Trajectories of self-rated health before and after retirement: Evidence from two cohort studies

Sari Stenholm[1, 2], Marianna Virtanen[3, 4], Jaana Pentti[1, 2, 5], Tuula Oksanen[6], Mika Kivimäki[5, 6, 7], Jussi Vahtera[1, 2]

[1] Department of Public Health, University of Turku and Turku University Hospital, Turku, Finland;
[2] Centre for Population Health Research, University of Turku and Turku University Hospital, Finland;
[3] School of Educational Sciences and Psychology, University of Eastern Finland, Joensuu, Finland;
[4] Stress Research Institute, Stockholm University, Stockholm, Sweden;
[5] Clinicum, Faculty of Medicine, University of Helsinki, Finland;
[6] Finnish Institute of Occupational Health, Turku and Helsinki, Finland;
[7] Department of Epidemiology and Public Health, University College London, London, UK;

Word count: 3394

Correspondence:
Prof. Sari Stenholm
Department of Public Health, University of Turku, Finland
Email: sari.stenholm@utu.fi
Tel: +358 50 465 1745
ORCID: orcid.org/0000-0001-7560-0930

KEY MESSAGES

What is already known about this subject?

- Retirement is associated with removal of work-related stressors and increase in time availability and flexibility.
- Recent studies have reported positive changes in leisure-time physical activity and sleep after retirement, but inconsistent findings have been reported for perceived general health and mental health.

What are the new findings?

- Based on latent trajectory analysis, a large majority of public sector employees maintain their perceived health status during retirement transition and smaller subgroups of people show improvement or decline in health.
- Changes in self-rated health during retirement transition relate mainly to occupational status and work-related stress factors.

How might this impact on policy or clinical practice in the foreseeable future?

- Health development before and after retirement could be supported by paying more attention to people in lower occupational status or with physically and mentally strenuous work.

ABSTRACT

Objectives: Previous studies have produced conflicting findings on the health consequences of retirement. We aimed at identifying trajectories of self-rated health over retirement transition using repeated measurements and examined which pre-retirement factors predicted the membership to each trajectory.

Methods: The study population consisted of Finnish public sector employees from two independent cohorts (Finnish Public Sector study (FPS) n=5,776 with 4-year follow-up interval and Finnish Retirement and Aging study (FIREA) n=2,796 with 1-year follow-up interval). Both cohorts included assessment of self-rated health one to three times before and one to three times after retirement (average number of measurement points 3.7 in FPS and 3.5 in FIREA). We used latent trajectory analysis to identify trajectories of self-rated health.

Results: In both cohorts four similar trajectories were identified: 'Sustained good health' (47% in FPS and 74% in FIREA), 'From good to suboptimal health' (19% and 6%), 'From suboptimal to good health' (14% and 8%) and 'Sustained suboptimal health' (20% and 12%). There were more women and persons in high occupational status in the 'From suboptimal to good health' trajectory when compared to 'Sustained suboptimal health' trajectory group in FPS. Those in the trajectory 'From good to suboptimal health' had lower occupational status and more job strain in comparison to those in the 'Sustained good health' trajectory in both cohorts.

Conclusions: Large majority of public sector employees maintain their perceived health status during retirement transition. Adverse trajectory in self-rated health relate to low occupational status and work-related stressors.

Key words: aging, cohort, retirement, self-rated health, trajectory

INTRODUCTION

Retirement is a life transition in late adulthood accompanied by removal of work-related activities, roles and stressors as well as reduced income and increase in time availability and flexibility. Increasing number of studies have examined the effect of retirement on physical and mental health, but the results have been inconsistent [1], some studies suggesting improved perceived general health [2-5] and mental health [6-10], while other studies have found negative or no changes in health after retirement [9, 11, 12].

The mixed findings on the health changes associated with retirement may stem from the wide variation in study designs (e.g. different follow-up time), study populations and retirement ages due to different pension policies across countries. They may also reflect differences in health status, living situation and strain experienced at work among those who are retiring, which may influence on the health development during retirement transition. For example, there is evidence that retirement may provide health benefits for less educated workers [13], for those retiring from lower occupational status and physically or psychologically demanding work [2], and for those with depression or physical illness [2].

Previous studies have examined health development separately by educational or occupational groups or based on the strenuousness of the work [2, 13], an approach which does not take into account the possibility that there can be multiple underlying factors which characterize the health developmental trajectories. An alternative approach is to use data-driven approach, e.g. latent trajectory analysis, which takes into account unobserved characteristics of the participants and enables

identification of homogenous subgroups. i.e. health trajectories, within the study population [14].

To provide new insights into health development during retirement transition, the aim of this this study was to identify trajectories of suboptimal self-rated health using repeated measurements around retirement. Two independent occupational cohorts were utilized to examine differences in trajectories when using different follow-up intervals. We also examined which sociodemographic and work-related factors predicted the membership of each trajectory.

METHODS

Study population

Data were from two occupational cohort studies from Finland, namely the Finnish Public Sector Study (FPS) and the Finnish Retirement and Aging Study (FIREA), in which the survey data has been collected during working years and after retirement.

FPS comprises a dynamic cohort of employees entering and leaving the service of ten municipalities and 5 hospital districts, representing more than 20% of Finland's public sector employees. In addition to the employer registers, repeat survey data have been collected every four years among the entire personnel employed at the time of the survey since 1997-98 and among all employees who had left the organizations after responding to a previous questionnaire [15]. For the current study, we used data from the surveys conducted in 2000–02, 2004, and 2008 for participants employed in the target organisations and 2005, 2009, and 2013 for those who had left the organisations (n=81,587), of whom 9,433 had moved to

statutory retirement in 2000-2011. We included retirees with at least one survey response before and after statutory retirement (n=5,898). We further restricted the study population to those who had information on self-rated health before and after retirement (n=5,776). The selection of the study population is described in detail elsewhere [16]. Participants provided data on self-rated health at 3.7 (SD 0.6) of the possible four study waves during a follow-up of 8-12 years.

FIREA is an ongoing study of ageing public sector employees in Finland, which includes employees whose estimated individual retirement date is between 2014 and 2019, and who were working in one of the 27 municipalities in Southwest Finland or in the 9 selected cities or 5 hospital districts around Finland in 2012 [17]. Information on the estimated individual retirement date from the municipal employer was obtained from the pension insurance institute for the municipal sector in Finland (Keva). Participants were first contacted 18 months prior to their estimated retirement date by sending a questionnaire, which was thereafter sent annually, four times in total. By the end of 2018, 6,783 of the FIREA cohort members had responded to at least one questionnaire and of them 5,603 had responded at least twice to questionnaires, 2,820 both prior and after the actual retirement date (2013-2018). Of them 2,796 had information on self-rated health before and after retirement, and they were included in the study. Participants provided data on self-rated health at 3.5 (SD 0.8) of the possible six study waves in the FIREA study during a follow-up of 2-6 years. The FIREA participants included in the current study do not overlap with participants of the FPS Study.

The FPS was approved by the Ethics Committee of the Hospital District of Helsinki and Uusimaa and the FIREA by the Ethics Committee of Hospital District of Southwest Finland.

Retirement

For the FPS, data on retirement were obtained from the Finnish Centre for Pensions, which coordinates all the earnings-related pensions for permanent residents in Finland [18]. The start dates for any pension were obtained for all participants and retirement age was calculated by using their birth date. We focused on those persons who had retired at the statutory retirement age (i.e. old age retirement) as their first awarded pension scheme, thus excluding those participants who retired part-time or on a health grounds or due to unemployment, because these types of retirement are endogenous and can cause bias in the results when the outcome is self-rated health.

For the FIREA, data on retirement was based on self-reported date inquired in the survey. Retirement age was calculated using retirement date and birth date. Since FIREA participants were first contacted close to their estimated statutory retirement age and had to be working to be eligible for the study, large majority of the FIREA participants retired based on their age and not due to disease.

Self-rated health

In both studies, self-reported health was assessed by asking participants to rate their overall health status on a five-point scale (1=good, 2=rather good, 3=average, 4=rather poor, 5=poor). A dichotomous “self-rated health” variable was created by classifying the replies into good (good or rather good) and suboptimal (average, fairly poor, poor).

Sociodemographic and work-related factors

Information on participants' sex and occupational title were obtained from the employers' registers in the FPS and from the pension insurance institute for the FIREA. The occupational titles of the last occupation preceding retirement were coded according to the International Standard Classification of Occupations (ISCO) and categorized into three groups: high (ISCO classes 1-2 e.g., teachers, physicians), intermediate (ISCO classes 3-4 e.g., registered nurses, technicians), and low (ISCO classes 5-9 e.g., cleaners, maintenance workers). The ISCO was also used together with validated gender-specific job exposure matrix for physical exposures to identify physically heavy work (no vs. yes) [19, 20]. In both studies, information from the last questionnaire before retirement was used to measure job strain. By using job control and job demands scales from the shorter version of the Job Content Questionnaire and median values from each cohort, we identified participants with job strain (a high demands and a low control score) (no vs. yes) [21, 22].

Confounders

In both studies, information from the last questionnaire preceding retirement was used to define smoking status (no vs. yes), alcohol risk use (no vs. yes (>24 units for men and >16 units for women) [23], low physical activity (no vs. yes (<14 Metabolic Equivalent (MET)) [24], and body mass index (BMI, normal weight <25 kg/m^2, overweight ≥25 to <30 kg/m^2 and obese ≥30 kg/m^2).

Statistical Analysis

Cohort specific characteristics of the participants before retirement are presented as frequencies and proportions for categorical variables and as means and SDs for continuous variables.

To illustrate the development of self-rated health at population level throughout the retirement transition in both study cohorts, we calculated prevalence estimates and their 95% confidence intervals (CI) for suboptimal health in each study wave around retirement by using log-binominal regression analyses with generalised estimating equations (GEE). In the FPS Study the study waves were four years apart and in the FIREA Study one year apart. The GEE models control for the intra-individual correlation between repeated measurements using an exchangeable correlation structure and are not sensitive to measurements missing completely at random [25, 26]. These analyses were adjusted for sex, age and occupational status.

To examine the heterogeneity in the health development throughout the retirement transition, we identified trajectories of suboptimal self-rated health using latent trajectory analysis in both study cohorts. This approach enables identifying distinctive groups of individuals who show similar developmental trajectories over time [27]. We used PROC TRAJ to estimate latent trajectories in the statistical software SAS 9.4 (SAS Institute Inc., Cary, NC, USA). We used Nagin's two-step procedure to determine the optimal number trajectories and choose the number and order of regression parameters [27]. In the first step, we fitted increasing number of trajectory models with cubic polynomial shape for suboptimal self-rated health until

no improvement in model fit was observed. Assessment of model fit was based on Bayesian information criterion values (BIC), Akaike information criterion values (AIC), Log-likelihood and posterior probabilities. Model fit statistics for the one to six trajectory solutions are presented in Supplementary Table 1. In the second step, we tested models with quadratic and linear trajectories for the selected model chosen in the first step. In both study cohorts, a four trajectory solution with the best fit was selected. In addition, three groups had a cubic and one group a linear order in the model.

Finally, to examine which pre-retirement factors best characterize membership of different trajectory groups, we used multinomial logistic regression analysis to calculate odds ratios (OR) and 95% CIs for each pre-retirement factor (sex, age at retirement, occupational status, job strain and heavy physical work). From this analysis we report two comparisons: the ‘Sustained good health’ trajectory group with the ‘From good to suboptimal health’ trajectory group, and the ‘Sustained suboptimal health’ trajectory group with the ‘From suboptimal to good health’ trajectory group. The model was adjusted for gender, retirement age, smoking, alcohol use, physical activity and BMI measured before retirement.

All analyses were performed using statistical software SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

RESULTS

In both cohorts the majority of the participants were women (80% in FPS and 84% in FIREA) and about third of the participants were in the lower occupational status. The

average retirement age was 61.9 (SD 2.0) in FPS and 63.8 (SD 1.3) in FIREA. Work-related characteristics before retirement were very similar in both cohorts (Table 1).

First, we examined population mean prevalence of suboptimal health before and after retirement (Figure 1). The proportion of those with suboptimal health before retirement was higher in FPS (35%) than in FIREA (25%). The prevalence of suboptimal health decreased by 11% in the FPS with prevalence ratio (PR) of 0.71 (95% 0.68-0.74) during 4-year interval window around transition to retirement and by 5% in the FIREA with PR of 0.80 (95% CI 0.75-0.86) during 1-year window around transition.

We then identified four different health trajectories in both cohorts (Supplementary Table 1), which are shown in Figure 2. Predicted probabilities of trajectory group membership ranged from 0.70-0.89 in the FPS and 0.69-0.94 in the FIREA. In both cohorts, the largest the trajectory was ‘Sustained good health’ (47% FPS and 74% FIREA). The second largest trajectory was ‘From good to suboptimal health’ indicating a group of people whose probability of reporting suboptimal health increased over time (19% FPS and 6% FIREA). This increase was seen already before retirement, the trend levelled off during the retirement transition and further increased after retirement. The third trajectory was ‘From suboptimal to good health’ indicating a group of people with suboptimal health before retirement followed by an improvement in health during retirement transition (14% FPS and 8% in FIREA). The fourth trajectory was ‘Sustained suboptimal health’ which included individuals who had constantly suboptimal health (20% FPS and 12% FIREA).

Pre-retirement characteristics associated with the four selected trajectories are presented in Table 2. There were more men in the ‘Sustained suboptimal health’

trajectory group compared to other groups in FPS, but no gender difference across trajectory groups was observed for FIREA. High occupational status was most common in the ‘Sustained good health’ trajectory group and low occupational status most common in the ‘Sustained suboptimal health’ trajectory group in both cohorts. Job strain was most common in the ‘Sustained suboptimal health’ and ‘From suboptimal to good health’ trajectory groups in both cohorts. Physically heavy work was most common in the ‘Sustained suboptimal health’ and ‘From suboptimal to good health’ trajectory group in both cohorts. Smoking, low physical activity and obesity were less common in the ‘Sustained good health’ trajectory group.

Next, we examined how sociodemographic and work-related factors differed between trajectory groups in FPS and FIREA study populations (Table 3). We focused on two sets of comparisons. First, among those whose pre-retirement health was suboptimal, being female and higher occupational status were associated with greater likelihood of belonging to the ‘From suboptimal to good health’ trajectory group when compared to ‘Sustained suboptimal health’ trajectory group in FPS. In FIREA, the point estimates were towards the same direction but did not reach statistical significance. Secondly, among those whose pre-retirement health was good, lower occupational status, more job strain and physically heavy work were associated with the trajectory ‘From good to suboptimal health’ in comparison to the trajectory ‘Sustained good health’ while no gender difference was observed between these trajectories in FPS. In FIREA, similar associations were found for occupational status and job strain than in the FPS, although job strain did not quite reach statistical significance.

DISCUSSION

In this study based on two large cohorts of public sector employees, we found that most employees (47-74 %) sustain their good health and approximately 20% sustain suboptimal health throughout retirement transition. We also observed smaller subgroups of people whose health improved (8-14%) and declined (6-19%) during the retirement transition. Our findings provide further clarification to the conflicting evidence on health effects of retirement and show that this single-item measure of self-rated health is a useful and sensitive tool in capturing changes in persons' health development in retirement.

We compared the two health trajectories of those who perceived their health status as suboptimal before retirement. We found that people whose suboptimal health sustained throughout the retirement transition, had lower pre-retirement occupational status than those whose health improved, but no difference was found in terms of work-related stressors. The association with low occupational status is an important finding and it was not explained by removal of work-related strain after retirement. It is well known that lower occupational status is associated with higher prevalence of several chronic conditions, e.g. cardiovascular and musculoskeletal diseases [28, 29], thus people with low occupational status probably had chronic conditions already before retirement and therefore their health remained suboptimal also after retirement. Our findings somewhat disagree with findings from French GAZEL cohort which showed that perceived health problems are substantially relieved for those with low occupational status, high work demands and low satisfaction at work [2]. However, the retirement age in the GAZEL study population was markedly lower, around 55 years, and the occupations were also different than in our study, which may partly explain differences in the study findings. Moreover,

the results of the French study were based on a different analytical approach than ours as they reported average changes in suboptimal health before and after retirement in pre-specified groups, and our analyses was based on latent trajectory analyses. Previous studies have reported that transition to retirement associates with an improvement in mental health [8, 10], increase in physical activity [30] as well as decrease in sleep difficulties [16, 31] and in BMI [20], which may partly mediate the improved health perception after retirement especially among those with higher occupational status.

We also compared the two trajectories characterized by initially good pre-retirement health. One of these showed decline in health during the follow-up, while the other one sustained good health throughout retirement transition. The former was characterized by lower occupational status, more job strain and physically more demanding work. From the policy perspective, it would be important to find ways to reduce job strain and physical strenuousness of work among older workers with lower occupational position in order to support health already during the final working years and further into retirement.

The outcome of interest in the current study was self-rated health, which is a global measure of health status widely used in epidemiological research. Self-rated health measure has been shown to be associated with several health-related outcomes, such as disease status, health behaviors, symptoms [32] and even abnormalities in biomarkers [33]. Health status measured with a single-item question has also shown to be significantly and independently associated with subsequent health events, including functional decline [34], physician visits [35], hospital episodes [36] and mortality [37, 38]. For the current study we used binary self-rated

health as an outcome, which is commonly used in the previous studies enabling comparison of the population-level trajectories [2, 4].

A unique feature of our study is that it was based on two independent, but still very comparable cohorts. In both studies, the study population consists of Finnish public sector workers, with very similar characteristics and identical survey measures. The only marked difference between the cohorts is that the FIREA surveys are conducted annually and the FPS surveys every two to four years. This gave us an excellent opportunity to examine short- and long-term changes in health during the retirement transition. Based on the population-level examination, improvement in health was observed in both cohorts, both during the 1-year transition window in the FIREA and the 4-year transition in the FPS. However, the prevalence of suboptimal health was almost 10 percent points higher in the FPS than in the FIREA study despite the fact that FPS participants retired on average two years earlier than FIREA participants. These differences may reflect improved health status of older workers and their tendency to work longer than previous cohorts, as FPS participants had retired in 2000-2011 and FIREA participants in 2013-2018. Despite the differences in prevalence estimates for suboptimal health, the latent trajectory analyses produced similar solutions in both cohorts, which suggests that for those people whose health changes during retirement transition, the relief seems to be quite immediate after retirement. Regarding the long term health effects of retirement, all other trajectories showed relatively stable health development after retirement, but “From good to suboptimal health” trajectory showed health deterioration several years after retirement. This is most likely driven by incidence of chronic diseases and is independent of retirement.

A major advantage of the present investigation over previous studies is that we utilized longitudinal, data-driven trajectory modelling of health, whereas previous longitudinal studies have produced pre-defined mean estimates for health before and after retirement based on regression models, such as GEE, which does not take into account the possibility that individuals may have different developmental trajectories. To examine differences between these two analytical approaches, we also utilized GEE modelling and observed that at the population level suboptimal health decreased, i.e. perceived health improved, during retirement transition which concurs with findings from the French [2] and Japanese [4] studies which are based on repeated health measurements before and after retirement. When using the latent trajectory analysis, we observed that many people had stable health over retirement transition and some people even declined in their health status.

The study has also some limitations that warrant discussion. The cohorts consisted of public sector employees from Finland who moved into statutory retirement, thus they were healthy enough to continue working until age-based retirement. Although majority of the study participants were female, this represents well public sector work in the Nordic welfare [39] but the generalizability of the findings to other industries, retirement types and other countries may be limited. Information on physical strenuousness of the participants' work was derived from the gender-specific job exposure matrix (JEM) for physical exposure, which is based on occupational title codes. The JEM is a relatively crude measure of work exposure and therefore not able to capture between-worker variance in similar occupations, which may lead to biased estimates. However, the JEM used in the current study has been constructed based on representative Finnish data and the matrix was found to have relatively high specificity without compromising sensitivity [19].

Further studies are warranted to confirm these findings in other occupational cohorts and other countries. In addition, it would be useful to examine health development for people retiring at different ages, from different reasons (e.g. disability, part-time) and with different pension benefits, which would help in understanding better the interrelationship between timing and ways of retirement and health development with advancing age.

In conclusion, longitudinal modelling of repeated data showed that the majority of the participants retiring on a statutory basis at average age of 62-64 years sustained their pre-retirement health level (either good or suboptimal). This study also identified a group of people whose health improved or declined. Especially, individuals with lower occupational status, physically strenuous work and job strain are at risk of health decline during the retirement transition years. More attention should be paid to people in these risk groups to support their health development before and after retirement.

Contributors: SS, JV and MK conceived and designed the studies and designed the data collections. SS analyzed the data and drafted the first manuscript, with critical revisions from MV, JP, TO, MK and JV. All authors approved the final version of the manuscript.

Funding: This study was financially supported by the Academy of Finland (grant numbers 286294, 294154 and 319246 to SS), the Finnish Work Environment Fund

(118060 to SS and 117094 to TO). MK was supported by NordForsk, the Academy of Finland (311492) and Helsinki Institute of Life Science.

Competing interests: None declared.

Patient consent: Obtained.

Ethics approval: FPS was approved by the Ethics Committee of the Finnish Institute of Occupational Health. FIREA was approved by the Ethics Committee of Hospital District of South-West Finland.

References

1. van der Heide I, van Rijn RM, Robroek SJ, Burdorf A, Proper KI. Is retirement good for your health? A systematic review of longitudinal studies. BMC Public Health. 2013;13:1180.
2. Westerlund H, Kivimäki M, Singh-Manoux A, Melchior M, Ferrie JE, Pentti J, et al. Self-rated health before and after retirement in France (GAZEL): a cohort study. Lancet. 2009;374(9705):1889-96.
3. Syse A, Veenstra M, Furunes T, Mykletun RJ, Solem PE. Changes in Health and Health Behavior Associated With Retirement. J Aging Health. 2017;29(1):99-127.
4. Oshio T, Kan M. The dynamic impact of retirement on health: Evidence from a nationwide ten-year panel survey in Japan. Prev Med. 2017;100:287-93.
5. Zhu R. Retirement and its consequences for women's health in Australia. Soc Sci Med. 2016;163:117-25.
6. Jokela M, Ferrie JE, Gimeno D, Chandola T, Shipley MJ, Head J, et al. From midlife to early old age: health trajectories associated with retirement. Epidemiology. 2010;21(3):284-90.
7. Westerlund H, Vahtera J, Ferrie JE, Singh-Manoux A, Pentti J, Melchior M, et al. Effect of retirement on major chronic conditions and fatigue: French GAZEL occupational cohort study. BMJ. 2010;341:c6149.
8. Oksanen T, Vahtera J, Westerlund H, Pentti J, Sjösten N, Virtanen M, et al. Is retirement beneficial for mental health?: antidepressant use before and after retirement. Epidemiology. 2011;22(4):553-9.
9. Mein G, Martikainen P, Hemingway H, Stansfeld S, Marmot M. Is retirement good or bad for mental and physical health functioning? Whitehall II longitudinal study of civil servants. Journal of epidemiology and community health. 2003;57(1):46-9.
10. Fleischmann M, Xue B, Head J. Mental health before and after retirement – assessing the relevance of psychosocial working conditions: the Whitehall II prospective study of British Civil Servants. 2019.
11. Ekerdt DJ, Bosse R. Change in self-reported health with retirement. Int J Aging Hum Dev. 1982;15(3):213-23.
12. van Solinge H. Health Change in Retirement A Longitudinal Study among Older Workers in the Netherlands. Research on Aging. 2007;29(3):225-56.
13. Schuring M, Robroek SJ, Lingsma HF, Burdorf A. Educational differences in trajectories of self-rated health before, during, and after entering or leaving paid employment in the European workforce. Scand J Work Environ Health. 2015;41(5):441-50.
14. Collins LM, Lanza ST. Latent Class and Latent Transition Analysis: Hoboken, NJ: John Wiley & Sons, Inc; 2010.
15. Kivimäki M, Hamer M, Batty GD, Geddes JR, Tabak AG, Pentti J, et al. Antidepressant medication use, weight gain, and risk of type 2 diabetes: a population-based study. Diabetes Care. 2010;33(12):2611-6.
16. Myllyntausta S, Salo P, Kronholm E, Pentti J, Kivimaki M, Vahtera J, et al. Changes in Sleep Difficulties During the Transition to Statutory Retirement. Sleep. 2018;41(1).
17. Leskinen T, Pulakka A, Heinonen OJ, Pentti J, Kivimaki M, Vahtera J, et al. Changes in non-occupational sedentary behaviours across the retirement transition:

the Finnish Retirement and Aging (FIREA) study. J Epidemiol Community Health. 2018;72(8):695-701.
18. Suoyrjö H, Oksanen T, Hinkka K, Kivimäki M, Klaukka T, Pentti J, et al. The effectiveness of vocationally oriented multidisciplinary intervention on sickness absence and early retirement among employees at risk: an observational study. Occup Environ Med. 2009;66(4):235-42.
19. Solovieva S, Pehkonen I, Kausto J, Miranda H, Shiri R, Kauppinen T, et al. Development and validation of a job exposure matrix for physical risk factors in low back pain. PLoS One. 2012;7(11):e48680.
20. Stenholm S, Solovieva S, Viikari-Juntura E, Aalto V, Kivimaki M, Vahtera J. Change in body mass index during transition to statutory retirement: an occupational cohort study. Int J Behav Nutr Phys Act. 2017;14(1):85.
21. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol. 1998;3(4):322-55.
22. Fransson EI, Nyberg ST, Heikkila K, Alfredsson L, Bacquer de D, Batty GD, et al. Comparison of alternative versions of the job demand-control scales in 17 European cohort studies: the IPD-Work consortium. BMC Public Health. 2012;12:62.
23. Halonen JI, Stenholm S, Pulakka A, Kawachi I, Aalto V, Pentti J, et al. Trajectories of risky drinking around the time of statutory retirement: a longitudinal latent class analysis. Addiction. 2017;112(7):1163-70.
24. Leskinen T, Stenholm S, Heinonen OJ, Pulakka A, Aalto V, Kivimaki M, et al. Change in physical activity and accumulation of cardiometabolic risk factors. Prev Med. 2018;112:31-7.
25. Zeger SL, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. Biometrics. 1986;42:121-30.
26. Diggle P, Heagerty P, Liang K-Y, Zeger S. Analysis of Longitudinal Data. New York: Oxford University Press, USA; 2002.
27. Nagin DS. Group-based modeling of development. Cambridge, MA: Harvard University Press; 2005.
28. Schultz WM, Kelli HM, Lisko JC, Varghese T, Shen J, Sandesara P, et al. Socioeconomic Status and Cardiovascular Outcomes: Challenges and Interventions. Circulation. 2018;137(20):2166-78.
29. Madsen IEH, Gupta N, Budtz-Jorgensen E, Bonde JP, Framke E, Flachs EM, et al. Physical work demands and psychosocial working conditions as predictors of musculoskeletal pain: a cohort study comparing self-reported and job exposure matrix measurements. Occup Environ Med. 2018;75(10):752-8.
30. Stenholm S, Pulakka A, Kawachi I, Oksanen T, Halonen JI, Aalto V, et al. Changes in physical activity during transition to retirement: a cohort study. Int J Behav Nutr Phys Act. 2016;13(1):51.
31. Myllyntausta S, Salo P, Kronholm E, Pentti J, Oksanen T, Kivimäki M, et al. Does Removal of Work Stress Explain Improved Sleep Following Retirement? The Finnish Retirement and Aging (FIREA) study Sleep. 2019;In press.
32. Jylhä M. What is self-rated health and why does it predict mortality? Towards a unified conceptual model. Social Science and Medicine. 2009;69(3):307-16.
33. Jylhä M, Volpato S, Guralnik JM. Self-rated health showed a graded association with frequently used biomarkers in a large population sample. Journal of clinical epidemiology. 2006;59(5):465-71.

34. Idler EL, Kasl SV. Self-ratings of health: do they also predict change in functional ability? J Gerontol B Psychol Sci Soc Sci. 1995;50(6):S344-53.
35. Miilunpalo S, Vuori I, Oja P, Pasanen M, Urponen H. Self-rated health status as a health measure: the predictive value of self-reported health status on the use of physician services and on mortality in the working-age population. J Clin Epidemiol. 1997;50(5):517-28.
36. Kennedy BS, Kasl SV, Vaccarino V. Repeated hospitalizations and self-rated health among the elderly: a multivariate failure time analysis. Am J Epidemiol. 2001;153(3):232-41.
37. Stenholm S, Kivimäki M, Jylhä M, Kawachi I, Westerlund H, Pentti J, et al. Trajectories of self-rated health in the last 15 years of life by cause of death. Eur J Epidemiol. 2016;31(2):177-85.
38. DeSalvo KB, Bloser N, Reynolds K, He J, Muntner P. Mortality prediction with a single general self-rated health question. A meta-analysis. Journal of General Internal Medicine. 2006;21(3):267-75.
39. Statistics Finland. Women and men in Finland 2016. 2016.

Table 1. Characteristics of the participants before retirement by study cohort.

	FPS (n=5,776)		FIREA (n=2,796)	
	Mean	SD	Mean	SD
Age at retirement	61.9	2.0	63.8	1.3
	n	%	n	%
Women	4610	79.8	2339	83.7
Occupational status				
High	2193	38.2	910	32.9
Intermediate	1537	26.7	854	30.8
Low	2017	35.1	1006	36.3
Job strain	1415	24.8	562	22.1
Physically heavy work	901	15.6	412	14.9
Smoking	496	8.8	245	9.0
Alcohol risk use	437	7.6	229	8.2
Low physical activity	2426	42.3	1062	38.3
Obesity	896	15.9	579	21.0

Table 2. Pre-retirement characteristics of the four developmental health trajectories in the FPS and the FIREA.

	FPS (n=5,776)					FIREA (n=2,796)				
	Sustained good health	From good to suboptimal health	From suboptimal to good health	Sustained suboptimal health	p	Sustained good health	From good to suboptimal health	From suboptimal to good health	Sustained suboptimal health	p
n (%)	2718 (47%)	1099 (19%)	791 (14%)	1168 (20%)		2055 (74%)	179 (6%)	223 (8%)	339 (12%)	
Age at retirement, mean (SD)	61.9 (2.0)	62.0 (2.0)	61.8 (2.0)	61.9 (1.9)	0.08	63.9 (1.4)	63.7 (1.3)	63.4 (1.3)	63.6 (1.2)	<.0001
Women, %	81.0	80.4	80.4	76.0	0.004	83.7	83.8	84.8	82.9	0.95
Occupational status, %					<.0001					<.0001
High	45.0	34.3	34.4	28.4		35.6	25.8	26.0	24.6	
Intermediate	26.3	27.5	28.6	26.0		30.0	34.8	34.5	31.4	
Low	28.7	38.3	37.0	45.6		34.5	39.3	39.5	44.0	
Job strain, %	18.5	23.9	32.0	35.5	<.0001	19.6	25.9	28.5	30.9	<.0001
Physically heavy work, %	13.0	16.0	17.0	20.5	<.0001	13.4	16.3	19.7	19.8	0.003
Smoking	7.4	10.8	8.7	10.3	0.002	8.0	10.3	10.1	13.0	0.03
Alcohol risk use	7.9	7.3	7.6	7.3	0.9237	8.0	9.6	7.2	9.5	0.6813
Low physical activity	33.8	45.8	47.8	55.0	<.0001	33.8	47.2	51.1	52.7	<.0001
Obesity	8.8	18.2	17.0	29.7	<.0001	15.6	29.9	30.6	43.6	<.0001

Table 3. Association of pre-retirement predictors with different trajectory groups in FPS and FIREA.

	Sustained good health (ref)	From good to suboptimal health			Sustained suboptimal health (ref)	From suboptimal to good health		
	OR	OR	95% CI		OR	OR	95% CI	
FPS								
Male vs. female	1	0.97	0.77	1.22	1	0.76	0.58	0.99
Occupational status								
Intermediate vs high	1	1.42	1.14	1.77	1	0.97	0.73	1.28
Low vs high	1	1.63	1.32	2.00	1	0.75	0.58	0.97
Job strain (yes vs no)	1	1.46	1.18	1.80	1	0.88	0.70	1.11
Physically heavy work (yes vs no)	1	1.25	0.98	1.60	1	0.86	0.65	1.13
FIREA								
Male vs. female	1	1.00	0.66	1.53	1	0.88	0.55	1.42
Occupational status								
Intermediate vs high	1	1.44	0.96	2.18	1	1.01	0.64	1.61
Low vs high	1	1.56	1.03	2.37	1	0.83	0.53	1.30
Job strain (yes vs no)	1	1.43	0.97	2.10	1	0.92	0.61	1.40
Physically heavy work (yes vs no)	1	1.25	0.81	1.93	1	1.04	0.67	1.60

Notes: The comparisons are derived from a multinomial logistic regression analysis adjusted for gender, age at retirement and smoking, alcohol use, physical activity and BMI before retirement.

Figure 1. Mean prevalence of suboptimal self-rated health before and after retirement in the FPS and the FIREA. Adjusted for age, sex and occupational status. Gray area indicates time when retirement has taken place.

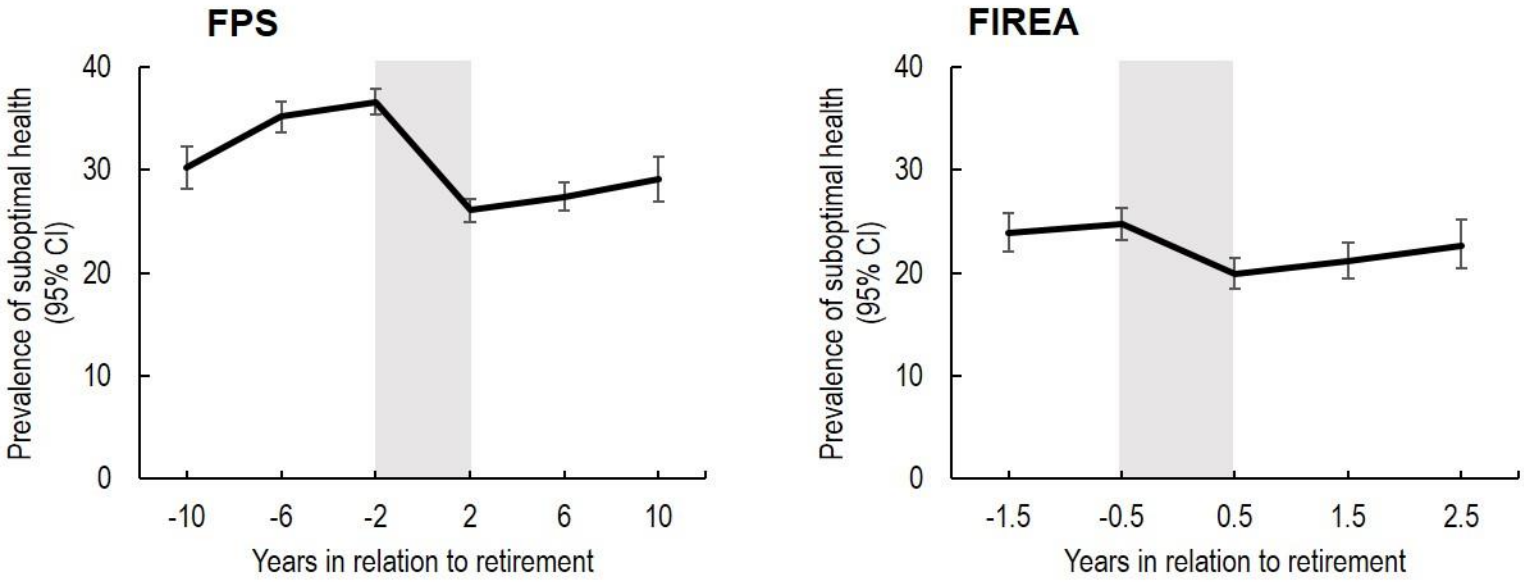
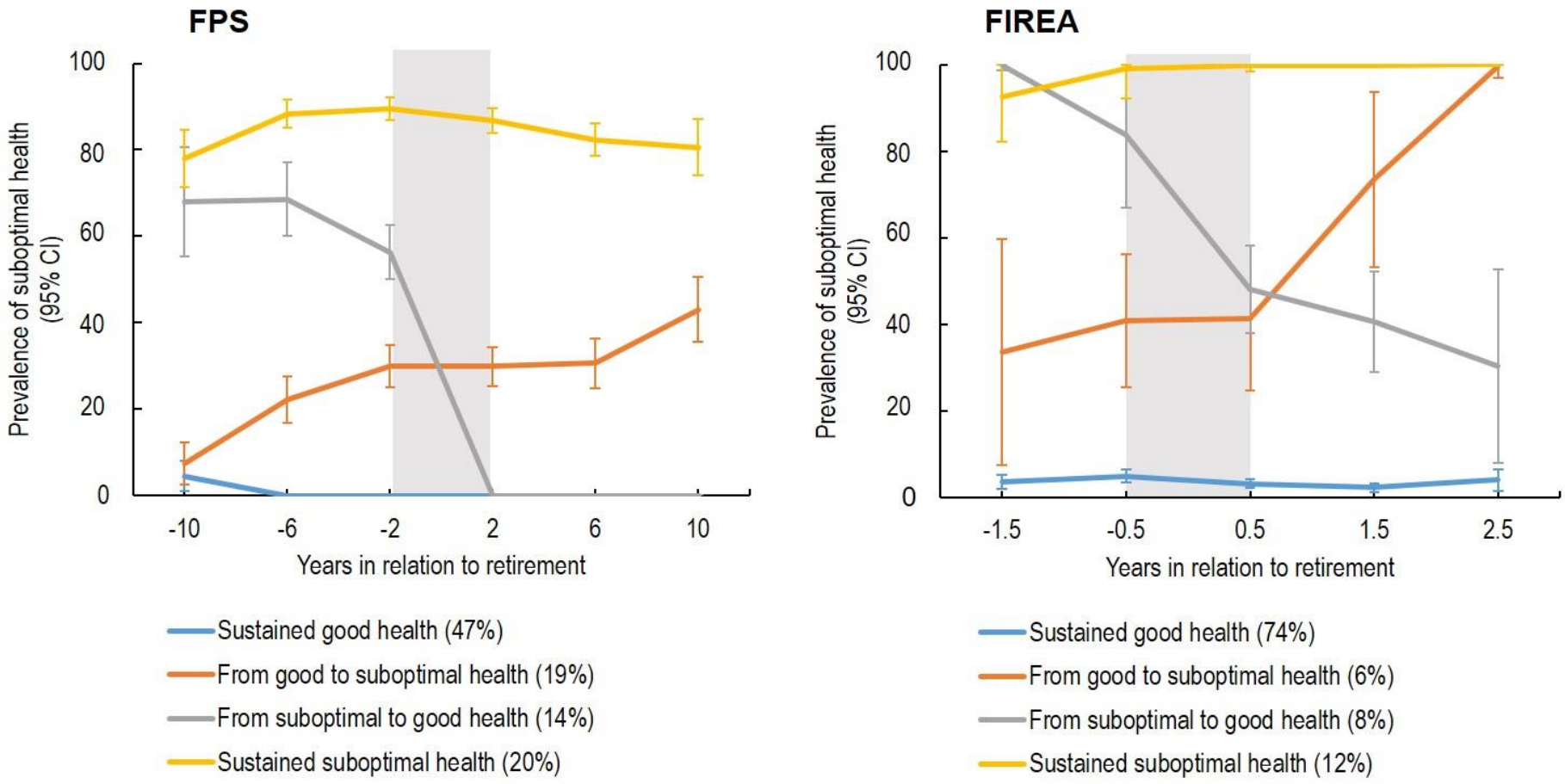


Figure 2. Trajectories of suboptimal self-rated health before and after retirement in the FPS and the FIREA. Gray area indicates time when retirement has taken place.



SUPPLEMENTARY FILES

Supplementary Table 1. Model fit statistics of the latent trajectory analysis from polynomial models with 1 to 6 trajectories for the FPS Study and the FIREA Study.

Number of trajectories	Polynomial order*	BIC	AIC	Log-likelihood	Average posterior probabilities	Smallest group
FPS						
1	3	-13168.5	-13155.2	-13151.2	1	100
2	33	-11255	-11225.1	-11216.1	0.963/0.877	33.4
3	333	-11157.3	-11110.7	-11096.7	0.882/0.641/0.928	14.6
4	3333	-11130.2	-11066.9	-11047.9	0.725/0.804/0.696/0.886	15
5	33333	-11141.9	-11061.9	-11037.9	0.769/0.692/0.687/0.663/0.669	11.3
6	333333	-11147.5	-11050.9	-11021.9	0.772/0.678/0.732/0.553/0.735/0.587	6.1
4	**1333**	**-11121.6**	**-11064.9**	**-11047.9**	**0.725/0.804/0.696/0.886**	**15**
FIREA						
1	3	-5137.61	-5125.74	-5121.74	1	100
2	33	-3971.42	-3944.71	-3935.71	0.978/0.922	24.7
3	333	-3971.83	-3930.28	-3916.28	0.875/0.942/0.697	4.6
4	3333	-3961.2	-3904.81	-3885.81	0.678/0.938/0.782/0.74	6.1
5	33333	-3979.8	-3908.57	-3884.57	0.685/0.936/0.496/0.740/0.750	2.5
6	333333	-3999.52	-3913.45	-3884.45	0.754/0.678/0.707/0.609/0.694/0.726	3
4	**3331**	**-3954.11**	**-3903.66**	**-3886.66**	**0.692/0.941/0.721/0.732**	**9.2**

Notes: *Polynomial function 1 refers to linear and 3 to cubic shape of trajectory