OPEN ACCESS

ORIGINAL ARTICLE

Childhood adversity, adult socioeconomic status and risk of work disability: a prospective cohort study

Jaana I Halonen,[1] Mika Kivimäki,[1,2,3] Jussi Vahtera,[4,5] Jaana Pentti,[1,3] Marianna Virtanen,[1] Jenni Ervasti,[1] Tuula Oksanen,[1] Tea Lallukka[1,3]

[1]Finnish Institute of Occupational Health, Helsinki, Finland
[2]Department of Epidemiology and Public Health, University College London, London, UK
[3]Department of Public Health, Faculty of Medicine, University of Helsinki, Helsinki, Finland
[4]Department of Public Health, University of Turku, Turku, Finland
[5]Turku University Hospital, Turku, Finland

Correspondence to
Jaana I Halonen, Finnish Institute of Occupational Health, Helsinki, PO Box 301, 70101 Kuopio, Finland; jaana.halonen@ttl.fi

Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/oemed-2017-104319)

Received 18 January 2017
Revised 29 March 2017
Accepted 10 April 2017
Published Online First 9 May 2017

ABSTRACT

Objectives To examine the combined effects of childhood adversities and low adult socioeconomic status (SES) on the risk of future work disability.

Methods Included were 34 384 employed Finnish Public Sector study participants who responded to questions about childhood adversities (none vs any adversity, eg, parental divorce or financial difficulties) in 2008, and whose adult SES in 2008 was available. We categorised exposure into four groups: neither (reference), childhood adversity only, low SES only or both. Participants were followed from 2009 until the first period of register-based work disability (sickness absence >9 days or disability pension) due to any cause, musculoskeletal or mental disorders; retirement; death or end of follow-up (December 2011). We ran Cox proportional hazard models adjusted for behavioural, health-related and work-related covariates, and calculated synergy indices for the combined effects.

Results When compared with those with neither exposure, HR for work disability from any cause was increased among participants with childhood adversity, with low SES, and those with both exposures. The highest hazard was observed in those with both exposures: HR 2.53, 95% CI 2.29 to 2.79 for musculoskeletal disability, 1.55, 95% CI 1.36 to 1.78 for disability due to mental disorders and 1.29, 95% CI 1.20 to 1.39 for disability due to other reasons. The synergy indices did not indicate synergistic effects.

Conclusions These findings indicate that childhood psychosocial adversity and low adult SES are additive risk factors for work disability.

What this paper adds

- Both childhood adversities and low socioeconomic status in adulthood have been linked to increased work disability, but their combined effects are not known.
- In a study of over 34 000 public sector employees, the highest risk of work disability was observed among those with both exposures.
- The combined effects of childhood adversities and low adult socioeconomic status were additive rather than synergistic.

INTRODUCTION

Work disability is a major economic burden in the developed countries.[1] Throughout the developed world, musculoskeletal disorders are the third leading cause of overall disease burden and the leading cause of work disability followed by mental disorders.[1–5] At an individual level, the harmful effects of work disability include increased risks for lower income level, becoming excluded from the labour market, and increased risk of death.[6–8]

Employees' health is dependent on individual and social factors operating from across the life course, including those related to workpl ace conditions.[9] Studies have shown that negative life events during childhood may predict decreased labour market participation in young adults,[10] as well as disability pension and long-term sickness absence in adult women.[11] One study found that the risk of disability retirement increased in a dose–response manner with a growing number of childhood adversities.[12]

A major adverse exposure in adulthood is low socioeconomic status (SES). Conventional indicators of low SES, such as low education or low occupational status, as well as other measures including poor financial situation, and poor housing have been linked to increased risk of work disability.[13–18] High SES, in turn, has been associated with lower risk of long-term work disability due to psychiatric disorders.[19] A combination of childhood adversity and low SES in adulthood has been shown to associate with behavioural risk factors of disability retirement, such as obesity, smoking and physical inactivity.[20]

The childhood and adult exposures may have independent, additive or synergistic effects on adult health and work disability. Exposure to childhood adversities may trigger a long-term pattern of heightened psychological and physiological reactivity to stress, a biological pathway which may characterise important life course influence.[21] Dysregulated or chronically activated stress responses have been linked to the progression of physical illnesses over time,[22] and may explain why early adversities make individuals vulnerable to poor health.[23] Furthermore, social pathways may contribute to adverse life course effects,[21] because persons exposed to adverse experiences in childhood may be more likely to face further interpersonal problems later in life.[20] However, the combined effects of exposure to childhood adversities and low SES in adulthood on work disability have not been examined.

To address this gap in evidence, we examined whether the associations for childhood adversity and low adult SES with work disability are

To cite: Halonen JI, Kivimäki M, Vahtera J, *et al*. *Occup Environ Med* 2017;**74**:659–666.

independent, additive or synergistic. In addition to overall work disability, work disability due to musculoskeletal and mental disorders was analysed separately as these are the leading single causes of work disability.

METHODS

Study participants

Participants of the Finnish Public Sector (FPS) study, an ongoing cohort study including employees of 10 towns and 6 hospital districts in Finland, formed the basis for the study population. The participants are from a wide range of occupations, from administrative personnel and professionals (eg, doctors) to semi-skilled and unskilled workers (eg, cleaners). Surveys were sent to all permanent employees and those with a long-term contract with the target organisations at the time of the survey. Surveys have been repeated by 2–4 year intervals with responding always being voluntary.

Selection of the participants is presented in figure 1. Information on childhood adversities was collected in the 2008 survey that was sent to 50 284 eligible employees of the 10 towns (response rate 71%, n=35 498). Of the responders, 8 died and 599 retired before the start of follow-up, 366 had missing information on childhood adversities, 507 had no data on adult SES (ie, occupational status in 2008) and 2545 had no information for some of the covariates and they were all excluded. This resulted in an analytical sample of 31 473 participants. All register data were linked to the participants of the analytical sample using personal identification codes that were then recoded for confidentiality into research identification codes for the analyses. The linkages were complete for all participants. The analytic sample was similar to the sample with missing data on covariates in terms of proportion of men and low SES in adulthood, as well as according to mean age and disability rate (see online supplementary table S1). Compared with the eligible population, the analytic sample included slightly less men (22% vs 28%) and those with low adult SES (43% vs 48%). The mean age of the analytic sample was 47.1 (SD=9.6) years and that of the eligible 47.2 (SD=9.7) years.

Measurement of childhood adversity and low SES in adulthood

The questions regarding childhood adversities were modified from the *Survey of Living Conditions* developed by Statistics Finland.[24] The participants were asked whether they had experienced any of the following six adversities in their childhood: divorce/separation of the parents, long-term financial difficulties in the family, serious conflicts in the family, frequent fear of a family member, serious or chronic illness of a family member or an alcohol problem of a family member (response categories for each item: no, yes or cannot say). Response category 'cannot say' was coded as a missing value (4% of all responses). The prevalence of the individual adversities ranged from 14.3% (fear of a family member) to 28.9% (serious or chronic illness of a family member) (see online supplementary table S2). For the analyses including calculation of synergy indices of the two exposures, we formed a binary variable for the childhood adversities (none vs any). In our preliminary analysis using a summary variable from the six questionnaire items (range from 0 to 6), even having one adversity was associated with a slightly increased risk of all-cause work disability (HR compared with having no adversities 1.05, 95% CI 1.00 to 1.11) and having all six adversities was associated with the greatest risk (HR 1.72, 95% CI 1.47 to 2.02). In a separate analysis of specific adversities, each individual adversity was associated with an increased disability risk (range of HRs from 1.14 (95% CI 1.09 to 1.19) for long-term illness to 1.31 (95% CI 1.24 to 1.38) for fear of a family member) (see online supplementary table S3).

Occupational position was used as an indicator of adult SES. For each participant, we obtained International Classification of Occupations (ISCO) codes for year 2008 from the employers' registers. We dichotomised the occupational positions[25] into 'high' (=ISCO classes 1–3; including managers, professionals and technicians) and 'low' (=ISCO classes 4–9; including clerical, service and manual workers) category like in a previous study.[26]

For the analyses, the participants were classified into four categories of the combined exposure: neither (no childhood adversity nor low adult SES, the reference group); childhood adversity only; low adult SES only and both (childhood adversity and low adult SES).

Ascertainment of work disability

We obtained data on all granted work disability periods from the registers of the Social Insurance Institution (SII) of Finland (sickness absence) and the Finnish Centre for Pensions (temporary and permanent work disability pensions). An episode of *work disability*

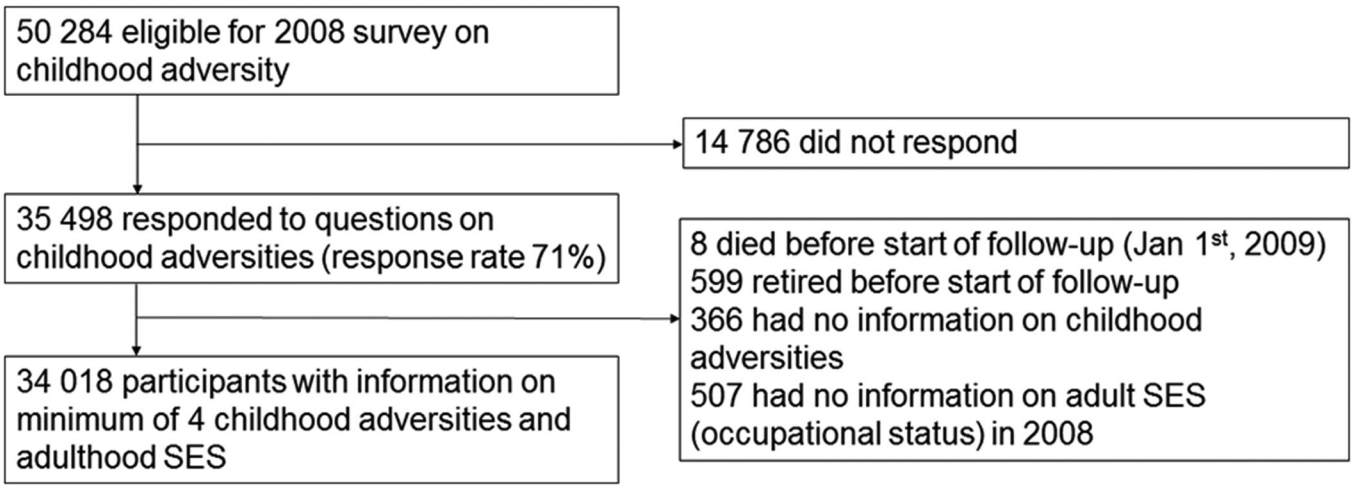

Figure 1 Flow chart of the selection of the analytic sample. SES, socioeconomic status.

could include a period of sickness absence beyond nine work days, or a period of temporary or permanent disability pension, or both, if sickness absence was followed by disability pension. Nine work days is the cut-off for sickness absence periods as the SII only reimburses and records sickness absence periods lasting more than nine work days. Disability pension can be granted for a person whose capacity for work is severely and long-term impaired by at least 60% by an illness diagnosed by a doctor.[27]

We examined work disability for any cause, and specifically due to musculoskeletal (International Classification of Diseases (IDC) 10th revision codes M00-M99) and mental (ICD–10 codes F00-F99) disorders and other causes. Most disability periods were due to sickness absence (93%). Of all participants, 2.5% were granted disability pension; of these musculoskeletal disorders covered 48% and mental disorders 20%. Due to low numbers, however, the disability pension was not analysed by diagnostic groups.

Assessment of covariates

Information about age and sex was derived from the employers' registers. Age and sex were used as confounders in all analyses. With only one baseline assessment, we were not able to reliably separate whether the other covariates act as confounders or as mediators in the associations of childhood adversity and adulthood SES with work disability. From the questionnaires we obtained information about factors that have been linked to increased risk of work disability: marital status[28] (married or cohabiting vs not); smoking[16] (current smoker vs not); heavy alcohol use[16 29] (consumption >24 units/week in men and >16 units/week in women (yes vs no)[30]; physical activity[16] (measured as weekly Metabolic Equivalent Task (MET) hours[31] and categorised as <14 MET hours/week= low and ≥14 MET hours/week= moderate-high)[31]; body mass index[16] (BMI) (measured as weight/height squared in metres, kg/m^2, categorised as ≤25: normal weight; 25–29.9:

Table 1 Descriptive statistics of the study population at baseline by childhood adversity and adult socioeconomic status (SES)

	All (n=31 473)	Neither (n=7342)	Childhood adversity only (n=10 613)	Low adult SES only (n=4868)	Both (n=8650)
Confounder/mediator	**N (% of all participants)**				
Sex (p value<0.001)					
Men	7010	1855 (26)	2391 (34)	1097 (16)	1667 (24)
Women	24 463	5487 (22)	8222 (34)	3771 (15)	6983 (29)
Age group, years (<0.001)					
<35	3884	1016 (26)	1303 (34)	555 (14)	1010 (26)
35–50	14 728	3608 (25)	5115 (35)	2113 (14)	3892 (26)
>50	12 861	2718 (21)	4195 (33)	2200 (17)	3748 (29)
Married or cohabiting (<0.001)					
Yes	23 771	5903 (25)	8073 (34)	3606 (15)	6129 (26)
No	7762	1439 (19)	2540 (33)	1262 (16)	2521 (32)
Smoking (<0.001)					
No	26 582	6678 (25)	9412 (35)	3925 (15)	6567 (25)
Yes	4891	664 (14)	1201 (24)	943 (19)	2083 (43)
Heavy alcohol use (<0.001)					
No	28 340	6599 (23)	9404 (33)	4489 (16)	7848 (28)
Yes	3133	743 (24)	1209 (39)	379 (12)	802 (26)
Physical activity (<0.001)					
Moderate	23 328	5755 (25)	8097 (35)	3490 (15)	5986 (26)
Low	8145	1587 (19)	2516 (31)	1378 (17)	2664 (33)
Body mass index (<0.001)					
<25	15 286	4022 (26)	5439 (36)	2179 (14)	3646 (24)
25–30	10 889	2372 (22)	3581 (33)	1762 (16)	3174 (29)
>30	5298	948 (18)	1593 (30)	927 (18)	1830 (34)
Chronic disease (<0.001)					
No	26 688	6427 (24)	9085 (34)	4068 (15)	7108 (27)
Yes	4785	915 (19)	1528 (32)	800 (17)	1542 (32)
Psychological distress (<0.001)					
No	24 044	5904 (24)	7716 (32)	4027 (17)	6397 (27)
Yes	7429	1438 (20)	2897 (39)	841 (11)	2253 (30)
Job strain (<0.001)					
No	24 385	6265 (26)	8686 (36)	3500 (14)	5934 (24)
Yes	7088	1077 (15)	1927 (27)	1368 (19)	2716 (39)
Shift work (<0.001)					
No	25 012	6627 (26)	9230 (37)	3376 (14)	5779 (23)
Yes	6461	715 (11)	1383 (21)	1492 (23)	2871 (45)
Job contract (<0.001)					
Permanent	28 475	6568 (23)	9379 (33)	4551 (16)	7977 (28)
Fixed-term	2998	774 (26)	1234 (41)	317 (11)	673 (22)

Table 2 Baseline associations (prevalence ratio, PR)* of exposure to childhood adversity and low adult socioeconomic status (SES) with risk factors

Exposure		Smoking		Heavy alcohol use		Low physical activity		Obesity		Chronic disease		Psychological distress	
	N	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Neither	7342	1.00		1.00		1.00		1.00		1.00		1.00	
Childhood adversity only	10 613	1.28	1.17 to 1.40	1.13	1.04 to 1.22	1.08	1.02 to 1.14	1.16	1.08 to 1.25	1.12	1.04 to 1.20	1.38	1.31 to 1.46
Low adult SES only	4868	2.18	2.00 to 2.39	0.73	0.65 to 0.82	1.29	1.22 to 1.37	1.42	1.31 to 1.54	1.21	1.11 to 1.31	0.88	0.825 to 0.9
Both	8650	2.76	2.55 to 2.99	0.89	0.81 to 0.97	1.41	1.33 to 1.48	1.61	1.50 to 1.72	1.37	1.28 to 1.47	1.32	1.25 to 1.40
Synergy index		1.20	1.02 to 1.41	0.77	0.29 to 2.00	1.10	0.86 to 1.42	1.04	0.80 to 1.34	1.15	0.77 to 1.72	1.22	0.84 to 1.77
		Job strain		Shift work		Fixed-term contract							
Neither	7342	1.00		1.00		1.00							
Childhood adversity only	10 613	1.23	1.15 to 1.31	1.35	1.24 to 1.46	1.16	1.07 to 1.26						
Low adult SES only	4868	1.90	1.77 to 2.03	3.20	2.96 to 3.46	0.70	0.62 to 0.79						
Both	8650	2.08	1.95 to 2.21	3.43	3.19 to 3.68	0.78	0.71 to 0.86						
Synergy index		0.96	0.84 to 1.10	0.95	0.86 to 1.06	1.51	0.61 to 3.77						

*Adjusted for age and sex.

overweight; ≥30 obese)[32]; and psychological distress[28] (measured by a psychological distress scale using the 12–item General Health Questionnaire[33] with participants with a summary score of four or more were coded as cases of psychological distress).[34] Chronic diseases (hypertension, cardiac failure, ischaemic heart disease, diabetes, asthma or other chronic obstructive lung disease, rheumatoid arthritis and mental disorders) were identified from the Drug Reimbursement Register maintained by the SII of Finland.[35] Information on all cancers diagnosed in 2001 through 2008 was obtained from the Finnish Cancer Registry.[36] Information about work-related covariates possibly related to work disability, job strain[16] (ie, high job demands and low job control based on questions from the Job Content Questionnaire)[37] and shift work (no shift work vs any type of shift work) was also obtained from the questionnaires. Type of job contract (fixed-term vs permanent) was from the employers' registers.

Statistical analysis

We first examined the associations of the combined exposure variable with the health-related and work-related covariates. We used log-binomial regression models and present the results as age-adjusted and sex-adjusted prevalence ratios (PR) and their 95% CIs for each category of the exposure variable. The 'neither' category (no childhood psychosocial adversity and no low adult SES) served as the reference.

We then examined whether the health-related and work-related covariates predicted work disability using Cox proportional hazard models adjusting for age and sex. Participants employed at baseline (1 January 2009, that is, after the 2008 survey requesting childhood adversities) were followed up to the first period of work disability, statutory retirement, death or end of follow-up (ie, end of register data update on 31 December 2011). The results of this analysis are presented as HRs with 95% CI.

The main analysis examined the associations between the combined exposure to childhood adversity and low adult SES and work disability using the Cox proportional hazards models. We ran two models with different adjustments: model 1 was adjusted for age and sex that could be considered confounders. In model 2 we additionally adjusted for the possible mediators/confounders: marital status, smoking, heavy alcohol use, physical activity, BMI, chronic disease, psychological distress, job strain, shift work and type of job contract. We checked the proportionality assumption of the hazard models by calculating group*time interaction. p Value of 0.12 for the interaction indicated there was no evidence against the proportional hazards.

Finally, we calculated the synergistic effect of the two exposures using synergy index that indicates relative excess risk due to interaction between the two exposures.[38–41] Synergy index values >1 indicate that the effects of adversity in childhood and SES in adulthood in combination are greater than one would expect from these factors in isolation.[42] The formula for calculating synergy index for two dichotomised variables is: $S = (RR_{A+B+} - 1) / [(RR_{A+B-} - 1) + (RR_{A-B+} - 1)]$. Applied to the present study, RR_{A+B+} is the relative risk of work disability if both factors A (childhood adversity) and B (low adult SES) are present, RR_{A+B-} is the relative risk of disability if A is present but B is absent and RR_{A-B+} is the relative risk of disability if B is present but A is absent.

As a sensitivity analysis, we used educational level as an additional indicator of adult SES. Information about education was obtained from the registers of Statistics Finland[43] and was available for all participants. We categorised educational level as 'high' (=university degree) and 'intermediate/low' (=high school, or vocational school, or basic education). We ran models also for disability pension only, and using categorisation 0–1 vs 2–6 for the childhood adversities that was used in our previous study.[20]

RESULTS

Mean follow-up time for all-cause work disability was 2.3 (SD=1.0) years. Of the participants, 78% were female and the mean age of the participants at baseline was 47.1 (range 19–68) years. Descriptive statistics of the study population are presented

by the four exposure categories in table 1. The largest exposure group (33% of all participants) was the group of participants with at least one childhood adversity (and high SES) followed by the group with both exposures (28% of all participants).

Childhood adversity, low adult SES and their combination were associated with an increased risk of smoking, low physical activity, obesity and having a chronic disease (table 2). Childhood adversity and low adult SES were synergistically associated with smoking. Exposure to childhood adversities only also increased the risk of heavy alcohol use and psychological distress. Both exposures alone and together were also associated with job strain and shift work, but only childhood adversity was associated with fixed-term job contract (table 2). Low adult SES was inversely associated with heavy alcohol consumption and fixed-term job contract. The exposures and the health-related and work-related covariates were also positively associated with the work disability outcomes, with the exception of the fixed-term job contract (see online supplementary table S4).

In figure 2 we show crude cumulative hazards of work disability by the four exposure categories of childhood adversity and adult SES. The highest cumulative probability during the follow-up was observed among those exposed to both (46%). Results of the main analysis are presented in table 3. The combined exposure was associated with a 1.95–fold (95% CI 1.85 to 2.06) hazard of work disability for any cause in the model adjusted for age and sex (model 1). The corresponding HR in a model including those with missing values for possible confounders/mediators was 1.95 (95% CI 1.85 to 2.05). The fully adjusted HR was 1.62 (95% CI 1.53 to 1.71). After adjustment for the possible confounders/mediators, the HR among those with both exposures was 2.53 (95% CI 2.29 to 2.79) for disability due to musculoskeletal disorders, 1.55 (95% CI 1.36 to 1.78) for disability due to mental disorders and 1.29 (95% CI 1.20 to 1.39) for disability due to other reasons (table 3). The synergy index was 1.1 in all baseline models and 0.9–1.0 in the fully adjusted models indicating little synergistic effects. Childhood adversity and low adult SES were independently associated with an increased risk of work disability. Adjustment for childhood adversity attenuated the association between low adulthood SES and work disability only slightly (3%) the adjusted HR for low adulthood SES being 1.69 (95% CI 1.62 to 1.75) (see online supplementary table S3).

The sensitivity analysis using education as an indicator of adult SES resulted in largely similar findings (HR for all-cause disability 1.67, 95% CI 1.58 to 1.77 in model 2) (see online supplementary table S5). Analyses for disability pension only resulted in similar but slightly stronger associations for all-cause disability; the fully adjusted HR for disability pension was 2.79 (95% CI 2.14 to 3.65) among those exposed to childhood adversity and low adult SES. The corresponding HR was 2.96 (95% CI 2.24 to 3.91) among those exposed to childhood adversity and low education (see online supplementary table S6). Analyses using different categorisation of the childhood adversities also resulted in similar findings (HR for all-cause disability 1.69, 95% CI 1.60 to 1.79 in model 3) (see online supplementary table S7).

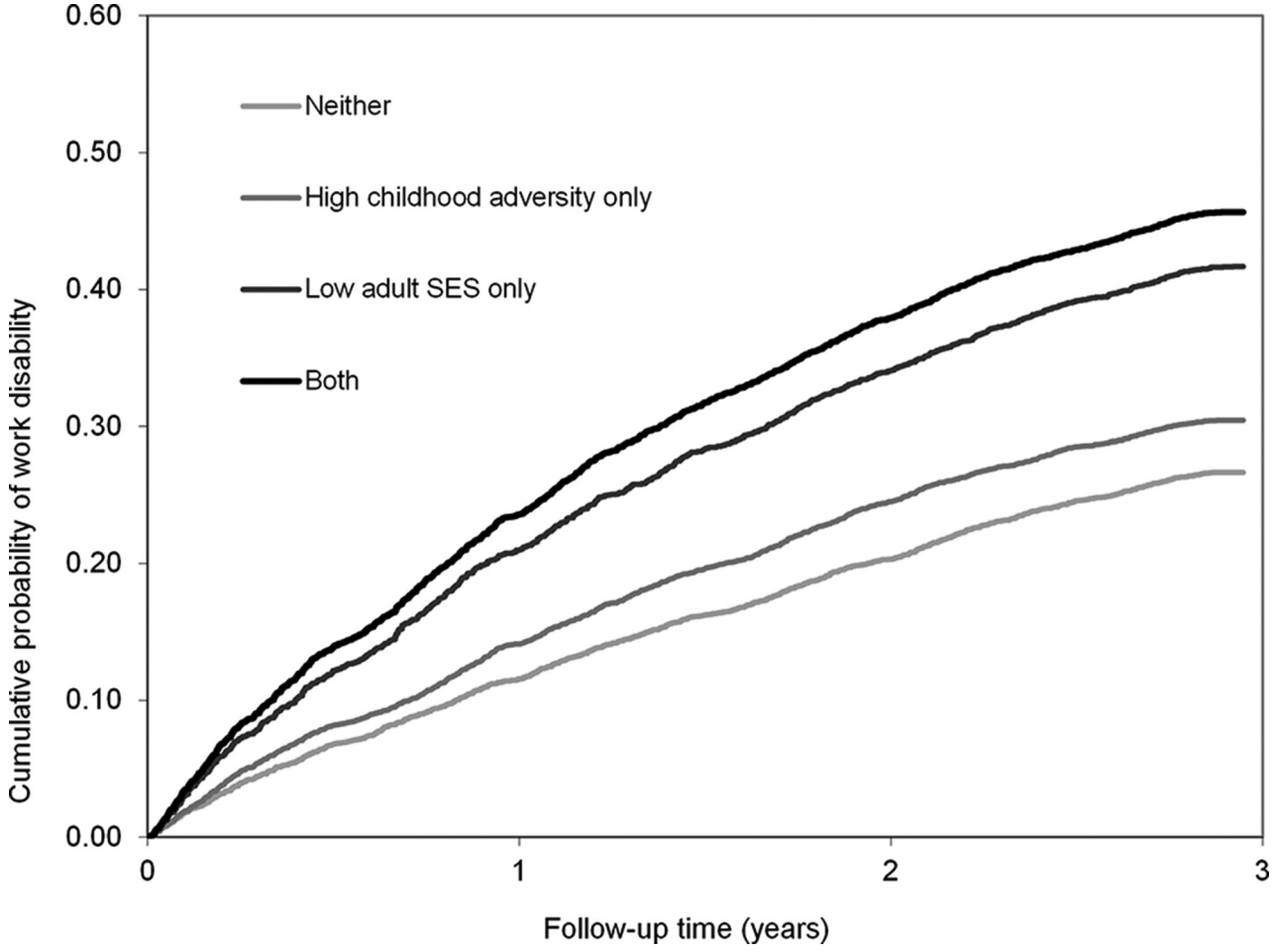

Figure 2 Non-adjusted cumulative hazard of the occurrence of work disability by childhood adversity and adult socioeconomic status (SES).

DISCUSSION

We found that adversities in childhood and low SES in adulthood were independently associated with the risk of work disability. The combined effect of childhood adversities and low SES in adulthood on all-cause work disability as well as disability due to musculoskeletal and mental disorders or due to other reasons was additive rather than synergistic. These findings indicate that childhood adversities together with later exposure to low SES may lead to cumulative health effects such that each additional period of adversity in life adds to the health disadvantage. This interpretation is consistent with the accumulation model described in life course epidemiology.[44]

We are not aware of previous studies examining the possible synergistic effects of childhood adversity and low adult SES on work disability. Although no synergistic effect of these exposures was observed, both childhood adversity and low adult SES were associated with work disability, which is consistent with previous findings. For instance, in studies focusing only on childhood exposures, adversities have been linked with increased risk of work disability for any cause after controlling for adult conditions,[11 12 45] and with lowered labour market participation.[10] None of these studies examined cause-specific disability due to musculoskeletal or mental disorders separately. A more recent study suggested that childhood adversities are highly prevalent among young adults on disability pension due to mental disorders,[46] which is also in agreement with our findings. A possible pathway from childhood adversity to mental problems is through changes in brain structure and function activated by adversities, which may further mediate the risk of psychopathology.[47 48] Another potential pathway is via epigenetic regulation that is based on findings where maternal care in rats was found to affect the hypothalamic-pituitary-adrenal activity that is involved in stress responses also later in life.[49]

Associations between adult SES and work disability have been previously examined.[14 16 45] In a study by Robroek and others a 1.84 times higher likelihood of receiving disability benefit was reported among those with low compared with high education.[16] This is similar to our findings for any short-term or long-term work disability, but lower than the likelihood for disability pension among those with low education only. In their study by Robroek and others, the association was attenuated by 62% and did not remain significant after adjustment for health-related and work-related factors, whereas in our study the association remained robust after controlling for these pertinent risk factors. However, the findings are not directly comparable due to different definitions of disability; in the Netherlands, disability benefit could be granted only after 2 years of illness, whereas in Finland disability pension can be granted after 1 year of illness. Furthermore, our measure of any work disability included also sickness absence spells beyond nine work days.

Some previous studies have focused on the associations between adult SES and cause-specific work disability. Like in our study, indicators of low adult SES have been linked to an increased risk of disability due to depression,[17] musculoskeletal and mental disorders.[18] A possible reason for why low SES was, in particular, associated with work disability due to musculoskeletal disorders is physically demanding work[50] that is more common in the low than high occupational groups.

The main strength of this investigation is the large study population and the comprehensive control for the risk factors as well as the high-coverage register data on the outcomes. However, there are also some limitations including the use of retrospectively assessed childhood adversity that is subject to reporting and recall biases. This may have both underestimated and overestimated the associations.[51] The use of retrospective measures on childhood adversity also leaves room for differential misclassification error, which may limit the validity of the data. The reliability of the self-reported measure of childhood adversity may be good,[52] but the validity of self-reported adversity can be assessed only by means of prospective studies beginning from childhood. There also remains possibility of unmeasured confounding as we had no information from childhood about possible confounders. In addition, persons with childhood adversities may be under-represented in our data because a larger proportion of these people tend to drop out of labour force prematurely or may fail to respond to surveys. Such under-representation may bias the results towards the null. As the study population consisted of the FPS employees that were predominantly female and virtually all of European

Table 3 HRs for subsequent work disability* by childhood adversity and low adult socioeconomic status (SES)

		Model 1†		Model 2‡	
Exposure	**N/events**	**HR**	**95% CI**	**HR**	**95% CI**
Work disability, any cause	31 473/11 820				
Neither	7342/2035	1.00		1.00	
Childhood adversity only	10 613/3361	1.15	1.09 to 1.22	1.08	1.02 to 1.14
Low adult SES only	4868/2188	1.71	1.60 to 1.82	1.52	1.42 to 1.62
Both	8650/4236	1.95	1.85 to 2.06	1.62	1.53 to 1.71
Synergy index		1.11	0.96 to 1.27	1.03	0.85 to 1.25
Musculoskeletal (ICD-10 M00-M99)	31 473/4889				
Neither	7342/603	1.00		1.00	
Childhood adversity only	10 613/1036	1.18	1.06 to 1.31	1.11	1.00 to 1.23
Low adult SES only	4868/1099	2.78	2.50 to 3.08	2.38	2.14 to 2.64
Both	8650/2151	3.15	2.87 to 3.46	2.53	2.29 to 2.79
Synergy index		1.10	1.01 to 1.20	1.03	0.93 to 1.15
Mental (ICD-10 F00-F99)	31 473/2357				
Neither	7342/364	1.00		1.00	
Childhood adversity only	10 613/813	1.57	1.38 to 1.78	1.40	1.23 to 1.59
Low adult SES only	4868/327	1.34	1.15 to 1.57	1.21	1.03 to 1.42
Both	8650/853	1.96	1.72 to 2.22	1.55	1.36 to 1.78
Synergy index		1.05	0.91 to 1.22	0.91	0.74 to 1.12
Other (ICD-10 not F or M)	31 473/7019				
Neither	7342/1320	1.00		1.00	
Childhood adversity only	10 613/2073	1.07	1.00 to 1.15	1.02	0.95 to 1.10
Low adult SES only	4868/1257	1.40	1.29 to 1.52	1.26	1.16 to 1.36
Both	8650/2369	1.52	1.42 to 1.63	1.29	1.20 to 1.39
Synergy index		1.09	0.88 to 1.36	1.04	0.73 to 1.48

*Sickness absence >9 days or work disability pension,
†Model 1 adjusted for sex, age,
‡Model 2 adjusted for sex, age, marital status, smoking, heavy alcohol use, physical activity, body mass index, chronic disease, psychological distress, job strain, shift work and type of job contract.
ICD-10, International Classification of Diseases 10th revision diagnosis codes.

origin, further studies in more diverse populations from various well-fare regimens and branches of industry are needed to confirm the generalisability of our findings.

CONCLUSIONS

Exposure to adversities in childhood and low SES in adulthood were independently associated with work disability. Exposure to both these risk factors was associated with the highest risk of work disability, although this was additive rather than synergistic association. Childhood adversity was associated with disability due to mental disorders in particular, whereas low adult SES was more strongly associated with disability due to musculoskeletal disorders. These findings suggest that psychosocial and socioeconomic exposures from across the life course have an impact on work disability.

Contributors JIH, MK, JV, JP and TL conceived and designed the experiments. JIH analysed the data. MK, JP, JV, MV, JE and TO contributed reagents/materials/analysis tools. MK, JV and TL contributed to the funding of the study. TL is the guarantor of the study. All authors were involved in writing the paper and approved the submitted and published versions.

Funding This study was supported by the Academy of Finland (grant numbers 287488 and 294096 for TL, 258598 and 292824 for MV & JE, and 267727 for JV). MK is supported by Nordforsk, the Nordic Programme on Health and Welfare, the Finnish Work Environment Fund, and the UK Medical Research Council (K013351). The funders had no role in the data collection, analysis or writing of the paper.

Competing interests None declared.

Patient consent Responding was voluntary and data were analyzed in anonymized form.

Ethics approval The FPS cohort study was approved by the Ethics Committee of the Hospital District of Helsinki and Uusimaa, Finland.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 OECD. Sickness, disability and work: breaking the barriers. A synthesis of findings across OECD countries. 2010 http://dx.doi.org/10.1787/9789264088856-en.
2 Bevan S. Economic impact of musculoskeletal disorders (MSDs) on work in Europe. *Best Pract Res Clin Rheumatol* 2015;29:356–73.
3 European Union. European Foundation for the Improvement of Living and Working Conditions. Dublin (Ireland): European Union, 2010.
4 Hoy DG, Smith E, Cross M, *et al*. Reflecting on the global burden of musculoskeletal conditions: lessons learnt from the global burden of disease 2010 study and the next steps forward. *Ann Rheum Dis* 2015;74:4–7.
5 Birnbaum HG, Kessler RC, Kelley D, *et al*. Employer burden of mild, moderate, and severe Major depressive disorder: mental health services utilization and costs, and work performance. *Depress Anxiety* 2010;27:78–89.
6 Virtanen M, Kivimäki M, Vahtera J, *et al*. Sickness absence as a risk factor for job termination, unemployment, and disability pension among temporary and permanent employees. *Occup Environ Med* 2006;63:212–7.
7 Helgesson M, Johansson B, Nordqvist T, *et al*. Sickness absence at a young age and later sickness absence, disability pension, death, unemployment and income in native swedes and immigrants. *Eur J Public Health* 2015;25:688–92.
8 Pongiglione B, De Stavola BL, Kuper H, *et al*. Disability and all-cause mortality in the older population: evidence from the English Longitudinal Study of ageing. *Eur J Epidemiol* 2016;31:735–46.
9 WHO. Workers' health: global plan of action. Sixtieth worll health asembly. 2007 http://www.who.int/occupational_health/WHO_health_assembly_en_web.pdf?ua=1.
10 Lund T, Andersen JH, Winding TN, *et al*. Negative life events in childhood as risk indicators of labour market participation in young adulthood: a prospective birth cohort study. *PLoS One* 2013;8:e75860.
11 Upmark M, Thundal KL. An explorative, population-based study of female disability pensioners: the role of childhood conditions and alcohol abuse/dependence. *Scand J Public Health* 2002;30:191–9.
12 Harkonmäki K, Korkeila K, Vahtera J, *et al*. Childhood adversities as a predictor of disability retirement. *J Epidemiol Community Health* 2007;61:479–84.
13 Gustafsson K, Aronsson G, Marklund S, *et al*. Social integration, socioeconomic conditions and type of ill health preceding disability pension in young women: a swedish population-based study. *Int J Behav Med* 2014;21:77–87.
14 Leinonen T, Martikainen P, Lahelma E. Interrelationships between education, occupational social class, and income as determinants of disability retirement. *Scand J Public Health* 2012;40:157–66.
15 Polvinen A, Gould R, Lahelma E, *et al*. Socioeconomic differences in disability retirement in Finland: the contribution of ill-health, health behaviours and working conditions. *Scand J Public Health* 2013;41:470–8.
16 Robroek SJ, Rongen A, Arts CH, *et al*. Educational inequalities in exit from paid Employment among Dutch Workers: the influence of Health, Lifestyle and Work. *PLoS One* 2015;10:e0134867.
17 Ervasti J, Vahtera J, Pentti J, *et al*. Depression-related work disability: socioeconomic inequalities in onset, duration and recurrence. *PLoS One* 2013;8:e79855.
18 Leinonen T, Pietiläinen O, Laaksonen M, *et al*. Occupational social class and disability retirement among municipal employees--the contribution of health behaviors and working conditions. *Scand J Work Environ Health* 2011;37:464–72.
19 Virtanen M, Kawachi I, Oksanen T, *et al*. Socio-economic differences in long-term psychiatric work disability: prospective cohort study of onset, recovery and recurrence. *Occup Environ Med* 2011;68:791–8.
20 Halonen JI, Stenholm S, Pentti J, *et al*. Childhood Psychosocial Adversity and Adult Neighborhood Disadvantage as Predictors of Cardiovascular Disease: a Cohort Study. *Circulation* 2015;132:371–9.
21 Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *Int J Epidemiol* 2002;31:285–93.
22 Miller GE, Chen E, Parker KJ. Psychological stress in childhood and susceptibility to the chronic diseases of aging: moving toward a model of behavioral and biological mechanisms. *Psychol Bull* 2011;137:959–97.
23 Luecken LJ, Appelhans BM, Kraft A, Brown AKA, *et al*. Never far from home: a cognitive-affective model of the impact of early-life family relationships on physiological stress responses in adulthood. *J Soc Pers Relat* 2006;23:189–203.
24 Rahkonen O, Lahelma E, Huuhka M. Past or present? childhood living conditions and current socioeconomic status as determinants of adult health. *Soc Sci Med* 1997;44:327–36.
25 Statistics Finland. Classification of occupations 2001. 2002 http://www.stat.fi/meta/luokitukset/ammatti/001-2001/index_en.html.
26 Virtanen M, Lallukka T, Ervasti J, *et al*. The joint contribution of cardiovascular disease and socioeconomic status to disability retirement: a register linkage study. *Int J Cardiol* 2017;230.
27 Huunan-Seppälä A, Järvisalo J, Laine A, *et al*. *The prevention of problems related to disallowed disability pensions. A Report Commissioned by the Parliamentary Trustees of the Social Insurance Institution, Finland*. Finland: Oula-Finna, 2003.
28 Ervasti J, Kivimäki M, Dray-Spira R, *et al*. Psychosocial factors associated with work disability in men and women with diabetes: a pooled analysis of three occupational cohort studies. *Diabet Med* 2016;33:208–17.
29 Böckerman P, Hyytinen A, Maczulskij T. Devil in disguise: does drinking lead to a disability pension? *Prev Med* 2016;86:130–5.
30 Halonen JI, Kivimäki M, Virtanen M, *et al*. Living in proximity of a bar and risky alcohol behaviours: a longitudinal study. *Addiction* 2013;108:320–8.
31 Ainsworth BE, Haskell WL, Herrmann SD, *et al*. 2011 compendium of physical activities: a second update of codes and MET values. *Med Sci Sports Exerc* 2011;43:1575–81.
32 WHO. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser* 2000;894:1–253. i-xii.
33 Goldberg DP, Gater R, Sartorius N, *et al*. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychol Med* 1997;27:191–7.
34 Holi MM, Marttunen M, Aalberg V. Comparison of the GHQ-36, the GHQ-12 and the SCL-90 as psychiatric screening instruments in the finnish population. *Nord J Psychiatry* 2003;57:233–8.
35 Social Insurance Institute of Finland. Statistics on reimbursements for medical expenses. 2016 http://www.kela.fi/web/en/statistics-by-topic_statistics-on-reimbursements-for-medical-expenses?inheritRedirect=true.
36 Teppo L, Pukkala E, Lehtonen M. Data quality and quality control of a population-based Cancer registry. experience in Finland. *Acta Oncol* 1994;33:365–9.
37 Karasek RA, demands J. Job Demands, Job Decision Latitude, and Mental Strain: implications for Job Redesign. *Adm Sci Q* 1979;24:285–308.
38 Lundberg M, Fredlund P, Hallqvist J, *et al*. A SAS program calculating three measures of interaction with confidence intervals. *Epidemiology* 1996;7:655–6.
39 Hosmer DW, Lemeshow S. Confidence interval estimation of interaction. *Epidemiology* 1992;3:452–6.

40 Dorner TE, Alexanderson K, Svedberg P, *et al*. Synergistic effect between back pain and common mental disorders and the risk of future disability pension: a nationwide study from Sweden. *Psychol Med* 2016;46:425–36.
41 Andersson T, Alfredsson L, Källberg H, *et al*. Calculating measures of biological interaction. *Eur J Epidemiol* 2005;20:575–9.
42 Rothman KJ. Synergy and antagonism in cause-effect relationships. *Am J Epidemiol* 1974;99:385–8.
43 Statistics Finland. Employment. 2011 http://www.stat.fi/meta/til/tyokay_en.html.
44 Kuh D, Ben-Shlomo Y, Lynch J, *et al*. Life course epidemiology. *J Epidemiol Community Health* 2003;57:778–83.
45 Gravseth HM, Bjerkedal T, Irgens LM, *et al*. Life course determinants for early disability pension: a follow-up of norwegian men and women born 1967-1976. *Eur J Epidemiol* 2007;22:533–43.
46 Joensuu M, Mattila-Holappa P, Ahola K, *et al*. Clustering of adversity in young adults on disability pension due to mental disorders: a latent class analysis. *Soc Psychiatry Psychiatr Epidemiol* 2016;51:281–7.
47 Holz NE, Laucht M, Meyer-Lindenberg A. Recent advances in understanding the neurobiology of childhood socioeconomic disadvantage. *Curr Opin Psychiatry* 2015;28:365–70.
48 Clark C, Caldwell T, Power C, *et al*. Does the influence of childhood adversity on psychopathology persist across the lifecourse? A 45-year prospective epidemiologic study. *Ann Epidemiol* 2010;20:385–94.
49 Anacker C, O'Donnell KJ, Meaney MJ. Early life adversity and the epigenetic programming of hypothalamic-pituitary-adrenal function. *Dialogues Clin Neurosci* 2014;16:321–33.
50 Andersen LL, Fallentin N, Thorsen SV, *et al*. Physical workload and risk of long-term sickness absence in the general working population and among blue-collar workers: prospective cohort study with register follow-up. *Occup Environ Med* 2016;73:246–53.
51 Hardt J, Rutter M. Validity of adult retrospective reports of adverse childhood experiences: review of the evidence. *J Child Psychol Psychiatry* 2004;45:260–73.
52 Sumanen M, Koskenvuo M, Sillanmäki L, *et al*. Childhood adversities experienced by working-aged coronary heart disease patients. *J Psychosom Res* 2005;59:331–5.

Childhood adversity, adult socioeconomic status and risk of work disability: a prospective cohort study

Jaana I Halonen, Mika Kivimäki, Jussi Vahtera, Jaana Pentti, Marianna Virtanen, Jenni Ervasti, Tuula Oksanen and Tea Lallukka

Occup Environ Med 2017 74: 659-666 originally published online August 7, 2017
doi: 10.1136/oemed-2017-104319