ORIGINAL ARTICLE

Occupational and leisure-time physical activity and risk of disability pension: prospective data from the HUNT Study, Norway

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ABSTRACT

Objectives To prospectively investigate the association between occupational physical activity (OPA) and disability pension due to musculoskeletal cause, mental cause or any cause. We also examined the combined association of OPA and leisure-time physical activity (LTPA) with disability pension.

Methods A population-based cohort study in Norway on 32 362 persons aged 20–65 years with questionnaire data on OPA and LTPA that were followed up for incident disability pension through the National Insurance Database. We used Cox regression to estimate adjusted HRs with 95% CIs.

Results During a follow-up of 9.3 years, 3837 (12%) received disability pension. Compared with people with mostly sedentary work, those who performed much walking, much walking and lifting, and heavy physical work had HRs of 1.26 (95% CI 1.16 to 1.38), 1.44 (95% CI 1.32 to 1.58) and 1.48 (95% CI 1.33 to 1.70), respectively. These associations were stronger for disability pension due to musculoskeletal disorders, whereas there was no clear association between OPA and risk of disability pension due to mental disorders. People with high OPA and low LTPA had a HR of 1.77 (95% CI 1.58 to 1.98) for overall disability pension and HR of 2.56 (95% CI 2.10 to 3.11) for disability pension due to musculoskeletal disorders, versus low OPA and high LTPA.

Conclusions We observed a positive association between OPA and risk of disability pension due to all causes and musculoskeletal disorders, but not for mental disorders. Physical activity during leisure time reduced some, but not all of the unfavourable effect of physically demanding work on risk of disability pension.

What this paper adds

- Due to ageing populations, it is essential to identify modifiable factors, such as occupational physical activity (OPA) and leisure-time physical activity (LTPA), to reduce premature exit from work.
- In a large population-based cohort followed up for 11 years, high levels of OPA increased the risk of disability pension due to all causes and musculoskeletal disorders, but not mental disorders.
- LTPA reduced some of the risk of disability pension, irrespective of work type.
- It could be useful to incorporate policies to reduce the negative health impact of OPA, as well as encouraging LTPA, to reduce work disability.

INTRODUCTION

Contrary to the extensive evidence of favourable health effects from leisure-time physical activity (LTPA) on health outcomes[1–5] and work capacity,[6–13] high physical work demands requiring high levels of occupational physical activity (OPA) have shown both positive[14–16] and negative[17–22] associations with various health outcomes. In addition, high OPA has been associated with increased risk of sickness absence[11 23 24] and disability pension[25–27] in several studies, perhaps through detrimental effects on chronic diseases and conditions such as musculoskeletal pain[25] and cardiovascular diseases.[19] Holtermann *et al*[11] recently reported that OPA and LTPA had opposing associations with risk on long-term sickness absence, where OPA was associated with increased risk and LTPA with reduced risk. Hence, it may be important for all workers to engage in LTPA, irrespective of OPA. However, a methodological concern is that the association between OPA, LTPA and work disability outcomes could be biased due to insufficient adjustment for possible confounders, such as socioeconomic status.[28]

The proportion of non-working inhabitants in western populations will increase substantially during the next few decades due to the increasing number of elderly people.[29] Thus, it is essential to identify modifiable factors that may have a role in preventing premature exit from the labour market. Since a substantial proportion of the working population have high physical work demands,[11 19] it is of considerable public health interest to investigate the possible contrasting effects of LTPA and OPA on work disability. Previous studies on the association between OPA and work disability have either examined work disability outcomes due to all causes[11 24] or musculoskeletal diagnoses,[23 25–27] while the association with work disability due to mental disorders, the other prevailing cause of disability pension,[30] has received little attention.

In a large population-based cohort, we investigated the association between OPA and disability pension due to all causes, as well as musculoskeletal and mental causes. Moreover, we also examined the

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combined association of OPA and LTPA with disability pension, to assess whether LTPA could modify the association between OPA and disability pension.

MATERIALS AND METHODS

Study population

This prospective observational study is based on data from the second survey of the Nord-Trøndelag Health Study (HUNT2) conducted in 1995–1997. All 92 205 persons aged ≥20 years residing in the county of Nord-Trøndelag were invited to participate and 65 215 (~70%) attended the survey. Participants filled in a questionnaire and took part in a medical examination. Further details about the HUNT Study are described elsewhere.[31–33] We have previously reported on the association between LTPA and disability pension for the same cohort and the description of the methods are partly overlapping.[13]

To reduce possible reverse causality, we excluded the two first years of follow-up and anyone who retired before or during this period, that is, recipients of disability pensions, contractual early retirements and old-age pensions. The official statutory retirement age in Norway during the study period was 67 years. Hence, we included only those aged 20–65 years at baseline (n=42 996). We excluded all persons with information missing from the variables being used in the main analyses, yielding a total number of 32 362 people.

Disability pension

Data on disability pension were provided by the National Insurance Database and linked to HUNT2 (1995–1997) data using the personal identification number of Norwegian citizens. The data were also linked to the Central Person Registry for information on vital status and possible emigration out of Norway. Disability pension is intended to secure the income of individuals whose earning ability is permanently impaired by at least 50% due to illness, injury or disability. Before a disability pension can be granted, appropriate treatment and vocational rehabilitation measures must have been performed. A temporary 4-year disability benefit was available in Norway between 2004 and 2010 and was also regarded as disability pension. Primary diagnoses were coded according to the International Classification of Diseases (ICD) versions 9 and 10. We categorised causes of disability pension as musculoskeletal (ICD9:290–319; ICD10: M-diagnoses) or mental (ICD9: 710–739; ICD10: F-diagnoses). Participants contributed with person-years until date of disability pension or until date of contractual early retirement, old-age retirement, emigration, death or 31 December 2007, whichever occurred first in analyses of all causes and until 31 December 2006 in cause-specific analyses.

Occupational physical activity

Participants answered the following question[34]: "How would you describe your work?" with four mutually exclusive response options: (1) mostly sedentary (eg, at a desk and on an assembly line), (2) much walking (eg, delivery work, light industrial work and teaching), (3) much walking and lifting (eg, postman, nurse and construction work) or (4) heavy physical work (eg, forestry work, heavy agricultural work and heavy construction work). A very similar OPA question predicted objectively measured OPA with reasonable accuracy.[35] For the purpose of the combined analysis of OPA and LTPA, as well as in stratified analyses, OPA was reclassified collapsing the categories 'much walking and lifting' and 'heavy work' into 'high OPA'.

Leisure-time physical activity

Participants answered two questions regarding average hours per week of light and hard LTPA performed during the last year. Light activity was defined as not sweating or being out of breath, whereas hard activity was defined as being sweat and/or out of breath. The response options for both questions were: 0, <1, 1–2 and ≥3 hours per week. In a previous validation study, the question about hard LTPA had acceptable validity compared with objective measures of activity, metabolic equivalents and maximal oxygen uptake, whereas light physical activity showed weaker correlations with these objective measures.[36]

In the combined analyses of OPA and LTPA, as well as in OPA-stratified analyses, we classified participants into two categories of LTPA: those who were active (at least some hard activity and/or at least 3 hours of light activity) and those who were inactive (no hard activity and <3 hours of light activity).

Covariates

Chronic somatic conditions were categorised from zero to three or more reported for the following conditions: asthma, cardiovascular conditions (stroke, myocardial infarction or angina pectoris), diabetes, thyroid disease (hyperthyroidism, hypothyroidism, goitre or other thyroid diseases), rheumatological conditions (rheumatoid arthritis, osteoarthritis or ankylosing spondylitis), osteoporosis, epilepsy, cancer or other long-standing diseases. Traumas (hip fractures or other trauma necessitating hospital admission) were also included, as they may lead to sequelae.

Somatic symptoms or symptom-based diagnoses were also enumerated, ranging from zero to five reported symptoms: respiratory/cardiac symptoms (cough, dyspnoea, wheezing or palpitations), gastrointestinal symptoms (dyspepsia, nausea, constipation or diarrhoea), muscle/joint symptoms (pain or stiffness or diagnoses of fibromyalgia), headache and sleep disturbance (difficulty in falling asleep or waking early often or almost every night). Depression and anxiety were assessed with the Hospital Anxiety and Depression Scale (HADS), a validated screen for general population samples.[37]

Body mass index (BMI) was based on objectively measured body weight and height and calculated as weight divided by the square value of height (kg/m^2) and classified as <25.0, 25.0–29.9 or ≥30.0 kg/m^2. Smoking status was classified as present, former or never-smoker based on a number of variables related to smoking onset, smoking cessation, smoking duration and smoking intensity. Education was categorised in three levels (primary school, high school or college/university; collected from the National Education Database). Sex, age and marital status (unmarried, married, widow/widower and divorced/separated) were obtained from national registers.

Statistical analysis

We used Cox proportional hazards regression (with time on study as the time scale in a stratified model with 5-year age strata) to estimate HRs of disability pension due to all causes, as well as musculoskeletal and mental causes, between OPA categories using those who had mostly sedentary OPA as reference. The precision of the estimated associations was assessed by 95% CIs. We tested for statistical interaction (ie, departure from multiplicativity) in likelihood ratio tests comparing models including product terms between OPA and age, as well as OPA and sex, against models without these product terms. There was no evidence of statistical interaction with sex (p=0.73) or age (p=0.83) from these analyses, nor from analyses stratified by age

(<50 years vs ≥50 years) and sex. Thus, we present data for the total sample without stratifying on these factors.

Cox regression was also used to assess the combined association of OPA and LTPA with disability pension due to all causes and musculoskeletal disorders, using those who had mostly sedentary OPA and were physically active at leisure time as reference. Possible modifying effects of LTPA on the association between OPA and risk of disability pension were assessed both as statistical interaction between OPA and LTPA in a likelihood ratio test of a product term of these variables, as well as in analyses stratified by OPA.

All analyses were adjusted for age and sex, and in full models we additionally adjusted for education, marital status, smoking, chronic somatic conditions, somatic symptoms, mental health (HADS anxiety and depression included as separate continuous scales), BMI and LTPA (the latter not in the combined OPA and LTPA analyses). Furthermore, we conducted three sensitivity analyses where we: (1) excluded the first 5 years of follow-up to further reduce the possibility for reverse causality by ill health, (2) compared inactive individuals with individuals who reported at least 1 hour of hard LTPA per week (32.3% of the study sample) to evaluate the possible favourable effect of more strenuous LTPA and (3) excluded health-related variables from the full models that may confound but also andmediate the association and possibly should not be adjusted for (these analyses were adjusted for age, sex, education, marital status and smoking).

Schoenfeld residuals and graphical procedures suggested no violation of the proportional hazards assumption for the physical activity variables and the other covariates included in the regression model. All statistical tests were two sided, and all analyses were conducted using Stata V.13.1 for Windows (Stata).

RESULTS

Baseline characteristics according to OPA categories are presented in table 1. Throughout a median follow-up period of 9.3 years and 265 592 person-years, 3837 of 32 362 persons (12%) received disability pension. During 240 403 person-years (median follow-up time: 8.3 years), 1474 participants received a disability pension due to a musculoskeletal diagnosis and 410 participants due to a mental diagnosis.

Table 2 shows the associations of OPA with risk of disability pension due to all causes, as well as musculoskeletal and mental causes. For disability pension due to all causes, those who reported much walking in their jobs had increased risk of disability pension (adjusted HR 1.26, 95% CI 1.16 to 1.38). The risks were even higher for participants who performed much walking and lifting (HR 1.44, 95% CI 1.32 to 1.58) or had heavy physical work (HR 1.4, 95% CI 1.33 to 1.70). The associations were somewhat stronger for disability pension due to musculoskeletal disorders, whereas there were no clear associations between OPA and disability pension due to mental disorders.

In the analysis of the combined relationship between OPA and LTPA with disability pension (table 3), the OPA groups 'much walking and lifting' and 'heavy work' were combined to ensure robust group sizes, as the HRs were similar for these exposures. There was no statistical interaction between OPA and LTPA on risk of disability pension due to all causes (p=0.67) or musculoskeletal disorders (p=0.52). Relative to the reference group with sedentary OPA and being active during leisure time, all other groups had higher risk of disability pension. The combination of high OPA and being inactive during leisure time was associated with the highest risk of disability pension (HR 1.77, 95% CI 1.58 to 1.98). For all categories of OPA, persons who were inactive during leisure time had higher risk of disability pension. Correspondingly in stratified analyses, the risk of disability pension was higher for persons who were not physically active during leisure time in all OPA categories (mostly sedentary: HR 1.25, 95% CI 1.09 to 1.43; much walking: HR 1.30, 95% CI 1.16 to 1.46) or high: HR 1.22, 95% CI 1.11 to 1.34). These associations remained similar in all sensitivity analyses.

Table 1 Baseline characteristics by occupational physical activity for participants in the Nord-Trøndelag Health Study 1995–1997 (HUNT2)

	Occupational physical activity			
	Mostly sedentary	Much walking	Much walking and lifting	Heavy physical work
Persons (n)	9690	9916	8837	3919
Mean age, years (SD)	41.7 (10.7)	42.0 (10.9)	39.7 (10.8)	41.1 (10.9)
Mean BMI, kg/m^2 (SD)	26.0 (3.3)	25.8 (3.8)	25.9 (3.9)	26.4 (3.5)
Mean HADS anxiety (SD)	4.1 (3.1)	4.2 (3.1)	4.2 (3.2)	4.1 (3.1)
Mean HADS depression (SD)	2.9 (2.8)	2.9 (2.7)	3.0 (2.7)	3.5 (3.0)
Education, years (%)				
<10	7	13	13	18
10–12	60	60	72	78
≥12	33	27	15	4
Leisure-time physical activity (%)				
Inactive	31	34	36	33
Active	69	66	64	67
No of somatic conditions (%)				
0	62	62	63	58
1	30	30	29	33
2	6	6	7	7
≥3	2	2	2	2
Smoking (%)				
Never	50	48	44	50
Previous	25	23	22	22
Current	25	29	34	27

BMI, body mass index; HADS, Hospital Anxiety and Depression Scale.

DISCUSSION

In this large population-based prospective study that followed participants over an 11-year period, we found that OPA increased the risk of disability pension due to all causes and those caused by musculoskeletal disorders, but not those due to mental disorders. Being physically active reduced, but could not completely compensate for, the increased risk of high OPA. The combination of high OPA and being inactive during leisure time was particularly harmful, with the risk of disability pension being about twice as high as for workers with mostly sedentary work who were active during leisure time.

Recently there has been a growing interest in the context in which physical activities are performed. While substantial evidence suggests that lack of physical activity is detrimental for various health outcomes,[5 38] including work ability,[13 39] high OPA has been associated with increased risk of sickness absence[11 23 24] and disability pension[25–27] in several studies. Holtermann *et al*[11] recently reported that OPA and LTPA, mutually adjusted, had opposing risk on long-term sickness absence as OPA increased the risk and LTPA reduced the risk. However, that study only

Table 2 HRs for disability pension due to all causes, musculoskeletal and mental disorders in persons aged 20–65 years (first 2 years of follow-up excluded)

	No of cases	Incidence rate (per 1000 py)	HR*	HR†	95% CI†
All causes					
Mostly sedentary	882	11	1.00	1.00	
Much walking	1239	15	1.28	1.26	1.16 to 1.38
Much walking + lifting	1199	16	1.69	1.44	1.32 to 1.58
Heavy physical work	517	16	1.76	1.49	1.33 to 1.70
Musculoskeletal disorders					
Mostly sedentary	273	4	1.00	1.00	
Much walking	461	5	1.47	1.43	1.23 to 1.67
Much walking + lifting	485	7	2.21	1.82	1.57 to 2.12
Heavy physical work	255	9	2.94	2.39	2.00 to 2.86
Mental disorders					
Mostly sedentary	124	2	1.00	1.00	
Much walking	142	2	1.05	1.09	0.85 to 1.39
Much walking + lifting	100	2	0.97	0.93	0.71 to 1.23
Heavy physical work	44	2	1.01	0.98	0.68 to 1.40

Occupational physical activity groups relative to the mostly sedentary group.
*Adjusted for age (continuous) and sex.
†Adjusted for age (continuous), sex and education (<10, 10–12 and ≥13 years), marital status (unmarried, married, widow/widower and divorced/separated), smoking (never, previous and current), physical symptoms (0–5), number of somatic conditions (0, 1, 2 and ≥3), Hospital Anxiety and Depression Scale (continuous), leisure-time physical activity (inactive and active) and body mass index (<25.0, 25.0–29.9 and ≥30.0 kg/m^2).
py, person-years.

had a 2-year follow-up period, and thus the results could be influenced by reverse causality. Our findings expand on previous research by showing that LTPA contributed to maintain the work ability for both workers with sedentary and physically demanding work. Being physically active during leisure time reduced the risk of disability pension in all OPA categories, suggesting that there is an independent effect of LTPA that is irrespective of OPA. Therefore, it could be useful to incorporate policies to reduce the negative health impact of OPA, as well as promoting LTPA, to reduce premature exit from the workforce due to health problems, and particularly musculoskeletal disorders.

The contrasting associations of LTPA and OPA on disability pension could be related to the nature of the physical activities performed in these separate contexts. OPA is characterised by repetitive and static tasks, heavy lifting and awkward postural positions such as arms elevated above shoulder level or the back bent forward or twisted for longer periods,[11 24] and is not associated with physical fitness.[18 40 41] Such work has been associated with increased risk of long-term sickness absence.[24] Conversely, LTPA is characterised by dynamic muscle contractions with high intensity taxing the cardiovascular system for shorter time periods, the possibility to rest when desired and recover between sessions, and is well documented to provide a training effect.[5 11 40] Physical fitness has been reported to be inversely associated with the risk of disability pension,[42] and in men with high OPA, physical fitness decreased the risk of early retirement.[43] Still, for a worker with pain, it would likely be more difficult to perform physically demanding work than more sedentary work. This could at least partly explain the higher risk of disability pension with high OPA. The finding of stronger associations for disability pension due to musculoskeletal disorders, and no association for mental disorders, strengthens this notion. There could also be greater barriers for workers with physically strenuous work to engage in physical activity during their leisure time, particularly if they feel exhausted after a day's work.

The main strengths of this study are the large population-based sample with a long follow-up period. Objective information on disability pension was obtained from a high-quality national register. Still, some limitations must be acknowledged: LTPA, OPA and health information was based on questionnaires at baseline, and there is no information on

Table 3 HRs for disability pension due to all causes and musculoskeletal disorders in persons aged 20–65 years (first 2 years of follow-up excluded), according to the combined categories of occupational and LTPA

OPA	LTPA	Persons (n)	Cases (n)	Incidence rate (per 1000 py)	HR*	HR†	95% CI†
All causes							
Mostly sedentary	Active	6694	509	9	1.00	1.00	
Mostly sedentary	Inactive	2996	373	16	1.45	1.25	1.09 to 1.42
Much walking	Active	6527	675	13	1.29	1.27	1.13 to 1.43
Much walking	Inactive	3389	564	21	1.82	1.56	1.38 to 1.76
High	Active	8257	927	13	1.76	1.49	1.33 to 1.66
High	Inactive	4499	789	22	2.28	1.77	1.58 to 1.98
Musculoskeletal							
Mostly sedentary	Active	6694	145	3	1.00	1.00	
Mostly sedentary	Inactive	2996	128	6	1.67	1.42	1.12 to 1.80
Much walking	Active	6527	230	5	1.49	1.47	1.19 to 1.81
Much walking	Inactive	3389	231	10	2.40	1.99	1.61 to 2.46
High	Active	8257	385	6	2.65	2.16	1.77 to 2.62
High	Inactive	4499	355	11	3.46	2.56	2.10 to 3.11

High OPA indicates pooled categories of 'much walking and lifting' and 'heavy work'.
*Adjusted for age (continuous) and sex.
†Adjusted for age (continuous), sex and education (<10, 10–12 and ≥13 years), marital status (unmarried, married, widow/widower and divorced/separated), smoking (never, previous and current), physical symptoms (0–5), number of somatic conditions (0, 1, 2 and ≥3), Hospital Anxiety and Depression Scale (continuous) and body mass index (<25.0, 25.0–29.9 and ≥30.0 kg/m^2).
LTPA, leisure-time physical activity; OPA, occupational physical activity; py, person-years.

potential changes in the follow-up period. Especially self-reported physical activities with light intensity have limited reliability and validity compared with laboratory methods.[43] However, physical activity questionnaires are still useful for crude categorisation of population activity levels.[43] Furthermore, although we adjusted for several confounding variables, residual confounding is still possible due to unmeasured or poorly measured factors. Hence, it could be that LTPA is a proxy measure for a healthy lifestyle. Still, all sensitivity analyses corroborated the findings. Finally, Norway has a more generous disability pension benefit than several other countries with lower compensation le, and this may question the generalisability of the results.

In conclusion, we observed a positive association between OPA and risk of disability pension, particularly due to musculoskeletal disorders, whereas physical activity during leisure time reduced some, but not all, of the unfavourable effect of physically demanding work on risk of disability pension. The combination of high OPA and being inactive during leisure time was associated with the highest risk of disability pension due to all causes and musculoskeletal disorders. Intervention studies should be performed to confirm these associations.

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Contributors MSF and TILN planned the study. MSF, TILN and GV analysed the data. MSF drafted the article. All authors interpreted the results, critically revised the article and approved the final version. MSF and TILN are the guarantors of the study.

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