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Who maintains good health functioning? The contribution of social, work-related and behavioural factors to mental and physical health functioning trajectories in ageing employees

Running head: Who maintains good health functioning at work?

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ABSTRACT

Objectives: The determinants of poor functioning and subsequent early exit from work are well-established but very little is known about the positive determinants of maintaining good functioning among the ageing workforce. We investigated modifiable determinants of maintaining good mental and physical health functioning.

Methods: We used prospective survey data collected across four waves among the midlife employees of the City of Helsinki, Finland, 2000-2017 (n=3342). Health functioning was repeatedly measured using the SF-36 inventory. Trajectories of mental and physical health functioning were separately examined using group-based trajectory analysis. Multinomial logistic regression models were fitted to examine determinants of each trajectory.

Results: Four trajectory solutions for the developmental patterns in health functioning during the 17-year follow-up period were selected, with a slightly different shape of the first trajectory for mental and physical functioning: 1) continuously low (mental), low & decreasing (physical), 2) increasing, 3) decreasing, and 4) continuously high functioning. After adjustments, the employees in the continuously high mental health functioning group were more likely to have optimal job demands, high job control, no sleep problems and no binge drinking behaviour. Employees in the continuously high physical functioning group had more likely low levels of physically strenuous work and hazardous working environment and no sleep problems and normal weight.

Conclusion: High job control, good sleep and avoiding binge drinking may help maintain good mental health functioning. Low levels of physical or environmental work exposures, good sleep and recommended healthy weight may support maintenance of good physical health functioning among ageing employees.

Keywords: quality of life; workload; epidemiology; public health; sleep

KEY MESSAGES

What is already known about this subject?

- Previous studies have mainly focused on poor functioning and its determinants, while little is known about the positive determinants of maintaining good functioning among the ageing workforce.
- Most of the previous evidence comes from studies, which have used variable-oriented methods, without identifying groups of people with similar development in their functioning over time. With such person-oriented methods, it is possible to avoid subjective, a priori assumptions, i.e., classifications based on predefined cut off points.

What are the new findings?

- We identified groups of ageing employees who follow similar developmental trajectories in their functioning during a follow-up of 15 to 17 years towards the end of the working life span
- Our findings highlight that favourable psychosocial and physical working conditions, as well as healthy behaviours and good sleep support maintenance of health functioning.

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

- The key policy implication of this study is that to promote the opportunities of midlife and ageing employees to continue working until the statutory retirement age and even beyond, the potentially modifiable determinants of the development of health functioning could be targeted.

INTRODUCTION

In ageing populations, such as in Finland, the proportion of working-age people is rapidly decreasing. In this context, extending working careers, promoting good health functioning at work and avoiding early exit from paid employment are key challenges.[1-3] Health functioning reflects health status in general, and the ability to perform everyday tasks.[4-7] It is important to increase our understanding about the determinants of different domains of health functioning as they predict sickness absence,[8, 9] while sickness absence in turn is a marker of future disability pension.[10] In particular, understanding who maintains good health functioning at work and examining the role of the potentially modifiable determinants of health functioning may help us intervene appropriately and thereby improve good health functioning and work participation among ageing employees.

Previous studies have extensively focused on the risk factors of *poor* functioning and related sickness absence, as well as early exit from paid employment,[11-13] while the evidence about the positive determinants of maintaining *good* functioning among the ageing workforce is much more limited. In addition, most of the evidence comes from studies which have used variable oriented methods, i.e., have assessed associations between a pre-defined predictor and a dichotomous (such as disability pension) or count outcomes (such as sickness absence).[14, 15] However, identifying groups of employees who follow similar developmental patterns in their functioning over time may reveal additional insights for efforts to identify factors supporting maintenance of the good functioning in later working life. For example, using group-based trajectory analysis enables to identify trajectories from the data,[16] and possibly reveal a group that is able to maintain good health functioning.

Socioeconomic factors are important determinants of health functioning;[17, 18] people with low education and low occupational class experience the greatest decline in their health and functioning as they age.[19, 20] Moreover, as the social patterning of physical and mental health appears to vary,[21] physical and mental health functioning should be examined separately. This helps confirm

if trajectories in physical and mental health functioning, and their determinants, also vary. Additionally, behavioural factors such as binge drinking, smoking, obesity and poor sleep have been shown to contribute to health functioning,[11, 22, 23] and could be assumed to contribute to memberships to the distinct trajectory groups.

Therefore, the present study aims to identify trajectories of mental and physical health functioning among midlife and ageing employees and then to investigate their social (age, gender, marital status, occupational class), work-related (physical and psychosocial working conditions), and behavioural (smoking, drinking, obesity, sleep) determinants. A special focus is to recognise potential *modifiable* predictors (such as working conditions and behavioural factors) of maintenance of good mental and physical health functioning.

METHODS

Data

We used prospective survey data of public sector employees of the City of Helsinki, Finland, followed up in three to four surveys through 2000 to 2017 (the Helsinki Health Study, HHS). At baseline in 2000-2002, the participants of the original HHS cohort were aged 40-60 years, and they were all employed by the City of Helsinki (n=8960). The City of Helsinki is the largest employer in Finland, and there are hundreds of different occupational titles from routine manual work to administrative and professional positions. The largest branches include e.g. social and health care, and physical work is prevalent e.g. in many manual jobs and in care work. The target population was all employees reaching 40, 45, 50, 55 or 60 years of age at baseline in 2000, 2001 or 2002. Inclusion and exclusion criteria and details about recruitment, non-response and attrition and have been described earlier [24-26]. For the current study we included only participants aged 40-55 at baseline who were continuously employed and had no missing data on their health functioning (component summary

scores) in at least three of the four surveys (conducted in 2000-2, 2007, 2012 and 2017, response rates 67%, 83%, 79% and 82%, respectively) (See the inclusion criteria in Supplementary Figure S1, displayed as a flow chart). The age restriction was done to have an adequate number (i.e. three) of measurement points whilst still employed. The final analytic sample consisted of 3342 employees.

Measures

Health functioning

Mental and physical health functioning were measured at baseline and follow-up waves using the SF-36 inventory.[4-7] We used a validated Finnish translation of this inventory.[27] The inventory includes altogether 36 items that form eight subscales, from which component summary scores describing physical and mental health functioning were calculated. Four subscales contribute to the physical health functioning domain: physical functioning, role limitations due to poor physical health, bodily pain, and general health perceptions, while vitality, social functioning, role limitations due to emotional problems, and mental health contribute to the mental health functioning domain. All eight subscales contribute to the aggregated weighted summary scores of physical and mental health functioning that have been estimated to comprise a large majority of the variance in the subscales.[28] Moreover, the reliability of the component scores has been shown to be higher than that of the separate subscales,[5] although some concern about the summary scores also exist [29]. Nonetheless, the inventory has good psychometric properties, high internal consistency and construct validity, and high test-retest reliability.[4, 7] For the purposes of this study, we decided to model the development trajectories using the component scores. The scores were constructed to have a mean of 50 and standard deviation (SD) of 10 in the general population. Higher scores indicate better functioning.

Social determinants

All predictors of the trajectories were measured at baseline in 2000-2002. We included gender (1=man, 2=woman), age (continuous) and marital status (married/cohabiting vs. others) as sociodemographic factors. Occupational class as an indicator of socioeconomic position was derived from the employer's personnel register for those with a consent for such linkage (78%), and completed from the questionnaire survey responses for the rest. Self-reported occupational titles were classified according to the register data. Occupational class was then divided into managers and professionals, semi-professionals, routine non-manual workers and manual workers.

Work-related factors

Working conditions were measured as supporting positive factors and dummy variables were coded to represent the most optimal approximate quartile in each scale. Job demands and job control were measured by the Framingham version of Karasek's Job Content Questionnaire.[30] The weighted mean of demands and control scales were calculated for those responding over half of the corresponding questions (3 or more / 5 for job demands and 5 or more / 9 for job control). Then those scoring approximately in the highest quartile in the job control scale were defined as having high job control and those scoring approximately in the lowest quartile in the job demands scale were defined having optimal job demands.

Good physical working conditions included low level of physically strenuous work and low level of hazardous working environment. The employees were asked about the presence of 18 physical working conditions (FIOH 18-item questionnaire)[31] with four response options: 1) not present, 2) present, but does not bother at all, 3) present and somewhat bothers, 4) present and bothers a lot. For those with four or less missing items, any missing items were replaced by the sample mode of that item. Then, following our previous studies,[32-34] a factor analysis was conducted, and a three factor solution was selected: physical workload factors (loading the following items: awkward

working positions, rotation of the back, repetitive movements, standing, walking and heavy physical effort or lifting & carrying) and hazardous working environment (noise, vibration, weak or disruptive lighting, solvents, gasses or irritants, warmth, coldness or changes in temperature, dryness of air, dirt, dampness or wetness, mould). The third factor comprised sedentary work/working with computer (working at monitor and using a computer mouse), but it was omitted because we focused on physical working conditions, and the third factor mainly concerns non-physical work. The factor scores were dichotomized and employees in the lowest quartile (25%) in each scale were defined as having no physically strenuous work and no hazardous working environment.

Working time pattern was measured by adverse working times (night/shift work weekdays or weekends vs. others) and overtime (reporting average working time more than 40 hours per week vs. others).

Behavioural factors

Behavioural determinants were self-reported and included baseline smoking, drinking, obesity and poor sleep. Smoking was divided into never smoking, past smoking and current smoking. Binge drinking was indicated by drinking six or more units of alcohol on a single occasion once a week or more often. Body mass index (BMI) was defined based on height and weight and then divided into three groups: normal weight ($BMI < 25$), overweight ($25 \leq BMI < 30$) and obese ($BMI \geq 30$). Sleep problems were measured by a 4-item version of the Jenkins questionnaire [35] and those respondents reporting at least one of the four symptoms occurring more than 14 days in the past four weeks were classified as having a sleep problems.[36]. Those with more than one item missing from the four questions were set to missing.

Statistical analyses

Trajectories of health functioning were examined using a group-based trajectory analysis (GBTA).

GBTA is used to identify distinct groups of the study population, who have similar trajectories over the study period.[16] Health functioning component scores were used as repeated outcomes with a normal distribution. The method uses maximum likelihood and participant with maximum of one missing outcome score (i.e. those with three valid survey responses) are included with missing at random assumption. Next, shapes of the trajectories were defined. As health functioning may not develop linearly with time, we tested the fit also with second degree polynomial curves. The optimal number of trajectory groups was chosen based on the Bayesian information criteria (BIC) and distinct interpretation and reasonable sizes of trajectory groups were also required (Supplement tables S1 and S2).[16] Participants were assigned to the trajectory group for which their probability of group membership was highest. The average group membership probabilities for each group in comparison to the assigned group membership are shown in supplement tables S3 and S4. For both trajectory analyses, the model indicated good fit with distinct trajectories with high average group membership probabilities (0.93 for the selected group for mental functioning trajectories and 0.90 for physical functioning trajectories). The trajectory analyses thus produced clearly distinct groups, and particularly the trajectory describing continuously high functioning is distinct from the other groups, with higher group membership probabilities.

The composition of the trajectory groups was first descriptively examined using cross-tabulations and Chi² tests. Then, multinomial logistic regression models were used to examine the determinants of the trajectory group membership. A single model was fitted adjusting for all covariates. To illustrate differences in predicted probabilities for each trajectory group membership, we report average marginal effects (AMEs) and their 95% confidence intervals. Reporting marginal effects was chosen over showing odds ratios, as the proportions are concrete and more clearly show the actual difference between groups, as compared to less tangible odds ratios.

There were no systematic differences by sex, and thus all analyses were run in pooled data.

Missing values

Around 9% of the sample had some missing values in the predictors. First, we explored patterns of missingness, and then the missingness was imputed using multiple imputations by chained equations and created 20 datasets. This method was selected, as by using multiple imputations by chained equations, we can take into account missing values that are related to other predictors. We considered this as a better option than omitting all those with missing values. We used all predictors and trajectory groups in the imputation process and multinomial and logistic regression were used when appropriate. The results from complete case analysis, however, provided consistent and fairly similar results.

RESULTS

Mental health functioning

Figure 1 presents the estimated trajectory groups and their means and interquartile range of mental health functioning scores. We identified four mental health functioning trajectories within the 17-year follow-up period: continuously low (4%), increasing (8%), decreasing (14%) and a stable high trajectory, which represents maintaining good mental health functioning (75%) (Figure 1 and Table 1). Employees in the stable high group were more likely to report optimal job demands and low level of physically strenuous or hazardous working environment at baseline. Having no behavioural risk factors, i.e., non-smoking, no sleeping problems and no binge drinking were also more common among those assigned to the group of stable high mental health functioning compared to the other trajectory groups (Table 1). However, before adjustments there were no differences in mental health functioning trajectories between BMI groups. Finally, those who were able to maintain good mental health functioning were also more likely to maintain good physical health functioning (Table 1).

Table 1: Descriptive statistics of the study population by mental health functioning (MCS) trajectory group assignment* The Helsinki Health Study

	MCS trajectory group					p-value
	Continuously low	Increasing	Decreasing	Stable high	Total	
	Col %	Col %	Col %	Col %	Col %	
MCS trajectory group						
%	4	8	14	75	100	
n	130	254	455	2,503	3,342	
Age						
Mean	44	45	44	45	45	
PCS trajectory group						
Low and decreasing	13	7	9	6	7	<0.001
Increasing	6	5	6	4	4	
Decreasing	35	28	30	23	25	
Stable high	46	61	55	67	64	
Gender						
Men	22	22	17	16	17	0.035
Women	78	78	83	84	83	
Marital status						
Co-habiting/married	53	67	68	73	71	<0.001
Never married/divorced/widowed	46	32	32	27	28	
Missing	1	1	0	1	0	
Occupational class						
Managers and professionals	37	36	31	29	30	0.134
Semi-professionals	16	23	22	24	23	
Routine non-manual workers	29	28	32	33	33	
Manual workers	15	11	14	12	12	
Missing	2	2	1	1	1	
Shift or night work						
No	78	84	80	81	81	0.430
Shift or night work	22	15	19	18	18	
Missing	1	1	0	1	1	
Long working hours (more than 40h/w)						
No	85	82	87	84	84	0.231
Long working hours (more than 40h/w)	14	17	11	14	14	
Missing	1	1	2	1	1	
Work demand						
High	81	83	82	71	73	<0.001
Optimal work demand	19	17	18	29	26	
Missing	0	0	0	1	1	
Work control						
Low	83	81	79	76	77	0.058
High work control	17	19	21	24	23	
Missing	0	0	0	0	0	
Physically strenuous work						
No	80	78	81	73	74	0.000
Low level of physically strenuous work	18	21	18	27	25	

Missing	2	0	1	1	1	
<hr/>						
Hazardous working environment						
No	80	80	77	73	74	
Low level of hazardous working environment	18	20	22	26	25	0.015
Missing	2	0	1	1	1	
<hr/>						
Sleep problems						
No	43	66	79	87	82	
Sleep problems	55	32	18	11	15	<0.001
Missing	2	2	3	2	3	
<hr/>						
Smoking						
No	48	52	43	55	53	
Past smoking	20	22	29	23	24	<0.001
Current smoking	32	26	28	21	23	
Missing	0	1	0	0	0	
<hr/>						
Binge drinking						
No	75	81	87	90	89	
Binge drinking (once a week or more)	22	16	11	8	10	<0.001
Missing	2	2	2	1	2	
<hr/>						
Obesity						
Normal weight	55	60	60	61	60	
Overweight	33	28	30	29	29	0.889
Obesity	11	10	9	10	10	
Missing	2	1	1	0	1	

*All predictors measured at baseline. Missing category omitted from the Chi² test.

After mutual adjustments, those with optimal job demands (AME for optimal job demands 0.09 (95% confidence interval 0.06 – 0.12)), high job control (0.05 (0.02 - 0.08)), no sleeping problems (-0.23 (-0.28 - -0.19)) and no binge drinking (-0.10 (-0.15 - 0.05)) at baseline were more likely to maintain good mental health functioning during their later working years. Furthermore, having low level of physical work (0.08 (0.04 - 0.11)) and not smoking (AME for current smoking -0.07 (-0.11 - -0.03)) were linked to a slightly higher likelihood to maintain good mental health functioning (Table 2).

Table 2: Results from multinomial regression model for mental health functioning (MCS) trajectory assignment. Average marginal effects (AMEs) and their 95 % confidence intervals (95% CI) for each group.

	MCS trajectory group			
	Continuously low	Increasing	Decreasing	Stable high
	AME (95% CI)	AME (95% CI)	AME (95% CI)	AME (95% CI)
Gender				
Men	Ref.	Ref.	Ref.	Ref.
Women	-0.00 (-0.02 - 0.01)	-0.02 (-0.05 - 0.00)	-0.01 (-0.04 - 0.03)	0.03 (-0.01 - 0.08)
Marital status				
Co-habiting/married	Ref.	Ref.	Ref.	Ref.
Never married/divorced/widowed	0.03*** (0.01 - 0.05)	0.01 (-0.01 - 0.03)	0.02 (-0.00 - 0.05)	-0.07*** (-0.10 - -0.03)
Occupational class				
Managers and professionals	Ref.	Ref.	Ref.	Ref.
Semi-professionals	-0.03** (-0.05 - -0.01)	-0.01 (-0.04 - 0.01)	-0.03 (-0.06 - 0.01)	0.07*** (0.03 - 0.11)
Routine non-manual workers	-0.02* (-0.05 - 0.00)	-0.03 (-0.05 - 0.00)	-0.03 (-0.07 - 0.00)	0.08*** (0.04 - 0.12)
Manual workers	-0.02 (-0.05 - 0.00)	-0.03* (-0.06 - 0.00)	-0.03 (-0.07 - 0.01)	0.09*** (0.04 - 0.14)
Shift or night work				
No	Ref.	Ref.	Ref.	Ref.
Shift or night work	0.01 (-0.01 - 0.03)	-0.02 (-0.04 - 0.01)	0.00 (-0.03 - 0.03)	0.01 (-0.03 - 0.04)
Long working hours (more than 40h/w)				
No	Ref.	Ref.	Ref.	Ref.
Long working hours	-0.00 (-0.02 - 0.01)	0.01 (-0.02 - 0.03)	-0.04* (-0.07 - 0.00)	0.03 (-0.01 - 0.07)
Work demand (~lowest 25%)				
No	Ref.	Ref.	Ref.	Ref.
Optimal work demand	-0.01 (-0.02 - 0.01)	-0.03** (-0.05 - 0.01)	-0.06*** (-0.08 - 0.03)	0.09*** (0.06 - 0.12)
Work control (~highest 25%)				
No	Ref.	Ref.	Ref.	Ref.
High work control	-0.01 (-0.03 - 0.00)	-0.02* (-0.04 - 0.00)	-0.02 (-0.04 - 0.01)	0.05** (0.02 - 0.08)
Physically strenuous work (lowest 25%)				

No	Ref.	Ref.	Ref.	Ref.
Low level of physically strenuous work	-0.01 (-0.03 - 0.00)	-0.02* (-0.04 - 0.00)	-0.04** (-0.07 - 0.02)	0.08*** (0.04 - 0.11)
Hazardous working environment (lowest 25%)				
No	Ref.	Ref.	Ref.	Ref.
Low level of hazardous working environment	-0.00 (-0.02 - 0.01)	-0.01 (-0.03 - 0.01)	-0.01 (-0.04 - 0.02)	0.03 (-0.01 - 0.06)
Sleep problems				
No	Ref.	Ref.	Ref.	Ref.
Sleep problems	0.11*** (0.08 - 0.14)	0.09*** (0.06 - 0.12)	0.03 (-0.00 - 0.07)	-0.23*** (-0.28 - 0.19)
Smoking				
Never	Ref.	Ref.	Ref.	Ref.
Past smoking	-0.01 (-0.02 - 0.01)	-0.01 (-0.03 - 0.01)	0.06*** (0.03 - 0.09)	-0.04* (-0.08 - 0.01)
Smoking	0.01 (-0.01 - 0.02)	0.01 (-0.02 - 0.03)	0.06*** (0.02 - 0.09)	-0.07*** (-0.11 - 0.03)
Binge drinking				
No	Ref.	Ref.	Ref.	Ref.
Binge drinking (once a week or more)	0.04** (0.01 - 0.07)	0.04* (0.01 - 0.08)	0.01 (-0.03 - 0.05)	-0.10*** (-0.15 - 0.05)
Obesity				
Normal weight	Ref.	Ref.	Ref.	Ref.
Overweight	0.01 (-0.01 - 0.02)	-0.01 (-0.03 - 0.01)	0.01 (-0.02 - 0.03)	-0.00 (-0.04 - 0.03)
Obesity	-0.00 (-0.02 - 0.02)	-0.01 (-0.04 - 0.02)	-0.01 (-0.05 - 0.03)	0.02 (-0.03 - 0.07)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ for the difference compared to reference category. Additionally adjusted for age.

Physical health functioning

In terms of physical health functioning, an almost similar four trajectory solution was identified and selected as the best model: low and decreasing (7%), increasing (4%), decreasing (25%) and a stable high trajectory reflecting maintenance of good mental health functioning (64%). (Figure 1, and Table 3). Individuals maintaining good physical health functioning were more likely to report no shift/night

work; good psychosocial and low levels of adverse physical working conditions were also more common in this group. Behavioural factors, that is, smoking, sleep problems, overweight and obesity were less common among those assigned to the stable high physical health functioning trajectory, compared to other those assigned to the other trajectory groups (Table 3). Finally, it is of note that male employees were more likely to maintain good physical health functioning.

Table 3: Descriptive statistics of the study population by physical health functioning* (PCS) trajectory group assignment* The Helsinki Health Study

	PCS trajectory group				p-value
	Low and decreasing	Increasing	Decreasing	Stable high	
	Col %	Col %	Col %	Col %	
PCS trajectory group					
%	7	4	25	64	
n	226	148	840	2,128	
Age					
Mean	45	45	44	45	
MCS trajectory group					
Continuously low	8	5	5	3	<0.001
Increasing	8	8	8	7	
Decreasing	19	19	16	12	
Stable high	66	68	70	78	
Gender					
Men	12	19	13	19	<0.001
Women	88	81	87	81	
Marital status					
Co-habiting/married	57	67	68	74	<0.001
Never married/divorced/widowed	42	33	31	26	
Missing	0	0	1	0	
Occupational class					
Managers and professionals	21	28	22	35	<0.001
Semi-professionals	14	22	21	25	
Routine non-manual workers	44	36	38	29	
Manual workers	20	14	17	10	
Missing	1	1	1	1	
Shift or night work					
No	79	81	77	83	0.001
Shift or night work	20	19	22	16	
Missing	1	0	1	1	
Long working hours					
No	86	82	87	84	0.165
Long working hours (more than 40h/w)	13	16	12	15	
Missing	1	2	1	2	
Work demand					
High	75	83	76	72	0.001
Optimal work demand	24	16	23	28	
Missing	0	1	1	0	
Work control					
Low	81	81	82	74	<0.001
High work control	18	19	18	26	
Missing	1	0	1	0	
Physically strenuous work					
No	89	83	83	69	<0.001
Low level of physically strenuous work	10	16	16	31	
Missing	1	1	1	1	
Hazardous working environment					
No	83	79	79	71	

Low level of hazardous working environment	16	20	21	28	<0.001
Missing	1	1	1	1	
Sleep problems					
No	68	65	77	87	<0.001
Sleep problems	29	32	20	10	
Missing	3	3	2	2	
Smoking					
No	41	49	48	57	<0.001
Past smoking	27	28	24	23	
Smoking	32	24	28	20	
Missing	1	0	0	0	
Binge drinking					
No	87	87	88	89	0.255
Binge drinking (once a week or more)	13	9	10	9	
Missing	0	3	2	2	
Obesity					
Normal weight	40	46	52	67	<0.001
Overweight	32	39	33	26	
Obesity	27	15	14	6	
Missing	1	1	1	0	

*All predictors measured at baseline. Missing category omitted from the Chi² test.

After adjustments (Table 4), particularly those with low levels of physically strenuous work (0.13 (0.09 - 0.17)), low levels of hazardous working environment (0.07 (0.03 - 0.10)), good sleep (-0.20 (-0.24 - -0.15)), non-smoking (-0.07 (-0.11 - -0.03)) and normal weight (-0.27 (-0.33 - -0.22) compared to obesity and -0.12 (-0.15 - -0.08) overweight) at baseline were significantly more likely to maintain good physical health functioning during their later working life span.

Table 4: Results from multinomial regression model for physical health functioning (PCS) trajectory assignment. Average marginal effects (AMEs) and their 95 % confidence intervals (95% CI) for each group.

	PCS trajectory group			
	Low and decreasing	Increasing	Decreasing	Stable high
	AME (95% CI)	AME (95% CI)	AME (95% CI)	AME (95% CI)
Gender				
Men	Ref.	Ref.	Ref.	Ref.
Women	0.03* (0.01 - 0.05)	-0.01 (-0.03 - 0.01)	0.06** (0.02 - 0.10)	-0.08*** (-0.12 - -0.04)
Marital status				
Co-habiting/married	Ref.	Ref.	Ref.	Ref.
Never married/divorced/widowed	0.03** (0.01 - 0.05)	0.01 (-0.01 - 0.02)	0.01 (-0.02 - 0.04)	-0.04* (-0.08 - -0.01)
Occupational class				
Managers and professionals	Ref.	Ref.	Ref.	Ref.
Semi-professionals	-0.02 (-0.04 - 0.00)	-0.00 (-0.02 - 0.02)	0.01 (-0.03 - 0.05)	0.01 (-0.03 - 0.06)
Routine non-manual workers	0.01 (-0.01 - 0.04)	0.01 (-0.01 - 0.03)	0.04* (0.00 - 0.09)	-0.07** (-0.11 - -0.02)
Manual workers	0.02 (-0.01 - 0.05)	-0.00 (-0.03 - 0.02)	0.08** (0.02 - 0.13)	-0.10** (-0.15 - -0.04)
Shift or night work				
No	Ref.	Ref.	Ref.	Ref.
Shift or night work	-0.00 (-0.02 - 0.02)	-0.00 (-0.02 - 0.01)	0.03 (-0.01 - 0.07)	-0.03 (-0.07 - 0.01)
Long working hours (more than 40h/w)				
No	Ref.	Ref.	Ref.	Ref.
Long working hours	-0.00 (-0.03 - 0.02)	0.00 (-0.02 - 0.02)	-0.03 (-0.07 - 0.01)	0.03 (-0.02 - 0.07)
Work demand (~lowest 25%)				
No	Ref.	Ref.	Ref.	Ref.
Optimal work demand	-0.00 (-0.02 - 0.01)	-0.02** (-0.04 - -0.01)	-0.04* (-0.07 - -0.01)	0.07*** (0.03 - 0.10)
Work control (~highest 25%)				
No	Ref.	Ref.	Ref.	Ref.
High work control	-0.00 (-0.02 - 0.02)	-0.01 (-0.02 - 0.01)	-0.04* (-0.08 - -0.00)	0.05* (0.01 - 0.08)
Physically strenuous work (lowest 25%)				
No	Ref.	Ref.	Ref.	Ref.
Low level of physically strenuous work	-0.04*** (-0.06 - -0.03)	-0.02* (-0.03 - -0.00)	-0.07*** (-0.11 - -0.04)	0.13*** (0.09 - 0.17)
Hazardous working environment (lowest 25%)				
No	Ref.	Ref.	Ref.	Ref.
Low level of hazardous working environment	-0.02** (-0.04 - -0.01)	-0.01 (-0.02 - 0.01)	-0.04* (-0.07 - -0.00)	0.07*** (0.03 - 0.10)
Sleep problems				
No	Ref.	Ref.	Ref.	Ref.
Sleep problems	0.06*** (0.03 - 0.09)	0.05*** (0.03 - 0.08)	0.09*** (0.04 - 0.13)	-0.20*** (-0.24 - -0.15)
Smoking				
Never	Ref.	Ref.	Ref.	Ref.
Past smoking	0.02 (-0.00 - 0.04)	0.01 (-0.01 - 0.02)	0.01 (-0.02 - 0.05)	-0.04 (-0.08 - 0.00)
Smoking	0.02 (-0.00 - 0.04)	0.00 (-0.02 - 0.02)	0.05* (0.01 - 0.09)	-0.07*** (-0.11 - -0.03)
Binge drinking				
No	Ref.	Ref.	Ref.	Ref.

Binge drinking (once a week or more)	0.02 (-0.01 - 0.05)	-0.01 (-0.03 - 0.02)	0.01 (-0.04 - 0.06)	-0.02 (-0.08 - 0.03)
Obesity				
Normal weight	Ref.	Ref.	Ref.	Ref.
Overweight	0.02** (0.01 - 0.04)	0.02** (0.01 - 0.04)	0.07*** (0.03 - 0.10)	-0.12*** (-0.15 - -0.08)
Obesity	0.12*** (0.08 - 0.16)	0.03 (-0.00 - 0.05)	0.13*** (0.07 - 0.18)	-0.27*** (-0.33 - -0.22)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ for the difference compared to reference category. Additionally adjusted for age.

DISCUSSION

This study was set to identify mental and physical health functioning trajectories among midlife employees. More specifically, the aim was to examine who maintains *good* health functioning during later working life span, and what are the determinants of the different developmental patterns in health functioning from midlife towards the end of working careers. We focused on the potentially modifiable determinants of the trajectory memberships, i.e., working conditions and behavioural factors, which could be targeted to help employees maintain good physical and mental functioning and continue working until the statutory retirement age and even beyond.

For both mental and physical health functioning, a four trajectory model was chosen. Thus, we identified groups of employees who follow similar developmental trajectories in their functioning over the period of up to 17 years, with a slight difference only regarding the first distinct group: 1) continuously low functioning (for mental functioning), low and decreasing (for physical functioning), 2) decreasing, 3) increasing and 4) stable high functioning, which reflects maintenance of health functioning throughout the follow-up. There are some differences in the prevalence and shapes of the trajectories regarding physical and mental functioning, but for both outcomes, there was a distinct group of stable high functioning. Good sleep and not smoking were the key determinants for maintaining both mental and physical health functioning. For maintaining a good mental health functioning, particularly good psychosocial working conditions and avoiding binge drinking emerged as key determinants, whereas having low physical and environmental exposures and normal weight supported maintenance of good physical functioning.

Although modifiable determinants of the development trajectories of health functioning are poorly understood among older employees, these results confirm the significance of good working conditions, good sleep and healthy lifestyle to good functioning, and thereby a lower risk of work disability.[23, 37, 38] However, previous evidence is from studies where the focus has been on the associations between variables, while determinants of developmental trajectories of health

functioning among midlife employees have not been studied. As all participants continued working throughout the follow-up, we could identify groups of employees, who are likely to follow similar development in their health functioning over time, and investigate the determinants of trajectory group memberships. As poor functioning is linked to sickness absence and early exit from paid employment,[8-10] people in different trajectory groups subsequently differ in their abilities to be able to continue working until the statutory retirement age. By focusing on potentially modifiable determinants of trajectory memberships, the results can be used in efforts to support maintenance of work ability, and in interventions to modify demanding or hazardous working conditions, for example.

Further elaboration on the mechanisms through which the examined determinants are linked to physical or mental health functioning trajectories is a crucial point for the future. As this is an observational study, we are careful not to provide causal interpretation of our results (including speculating potential mechanisms). Nonetheless, we have shown associations and identified and highlighted groups at risk which might be targeted, e.g. in intervention studies. We are not aware of previous studies that had focused on maintenance of functioning using person-oriented methods, and the determinants of the trajectory memberships.

A limitation of this observational and descriptive study is that only survey data were available, and thus there could be reporting bias in both determinants and outcome measures. Another limitation is that all employees worked in the public sector and for one employer, and the sample is not representative of the national working population of the same age range. Thus, generalizability to other sectors could be limited. It is also of note that although the identified trajectories were found to be reliable (Supplementary tables), misclassification cannot be ruled out, and trajectory memberships are only approximations. The true development may be different for any member of any of the trajectories. Many factors could also contribute to either an increase or a decrease in physical and mental health functioning during the 15 to 17 year follow-up, from midlife towards the

end of the working life span but detailed investigations of such factors go beyond those included in this study. Additionally, health of the participants likely varies within and between trajectories, but this was not considered. Our outcome is health functioning, and the focus is on the modifiable predictors of developmental patterns in health functioning. These are likely intertwined with health in complex ways, but partly measure the same thing, i.e., health functioning is a general health measure [4-7]. Health status was therefore not included in the models to avoid overadjustment.

A strength of this study is its follow-up design with up to four time points for each individual, which enabled us to reliably examine developmental trajectories in health functioning during a long period of time, from midlife towards statutory retirement age. Furthermore, response rates at baseline were high, and attrition was low over the entire follow-up (response rates at follow-up surveys ranged from 79% to 82%). Thus, the sample likely was, and has remained representative of the target population. We had the validated SF-36 measure [27] repeated at each time point, as well as work and behavioural related determinants of the trajectory memberships, using widely used and validated measures [35, 39]. A further strength is the use of a person-oriented method, helping to identify somewhat homogenous groups of employees, who are likely to follow a similar developmental trajectory in their functioning. The advantage is that then we could further identify factors that help explain maintenance of good functioning in particular. In variable oriented approaches commonly applied in previous studies, potential heterogeneity in the development patterns could be missed.

In conclusion, these results suggest that favourable psychosocial and physical working conditions are important determinants of maintaining good health functioning, as are keeping recommended healthy weight, avoiding binge drinking and smoking, as well as sleeping well. This is further likely to help people continue working until their normal retirement age or even longer, in line with the current efforts to extend working lives. Subsequent intervention studies could e.g. consider providing health promotion programmes that target health behaviours, and help maintain better

sleep and recommended healthy weight. Moreover, interventions to modify work environment, paying particular attention to physical workload and overall changes in workplace accommodations could be encouraged to maintain employees' good health functioning.

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Contributors: TL & AH conceived and designed the study, and AH analysed the data. TL prepared the first version of the manuscript. AH helped draft the manuscript. All authors (TL, AH, OP, MM, AK, and OR) discussed the results and commented on the manuscript, and approved the submission of the final version.

Patient consent: not required.

Ethical approvals: The Helsinki Health Study has been ethically approved by the City of Helsinki health authorities, and the Department of Public Health, University of Helsinki, Finland, ethical committee.

Data availability statement: data are available upon reasonable request. Data cannot be made publicly available due to strict data protection laws, but access to data can be applied from the Helsinki Health Study group.

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Figure legend

Figure 1.

Upper part. Estimated mental health functioning trajectory shapes and the mean scores (left figure) and interquartile range at the baseline and follow-ups of each trajectory group (right figure).

Lower part. Estimated physical health functioning trajectory shapes and the mean scores (left figure) and interquartile range at the baseline and follow-ups of each trajectory group (right figure).

SUPPLEMENTARY FILE

Who maintains good health functioning? The contribution of social, work-related and behavioural factors to mental and physical health functioning trajectories in ageing employees

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Supplementary figure S1. Flowchart of the study population

Supplementary table S1. Bayesian information criteria (BIC) and group sizes by number of selected groups for mental functioning trajectories.

Number of groups	BIC	Group sizes
2	-40680	543 / 2799
3	-40432	150 / 668 / 2524
4*	-40164	130 / 254 / 455 / 2503
5**	-39959	119 / 264 / 2439 / 267 / 253
*Selected number of groups		
** Group sizes were considered too small/ groups not to have distinct interpretations		

Supplementary table S2. Bayesian information criteria (BIC) and group sizes by number of selected groups for physical functioning trajectories.

Number of groups	BIC	Group sizes
2	-38644	748 / 2594
3	-38355	253 / 956 / 2133
4*	-38162	226 / 840 / 148 / 2128
5**	-38072	238 / 135 / 185 / 746 / 2038
*Selected number of groups		
**Group sizes were considered too small/ groups not to have distinct interpretations		

Supplementary table S3. Average class membership probabilities by the assigned class membership.
Mental functioning trajectories.

	Group 1 <i>Continuously low</i> membership probabilities	Group 2 <i>Increasing</i> membership probabilities	Group 3 <i>Decreasing</i> membership probabilities	Group 4 <i>Stable high</i> membership probabilities	
Assigned to group 1 <i>Continuously low</i>	0.90	0.04	0.07	<0.01	
Assigned to group 2 <i>Increasing</i>	0.02	0.84	0.07	0.08	
Assigned to group 3 <i>Decreasing</i>	0.03	0.05	0.82	0.10	
Assigned to group 4 <i>Stable high</i>	<0.01	0.01	0.03	0.96	
Total average group membership prob. to assigned class					0.93

Supplementary table S4. Average class membership probabilities by the assigned class membership.
Physical functioning trajectories.

	Group 1 <i>Low and decreasing</i> membership probabilities	Group 2 <i>Increasing</i> membership probabilities	Group 3 <i>Decreasing</i> membership probabilities	Group 4 <i>Stable high</i> membership probabilities	
Assigned to group 1 <i>Low and decreasing</i>	0.89	0.03	0.07	<0.01	
Assigned to group 2 <i>Increasing</i>	0.05	0.82	0.10	0.03	
Assigned to group 3 <i>Decreasing</i>	0.03	0.03	0.82	0.12	
Assigned to group 4 <i>Stable high</i>	>0.01	>0.01	0.06	0.93	
Total average group membership prob. to assigned class					0.90