Original article

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Cumulative years of biomechanical and psychosocial work exposures and long-term sickness absence: A register-based cohort study among early-career Norwegian employees

by Gunvor Grødem Kleven, MSc,[1,2] Rachel Louise Hasting, PhD,[2] Anne Kristin Møller Fell, Prof,[3] Julie Ulstein, PhD,[2]

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Objectives This study aimed to examine whether accumulated years of combined physical and psychosocial work exposure are associated with long-term sickness absence (LTSA) among early-career employees, and whether associations differ by gender.

Methods We conducted a cohort study using Norwegian register data from the Nor-Work cohort, including 244 715 employees aged 30–35 years. Five-year work exposure histories (2011–2015) prior to baseline were constructed using two validated, gender-specific job exposure matrices. Combined exposure was defined as values ≥60th percentile on both the physical and psychosocial index in a given year, accumulating to 0–5 years combined exposure. Cox proportional hazards models estimated hazard ratios (HR) with 95% confidence intervals (CI) for the first full (100%) and partial (<100%) LTSA during follow-up (2016–2020), stratified by gender.

Results For full LTSA among women, HR increased with exposure duration, then leveled off after three years, ranging from 1.24 (CI 1.19–1.30) for one year to 1.47 (1.42–1.51) for five years in adjusted models compared to those with 0 years combined exposure. Among men, risk estimates were consistently elevated with HR ranging from 1.16 (1.10–1.22) for one year to 1.21 (1.13–1.30) for three years. For partial LTSA among women, an inverse association was observed, while for men estimates were close to null.

Conclusions Accumulated years of predicted combined physical and psychosocial work exposures were associated with increased risk of full LTSA across gender, and a slightly reduced risk of partial LTSA among women. Workplace accommodation and preventive strategies targeting combined occupational exposures may help support labor market attachment and reduce LTSA.

Key terms accumulated work exposure; gender difference; job exposure matrix; Norway; occupational epidemiology; sickness leave; work demand; work environment.

Long-term sickness absence (LTSA) represents a considerable burden at individual, employer and societal levels. For individuals, LTSA has been linked to recurrent sickness absence (1), premature labor market exit and increased mortality risk (2). For employers and society, LTSA represents substantial costs and a leading cause of loss to productivity (3). Younger workers face more potentially harmful and hazardous working conditions compared to older workers (4). Because cumulative exposure to adverse working conditions can negatively impact health and increase LTSA risk (3), identifying modifiable work-related exposures among early-career employees is essential for LTSA prevention.

Individually, both physical and psychosocial work exposures have been linked to adverse health outcomes (5–8), including mental and musculoskeletal disorders (9–11), which are the leading causes of sickness absence in Norway and have increased in recent years (12). Physical exposures include ergonomic job demands such as heavy physical workload and awkward working positions, while psychosocial exposures refer to psychological and social dimensions of work, including job

1 Institute of Health and Society, University of Oslo, Oslo, Norway.
2 Department of Occupational Medicine and Epidemiology, National Institute of Occupational Health, Oslo, Norway.
3 Department of Community Medicine and Global Health, Institute of Health and Society, University of Oslo, Oslo, Norway.

Correspondence to: Julie Ulstein, PhD, Department of Occupational Medicine and Epidemiology, National Institute of Occupational Health, Pb 5330 Majorstuen, Oslo, 0304, Norway. [E-mail: Julie.Ulstein@stami.no]

demands and job control. Some studies suggest dose-response relationships between cumulative exposure to demanding work factors and LTSA risk (3, 13, 14). However, findings are not fully consistent (15).

The combined impact of physical and psychosocial exposures has seldom been examined, despite plausible additive or even synergistic effects whereby combined exposures exceed the sum of individual effects (16). A few studies have investigated the combined impact of physical and psychosocial work exposures, with evidence suggesting increased risk of work-related injuries (17), sickness absence and disability pension (18–20). These findings underscore the importance of assessing the impact of combined work exposures.

As the effects of occupational exposures often depend on cumulative exposure and a latency period to develop (17), cumulative years of combined exposure may affect labor market attachment and health differently than single exposures of shorter duration. The limited evidence on how accumulated combined physical and psychosocial work exposure relate to LTSA is especially concerning for early-career workers, as exposure to adverse working conditions may contribute to permanent labor market exit (7). By contrast, in later career stages, the most vulnerable workers may have already transitioned out of highly exposed roles or left the workforce altogether (21), leading to underestimation of risk in studies focusing on older workers. In the Norwegian labor market, early labor market exits could likely be prevented if they are driven fully or partially by modifiable work exposures (22). Keeping young workers in the workforce is increasingly important given the ageing population and the resulting strain on the working-age population and the welfare state (23).

Despite Scandinavia's reputation for gender equality, gender segregation in the labor market persists (24, 25). At the same time, women have considerably higher rates of sickness absence compared to men (26). Gender differences in LTSA may in part reflect exposure differences between male- and female-dominated occupations (27). As an example, one in three women in Norway are employed in the health and social care sector, characterized by high physical and psychosocial demands. In 2025, this sector exhibited the highest sickness absence rates across all industries, accounting for 8.5 million lost working days (28). However, gender-differences in LTSA are likely multifactorial and may also reflect biological differences, sociocultural mechanisms and double-burden processes (29), such as unequal home demands and role expectations. Although each of these explanations is supported by evidence, no single factor can fully account for the observed disparities. At the same time, recent Norwegian research has reported elevated LTSA risk, with only modest sex differences when simultaneously exposed to physical and psychosocial work factors (18), but the analyses focused on mid-career workers, who likely represent a health-selected workforce (21). This raises the possibility that the impact of combined exposures may be more visible earlier in working life.

Despite the insights from previous research, more knowledge of the associations between cumulative years of exposure to combined physical and psychosocial work exposures and LTSA among younger workers is still needed. In the present study, we aim to address these research gaps by answering the following research question: To what extent are accumulated years of combined physical and psychosocial work exposures associated with LTSA among Norwegian early-career employees, and do these associations differ between men and women?

Methods

Study population and design

This cohort study is based on data from the Nor-Work cohort, which contain prospectively collected national register data on all individuals born 1930–1992 who have worked and/or resided in Norway (30). The cohort is linked to several registers, including administrative data from Statistics Norway (SSB) which includes the Aa-register, A-ordningen, the sickness absence register, the national education database and the national population register. In the present study, all outcome and covariate data were obtained from SSB.

Baseline was set to 1 January 2016. To target Norwegian early-career employees, individuals at the age of 30–35 who were registered as residents in Norway at baseline and had an active employment record with valid occupational codes were included. To exclude students and individuals with minimal part-time work, inclusion required an annual income ≥3 times the basic amount (known as *grunnbeløpet* (G) in Norwegian). This threshold was inspired by recent research on mid-career workers (18), who required an annual income ≥3.5 times the same amount. Individuals with ongoing LTSA at start of follow-up or missing covariate information necessary for analyses were excluded. This resulted in a final study population of 244 715 individuals, of which 138 121 were men and 106 594 women. An overview of the sample selection process can be seen in figure 1. To ensure standardized and transparent reporting of the study, the STROBE checklist was followed.

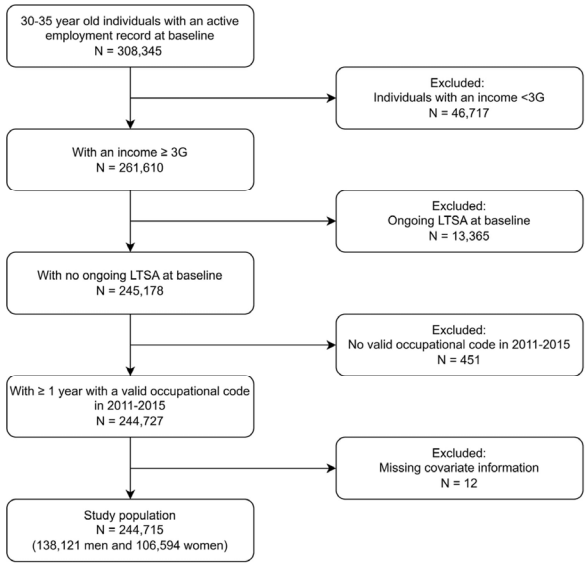


Figure 1. Flow diagram of sample selection.

Long-term sickness absence

In Norway, sickness absences >16 days are covered by The Norwegian Labor and Welfare Administration (Nav) and recorded in the sickness absence register, while shorter absences are covered by employers and are therefore not always registered (31). In this study, LTSA is therefore defined as sickness absence exceeding 16 days, to ensure complete registration. Sickness absences were classified as partial LTSA when the sickness absence grade was below 100%, and as full LTSA when the absence was graded at 100%. The first recorded LTSA episode per individual during follow-up (2016–2020) was included as the outcome.

Physical and psychosocial work exposures

Combined physical and psychosocial work exposures were assessed using the Occupational Mechanical Job Exposure Index and Occupational Job Strain Index (32, 33). Both gender-specific job-exposure matrices (JEM) are based on five waves of the Norwegian Survey of Living Conditions (34) and are validated for use with Norwegian registry data.

The mechanical index is based on a composite of eight exposures: heavy lifting (>20 kg), working with hands above shoulder height, heavy physical workload, neck flexion, squatting/kneeling, forward bending, awkward lifting and standing/walking (32). Higher index values indicate greater physical workload. The job strain index is inspired by Karasek's demand-control model (35), consisting of two dimensions: job demands and job control. Job demands consist of four factors: quantitative demands, conflicting ways of doing things, insufficient resources and contradictory requests, while job control consist of six factors: deciding how to go about work, deciding pace of work, being part of important decisions, using skills, developing skills and monotonous work (33). Higher index scores indicate greater psychosocial job demands and lower job control. For both indices, exposure was defined as the proportion of workers within each occupational group classified as exposed, with values ranging theoretically from 0 (no workers exposed) to 1 (all workers exposed). Detailed descriptions of the JEM are provided by Hermansen and Dahl (32) and Le, Hermansen and Dahl (33).

Years with combined physical and psychosocial exposure

We constructed five-year work histories prior to baseline using yearly occupation recorded in November from the employment registers. The main occupations for individuals were kept for each year. If a person had more than one main occupation, ties were solved by selecting the job with the highest hours, or highest occupational codes where the hours were equal. The yearly occupational data was merged with the JEM, creating a dataset with complete exposure information from 2011–2015. Individuals with a valid occupational code but without an exposure value in the JEM and individuals who were not employed during part of the five-year exposure period were defined as unexposed in the given year(s). Previous JEM-based studies have divided exposure into quartiles or quintiles and defined the top 40% most exposed as highly exposed (8, 18). To define combined physical and psychosocial exposure, both indices were therefore separately dichotomized at the 60th percentile. Observations were classified as exposed only when both indices were at or above this threshold in the same year, ie, the top 40% exposed, in both indices in the same year, corresponding to individuals with index values at or >0.27 on the physical index (range 0.01–0.67) and 0.33 on the strain index (range 0.16–0.48). Cumulative exposure was defined as the total number of years with predicted combined exposure during the five years preceding baseline.

Covariates

A directed acyclic graph (DAG) was constructed to guide covariate selection and identify the minimal sufficient adjustment set required to control for confounding (figure S1 in supplementary material). Model assumptions were evaluated based on substantive knowledge rather than through formal statistical testing, in line with recent methodological guidance (36). Based on the DAG, gender (male/female), education (lower secondary or below, upper secondary, tertiary undergradu-

ate, tertiary graduate and unspecified), marital status (unmarried/married or registered partner), country of birth (Norway/other), and number of children (0, 1, 2, ≥3) were identified as confounders and included in the adjusted analyses. Prior LTSA was considered a proxy for underlying health status and was defined as at least one episode of LTSA in the year prior to baseline (yes/no). However, prior LTSA may act as a mediator on the causal pathway between exposure and outcome. Therefore, analyses were conducted both with and without adjustment for prior LTSA.

Statistical analysis

Survival analyses were conducted to estimate LTSA incidence rates (IR) per 1000 person-years and describe time to first LTSA using Kaplan-Meier curves.

Grade-specific crude and multivariable Cox proportional hazard regression models were fitted, and results are presented as hazard ratios (HR) with 95% confidence intervals (CI). Follow-up started on 1 January 2016 and continued until the date of the outcome event or censoring due to death, emigration, occurrence of the alternative LTSA-grade, or end of follow-up (31 December 2020). All analyses were stratified by gender and performed using Stata version 18.5.

As a sensitivity analysis, we re-estimated all models using a different exposure threshold. After standardizing the physical and psychosocial indices, we dichotomized each at 0.50 and defined combined exposure as both indices ≥0.50.

Results

Descriptives

Baseline characteristics stratified by gender and exposure status are presented in table 1. In total, 35 350 women and 19 635 men were exposed to at least one year of predicted combined physical and psychosocial work exposure during the five years preceding baseline. A higher proportion of women (33.2%) than men (14.2%) were exposed, and women accumulated more exposure years than men. Exposed individuals had lower educational attainment and income compared with the unexposed, were more likely to be born outside Norway, and had a higher prevalence of prior LTSA. These patterns were consistent across genders. For a distribution of the main occupational groups stratified by gender and year, please see supplementary table S1.

Table 1. Baseline characteristics of the study population, stratified by gender and exposure status. [LTSA=long-term sickness absence; SD=standard deviation].

	Females				Males			
	Unexposed		Exposed		Unexposed		Exposed	
	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)
Total	71 244 (66.8)		35 350 (33.2)		118 486 (85.8)		19 635 (14.2)	
Age		32.6 (1.7)		32.4 (1.7)		32.5 (1.7)		32.4 (1.7)
Highest achieved education								
Lower secondary or below	3 377 (4.7)		4 622 (13.1)		14 459 (12.2)		5 313 (27.1)	
Upper secondary	13 100 (18.4)		11 914 (33.7)		46 306 (39.1)		8 936 (45.5)	
Tertiary, undergraduate	32 202 (45.2)		15 005 (42.5)		29 581 (24.9)		3 186 (16.2)	
Tertiary, graduate	21 603 (30.3)		2901 (8.2)		22 972 (19.4)		958 (4.9)	
Unspecified	962 (1.4)		908 (2.6)		5168 (4.4)		1242 (6.3)	
Income		498 391 (168 474)		413 153 (101 742)		591 131 (253 255)		512 460 (192 274)
Country of birth								
Norway	58 939 (82.7)		25 562 (72.3)		91 147 (76.9)		12 085 (61.5)	
Other	12 305 (17.3)		9788 (27.7)		27 339 (23.1)		7550 (38.5)	
Marital status								
Unmarried	41 979 (58.9)		22 011 (62.3)		76 169 (64.3)		12 939 (65.9)	
Married	29 265 (41.1)		13 339 (37.7)		42 317 (35.7)		6696 (34.1)	
Number of children								
0	23 310 (32.7)		11 147 (31.5)		53 197 (44.9)		9196 (46.8)	
1	16 488 (23.1)		7 863 (22.2)		27 842 (23.5)		4641 (23.6)	
2	24 359 (34.2)		11 757 (33.3)		29 049 (24.5)		4419 (22.5)	
≥3	7087 (10.0)		4583 (13)		8398 (7.1)		1379 (7.0)	
LTSA in 2015								
No	55 111 (77.4)		26 293 (74.4)		108 299 (91.4)		17 351 (88.4)	
Yes	16 133 (22.6)		9057 (25.6)		10 187 (8.6)		2284 (11.6)	
Years exposed								
1			6216 (5.9)				5044 (3.7)	
2			4662 (4.4)				3052 (2.2)	
3			4476 (4.2)				2552 (1.6)	
4			5794 (5.5)				3024 (2.2)	
5			14 202 (13.4)				5963 (4.3)	

Incidence rates

Incidence rates (IR) of LTSA per 1000 person-years, stratified by exposure status, gender and LTSA grade, are shown in table 2. For full LTSA, exposed women had substantially higher IR than the unexposed (121–157 versus 88 per 1000 person-years), with IR increasing across exposure duration. Among men, exposed individuals had higher IR than unexposed men (81–90 versus 56 incident cases of LTSA per 1000 person-years). IR increased with accumulated years of exposure up to three years and then plateaued at four to five years.

For partial LTSA among women, exposed individuals had lower IR than the unexposed (101–115 versus 119 per 1000 person-years), with a decreasing trend across increasing exposure duration, except for those exposed for five years. Among men, IR were similar between exposed and unexposed individuals (25–30 versus 25 per 1000 person-years), with no clear pattern across exposure duration.

Table 2. Long-term sickness absence (LTSA) incidence rates per 1000 person-years by years exposed to combined physical and psychosocial work exposures, stratified by gender and LTSA grade. [IR=incidence rate; CI=confidence interval].

Years exposed	Females		Males	
	Partial LTSA	Full LTSA	Partial LTSA	Full LTSA
	IR (95% CI)	IR (95% CI)	IR (95% CI)	IR (95% CI)
0	119 (118–121)	88 (86–89)	25 (25–25)	56 (56–57)
1	115 (110–120)	121 (116–126)	27 (25–29)	81 (77–85)
2	113 (107–119)	130 (124–136)	28 (25–31)	85 (80–91)
3	104 (99–110)	149 (143–156)	25 (22–28)	90 (84–96)
4	101 (96–106)	152 (146–158)	27 (24–30)	86 (81–92)
5	103 (100–107)	157 (153–161)	30 (28–32)	90 (87–95)

Full and partial LTSA

Hazard ratios (HR) from crude and adjusted Cox proportional hazards models stratified by gender and LTSA grade are presented in table 3. Among women, years of predicted combined exposure was associated with higher risk of full LTSA, with HR increasing with each additional year of combined exposure. The HR attenuated somewhat after adjustment and ranged from 1.24 (95% CI 1.19–1.30) for one year of combined exposure, to 1.47 (1.42–1.51) for five years of combined exposure

Table 3. Accumulated years of combined physical and psychosocial work exposures and incident long-term sickness absence (LTSA), stratified by gender and LTSA grade. Hazard ratios (HR) and 95% confidence intervals (CI) from Cox regression analyses with incremental adjustment for potential confounders.

	Case/Exposed	Model 1 [a]	Model 2 [b]	Model 3 [c]
		HR (95% CI)	HR (95% CI)	HR (95% CI)
Women				
Full LTSA				
Years exposed				
1	2093/6216	1.37 (1.31–1.43)	1.25 (1.19–1.30)	1.24 (1.19–1.30)
2	1658/4662	1.47 (1.39–1.54)	1.31 (1.25–1.38)	1.31 (1.25–1.38)
3	1796/4476	1.68 (1.60–1.76)	1.47 (1.40–1.54)	1.46 (1.39–1.53)
4	2383/5794	1.71 (1.64–1.79)	1.47 (1.40–1.53)	1.46 (1.40–1.53)
5	5929/14 202	1.77 (1.72–1.82)	1.49 (1.45–1.54)	1.47 (1.42–1.51)
Partial LTSA				
Years exposed				
1	1994/6216	0.95 (0.91–1.00)	0.97 (0.92–1.01)	0.96 (0.92–1.01)
2	1443/4662	0.93 (0.89–0.99)	0.97 (0.92–1.02)	0.97 (0.92–1.02)
3	1254/4476	0.86 (0.81–0.91)	0.90 (0.85–0.95)	0.90 (0.85–0.95)
4	1574/5794	0.83 (0.79–0.87)	0.86 (0.82–0.91)	0.86 (0.82–0.91)
5	3899/14 202	0.85 (0.82–0.88)	0.88 (0.85–0.91)	0.87 (0.84–0.90)
Men				
Full LTSA				
Years exposed				
1	1509/5044	1.42 (1.35–1.50)	1.16 (1.10–1.22)	1.16 (1.10–1.22)
2	958/3052	1.50 (1.41–1.60)	1.20 (1.12–1.28)	1.18 (1.10–1.26)
3	841/2552	1.58 (1.47–1.69)	1.23 (1.14–1.31)	1.21 (1.13–1.30)
4	961/3024	1.52 (1.42–1.62)	1.17 (1.10–1.25)	1.16 (1.09–1.24)
5	1959/5963	1.59 (1.52–1.67)	1.21 (1.15–1.26)	1.19 (1.13–1.24)
Partial LTSA				
Years exposed				
1	505/5044	1.07 (0.98–1.17)	1.01 (0.92–1.10)	1.01 (0.92–1.11)
2	309/3052	1.09 (0.97–1.22)	1.03 (0.92–1.15)	1.00 (0.90–1.12)
3	234/2552	0.99 (0.87–1.12)	0.92 (0.81–1.05)	0.90 (0.79–1.03)
4	300/3024	1.07 (0.95–1.20)	0.96 (0.86–1.08)	0.95 (0.84–1.06)
5	649/5963	1.19 (1.10–1.28)	1.05 (0.97–1.13)	1.02 (0.95–1.11)

[a] Model 1: unadjusted.

[b] Model 2: Model 1 + education, marital status, country of birth and number of children.

[c] Model 3: Model 2 + prior LTSA.

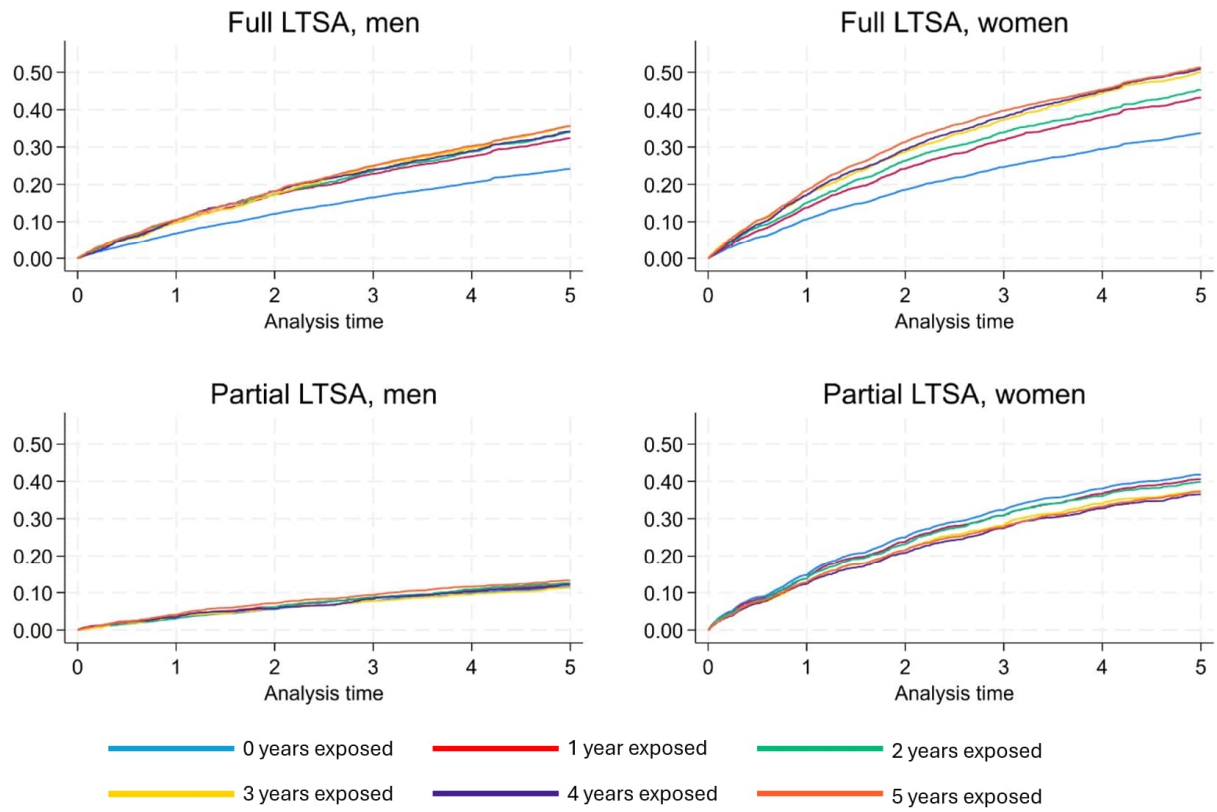


Figure 2. Cumulative incidence of LTSA by accumulated years of exposure, stratified by gender and LTSA grade.

in the fully adjusted model compared to those with 0 years of combined exposure. Among men, increasing years of predicted combined exposure were associated with higher risk of full LTSA in the crude model, with attenuation after adjustment. In the fully adjusted model, HR ranged from 1.16 (1.10–1.22) for one year of combined exposure to 1.21 (1.13–1.30) for three years of combined exposure, with HR reducing slightly after three years.

For partial LTSA among women, HR were below null in the crude model, with a decreasing trend across exposure duration except for after five years of predicted combined exposure. After adjustment, estimates approached null for one to two years of exposure, while remaining below null for three to five years, with HR ranging from 0.90 (0.85–0.95) to 0.86 (0.82–0.91) in the fully adjusted model. Among men, HR were close to null in both crude and adjusted models.

For a visual presentation of the cumulative incidence of LTSA, stratified by LTSA grade and gender, see figure 2.

Sensitivity analysis

The sensitivity analyses (table S2 in supplementary material) showed largely consistent results. With the alternative exposure classification, 14 876 men and 11 288 women were defined as exposed. In both crude and adjusted analyses, predicted combined exposure was associated with increased risk of full LTSA in both genders, with stronger estimates than in the main analyses. Among women, the exposure-response pattern was less pronounced and plateaued after four years of combined exposure. For partial LTSA, estimates were less consistent: the inverse association among women was attenuated, while estimates among men remained close to null. Overall, the direction of associations was similar across analyses.

As a supplementary analysis, we estimated models examining the independent effects of cumulative physical and psychosocial work exposures separately (table S3 in supplementary material).

Discussion

Summary of main findings

In the present study, accumulated years of predicted combined physical and psychosocial job exposure was associated with an increased risk of full LTSA among Norwegian early-career employees. These associations were observed in both men and women, although patterns differed by gender, with an increased risk of LTSA for longer exposure duration among women. In contrast, years of predicted combined exposure was associated with a slightly decreased risk of partial LTSA among women, while no clear associations were observed among men.

Interpretation of the findings

Our findings indicate that accumulated years of combined exposure to physical and psychosocial work exposure is associated with an increased risk of full LTSA, consistent with previous Scandinavian studies (16, 18, 20). Together, these findings support the notion that the combination of exposures from these domains represents an important risk factor for LTSA. Notably, the association differed by LTSA grade, as accumulated years of combined exposure was associated with slightly decreased risk of partial LTSA among women.

We observed an exposure-response relationship between accumulated years of predicted combined exposure and risk of full LTSA among women. This finding is consistent with previous JEM-based Scandinavian research demonstrating that cumulative physical work exposures are associated with increased LTSA risk, even after accounting for psychosocial work factors (14). However, few studies have examined the impact of combined work exposures accumulated over time, and it remains unclear whether the observed dose-response pattern reflect additive or synergistic mechanisms. Clarifying the relative contribution of these mechanisms, and the extent to which exposure duration modifies combined exposure risk, represents an important direction of future research.

Both men and women showed elevated risks of full LTSA following cumulative years of predicted combined physical and psychosocial work exposures, although risks were higher among women. This is consistent with Danish JEM-based research among younger employees, which found that higher psychosocial work exposure was associated with elevated risk of sickness absence, with stronger associations observed among women (8). Recent Norwegian findings reported less prominent gender differences in LTSA (18) but were limited to mid-career workers. In contrast, the present study included early-career employees and may therefore have been less affected by selection bias.

The observed risk reduction in partial LTSA among exposed women compared to the unexposed is noteworthy. One possible explanation is that opportunities for workplace accommodation differ between occupations, as the resources and opportunities available at the workplace may influence whether reduced health leads to LTSA (37). In occupations with combined physical and psychosocial exposure, such opportunities may be more limited, which could increase the likelihood of transitioning directly to full LTSA rather than partial absence. This is in line with reports of lower job control and lower control over work organization among younger Nordic workers (4), as well as evidence suggesting that workplace accommodations may mitigate work limitations among individuals with chronic conditions (37).

The observed gender differences may reflect gender segregation in the labor market. Male-dominated jobs such as warehousing and oil and gas extraction may differ from female-dominated jobs such as cleaning and healthcare, in both physical and psychosocial demands, although all involve combined exposures. For instance, many female-dominated occupations among the exposed groups are characterized by direct interactions with clients or patients. Certain psychosocial demands may arise in such interactions, and interpersonal stressors, such as emotional dissonance, have been associated with sickness absence, although the underlying mechanisms remain unclear (38). Female-dominated occupations have been associated with higher levels of sickness absence, even among men working in such occupations (27, 39). However, other biological or cultural factors may also contribute to the observed gender differences (29). For example, pregnancy-related sickness absence is common among women in this age group, and the need for such absence may be greater among those working in more demanding occupations compared to those in less demanding jobs.

Several mechanisms may explain the observed associations. Both physical workload and adverse psychosocial working conditions may increase physiological stress responses (40). In addition, structural constraints in the work environment, such as time pressure and high workload, may limit the feasibility of adhering to ergonomic recommendations. Such psychosocial demands have been identified as barriers to the use of safe patient handling equipment among healthcare workers (41), suggesting that workers may prioritize task completion or patient care over their own safety. Unfavorable ergonomic conditions arising from such work demands may increase the risk of work-related injuries, consistent with previous findings linking physical and psychosocial exposure to an increased risk of such injuries, which may in turn contribute to LTSA (17).

In the context of demographic ageing and increasing demand for health and care services (23), the importance

of combined occupational exposures may increase, particularly in occupations characterized by interpersonal interactions and service-oriented work (3). Our findings suggest that workplace accommodation could help support labor market attachment and reduce LTSA. Future research should further examine the cumulative and combined impacts of physical and psychosocial work exposures and their associations with different health outcomes, including diagnosis-specific LTSA. Longitudinal studies exploring accumulated work exposures across different stages of working life may also improve understanding of how early-career exposures influence later health and work capacity. In addition, further research is needed to explore gender differences and the mechanisms underlying the differing associations observed for full and partial LTSA.

Strengths and limitations

To our knowledge, this is the first Scandinavian registry-based cohort study examining the association between accumulated years of combined physical and psychosocial work exposures and LTSA among early-career employees. A major strength is the large register-based cohort with objective data on sickness absence, minimizing recall bias and reducing selection bias related to self-reporting of outcomes (42). The focus on early-career workers may also have reduced healthy worker bias (21), as there has been less time for health-related selection out of demanding occupations. Furthermore, the use of JEM enabled assessment of occupational exposures across a large population. Both JEM applied in this study have been developed and validated for use with Norwegian registry-data (32, 33). In addition, both JEM are gender-specific, potentially reducing exposure misclassification by capturing differences in work tasks and exposure patterns between men and women within the same occupation.

Despite the focus on early-career workers, a healthy worker effect may still be present, as employed individuals are generally healthier than those outside the labor market, and cumulative exposure requires remaining in exposed work. Consequently, workers with longer exposure may represent a selected group better able to tolerate demanding work. The observed associations may therefore reflect both true impact of work exposure and this selection process (21).

Importantly, causal inference cannot be made from these analyses, and despite the young cohort, prior health conditions and earlier work exposure may have influenced the observed associations. Though we adjusted for LTSA in the year before baseline, LTSA on pre-existing health conditions prior to this may still have affected the results. Future studies could consider adjusting for a longer period or use a more dynamic proxy for health status. Similarly, some individuals may have been exposed before our five-year exposure window, although large differences in pre-exposure are unlikely in a young cohort as in this study. We did not examine the timing of exposure within the five-year window, although more recent exposure may have a stronger influence on health and LTSA than exposure occurring further back. Future research could investigate whether the timing of exposure, and not only its duration modifies the association with LTSA.

Another limitation regards the lack of a dynamic outcome for LTSA. Using time to event measures simplifies the dynamic nature of labor market attachment and does not consider the importance of interaction between exposure and workforce participation (43). This was outside the scope of this study, but future research could consider using more dynamic outcomes to capture this relationship more fully.

Although JEM are widely applicable, they are not considered a gold standard measure of occupational exposure (33). Even when gender-specific, they assign exposure at the occupational level and thus ignore individual and task variability, which may lead to exposure misclassification. Moreover, the matrices are based on self-reported data (32, 33), which may be influenced by systematic differences in perception and reporting of working conditions between groups (44).

Residual confounding may also be present. Although analyses were adjusted for several sociodemographic factors, unmeasured factors such as lifestyle behaviors or other workplace characteristics may still influence the observed associations. However, education may partly function as a proxy for lifestyle factors and socioeconomic position.

The study was conducted within the Norwegian labor market, and as a result findings may not be directly generalizable to countries with different labor market structures or welfare systems. LTSA was defined as sickness absence exceeding 16 days, which is partly an administrative choice as this is the point at which registration in the sickness-benefits register becomes complete. Although there is no single agreed definition of LTSA (5), our results may not be directly comparable with studies using other thresholds. The restriction to individuals aged 30 to 35 years further limits generalizability to the whole population. Nevertheless, mechanisms linking demanding work environments to sickness absence and reduced labor market attachment are likely to be relevant across many occupational settings.

Concluding remarks

This study found that accumulated years of predicted combined physical and psychosocial work exposures were associated with an increased risk of full LTSA

among Norwegian early-career employees, and a slightly reduced risk of partial LTSA among women. Overall, our findings indicate that cumulative years of combined exposure to physical and psychosocial work demands increase the risk of LTSA among early-career workers, although patterns varied by gender and LTSA grade.

These findings underscore the importance of considering combined and cumulative impact of work exposures, as well as differences by gender and LTSA grade. Preventive strategies targeting both physical and psychosocial work exposures, including workplace accommodation, may help reduce LTSA among early-career workers.

Ethics and sources of funding

The research cohort and open access publishing was funded by the National Institute of Occupational Health (STAMI). Ethical approval for the study was granted by the Norwegian Regional Committees for Medical and Health Research Ethics (REK, case number 17344). A Data Protection Impact Assessment (DPIA) was conducted, and the projects handling of personal data was reviewed and approved by Sikt. Informed consent is not needed for this registry-based study according to Norwegian law (The Personal Data Act, Section 8 and 9, and The General Data Protection Regulation Article 6.1 e) and Article 9.2j)).

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Conflict of interest

Authors declare no conflicts of interest.

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