupation but are essentially bivariate in nature.

Kendler et al. (1999) show that more years of schooling are associated with both reduced smoking initiation and reduced nicotine dependence, even after controlling for individual characteristics such as income, religious and personality characteristics, psychosocial attributes, and lifetime psychopathology. Sander (1995) also shows that more education is associated with less smoking.

The channels for the effects of education upon such activities might be:

a) *Information Awareness*.
   The ability or confidence to search for and use information on health might inform healthier behaviour and healthier responses to illness. However, findings from the US suggest that only 5–20% of the association between education and health related behaviours is explained by knowledge of the extent to which these same health related behaviours affect physical health (Kenkel, 1991). Education has other more important channels for effects on behaviours.

b) *Psychosocial benefits*.
   To the extent that education increases individuals' sense of power over their own lives, this may have a direct effect on health related behaviours. Mirowsky and Ross

(1998) fit a covariance model to survey data relating to over 2,500 adults living in the USA, which suggests that personal control accounts for almost half (45%) of the association between education and health related behaviours.

c) *Direct effects on patience and/or risk aversion*.
As with crime, if education increases patience, it reduces the propensity to engage in short term pleasures with long term costs. Such an argument may explain the well known negative association of schooling and smoking (Sander, 1995), although this might also be explained by other related cultural factors such as social norms. Kendler et al. (1999) show that nicotine dependence (but not smoking initiation) is related to a number of personality characteristics relating to patience; namely mastery, self esteem, locus of control, and dispositional optimism.

Leigh and Dhir (1997) examine the association between years of schooling and exercise amongst men aged 65 and over in the USA, controlling for parental levels of education, family wealth during childhood, and area of residence during childhood. They find that there is a strong association between schooling and exercise and that this is partly, but not completely, mediated by patience, self efficacy and/or risk preference. This suggests that these mediating factors are related to schooling and also to exercise but, unfortunately, the magnitude of these effects cannot be established from the information given in the paper.

2.1.3 Direct psychosocial effects upon health

To the extent that education increases individuals' sense of power over their own lives, this may have a direct effect on stress levels and individual health. There is evidence for each stage of this process. Dench and Regan conducted 336 interviews with respondents aged between 50 and 71 in Britain and found that 80% reported a positive impact of learning upon psychological well-being.

Kubzansky and Sparrow (1999) found that adults living in the USA who had less education than high school were almost twice as likely to suffer from the physiological costs of long term stress as individuals with at least a college education. They control for age and lifestyle (smoking, alcohol consumption and exercise) in this analysis. The strength of the association is hardly attenuated when these lifestyle factors are taken into account, which implies the existence of a channel by which education reduces levels of hostility and stress and consequently improves health outcomes, quite independently of health related behaviours. However, since the stress measure used has no natural metric, effect sizes are not meaningful in this context.

Psychological well-being, which encompasses a sense of personal control, and freedom from stress and hostility, in turn appears to lead to better health outcomes. Seeman and

Lewis (1995) found that adults who reported greater health problems tended to be those who had reported that they felt powerless five years earlier, controlling for their health at that time. Kennedy et al. (1988) report studies of the immunological functioning of medical students during exam times. They find that exam stress is associated with weakened immunity.

2.1.4 Intergenerational factors

Finally, there is also evidence that the health benefits of education are transferred to children, though the nature of this transfer is not well understood. For example, neonatal mortality in the USA during the 1970s was associated with maternal levels of education, even after controlling for maternal poverty and perinatal and neonatal care (Corman & Grossman, 1985). The death rate for infants with mothers who had attended high school as compared to the death rate of infants with mothers who had not attended high school was on average 1.7 percentage points lower for whites and 1.3 points lower for blacks. The degree to which each of the three channels described above is operating here is not known. The channel may be the transmission of health related behaviours, through the advantages of wealth or through the transmission of human capital.

Related findings are that increases in levels of maternal education between 1964 and 1977 accounted for a drop in the death rate of infants during the first month of life of 0.7 per thousand for black families and 0.5 per thousand for white families.

A slightly more recent study shows that mothers with more education had higher birthweight babies in New York City in 1984, controlling for age, marital status, type of birth, health related behaviours, and antenatal care (Grossman & Joyce, 1990).

Finally, Mirowsky and Ross (1998) estimate that the proportion of the association between parental levels of education and their offspring's health related behaviours (in adulthood) that is explained independently of the education of the offspring is 44%.

3. The links—evidence of effects on health

3.1 Introduction

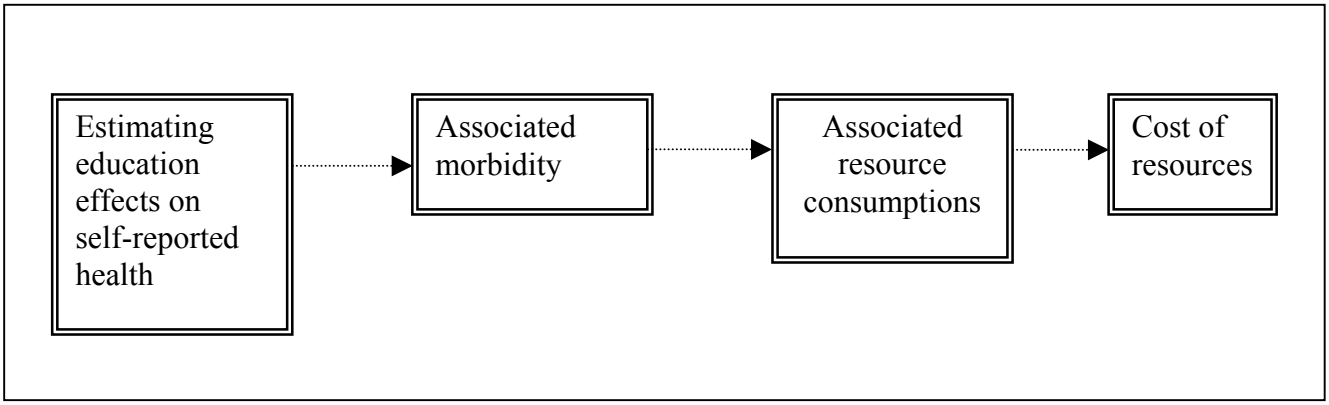
The total budget of the NHS was £48,096 million for 1998–1999 and £49,148 million for 1999–2000. This is just one component of the overall social cost of ill health. Acheson (1998) reports estimates that 240,000 working person years are lost annually due to 'premature death', defined as death before 65. Other substantial costs include the employer cost of time taken off work, insurance costs and the large and important private disbenefits of ill health.

Clearly, however, it is not possible to eliminate all the private and social costs of health care. Healthy lifestyles can only go so far in mediating the risks of genetically and/or environmentally influenced ill health. Moreover, the relative importance of different risk factors in the determination of ill health vary according to which condition is taken as the outcome. For each condition there are uncertainties about the causes of negative outcomes, and these vary according to the research design or population studied. Very little is known, therefore, in quantitative terms about the relative contributions of different lifestyles or life course events to the overall health of the population. It could be hypothesised that lifestyles and events are conditioned by education and learning, but given the current level of research knowledge it is not sensible to produce an overall figure for the health benefits of learning.

Indeed, research is as yet some way from costing the overall benefits of education in terms of even single morbidities, although good progress has been made and this route offers the best hope for future research. The most meaningful approach is to focus on particular morbidities about which there is good evidence, to establish the effects of education on morbidity and then to consider the resource and wider benefits of this influence.

This methodology is described in Figure 2.

Figure 2: Costing the health effects of education



Sections 4 and 5 of this report describe analysis of the effects of education on health in order to establish effect sizes. The analysis is based on the UK birth cohorts, studies of representative samples of those born in 1958 and 1970[4]. This is then linked to information on the costs of poor health to provide estimates of the social benefit that would accrue if educational participation was enhanced. Constraints exist in considering morbidities in terms of the information gathered in the birth cohorts for which it has been possible to find peer reviewed or reliable evidence of the associated costs. These are depression and obesity:

- *Depression*.
  A score of 8 or higher on the Malaise score was taken to indicate depression. This is a standard psychiatric diagnostic device for use in surveys of this kind. The cut off has been developed to discriminate those experiencing or at high risk of clinical depression from others.
- *Obesity*.
  Body mass index (BMI) was calculated as weight (kg) divided by squared height (m). BMI values of 30 or more were taken as an indicator of obesity. This cut off has been recommended by the International Obesity Task Force.

These aspects of health are in some cases only indirectly associated with morbidity. For example, obesity is not in itself a morbidity but obese people have an increased risk of a range of related disease including coronary heart disease, stroke, type 2 diabetes, hypercholesterolaemia, hypertension, gall stones, degenerative joint disease, cancer (e.g. cancer of the colon, rectal cancer, endometrial and ovarian cancer), gout and obstructive sleep apnoea. An important step in the analysis, therefore, has been to clarify the relation between the outcome measure available in these data and the morbidities for which associated resource consumption information is available.

[4] Please see the online resources at http://www.cls.ioe.ac.uk/Cohort/mainncds.htm for more information.

Time and research knowledge limitations have meant that it has not been possible to paint the full picture even for the morbidities given above. For example, depression can be linked to other serious conditions such as obesity, and to eating disorders in general, including *anorexia nervosa* and *bulimia nervosa*. These in their turn can be linked to yet another sub level of related problems caused through malnutrition. Depression is also commonly linked to sleeping disorders, and depressed patients are therefore often prescribed medication for the management of this condition. Depression is accepted as a principal cause of suicide, and a range of other psychiatric disorders may also be linked with it, especially neuroses such as anxiety, panic attacks, agoraphoba and obsessive compulsive disorders. It has not been possible to establish the full resource costs of each of these associated morbidities.

To use a metaphor other than the picture or jigsaw metaphors used elsewhere in this report, depression itself can be thought of as the apex of a pyramid of related conditions, for all of which depression may be a major risk factor. Obesity may also be a risk factor for depression and vice versa, so partitioning the real morbidity risks and associated resource consumptions into those proximally related to the depression indicator available in the data and ignoring those more distant is to a large extent a false exercise that also underestimates the full associated cost. Nonetheless, it is a necessary step if research is to begin to build up the fuller picture.

Clearly also, however, the two outcomes considered here represent only a proportion of the total morbidity of the UK population. Ageing effects are necessarily excluded since the consideration here is the importance of education on ill health of those aged 42 (in the 1958 cohort) and 30 (in the 1970 cohort). Illnesses with high prevalence, such as cancer and heart problems for example, are not considered[5]. Nonetheless, the intention here is to start the process of building up the full picture and to give indications of the kinds of effects that might be occurring across the full range of morbidities and different kinds of ill health in the wider population.

Section 3.2 describes the general costs associated with depression and obesity. Then Section 3.3 shows the raw association of education and these health outcomes, demonstrating the great extent to which the indicators of health are stratified by education. Section 4 describes the methodology adopted in anthe attempt to derive effects of education on health. Section 4.3 presents general results for education effects. Section 5 then costs the benefits of education in terms of reduced depression and obesity.

[5] Note, however, that the massive Global Burden of Disease study conducted by the World Health Organization, the World Bank, and Harvard University (Murray et al., 1996) concluded that 'the burden of psychiatric conditions has been heavily underestimated.' That study used the notion of Disability Adjusted Life Years (DALYs) to measure lost years of healthy life due to premature death or disability. Using the DALYs measure, major depression ranked second only to ischaemic heart disease in magnitude of disease burden in established market economies.

3.2 The costs of ill health: Depression and obesity

3.2.1 Depression

An International Labour Organisation study (ILO, 2000) reports that in the USA, clinical depression has become one of the most common illnesses, affecting one in ten working age adults each year, resulting in a loss of approximately 200 million working days each year. There are extremely large personal and social costs associated with this level of illness. The Department of Health estimates that 14% of NHS costs and 91 million working days are lost each year due to mental health problems (Department of Health, 1995). The Confederation of British Industry (CBI) has estimated that 30 times as many days are lost from mental ill health as from industrial disputes (CBI, 1992).

Focusing specifically on depression, in widely quoted research Kind et al. (1993) have estimated that if lost productivity and the cost of benefits are taken into account, the total cost of depression in Britain in 1993 was £3 billion. Of this the cost to the NHS was estimated at £420 million annually[6]. Recent estimates (Firte, 1999) suggest that the total cost may have risen to between £4 billion and £8 billion, although it is not presently possible to review this evidence. Therefore, focus is concentrated on the figure of £3 billion as a lower bound. Moreover, these costs exclude important social costs such as suicide (strongly linked to depression) and other personal costs and costs for distress borne by families. The links from depression to other related morbidities are not followed through. These may be substantial but remain unquantified. The estimated wider benefit of education on depression, therefore, represents a conservative estimate of the overall effect on the life course of the individuals concerned and omits intergenerational effects and other externalities.

The most reliable source of information on the prevalence of psychiatric morbidity in the working age population (Meltzer et al., 1995) reports that 11% of women and 8% of men meet diagnostic criteria for depression, according to the CIS-R inventory, which is more detailed and accurate than the measure used in the birth cohort data. Based on a working age population of Great Britain of 35 million[7], this implies 1.9 million depressed women and 1.4 million depressed men. The immediate public cost, therefore, is estimated at roughly £900 per year per depressed person.

[6] The figure was subsequently quoted in The UK Department of Health White Paper, 'Saving Lives—Our Healthier Nation. 1999.' Anita Patel and Martin Knapp (1998) of the Centre for the Economics of Mental Health (Institute of Psychiatry and University of Kent), include this in their estimate of the total cost of mental illness in the UK of £32 million. Of this total the major items were £12 billion due to lost employment and productivity, £8 billion to DSS payments and £4 billion to NHS costs.

[7] The figure reported by National Statistics (2000) for mid 1998 is 35,378,000.

3.2.2 Obesity

The National Audit Office report 'Tackling Obesity' (NAO, 2001) reports evidence that one in five adults in the UK is obese. This compares with a slightly lower rate of 0.16 in the 1958 cohort and 0.12 in the 1970 cohort, reflecting the positive age–obesity relationship. There is, however, a strongly rising trend in obesity and the rate has nearly trebled in the last 20 years, with worrying implications for the health of the nation. Table 1 reports literature review evidence summarised by the NAO on the increase in risk for diseases associated with obesity.

Table 1. Estimated increased risk for the obese of developing associated diseases, taken from international studies

Disease	Relative risk: women	Relative risk: men
Type 2 Diabetes *	12.7	5.2
Hypertension	4.2	2.6
Myocardial Infarction	3.2	1.5
Cancer of the Colon	2.7	3.0
Angina	1.8	1.8
Gall Bladder Diseases	1.8	1.8
Ovarian Cancer	1.7	
Osteoarthritis	1.4	1.9
Stroke	1.3	1.3

* Non-insulin dependent diabetes mellitus (NIDDM)

Note: The BMI range for the obese and non-obese groups used to estimate relative risk varies between studies, which limits the comparability of these data.

Source: National Audit Office (2001) estimates based on literature review.

Based on the cost of consultations, drugs and treatments associated with these diseases, the NAO estimate that the annual cost to the NHS of obesity was £0.5 billion in 1998. They further estimate that obesity is linked to the loss of 80 million working days a year in England and 40,000 lost years in working life. They measure the cost of this absence from work and premature mortality as £2.1 billion, giving a total of £2.6 billion.

3.3 The stratification of health by education

As stated above, there is evidence that education and learning enhance health through lifestyle effects, personal agency, income effects and intergenerational effects. This Section shows that this evidence is replicated by the birth cohorts.

Information is available in the birth cohorts on highest academic and vocational qualifications attained to date. These have been classified according to QCA guidelines into NVQ equivalent levels as shown in Table 2[8]. Appendix Table 1 gives more detailed information, particularly on vocational qualifications.

Table 2. Classification and frequencies of academic and vocational qualifications, 1958 and 1970 birth cohorts

NVQ Level	**Vocational Qualifications**				**Academic Qualifications**				
	1958		**1970**		**Classification**	**1958**		**1970**	
	No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**
	4787	41.9	4520	40.4		2285	20	3139	28.1
0					No qualifications				
1	1875	16.4	2254	20.2	CSE Grade 2–5	1705	14.9	940	8.4
2	1110	9.7	1329	11.9	Good O Levels, AS Levels, Diploma or 1 A Level	4591	40.2	4343	38.8
3	1652	14.5	2093	18.7	A Levels	972	8.5	519	4.6
4	1992	17.4	988	8.8	Degree, PGCE and higher degree	1869	16.4	2247	20.1
		100		100			100		100

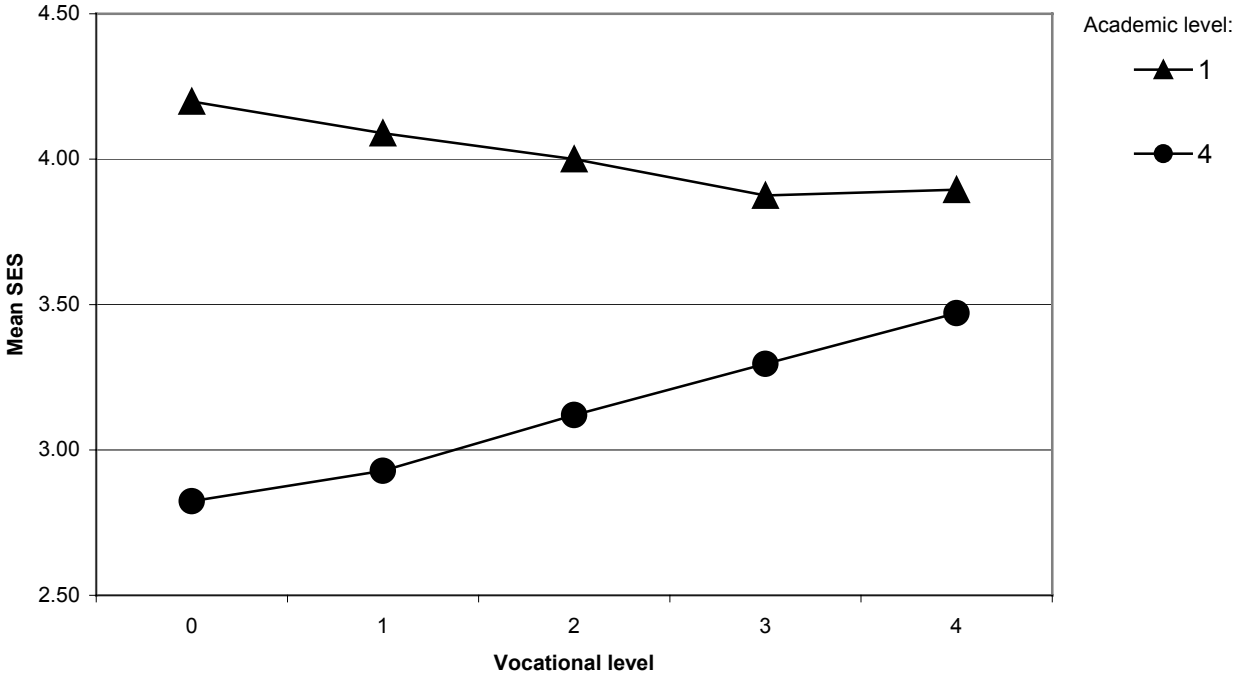
The interactions between the two sets of qualifications are complex. Generally one finds that higher levels of academic qualifications are positively associated with all measures of advantage in upbringing and of beneficial outcomes, suggesting that the academic qualifications variable provides a good ordering of individuals along a latent axis of advantage. It might also be the case, however, that the academic education variable proxies for unobserved advantages and attributes that might lead to better health that is not due to education but to the unobserved advantages. The problem is that a positive selection effect may be operating. This must be addressed in the estimation process, an issue which is returned to in detail in Section 4.

The case of vocational qualifications is rather different. Many individuals from advantaged backgrounds have no vocational qualifications but high academic qualifications and better adult health than those with high level vocational qualifications. Therefore, a comparison on the basis of vocational qualifications alone cannot provide a true reflection of the potential effect of vocational qualifications. This is a result of the general education, labour market and social climate of Great Britain and should come as no surprise.

[8] It can be seen that between the two cohorts, the proportion with NVQ Level 4 equivalent academic qualifications rose while that with Level 4 equivalent vocational qualifications fell.

The pattern can be seen in Figure 3, which graphs the average family background and social class of those who attain different vocational levels. Two lines are plotted, one for those with Level 4 academic qualifications (degrees) and one for those with Level 1 academic qualifications (CSEs). The social class variable is the father's occupational status, ranging from 1, representing managerial or professional occupations, to 6, representing unskilled manual work. The vertical dimension is, therefore, a proxy measure of disadvantage, with higher scores generally representing lower family income and lower levels of parental education.

Figure 3: Mean SES by academic and vocational level, 1970 cohort



Taking the line for those with academic Level 4, it can be seen that those with higher vocational qualifications tend to come from less advantaged families. Thus, the most advantaged in this group of people with degrees have no vocational qualifications. Higher vocational qualifications do not represent the choice of those with easier personal circumstances. It would not be expected, therefore, that for those with degrees, higher vocational qualifications would indicate unobserved advantage or be associated with better health in adulthood[9].

[9] In econometric terms, the selection effect is negative. Those in this group who select into higher vocational qualifications are likely to have worse health in adulthood.

For those with Level 1 academic qualifications, however, vocational qualifications are indicative of greater personal advantage. For those in this group, vocational qualifications might represent a positive selection effect.

The implication is that the vocational qualifications variable does not provide a simple linear ordering along an axis of advantage. For this reason, if you map outcomes such as depression against the vocational variable, you find much less extreme gradients than when the academic qualifications variable is used. It might appear from this that the advantages or effects of high vocational qualifications are relatively low, but this would be to conflate the vocational effect with the selection decision. The selection bias is likely to be strong and positive for academic qualifications but, at high levels of academic attainment, the selection effect may be negative for vocational qualifications. To assess the importance of vocational qualifications, therefore, as well as dealing with selection bias, it is important to restrict the sample to those for whom the qualifications represent a likely avenue of benefit.

In the following analysis, therefore, the consideration of the effects of vocational qualifications are restricted to those with academic qualifications at or below Level 2.

Figures 4–7 (p. 19-22) show clear and substantial stratification of the UK population in terms of education. Those with more education (as assessed by the qualifications extant when cohort members were in education and/or training) can be seen to be substantially healthier in both cohorts.

Figure 4, for example, shows the mean level of depression for men and women in each cohort, by academic qualification level. Depression rates for NCDS women fall from 29% at Level 0 to 9% at Level 4. The equivalent figures by vocational qualifications (for the low academic qualifications subgroup) are shown in Figure 5, and are 24% and 13%. Thus the gradients are still shallower for vocational qualifications, even when the sample is restricted as discussed, but nonetheless they are substantial.

Figures 6 and 7 record the patterns for obesity.

Figure 4: Raw association of academic education and depression, 1958 & 1970 cohorts

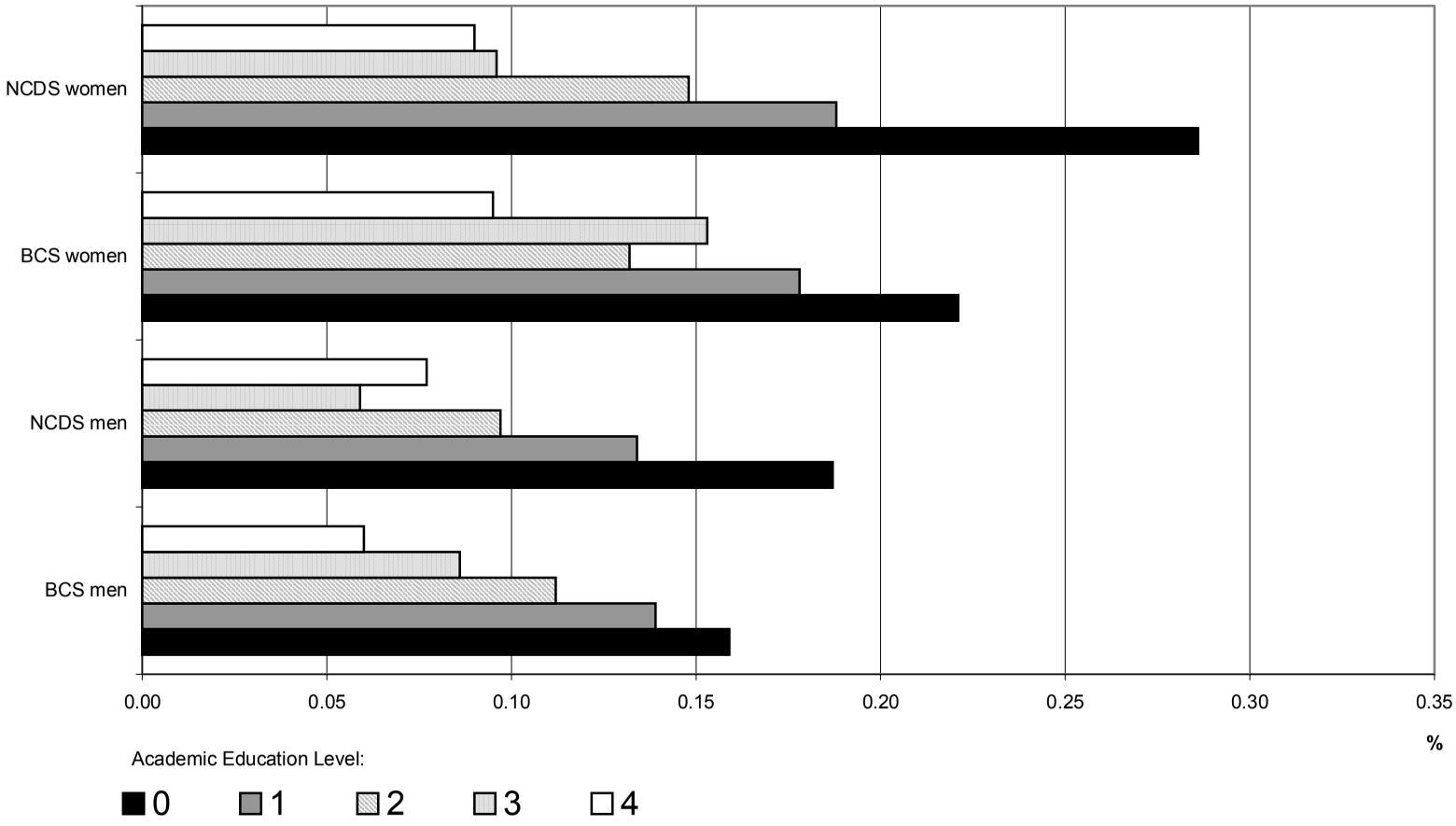


Figure 5: Raw association of vocational education and depression, 1958 & 1970 cohorts (restricted to academic qualifications below Level 3)

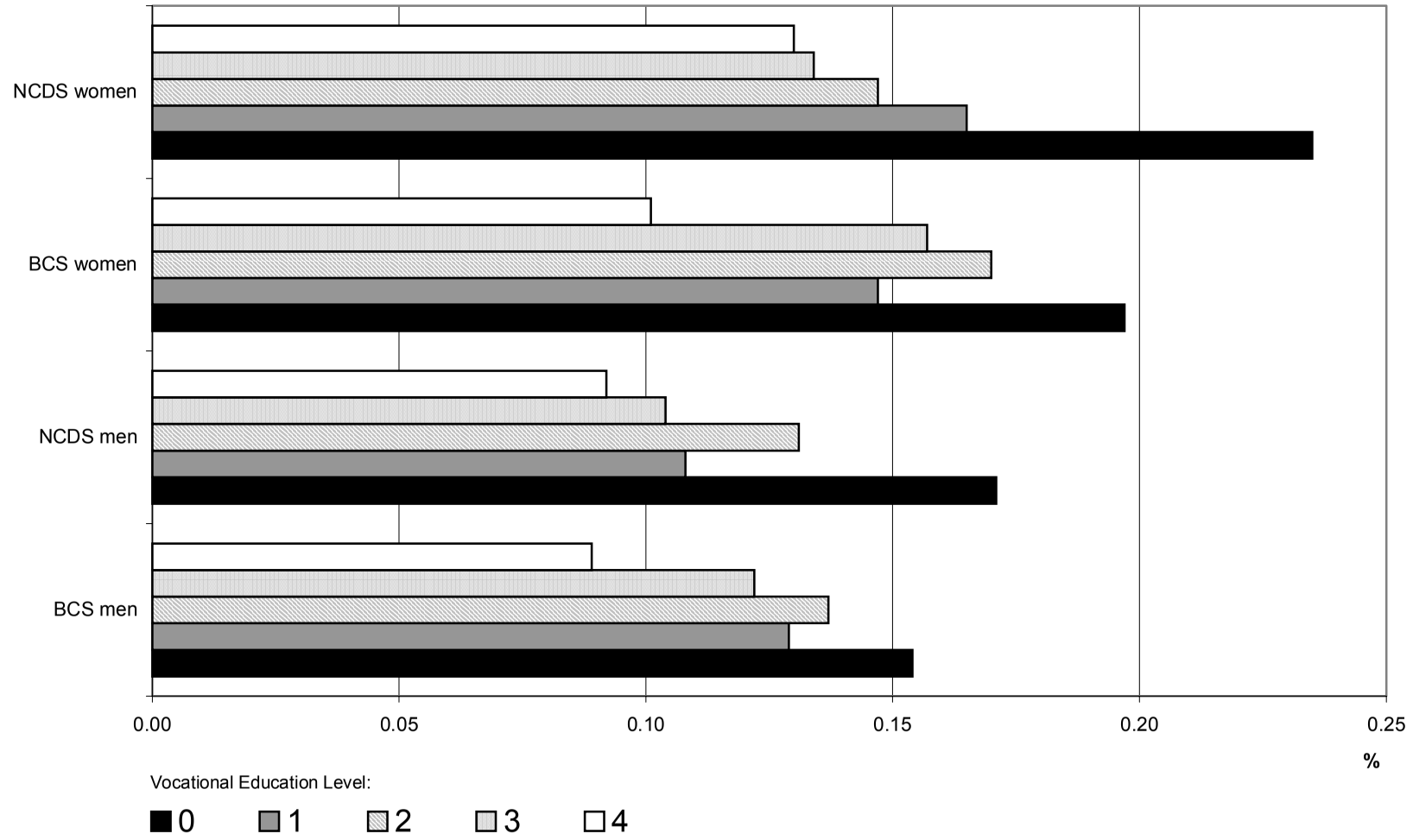


Figure 6: Raw association of academic education and obesity, 1958 & 1970 cohorts

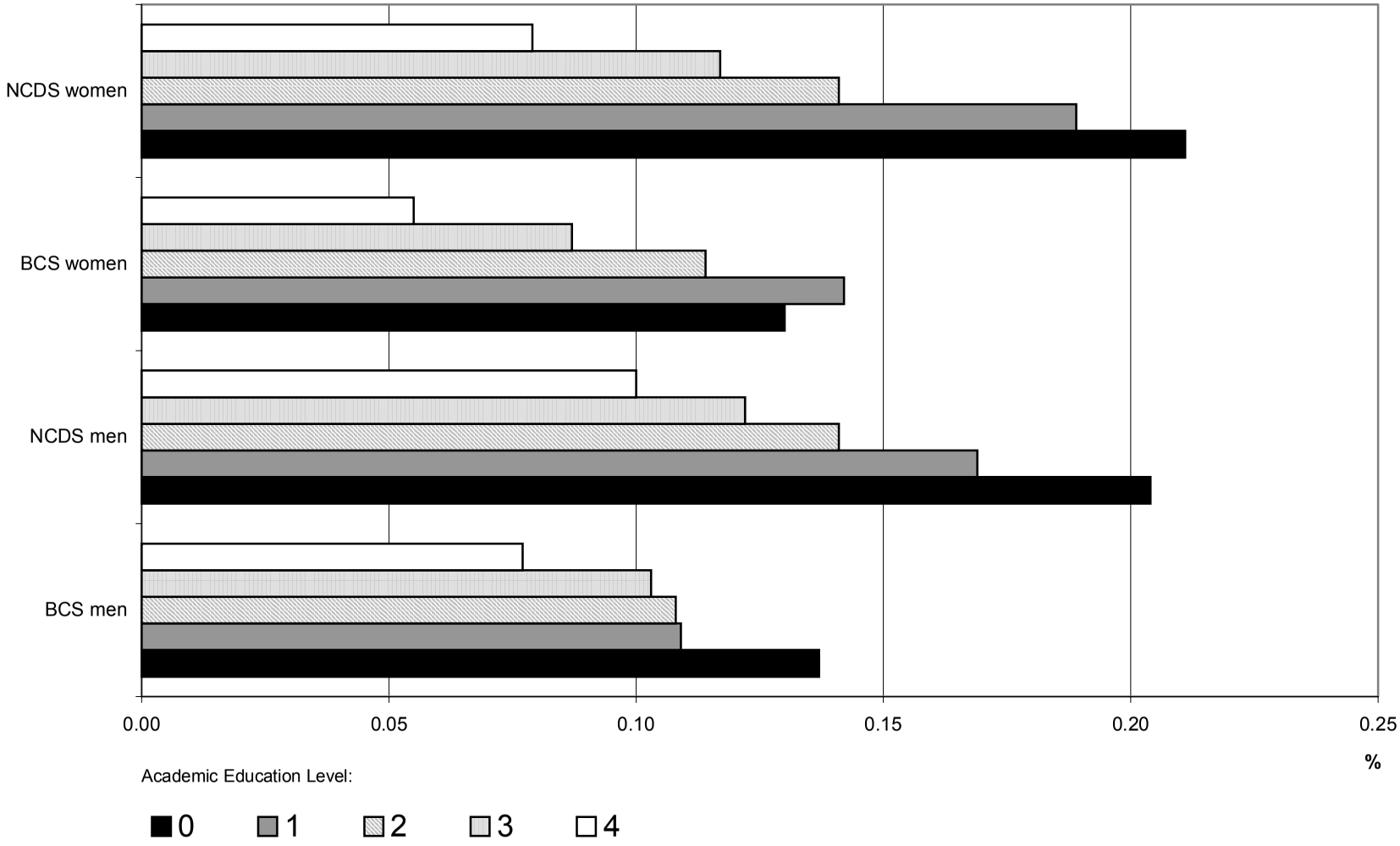
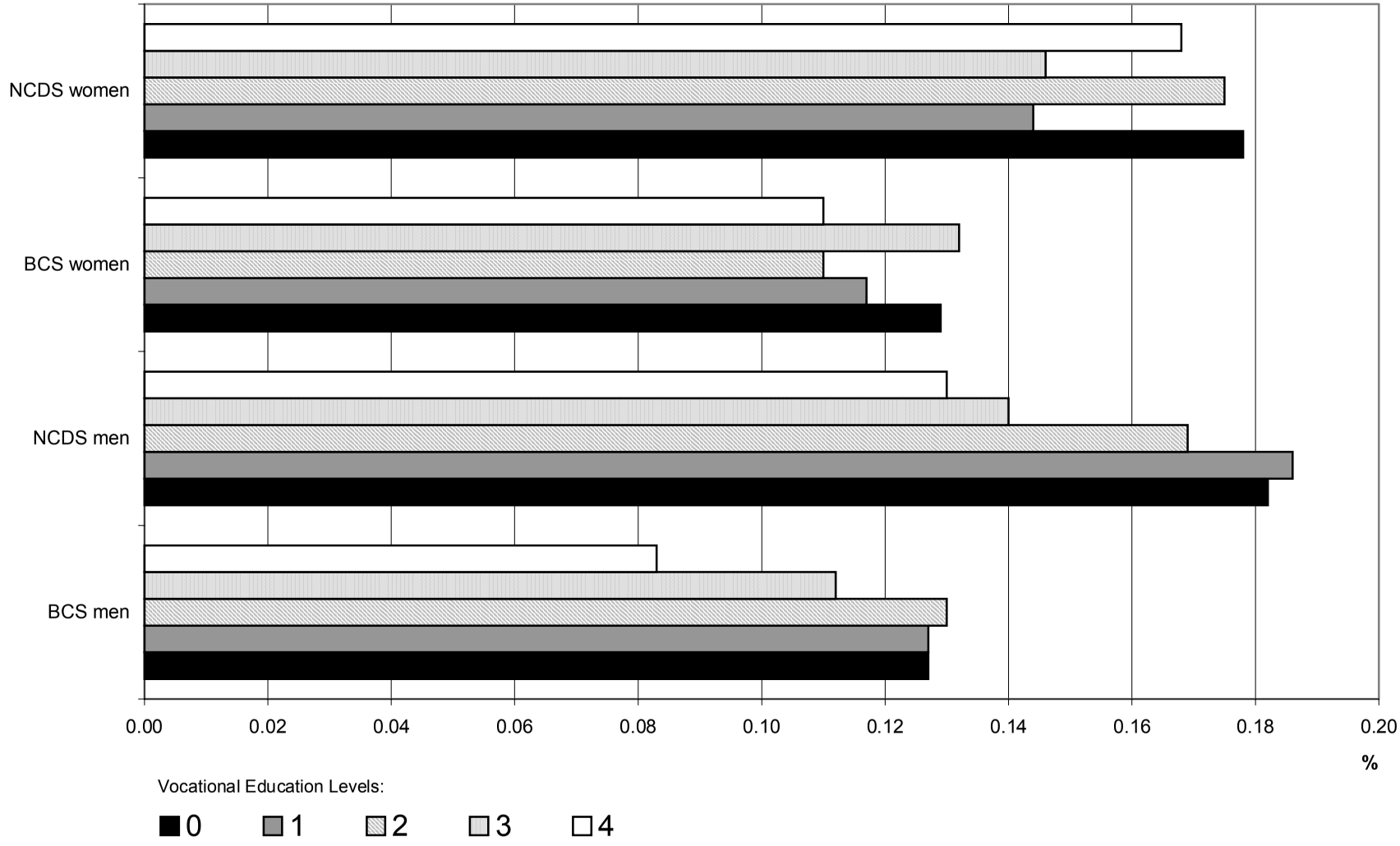


Figure 7: Raw association of vocational education and obesity, 1958 & 1970 cohorts (restricted to academic qualifications below Level 3)



Here it can be seen that the academic qualifications gradient is again strong, particularly for NCDS women. Obesity rates for NCDS women fall from 21% at Level 0 to 8% at Level 4. The equivalent figures by vocational qualifications (for the low academic qualifications subgroup) are shown in Figure 7, and are 18% and 17%. Moreover, the gradient between these two points is far from linear. For men in the NCDS the vocational gradient is clearer, ranging from 18% at Level 0 to 13% at Level 4, a decline in obesity risk of 5 points. However, the equivalent decline with academic qualifications is double this at 10 points.

Section 4 attempts to establish the extent to which this represents effects of education but first to summarise the bivariate evidence.

3.4 General conclusions

Overall, the following observations can be made on the bivariate depression and obesity associations:

- There are substantial, significant and fairly linear overall associations with education and health outcomes and healthy behaviours. Education is clearly a key risk factor for health[10].
- The gradients of health effects are shallower for the 1970 cohort than for the 1958 cohort. This is not surprising since there is more variation in outcomes in the 1958 cohort as sample members are older.
- The gradients for vocational associations were much less clear cut, for men and women but particularly for the later cohort.
- However, there are general significant benefits of progressing from vocational Level 0 to vocational Level 1, especially for depression, particularly for women and particularly in the earlier cohort.

[10] It is noteworthy that, as other research undertaken at the Centre for Research on the Wider Benefits of Learning has shown, the proportion reporting good health rises with educational qualifications from 17% at NVQ Level 0 to 35% at NVQ 5 for the 1958 cohort.

4. Estimating effects

The estimation problem, however, is to establish that these associations are in any way causal. If those with more education have the advantages described, it is not necessarily because education has caused them, it may rather be that these associated underlying advantages or protective factors have led them also to engage in education. The association between learning and health is, in fact, heavily confounded.

For example, 10.5% of those in the 1958 cohort were rated by medical officers as obese at age 16. This group were 4 percentage points less likely than others to get any educational qualifications (22% as opposed to 18% without qualifications). They were also 40 points more likely to be obese at 42. If the earlier obesity is not controlled for, then a spurious education effect will result. It is also clearly important to control for other childhood and adolescent medical conditions.

In theory, three approaches to this problem are possible. The first and most effective in terms of estimation is the experimental approach. The typical evaluation approach would in this context aim to quantify the impact of educational interventions ('treatment') on health, where one group is randomly selected to receive the treatment, while a second group remains untreated. However, social experiments are not in practice feasible in this area.

The second approach is to attempt econometric estimation of the kinds described above for estimating crime effects. However, for various reasons this has not so far been attempted (Carr-Hill, 2001). The third method is to use longitudinal data with sufficient background information to attempt to condition out or control for confounding factors. That is the approach adopted here, using the non-parametric matching method described below, with data from the 1958 and 1970 birth cohorts.

4.1 Confounding variables

It is feasible that education effects could be spuriously estimated because of a whole range of possible confounding factors, primarily:

- childhood physical health;
- childhood mental health;
- childhood ability, attitudes and attributes;
- childhood family background.

One example of this has already been given above. Another might be that children with low levels of cognitive development are less likely to stay on at school and also, perhaps, less likely to engage in healthy behaviours. If the earlier ability is not taken into account

in the estimation process then the poor health will be erroneously ascribed to schooling.

One of the great advantages of the UK birth cohort datasets is that it is possible to control for most of the confounding factors listed above. Appendix Table 2 lists the independent (confounding) variables used. The analysis takes account of substantial information reported by medical officers at age 16 for the 1958 cohort and age 10 for the 1970 cohort. It was ascertained whether the children were assessed as having any abnormal medical conditions across a whole range of systems including respiratory, mental, emotional, cardiovascular and general physical or motor functioning.

A great deal is also known about childhood family background, including the education and social class of parents, family size and poverty. Cognitive development is assessed by maths and reading tests at age 10 or 11. For the 1970 cohort information is also held from teachers about children's attentiveness, and information from the children themselves about self esteem.

4.2 Methodology

Two statistical methods of taking account of these other covariates are common. The first is ordinary least squares regression analysis. This particularly well known method conditions out the partial, linear correlations of confounding factors, leaving a remaining association of education and health, net of the effects of the confounding variables.

The second method is matching. The propensity score matching technique is used as described by Rosenbaum and Rubin (1983). This has several advantages over a regression approach and is a better technique for attempting to establish casual effects in naturalistic as opposed to experimental data. The technique is described in more detail in Appendix 1.

Essentially, the matching method 'adjusts' for differences between learners and non-learners by pairing each learner with a non-learner who has similar observable characteristics. This works best where the matched individuals are likely to be reasonably similar in terms of unobserved characteristics so matching estimation of the effect of moving from, say, Level 0 to Level 1 are likely to be more reliable than those of the effect of moving from Level 0 to Level 4. Therefore, in Section 4.3, below, only the results for these small movements are presented. Focus is concentrated in the text on the estimated effects of reaching Level 1 because these are the most precise estimates. However, the full set of estimated treatment effects is given in Appendix 4 Tables 1 and 2.

4.3 General matching results

Each health outcome is taken in turn. Although the estimated relation between education and health is considerably reduced when confounding factors are dealt with in the way described, there are nonetheless considerable statistically significant effects of education on health. The most important examples from many that can be observed in the Appendix are given here, together with other general findings. Section 5, on costed benefits, considers results within standard confidence intervals but in this section, for clarity of presentation, point estimates are presented. All figures described in the text are significantly different from zero at the 5% level, except where otherwise indicated.

4.3.1 Depression

There are strong effects of Level 1 learning on the probability of depression. These are summarised in Table 3.

Table 3. Estimated effects of Level 1 qualifications on probability of depression, by matching method

	Men				**Women**			
	Level 1 v. Level 0		**Level 1 or above v. Level 0**		**Level 1 v. Level 0**		**Level 1 or above v. Level 0**	
1958 Cohort								
Academic	–4.06	(1.68)	–5.59	(2.33)	–6.08	(2.06)	–7.23	(2.31)
Vocational	–4.37	(1.95)	–3.44	(2.02)	–6.21	(2.43)	–4.12	(2.28)
1970 Cohort								
Academic	–1.58	(0.43)	–6.30	(2.73)	–10.17	(2.48)	–2.34	(0.88)
Vocational	2.38	(0.79)	–0.92	(0.39)	–5.65	(2.36)	–4.29	(1.83)

Note: T-statistics in brackets. Full results are in Appendix 4 Table 1.

For the 1958 cohort, all the models give strong and significant effects of Level 1 qualifications in reducing depression rates. This is so for both sexes, for academic and vocational qualifications and comparing those with Level 1 to those with Level 0 or when comparing those with Level 1 or above to those with Level 0. In particular:

- the effect on the probability of depression for women going from Level 0 to Level 1 academic qualifications (and no further) is a reduction of 6 points for those in the 1958 cohort and 10 points for the 1970 cohort.
- for the 1958 cohort, the vocational effect of Level 1 is even higher than is the equivalent academic effect.

- for the 1970 cohort results are weaker but there are strong effects of Level 1 qualifications (academic or vocational) for women.

The differences between those with qualifications above Level 1 are substantially eroded when dealing with selection bias. In other words, it appears that the effects on depression of Level 3 or 4 academic qualifications or higher level vocational qualifications are much less robust than the effect of Level 1 qualifications. However, the findings are;

- for women in the 1958 cohort, the effect on the probability of depression of going from Level 1 vocational qualifications to vocational Level 2 or above is –9 points.
- for men the in the 1970 cohort the effect of Level 4 academic qualifications over Level 3 is –6 points. There is also quite a strong degree effect for women in the 1970 cohort, although this is not quite statistically significant at standard levels.

4.3.2 Obesity

There are not strong effects of learning on the probability of obesity. The results are summarised in Table 4.

Table 4. Estimated effects of Level 1 qualifications on probability of obesity, by matching method

	Men				**Women**			
	Level 1 v. Level 0		**Level 1 or above v. Level 0**		**Level 1 v. Level 0**		**Level 1 or above v. Level 0**	
1958 Cohort								
Academic	–4.71	(1.65)	–4.98	(1.72)	..*	..	2.11	(0.76)
Vocational	–0.52	(0.19)	–1.32	(0.69)	–5.14	(1.97)	–0.45	(0.25)
1970 Cohort								
Academic	–6.51	(2.11)	–4.38	(2.30)	2.23	(0.67)	0.22	(0.12)
Vocational	0.49	(0.17)	–1.73	(0.97)	0.46	(0.20)	–0.90	(0.48)

* Insufficient matches available.
Note: T-statistics in brackets. Full results are in Appendix 4 Table 2.

- The associations of academic and/or vocational training and obesity are not generally robust to the inclusion of the control variables.
- The primary exception is in the transition for men from no qualifications to academic Level 1 for which the resulting benefit was a 5 point drop in the probability of obesity for the 1958 cohort and 7 points for the 1970 cohort. In

addition, women in the 1958 cohort gaining Level 1 vocational qualifications benefited with a 5 point drop in the probability of obesity.

- It is also the case that for men the effect of academic Level 4 over and above Level 3 is –7 points for the 1958 cohort but this is not mirrored by an effect for the 1970 cohort or for women.

5 The costed benefits of education on depression and obesity

As stated above, it has been possible to find good information on costs associated with depression and the morbidities associated with obesity. Matching results encourage the view that substantial treatment effects are plausible, particularly for two types of effect:

- the effect on depression for women who progress to Level 1 academic qualifications;
- the effect on obesity for men who progress to Level 1 academic qualifications.

Substantial and significant effects of other education attainments are found but these are generally less robust because they are not true across both cohorts. For example, there is a strong effect of Level 1 vocational qualifications on depression for women in the 1958 cohort but not in the 1970 cohort. This suggests that the effects may be due to occupational and vocational training that is no longer available or that no longer carries the advantages that it did for the generation born around 1958. However, note that the effect of going from no qualifications to vocational Level 1 or above is significant in both cohorts. Therefore, the costed benefits for these vocational qualifications are evaluated.

Finally, in a fourth scenario, the effect on obesity for men who progress to Level 4 academic qualifications from Level 3 is evaluated. Although this effect is not statistically significant for the 1970 cohort it is for those in the 1958 cohort and it is feasible that the difference is due to increasing obesity rates as individuals age, rather than changes in the education system between the cohorts. It is not unreasonable, therefore, to take the view that the effect may still be operating. Therefore, the costing exercise for this policy change is repeated[11].

The matching model appears to work well for all four of these comparisons and the policy scenarios are not unreasonable. Therefore, estimates are provided of benefits in costed terms for these policy changes. The approach adopted is clarified with respect to the example of depression. However, the same approach is adopted for both outcomes.

5.1 Depression

5.1.1 The effects of academic qualifications

The effect of progress from no qualifications to academic Level 1 for women in the 1958 cohort ranges with 90% confidence between 1.2 and 10.9 points. For women in the 1970

[11] This might appear to enable a comparison of the effects of progress to Level 1 and Level 4. However, it must be emphasised that these benefit totals have not been calculated as social returns because the costs of running the programmes have not been taken into account. Comparison across programmes is therefore invalid.

cohort, the effect ranges between 3.4 and 16.9 percentage points [12].

In order to simplify matters, the average of these numbers is taken crudely, giving us a range of 2.3 and 13.9 points, a very wide range indicating the imprecision in the estimates. This oversimplifies substantially, partly because it ignores the importance of age and cohort variations, both of which can be expected to have strong implications for the true relation between education and depression. However, because of cohort differences in reporting and diagnosis of depression, these issues are in any case not well understood. Moreover, Meltzer et al. (1995) report that the rates of depression of those in the two age groups considered here are not significantly different from each other or from the working age mean. This range does give us, therefore, an initial view of the plausible average effect of education Level 1 qualifications on depression for women.

Other strong assumptions are required; one is that the £3 billion cost of depression is equally distributed across the 14% of the population who, in the birth cohort data, indicate depression, implying a per percentage point cost of £214 million. Thus, the policy scenario of changing education rates for those in the cohorts is equivalent to changing those year on year in the wider population. In order to achieve the benefits described it would be necessary to achieve the described target for each cohort in the population.

This also assumes that only those indicating a Malaise score over 8 incur or cause depression related costs. An assumption is also needed that effects are linear and that there are no offsetting effects elsewhere in the economy or the lives of individuals.

Women with no qualifications make up 11.4% of the birth cohort samples and they have an average 24.7% probability of depression. Their 'contribution' to the overall depression rate is 2.82 percentage points[13]. Therefore, if the depression rate for that group fell by the lower bound estimate of 2.3 points, the overall rate would fall by 0.26 percentage points[14]. This full gain would require all women with no qualifications to gain Level 1 qualifications[15]. If one in ten women with no qualifications progressed in this way, the effect on the total depression rate would be a reduction of 2.3*0.1*0.114, i.e. 0.026 percentage points.

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[12] In a linear regression, conditioning on all the medical, family and childhood ability control variables listed in Appendix 3, the results are remarkably similar: 5.7 by regression and 10.9 by matching for the 1970 cohort; 6.1 by regression and 7.0 by matching for the 1958 cohort. All these numbers are significant at 5%.

[13] This follows since the average probability of depression, P(D) is given by:

$$P(D) = \sum_{s=1}^{2}\sum_{l=0}^{4} P(D \mid sex = s, education\ level = l) * P(sex = s, education\ level = l)$$

[14] The change in overall depression rate, Δ, being given by $\Delta = \beta_{sl}$ x P(sex = s, education level =l) where β_{sl} denotes the estimated effect of the policy scenario on people of sex s and education Level l.

[15] Note that despite the intervention in which all women without qualifications are brought up to Level 1, some would, of course, remain depression or become depressed.

It was stated earlier that the estimated cost per percentage point of depressed people was £214 million. A reduction of 0.026 points is therefore equivalent to a benefit worth £5.6 million[16]. The higher bound effect of a one in ten change would be an overall change of 0.16 points, equivalent to an annual saving of £33.9 million.

Subject to the many caveats given above the estimation is made that the economic benefit in terms of reduced risks of depression, of educational interventions that enabled 10% of women who would otherwise gain no qualifications to progress to CSE or equivalent qualifications, are between £6 million and £34 million per year[17]. This is based on an intervention successfully affecting roughly 1% of the population, i.e. one in ten of the 11% of the population that are women without qualifications. It excludes all other benefits or personal and family costs associated with depression.

If the policy reduced the numbers of women without qualifications by half the benefits would be 5 times as large, i.e. between £30 million and £170 million.

If the effect of education on mental health generally is the same as that for depression, much larger savings would accrue. Research undertaken at the Centre for the Economics of Mental Health (Patel and Knapp 1998) has estimated that the total cost of mental illness in the UK is £32 billion. Of this total the major items are lost employment and productivity, benefits payments and NHS costs[18]. Savings calculations using these figures would therefore be higher by a factor of 10.67.

Therefore, assuming that the effect of education on mental health generally was the same as that on depression, the benefit of a policy that reduced the numbers of women leaving school without qualifications by half in every cohort would eventually be between £299 million per annum and £1,809 million per annum.[19].

These figures are summarised, together with those for obesity, in Table 5.

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[16] This costed benefit being given by β_{sl} x P(sex = s, education level =l) x 0.1 x £214 million.

[17] Caveats including concerns about i) estimation bias; ii) omitted age and cohort effects; iii) the underestimation of costs, and; iv) the probable importance of neglected general equilibrium effects and other resulting implications for the wider economy. See Section 6.

[18] The figure was subsequently quoted in the UK Department of Health White Paper, 'Saving Lives—Our Healthier Nation, 1999'.

[19] It is not necessary that the policy be one that affects qualifications at school leaving age, the same benefits would result if the effect was achieved by adult learning since the estimates presented in this paper are based on highest qualifications obtained by 1999/2000 regardless of when they were achieved.

Table 5. Estimated value of depression and mental health benefits of learning

Outcome	Group affected	Policy scenario	Value of benefit £m. p.a.
Depression	Women with no qualifications	10% to *academic* Level 1	5.6 - 33.9
		50% to *academic* Level 1	28.1 - 169.6
		10% to *vocational* Level 1	4.5 – 22.6
		50% to *vocational* Level 1	22.7 – 108.2
Mental health	Women with no qualifications	10% to *academic* Level 1	59.9 – 361.8
		50% to *academic* Level 1	299.4 – 1,809.1
		10% to *vocational* Level 1	48.5 – 231.0
		50% to *vocational* Level 1	242.4 – 1,154.9
Obesity	Men with no qualifications	10% to academic Level 1	1.6 – 24.4
		50% to academic Level 1	8.1 – 122.1
Obesity	Men with Level 3 qualifications	10% to academic Level 4	0.7 – 5.7
		50% to academic Level 4	3.4 – 28.4

5.1.1 The effects of vocational qualifications

The effect of vocational Level 1 qualifications on depression for women in the 1958 cohort ranges with 90% confidence between 2.3 and 10.8 points. Women with no qualifications make up 9.4% of the 1958 cohort. The depression rate is 14%, as before, so the per percentage point cost remains £214 million. Therefore, subject to the many caveats given above, an increase of 0.1 in the proportion of those with Level 1 vocational qualifications is predicted to create an annual saving in terms of reduced depression of between £5 million and £22 million, based on successfully targeting 10% of the 9% of the population that are women with no qualifications.

If the policy successfully affected half of those women who would otherwise leave without qualifications helping them achieve Level 1 vocational qualifications, the benefit would again be 5 times greater at between £23 million and £108 million per year. If other aspects of mental health were affected in the same way, the benefits would be between £242 million and £1,155 million per year.

5.2 Obesity

Level 1

The effect of progress from no qualifications to academic Level 1 for men in the 1958

cohort ranges with 90% confidence between 0 and 9.4 points. For men in the 1970 cohort, the effect ranges between 1.4 and 11.6 percentage points[20]. Taking averages as before gives a range of 0.7 and 10.5 points.

The assumption is made, as with depression, that the relation between obesity and associated costs is independent of age, cohort, sex and education. The average obesity rate across the two cohorts is 14%. The total annual cost is £2.6 billion. The per percentage point cost is, therefore, £186 million.

Men with no qualifications make up 12.5% of the birth cohort samples. Therefore, subject to the many caveats given above, an increase of 0.1 in the proportion of those with Level 1 educational qualifications is predicted to lead to a public economic saving in terms of reduced obesity costs of between £1.6 million and £24.4 million per year, based on successfully targeting 10% of the 12.5% of the population that are men with no qualifications.

If the policy successfully affected half of those men who would otherwise leave without qualifications so that they obtained Level 1 qualifications, the benefit would again be 5 times greater at between £8 million and £122.1 million per year.

Level 4

The effect of progress from no qualifications to academic Level 1 for men in the 1958 cohort ranges with 90% confidence between 1.4 and 11.6 points. The per percentage point cost for the 1958 sample is £163 million.

Men with Level 3 academic qualifications make up 4% of the 1958 Cohort sample. Therefore, subject to the many caveats given above, an increase of 0.1 in the proportion of those with Level 4 educational qualifications is predicted to lead to a public economic saving in terms of reduced obesity costs of between £0.7 million and £5.7 million per year, based on successful impact on 10% of 4% the population.

If half of men at Level 3 were affected, the benefit would rise to between £3.4 million and £28.4 million per year. These economic benefits of Level 4 academic qualifications in reducing obesity for males are less than those of Level 1 qualifications. However, it should be pointed out that the policy programme would be cheaper to run as fewer people would be targeted.

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[20] In a linear regression, conditioning on all the medical, family and childhood ability control variables listed in Appendix 3, the results are again similar: 5.0 by regression and 5.0 by matching for the 1970 cohort; 5.8 by regression and 6.0 by matching for the 1958 cohort, all numbers significant at 5%.

6. Concluding remarks

This report represents an attempt to begin to get to grips with the immensely wide ranging and substantial wider benefits of learning. The Centre for Research on the Wider Benefits of Learning, together with the DfES, has identified crime, health, ageing, parenting and social cohesion as key areas in which wider benefits are likely to be particularly important and to have costable implications for the UK taxpayer, as well as being important in personal terms.

It has been established in this report that the costable wider implications of learning are substantial and approachable statistically. The results shown in Table 5 indicate that the economic and social returns to educational investments that improve mental health are substantial.

Yet there are still clearly doubts and uncertainties. A great many simplifying assumptions were made in order to arrive at the estimates presented. Key amongst these are the following:

1. *that the matching method deals with selection bias* – it is unlikely that this is wholly true in the current case but the richness of the data suggests that, although not perfectly precise, the general message of the results is robust. Moreover, the results from matching are similar to those from ordinary least squares regression, providing a further proof of robustness;

2. *that costs are appropriately estimated* –dependent on the validity of research conducted elsewhere and that has not been considered in detail during the research for this report. It is likely that many aspects of cost, such as the cost of ill health to the quality of life have been substantially underestimated. It is also likely that other aspects of cost have been overstated for the current context. For example, work absence costs will be overstated because these are based on average earnings, rather than the appropriate level of earnings for those with no qualifications, as in the examples considered here;

3. *that those in the UK birth cohorts are representative of those in other cohorts* – this was a necessary assumption in the process of evaluating the wider social cost of illness for the whole population based on relationships established for those in the birth cohorts. The relation between education and depression/obesity estimated in this report are representative of the relations that hold for 33 and 42 year olds in 2000. Those relations are likely to be different for younger or older cohorts who experience different morbidity rates and have experienced different education systems. It was necessary to average across these age and cohort relations to proxy the whole population by the evidence for the birth cohorts. This will introduce some error but

again enables a 'ball park figure' to be obtained;

4. *that the relation between education and mental health mirrors that between education and depression* – this assumption is necessary if the costed effect on depression is to be factored up by 11 to give a figure for the effect on mental health generally. A more detailed and rigorous study would consider the feasibility of such a relation based on a literature review of other evidence;

5. *that there are no general equilibrium effects* – this refers to the scaling up problem. It may be that if more people had Level 1 qualifications, the benefit might start to diminish as the signalling advantage of the qualifications waned. The scaling up may result in an over supply of those with Level 1. It might also be, however, that the enhancement in productivity would offset this. There is as yet no evidence on the likely balance of effects;

6. *that effects are linear* – related to the previous point, it has been assumed that the benefit of an increase in the proportion with a particular level of qualification can be expanded with a constant rate of return. In fact the advantages for those hardest to target might either outweigh or fall short of those who are easiest to target. This important issue is cut across by assuming that the benefits are the same for all.

Given this long list of assumptions, it is clear that the estimates presented in this report need to be read with caution. They are presented in order to be transparent about the nature of the preliminary findings and the approaches adopted and hope they will be received in that spirit.

However, although the findings presented here do depend on the assumptions made, making any precision of the estimates spurious, it does not undermine the following general findings:

- substantial and robust health returns to learning exist;
- the sizable differences in health observed for those with different levels of education are partially due to the effects of education and are not due solely to differences that precede or explain education;
- the differences in health outcomes are important from a perspective of equity and also from a position of public finance and wider social well-being.

What is also found is that the effects of education on depression appear to be stronger than those of education on obesity.

Finally, whereas the effects of academic qualifications are robust across both cohorts those accruing to vocational qualifications may have waned somewhat. The lower statistical significance of findings for vocational qualifications than academic may be due

to the fact that the sample size for the vocational analysis are smaller than those for the academic analysis. Against this, it is pointed out that it is not just statistical significance that declines but also the magnitude of effects. This topic is left as an important avenue for future research.

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Appendix 1: The matching method

Statistical matching adjusts for differences in pre-treatment characteristics between treatment[21] and non-treatment groups by pairing to each treated unit a non-treated unit with the 'same' observable characteristics. In the propensity score approach adopted here matches are created on the basis of individuals' probabilities of receiving the treatment. The conditioning variables are used to create these probabilities, the propensity scores. The matching algorithm compares the average outcome of those with and without the treatment within a range of similar propensity scores. The range chosen here is 0.001. Thus, for example, those individuals with a probability of, say, between 50% and 50.1% of achieving the educational level considered are selected by the matching process. Each treated individual is matched with the untreated individual within that bandwidth that minimises the difference in propensity score.

For all matched pairs, the estimated effect of the treatment on the treated is the difference in the mean outcomes for the two groups. The choice of bandwidth is thus important. A small bandwidth guarantees a high quality match but increases the number of treated individuals who cannot be matched to control individuals and so are discarded. This reduces the precision of the estimation (higher standard errors). On the other hand, increasing the bandwidth is associated with an increase in bias (match of lower quality) and a reduction in the variance of the estimates (more matches).

The method compares the outcomes of individuals with similar background and personal characteristics, some of whom received the treatment and some of whom did not. The method is non-parametric, so no linearity assumptions are made and all background factors can interact. This improves the way in which confounding factors are dealt with and makes the implicit comparison between learners and non-learners more reliable. Assuming that all relevant differences between the two groups are captured by their observable characteristics, the average outcome experienced by the matched pool of non-treated individuals identifies the counterfactual outcome the treated individuals would have experienced, on average, had they not been treated.

So, to conclude, matching results can be considered to be more robust than regression results. Essentially, the method considers the results of learning once the differences between those who received the learning intervention and those who did not are taken into account. The remaining association is hypothesised to be the effect that would be expected if those who hadn't received the intervention then did so.

[21] The term 'treatment' is used here in the statistical sense, as a general term for participation in a programme that is to evaluated. Although, the method is strongly linked to the medical model of evaluation, there is no implication that the treatment be similar to that in medicine, or that those who participate will all receive an identical treatment.

The kind of confounding bias described above can also be thought of as 'selection bias', reflecting the idea that associations between education and health are not due to the effects of health but to the attributes, constraints and personalities of those who select in to the different education groups. The matching method attempts to match those in different groups on the basis of their background and other variables and so to compare the outcomes of similar people, some of whom received the additional education and some of whom did not.

Interpretation and caveats

The basic assumption of the matching method is that there is no selection on unobservables (i.e. factors not in the dataset.). What this means is that all the reasons for individuals to select into different academic or vocational levels must be observed and taken into account. If factors that influence selection are not observed and are also correlated with outcomes, then selection bias remains. The richness of these data means that a great deal of selection bias can be dealt with, but an unknown residual quantity undoubtedly remains. Thus, although these estimates are relatively robust, particularly compared to many others in the health literature, they are not perfect and they are not the final answer. This must be borne in mind.

It is emphasised, however, that subject to the assumption of the matching method, the effects estimated are those that could be expected disregarding differences between those with different levels of education, i.e. purged of selection bias. Thus, for example, the estimated effect of going from academic Level 0 to academic Level 4 is the predicted effect expected if people like those in the relevant cohort who had no qualifications were to attain Level 4. Now, clearly, this effect can only be hypothetical since the predicted effect would only happen if those in Level 0 could be brought up to Level 4 and it may be argued that the unobserved receptiveness, ability and social context of those at Level 0 are unlikely to make this scenario possible in many cases.

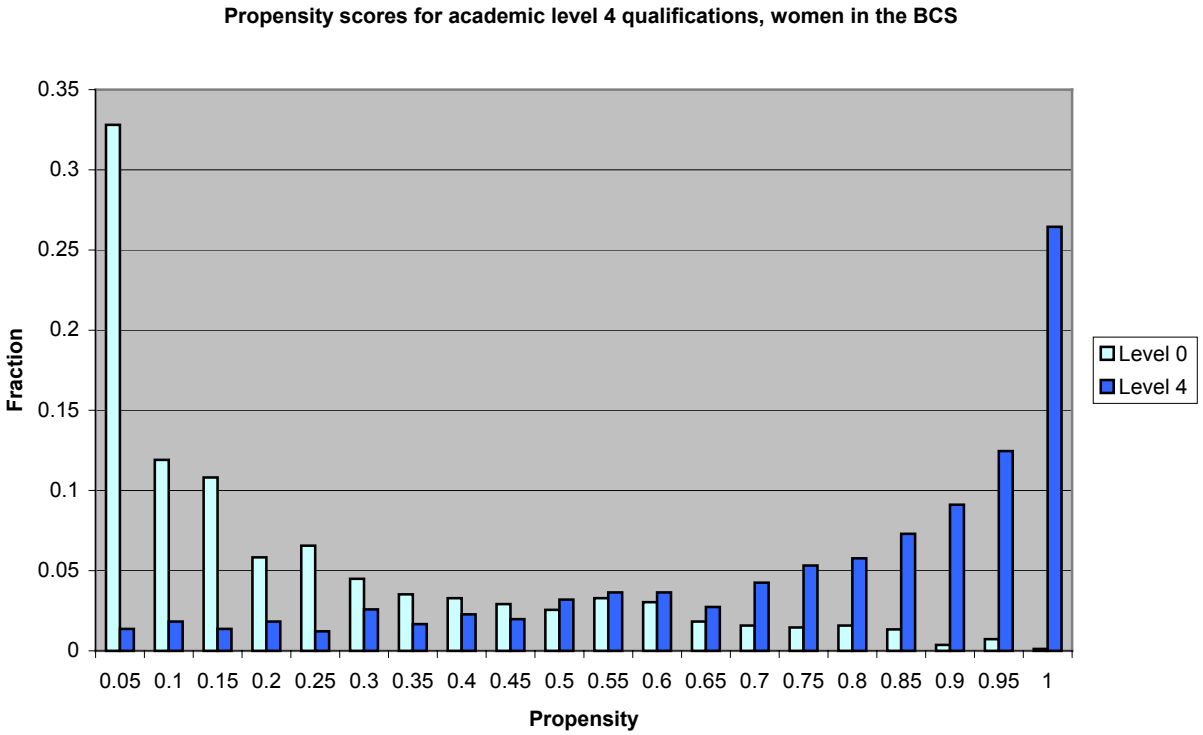
Moreover, it should be stressed that matching estimates may be biased if only a selected proportion of treated individuals are successfully matched to control individuals. In the above example, it is likely that only a few individuals achieving NVQ 4 will have matching characteristics with individuals with no qualifications. In this case, the matching will be based on a selected group of individuals; individuals with Level 4 and a relatively low propensity score will be matched to individuals with no education and a relatively high propensity score. In such a case, the assumption of selection on the observables is likely to be rejected. Matching estimates are likely to be the least biased when the distribution of propensity score is similar for the treated and the control populations.

The importance of these considerations is highlighted in Figures A1.1 and A1.2, which graph propensity scores; in the first figure for the probability of reaching Level 1 for those who did and those who didn't. For Figure A1.1, the histogram of scores is not very different for the two groups, suggesting that there will be good support for matching estimation. Certainly, there are many individuals who can be matched across the two groups.

This can be seen clearly by the comparison with Figure A1.2. This figure shows the two histograms for propensities to achieve Level 4 for those who stayed at Level 0 and those who achieved Level 4. Not surprisingly, there is little overlap between the two sets of propensities. Those who reached Level 4 had much higher propensities to do so than those who stayed at Level 0. Matching will, therefore, have to be based on very few observations, standard errors will be high and selection biases may remain.

Figure A1.1: Distribution of propensity score for Level 1, Women BCS

Figure A1.2: Distribution of propensity score for Level 4, Women BCS



Given these considerations, the costed benefits of all the estimated benefits of health are not developed. Section 4.3 describes the statistically significant findings from the matching method. These are results that do not depend on the particular sample selected but are thought to be representative. However, it is possible that they do result from a failure in the method to secure sufficient numbers of reliable matches. Therefore, Section 5 focuses only on those two key findings for which the matching method appears to have been particularly successful and not biased by selection on unobservables, i.e. that the implicit counterfactual seems plausible[22].

[22] In future work the matching results will be compared to those from linear regression models and also matching robustness tests will be applied.

Appendix 2: Classification of academic and vocational qualifications used in Section 4

Level of Qualification	General (Academic)	Vocationally related (Applied)	Occupational (Vocational)
4	Higher Degree Degree	BTEC Higher Certificate/Diploma HNC/HND	NVQ Level 5, NVQ Level 4 PGCE Professional degree level qualifications Nursing/Paramedic Other teacher training qualification City & Guilds Part 4/Career Ext/Full Tech RSA Higher Diploma
3	A Level AS Levels Scottish Highers Scottish Cert of 6th Year Studies	Advanced GNVQ BTEC National Diploma ONC/OND	NVQ Level 3 City & Guilds Part 3/Final/Advanced Craft RSA Advanced Diploma Pitmans Level 3
2	HE Diploma GCSE grade A*–C O Levels grade A–C O Levels grade D–E CSE grade 1 Scottish standard grade 1–3 Scottish lower or ordinary grades	Intermediate GNVQ BTEC First Certificate BTEC First Diploma	NVQ Level 2 Apprenticeships City & Guilds Part 2/Craft/Intermediate City & Guilds Part 1/Other RSA First Diploma Pitmans Level 2
1	GCSE grade D–G CSE grades 2–5 Scottish standard grade 4–5 Other Scottish school qualification	Foundation GNVQ Other GNVQ	NVQ Level 1, Other NVQ or units towards NVQ RSA Cert/Other Pitmans Level 1 Other vocational qualifications HGV

Appendix 3: Conditioning variables used in health matching models

1958 Cohort

	No .	Mean	s.d.	Min.	Max.
Health conditions, age 42					
Depressed	11419	0.14	0.35	0	1
Obese	10578	0.16	0.37	0	1
Respiratory problems	11419	0.28	0.45	0	1
Self reported health, good	11376	0.26	0.44	0	1
Self reported health, bad	11376	0.19	0.39	0	1
Exercise	11373	0.74	0.44	0	1
Childhood family background					
No of younger siblings	13415	1.03	1.07	0	6
No of older siblings	14270	1.31	1.54	0	10
Mother not interested in child's education	14967	0.22	0.41	0	1
Mother quite interested in child's education	14967	0.39	0.49	0	1
Mother very interested in child's education	14967	0.36	0.48	0	1
Father not interested in child's education	14945	0.52	0.50	0	1
Father quite interested in child's education	14945	0.22	0.42	0	1
Father very interested in child's education	14945	0.25	0.43	0	1
Mother stayed on at school	17358	0.25	0.43	0	1
Free school meals and overcrowding	18958	0.16	0.28	0	1
Not free school meals and overcrowding	18958	0.83	0.49	0	1
Father in manual occupation	18958	0.38	0.42	0	1
Father in intermediate occupation	18958	0.17	0.30	0	1
Father in professional occupation	18958	0.13	0.26	0	1
Father's occupation unknown	18958	0.33	0.40	0	1
Childhood ability					
Age 11 reading test score	14133	45.65	17.99	0	100
Age 11 maths test score	14129	41.57	25.88	0	100
Age 7 maths test score	14898	51.13	24.91	0	100
Age 7 reading test score	14847	53.98	19.66	0	100
Childhood medical, intellectual and emotional conditions					
Special school at 16	18958	0.03	0.17	0	1
General motor handicap	18958	0.009	0.10	0	1
General physical abnormality	18958	0.008	0.09	0	1
Mental retardation	18958	0.014	0.12	0	1
Emotional/behavioural problem	18958	0.017	0.13	0	1
Head and neck condition	18958	0.004	0.06	0	1
Upper limb condition	18958	0.008	0.09	0	1
Lower limb condition	18958	0.019	0.14	0	1
Spine condition	18958	0.005	0.07	0	1
Problem in respiratory system	18958	0.021	0.14	0	1
Problem in alimentary system	18958	0.003	0.05	0	1
Problem in urogenital system	18958	0.007	0.09	0	1
Heart condition	18958	0.007	0.08	0	1
Haematological condition	18958	0.002	0.05	0	1
Skin condition	18958	0.098	0.30	0	1
Epilepsy	18958	0.003	0.06	0	1
Other CNS condition	18958	0.003	0.05	0	1
Diabetes	18958	0.001	0.04	0	1

Eye condition	18958	0.094	0.29	0	1
Hearing defect	18958	0.023	0.15	0	1
Speech defect	18958	0.014	0.12	0	1
Other abnormal condition	18958	0.018	0.13	0	1

1970 Cohort

	No .	Mean	s.d.	Min.	Max.
Health conditions, age 30					
Depressed	11226	0.14	0.35	0	1
Obese	10477	0.12	0.32	0	1
Respiratory problems	11226	0.30	0.46	0	1
Self reported health, good	11176	0.27	0.44	0	1
Self reported health, bad	11176	0.15	0.36	0	1
Exercise	11169	0.79	0.41	0	1
Childhood family background					
Mother has NVQ 2 or equivalent	18617	0.25	0.43	0	1
Mother has NVQ 3 or equivalent	18617	0.06	0.23	0	1
Mother has NVQ 4 or equivalent	18617	0.02	0.13	0	1
Mother's NVQ Level unknown	18617	0.30	0.46	0	1
Father has NVQ 2 or equivalent	18617	0.26	0.44	0	1
Father has NVQ 3 or equivalent	18617	0.06	0.24	0	1
Father has NVQ 4 or equivalent	18617	0.07	0.26	0	1
Father's NVQ Level unknown	18617	0.30	0.46	0	1
Father in SES 1	18617	0.06	0.23	0	1
Father in SES 2	18617	0.19	0.39	0	1
Father in SES 3 non-manual	18617	0.08	0.27	0	1
Father in SES 3 manual	18617	0.41	0.49	0	1
Father in SES 4	18617	0.12	0.32	0	1
Father in SES 5	18617	0.10	0.31	0	1
Father in other SES group	18617	0.01	0.08	0	1
Father's SES unknown	18617	0.04	0.20	0	1
Overcrowding at 5	13135	0.05	0.22	0	1
No overcrowding at 5	13135	0.95	0.22	0	1
Childhood ability					
Age 5 copying test score	13137	58.60	25.20	0	100
Age 5 profile test score	13137	40.98	26.09	0	100
Age 5 vocab test score	13137	57.39	26.52	0	100
Age 10 self esteem	12520	0.00	1.00	–2.9	1.9
Age 10 attentiveness in school	12758	0.00	1.00	–3.1	2.1
Age 10 maths test score	11634	43.95	12.32	1	72
Age 10 reading test score	11642	40.23	12.68	0	65
Childhood medical, intellectual and emotional conditions					
Assessed by doctor at 10					
Abnormal facial and general appearance	18617	0.020	0.14	0	1
Skin condition	18617	0.070	0.26	0	1
Ear, nose or throat condition	18617	0.067	0.25	0	1
Upper respiratory condition	18617	0.024	0.15	0	1
Lower respiratory condition	18617	0.011	0.11	0	1
Cardiovascular condition	18617	0.012	0.11	0	1
Gastrointestinal condition	18617	0.007	0.08	0	1
Other abdominal condition	18617	0.009	0.09	0	1
Urogenital tract condition	18617	0.018	0.13	0	1
Neurological condition	18617	0.008	0.09	0	1
Musculo skeletal condition	18617	0.022	0.15	0	1
Endocrine condition	18617	0.005	0.07	0	1
Blood or lymphatic condition	18617	0.008	0.09	0	1
Mental handicap	18617	0.011	0.10	0	1
Behavioural or emotional problem	18617	0.022	0.15	0	1

Category of special educational needs treatment, form 4HP					
Partially sighted	18617	0.001	0.02	0	1
Deaf	18617	0.000	0.01	0	1
Partially hearing	18617	0.001	0.03	0	1
ESN (M)	18617	0.000	0.02	0	1
ESN (S)	18617	0.004	0.06	0	1
Epileptic	18617	0.002	0.04	0	1
Physically handicapped	18617	0.001	0.02	0	1
Speech defect	18617	0.002	0.04	0	1
Maladjusted	18617	0.001	0.03	0	1
Delicate	18617	0.001	0.03	0	1
Category of special educational needs treatment, form SE2					
Vision problem	18617	0.000	0.01	0	1
Hearing	18617	0.001	0.04	0	1
Speech and language problem	18617	0.001	0.02	0	1
Motor function problem	18617	0.002	0.04	0	1
Physical health problem	18617	0.001	0.03	0	1
Behavioural or emotional problem	18617	0.001	0.03	0	1
Intellectual development	18617	0.003	0.06	0	1
Unable to care for self	18617	0.006	0.08	0	1

Appendix 4: Full estimation results

Notes to Appendix 4

Tables 1 and 2 of this Appendix show the relation between academic/vocational qualifications and health, assessed in terms of (1) Depression and (2) Obesity.

For each outcome two panels are presented, the first showing results for the 1958 cohort, the second for the 1970 cohort.

For each panel, results are given separately for men and women and for academic and vocational qualifications, giving four columns to each panel. Within each column one further separation is made. This is the distinction between raw differences and estimated effects. The raw differences are those in health outcomes for the groups identified in the row. The estimated effects are the results of the matching procedure described in Section 4.2 of the main report. (Sample sizes for the estimates are given in Table 3.) Missing cells indicate matches where the matching algorithm failed to distinguish sufficient numbers of treated and untreated individuals with similar enough propensity scores.

In each panel, seven rows of results are presented, one for each comparison made as indicated in the first column, e.g. between those with Level 0 qualifications and Level 1 qualifications.

As well as the estimated difference between the indicated groups, t-statistics are reported in brackets. Readers are reminded that a high t-statistic means that the association or effect is statistically different from zero. More formally, a high t-statistic indicates that the difference between the two specified groups is statistically significant and that the null hypothesis that the two groups are identical is to be rejected. Because there is no hypothesis that education or training reduces health, the test of the hypothesis of health benefits is taken to be a one-tailed test. Therefore, the critical values of the t-statistic are as follows:

10% significance if $t \geq 1.28$
5% significance if $t \geq 1.65$
1% significance if $t \geq 2.33$

For example, if a t-statistic of greater than 2.33 is indicated, then the associated raw correlation or estimated effect can be considered to be statistically significant at 1%, i.e. there is less than one chance in 100 that the true difference is actually zero and that the observed difference is due to sampling variation.

Sample sizes for the estimates are given in Table 3.

Appendix 4: Table 1. Education and depression

1958 cohort

	Men				Women			
	Academic		*Vocational*		*Academic*		*Vocational*	
Level	Diff.	Effect	Diff.	Effect	Diff.	Effect	Diff.	Effect
0 to 1	–5.29	–4.06	–6.21	–4.37	–9.83	–6.08	–6.97	–6.21
		1.68		1.95		2.06		2.43
0 to 1+	–9.05	–5.59	–6.27	–3.44	–14.75	–7.23	–8.85	–4.12
		2.33		2.02		2.31		2.28
1 to 2	–3.66	–2.91	2.22	–0.46	–3.96	–0.82	–1.78	1.08
		1.42		0.15		0.33		0.35
1 to 2+	–4.72	–1.47	–0.08	–0.72	–5.95	–9.07	–2.79	–2.97
		0.59		0.37		2.48		1.28
2 to 3	–3.84	–1.66	–2.65	–1.09	–5.26	–3.69	–1.29	–0.69
		0.80		0.44		1.55		0.22
2 to 3+	–2.56	–1.68	–3.09	–1.55	–5.61	–1.14	–1.52	–0.94
		0.99		0.67		0.60		0.36
3 to 4	1.86	–0.56	–1.16	–1.83	–0.56	–0.42	–0.46	0.48
		0.28		0.77		0.18		0.15

1970 cohort

	Men				Women			
	Academic		*Vocational*		*Academic*		*Vocational*	
Level	Diff.	Effect	Diff.	Effect	Diff.	Effect	Diff.	Effect
0 to 1	–1.35	–1.58	–2.51	2.38	–4.16	–10.17	–4.77	–2.34
		0.43		0.79		2.48		0.88
0 to 1+	–6.01	–6.30	–3.19	–0.92	–9.15	–5.65	–4.49	–4.29
		2.73		0.39		2.36		1.83
1 to 2	–3.39	1.19	0.48	3.57	–4.63	–0.07	2.39	3.70
		0.36		1.14		0.02		1.17
1 to 2+	–5.36	–5.20	–0.88	–2.89	–5.57	–4.89	0.45	3.41
		1.40		1.07		1.27		1.43
2 to 3	–2.18		–1.04	0.49	1.95	–0.88	–1.49	–0.94
				0.16		0.25		0.28
2 to 3+	–4.79	–3.84	–1.88	0.20	–2.56	2.39	–3.15	–0.79
		1.66		0.07		1.07		0.25
3 to 4	–3.15	–6.17	–3.88	–1.29	–5.66	–4.90	–5.32	–2.73
		1.81		0.39		1.33		0.69

Note: The 'Diff' column reports raw differences in health outcomes for the groups identified in the row. The estimated effects are the results of the matching procedure described in Section 4.2 of the main report. See 'Notes to Appendix 4'.

Appendix 4: Table 2. Education and obesity

1958 cohort

	Men				Women			
	Academic		*Vocational*		*Academic*		*Vocational*	
Level	Diff.	Effect	Diff.	Effect	Diff.	Effect	Diff.	Effect
0 to 1	–3.97	–4.71	0.15	–0.52	–2.48	0.00	–4.03	–5.14
		1.65		0.19		0.00		1.97
0 to 1+	–7.70	–4.98	–2.88	–1.32	–8.40	2.11	–2.73	–0.45
		1.72		0.69		0.76		0.25
1 to 2	–2.97	–0.65	–2.00	0.56	–5.34	–3.29	2.95	2.39
		0.26		0.16		1.20		0.77
1 to 2+	–4.67	0.32	–4.22	0.07	–7.14	–2.90	1.94	4.43
		0.11		0.03		0.93		1.88
2 to 3	–2.28	0.66	–2.56	–3.83	–2.61	1.78	–2.91	–4.64
		0.01		1.13		0.76		1.21
2 to 3+	–4.04	–1.08	–3.02	–5.48	–5.10	–2.82	–1.53	2.91
		0.53		1.75		1.52		0.39
3 to 4	–2.56	–7.29	–1.20	4.18	–3.98	–3.47	2.83	6.45
		2.24		1.44		1.35		1.83

1970 cohort

	Men				Women			
	Academic		*Vocational*		*Academic*		*Vocational*	
Level	Diff.	Effect	Diff.	Effect	Diff.	Effect	Diff.	Effect
0 to 1	–3.46	–6.51	0.25	0.49	0.82	2.23	–1.35	0.46
		2.11		0.17		0.67		0.20
0 to 1+	–4.61	–4.38	–1.22	–1.73	–3.55	0.22	–1.30	–0.90
		2.30		0.97		0.12		0.48
1 to 2	–0.36	–1.26	0.25	3.38	–2.76	–0.88	–0.70	1.64
		0.44		1.08		0.25		0.55
1 to 2+	–1.32	–0.51	–1.92	1.63	–4.89	0.00	0.09	1.10
		0.15		0.67		0.00		0.54
2 to 3	–0.20	1.39	–2.45	–2.26	–3.19	–3.35	2.09	–0.73
		0.37		0.81		1.01		0.24
2 to 3+	–2.41	–1.08	–3.02	–1.86	–5.71	–5.65	1.27	0.54
		0.56		0.71		2.93		0.19
3 to 4	–2.65	1.72	–2.75	–5.64	–3.16	–2.48	–2.59	3.25
		0.49		1.63		0.83		0.75

Note: The 'Diff' column reports raw differences in health outcomes for the groups identified in the row. The estimated effects are the results of the matching procedure described in Section 4.2 of the main report. See 'Notes to Appendix 4'.

Appendix 4: Table 3. Sample sizes for matching

1958 cohort

	Men				Women			
	Academic		*Vocational*		*Academic*		*Vocational*	
Level	Total	Treated	Total	Treated	Total	Treated	Total	Treated
0 to 1	1201	897	1468	740	1073	808	2131	732
0 to 1+	5608	4408	4091	2624	5774	4702	4366	2236
1 to 2	2955	2058	1222	482	3327	2519	1239	507
1 to 2+	4408	3511	2624	1884	4702	3894	2236	1504
2 to 3	2517	459	1356	874	3030	511	1012	505
2 to 3+	3511	1453	1884	1402	3894	1375	1504	997
3 to 4	1453	994	1402	528	1375	864	997	492

1970 cohort

	Men				Women			
	Academic		*Vocational*		*Academic*		*Vocational*	
Level	Total	Treated	Total	Treated	Total	Treated	Total	Treated
0 to 1	1294	392	1138	475	1194	366	1272	887
0 to 1+	4418	3125	3250	2113	4742	3549	3518	2247
1 to 2	1999	1607	929	454	2357	1991	1391	504
1 to 2+	3125	2733	2113	1638	3549	3183	2247	1360
2 to 3	1801	194	1389	935	2235	244	1092	588
2 to 3+	2733	1126	1638	1184	3183	1192	1360	856
3 to 4	1126	932	1184	249	1192	948	856	268

WIDER BENEFITS OF LEARNING RESEARCH REPORT NO. 6

Quantitative Estimates of the Social Benefits of Learning, 2: Health (Depression and Obesity)

In this report, information from the latest sweeps of the UK national cohorts is used to estimate the magnitude of the effects of learning on depression and obesity. The estimated effects of education have then been linked to studies of the social costs of ill health, in order to make progress in the task of evaluating the health benefits of learning.

Findings show that the sizable differences in health observed for those with different levels of education are partially due to the effects of education and are not due solely to differences that precede or explain education. Moreover, these differences in health outcomes are important from a perspective of public finance as well as in terms of equity and wider social well-being.

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