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Joint association of multimorbidity and work ability with risk of long-term sickness absence: a prospective cohort study with register follow-up

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Objectives The aim of this study was to determine the joint association of multimorbidity and work ability with the risk of long-term sickness absence (LTSA) in the general working population.

Methods Cox regression analysis censoring for competing events (statutory retirement, early retirement, disability pension, immigration, or death) was performed to estimate the joint association of chronic diseases and work ability in relation to physical and mental demands of the job with the prospective risk for LTSA (defined as ≥6 consecutive weeks during 2-year follow-up) among 10 427 wage earners from the general working population (2010 Danish Work Environment Cohort Study). Control variables were age, gender, psychosocial work environment, smoking, leisure physical activity, body mass index, job group, and previous LTSA.

Results Of the 10 427 respondents, 56.8% had experienced ≥1 chronic disease at baseline. The fully adjusted model showed an association between number of chronic diseases and risk of LTSA. This association was stronger among employees with poor work ability (either physical or mental). Compared to employees with no diseases and good physical work ability, the risk estimate for LTSA was 1.95 [95% confidence interval (95% CI) 1.50–2.52] for employees with ≥3 chronic diseases and good physical work ability, whereas it was 3.60 (95% CI 2.50–5.19) for those with ≥3 chronic diseases and poor physical work ability. Overall, the joint association of chronic disease and work ability with LTSA appears to be additive.

Conclusions Poor work ability combined with ≥1 chronic diseases is associated with high risk of long-term sickness absence in the general working population. Initiatives to improve or maintain work ability should be highly prioritized to secure sustainable employability among workers with ≥1 chronic diseases.

Key terms back disorder; back pain; cancer; cardiovascular disease; CVD; chronic disease; diabetes; depression; occupational health; WAI; work ability index.

During recent years, the number of people with one or more chronic diseases has increased. This is likely due to unhealthy lifestyle and improved treatment, increasing survival rates of individuals with a chronic disease (1). In Denmark, 34.9% of the adult population report having at least one chronic disease and the prevalence increases with age (2). As the elderly accounts for an increasing proportion of the total population in most western societies, the age of the general workforce is rising (3, 4). Because of the strong association between chronic disease and age (2, 5), the proportion of workers with poor health is growing. Specifically, the prevalence of chronic disease in the Danish working population has increased from 25.1% in 2010 to 26.8% in 2013 and is expected to increase even further in future years (2, 6). Thus, research that can help to identify and improve health behavior early in working life (7) could potentially help reduce development of future diseases and thereby prevent premature exit from the labor market.

The coexistence of several chronic diseases – ie, multimorbidity – frequently occurs, especially in the elderly population (8). For instance, 43% of Americans with a chronic medical condition have multimorbidity and studies from Australia have reported that 80% of the population aged ≥65 years have ≥3 chronic conditions (9–11). Multimorbidity has been associated with

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a decline in many health outcomes – such as quality of life, mobility, functional ability – along with increases in hospitalizations, psychological distress, mortality and use of healthcare services (9, 12–14). Fortin and coworkers emphasized the need for research on multimorbidity with a specific focus on defining the population and exploring its consequences (15). Thus, to better manage the consequence of chronic diseases among the working population, the adverse impact of multimorbidity on occupational outcomes, such as long-term sickness absence (LTSA), needs to be thoroughly investigated.

Having a chronic disease can negatively affect labor market participation. Hence, a lower employment rate have been observed among people with a chronic disease compared with healthy individuals (1, 16). Workers with a chronic disease often experience difficulties in meeting physical and psychosocial work demands, which further challenges their capacity to participate in gainful employment (17). Consequently, having a chronic disease at work is often accompanied by an imbalance between work demands and individual resources. This scenario may further influence work participation and overall working life. The concept of work ability reflects this balance between the capacity of the worker and work demands (18, 19). Impaired work ability has been associated with chronic disease, loss of productivity, sickness absence, early retirement and all-cause mortality (20–24). To secure work ability and thereby sustainable employability among workers with a chronic disease, it is crucial that the work environment is adjusted to fit the capabilities of the worker (25). For instance, work ability can be improved by adjusting the work demands to the health status and abilities of the worker and/or by increasing the workers physical and mental resources. However, it remains unknown to what extent poor work ability influence the consequence of one or multiple chronic diseases.

This study aims to determine the joint prospective association of number of chronic diseases and work ability with the risk of LTSA. We hypothesized that the number of chronic diseases was progressively associated with the risk of LTSA and that having poor work ability in combination with one or multiple chronic diseases would further increase this risk.

Methods

Study design

This study determines the prospective association between different chronic diseases and LTSA through merging of data from the Danish Work Environment Cohort Study (DWECS) and the Danish Register for Evaluation of Marginalization (DREAM). Further, we estimate the risk of LTSA in relation to number of chronic diseases combined with either good or poor work ability.

Participants and setting

We used data from the 2010 round of the DWECS (26), which consists of a survey assessing work environment and health in the general working population of Denmark and has been repeated every fifth year since 1990. The questions on chronic diseases and work ability are specified below. A total of 10 427 currently employed wage earners were included in the present study. The exact number of participants included in each analysis varies since not all participants completed all the survey questions. Baseline characteristics of the study population are shown in table 1.

Ethical approval

The study was notified to and registered with the Danish Data Protection Agency (journal number: 2007-54-0059). According to Danish law, questionnaire-based and register-based studies do not need approval from ethical and scientific committees, nor do they need informed consent (27, 28). All data were de-identified and analyzed anonymously.

Table 1. Demographics, health and work-related characteristics of the participants. [SD=standard deviation.]

	N	Mean	SD	%
Age (years)	10 427	43.5	11.7	
Men	4762			45.7
Women	5665			54.3
Smoking				
Yes	2356			23.2
Ex-smoker	2916			28.7
No, never	4897			48.2
Physical activity during leisure				
Low	1365			13.4
Moderate	6853			67.5
High	1938			19.1
BMI (kg/m^2)	10 095	25.4	4.4	
Psychosocial work factors (0–100)				
Emotional demands	10 154	44.6	25.1	
Influence at work	10 085	67.4	24.0	
Support from colleagues	9473	73.1	21.5	
Support from leader	9710	69.7	25.8	
Long-term sickness at baseline				
No	9544			91.5
Yes	883			8.5
Number of chronic diseases				
0	4413			43.2
1	3318			32.5
2	1612			15.8
≥3	877			8.6
Work ability (physical demands)				
Good	9429			93.3
Poor	682			6.7
Work ability (mental demands)				
Good	9426			93.3
Poor	680			6.7

Predictor variables

Chronic disease. Chronic disease was based on the following question, "Have you ever been informed by a physician that you have or have had one or more of the following conditions?" with the response options being "yes" or "no, never" to the following diseases: Depression, asthma, diabetes (all types), cardiovascular disease, cancer, impaired hearing, eczema, back disorders, or other conditions (29).

Work ability. Work ability was assessed in relation to physical and mental demands of the job by two single-item questions from the Work Ability Index questionnaire (30): (i) "How do you rate your current work ability with respect to the physical demands of your work?" (ii) "How do you rate your current work ability with respect to the mental demands of your work?". Respondents were asked to reply on a 5-point scale: "excellent", "very good", "good", "fair" or "poor". Subsequently, these responses were dichotomized into good (excellent, very good and good) and poor (fair and poor) work ability to obtain more statistical power.

Outcome variable

The information on LTSA used in the present study was derived from DREAM and linked to the DWECS via the unique personal identification number which is given to all Danish citizens at birth. DREAM contains information on all transfer payments (including sickness absence compensation, employment, early retirement, government education, disability benefits etc) among other basic personal data for all Danish residents on a weekly basis. DREAM has high reliability, since all transfer payments are systematically recorded in the register and employers have a financial incentive to report sick leave as they can apply for compensation of employee sickness absence costs after 30 days of sick leave (31). LTSA was defined as having registered ≥6 consecutive weeks in DREAM during the 2-year follow-up period (2011–2012).

Control variables

Control variables included age, gender, body mass index (BMI), smoking status ("no, never", "ex-smoker", and "yes"), job group (86 different job groups), physical activity during leisure (described in detail below), psychosocial work environment (described in detail below), and previous LTSA. Previous LTSA was derived from the DREAM register and defined as ≥1 episode of LTSA (≥6 consecutive weeks) over the preceding two years prior to baseline.

As previously described by Andersen et al (32), physical activity during leisure was measured by the following question: "How much time have you spent on each of the following leisure-time activities during the last year (including commuting to and from work)?" (i) "Walking, biking or other low-intensity exercise, where you do not get short of breath and do not begin to sweat (eg, Sunday walks or low-intensity gardening)?"; (ii) "Exercise training, heavy gardening, or higher intensity walking/biking, where you sweat and get short of breath?"; and (iii) "Strenuous exercise training or competitive sports?" Response categories for each sub-question were: >4, 2–4, <2 hours/week or "I do not perform this activity". Low physical activity was defined as performing <4 hours of low-intensity physical activity per week and not performing moderate-intensity and high-intensity activities at all. Moderate physical activity was defined as performing >4 hours of low-intensity physical activity per week or moderate or high-intensity for <4 hours/week. High physical activity was defined as performing moderate or high activity for >4 hours/week or a combination of moderate and high activity for 2–4 hours/week (32, 33).

The psychosocial work environment was measured by four dimensions from the Copenhagen Psychosocial Questionnaire (COPSOQ) – each dimension included a number of questions (34). Specifically, the psychosocial work environment dimensions were influence at work, emotional demands, support from colleagues, and support from leaders.

Statistical analysis

Using the PROC PHREG procedure on SAS version 9.4 (SAS Institute, Cary, NC, USA), the Cox proportional hazard model was used for modelling the probability of LTSA (≥6 weeks) during the 2-year follow-up period. Specifically, we evaluated the cause-specific hazard of an LTSA event by a competing risk approach, where we applied the standard Cox-regression for LTSA and censored for all events of permanent labor market drop-out based on the DREAM register within the follow-up period (ie, statutory retirement, early retirement, disability pension, immigration, or death). Because this was a register-based study, ie, not dependent on questionnaire drop-outs or the like, individuals could only leave the study in case of permanent dropout of the labor market, immigration or death (ie, the censoring variables). Thus, individuals were censored either at the end of the 2-year follow-up or when one of the competing events occurred (survival time), whichever came first. When individuals had an onset of LTSA within the follow-up period, the survival times were non-censored and referred to as event times. The estimation method was maximum likelihood and the results are reported as cause specific hazard ratios (HR) with 95% confidence intervals (95% CI).

Results

Of the 10 427 participants, 3318 (32.5%), 1612 (15.8%) and 877 (8.6%) participants experienced 1, 2 or 3 or more chronic diseases, respectively (table 1). Further, 682 (6.7%) and 680 (6.7%) participants experienced poor work ability in relation to the physical and mental demands of their work, respectively.

Table 2 shows the absolute prevalence of LTSA in the follow-up period for the participants in each subgroup. Among those with no chronic diseases and good work ability [either physical (PWA) or mental (MWA)] <6% experienced LTSA in the follow-up period. Of those with ≥3 chronic diseases, the proportion of respondents with LTSA in the follow-up period were 15.5% when having good physical work ability (PWA) and 31.2% when having poor PWA. Of those having both depression and back disorders in combination with good PWA, 16.3% experienced ≥1 episode of LTSA in the follow-up period, whereas this was the case for 41.7% of those with the same disease status and poor PWA.

Table 3 shows the prevalence of each chronic disease as well as the prospective associations between different chronic diseases and risk of LTSA among the general working population. In the fully adjusted model 2, depression, cancer, back disorders and other conditions increased the risk for LTSA by 62%, 48%, 41% and 27%, respectively.

Table 4 shows prospective associations between number of chronic diseases combined with poor or good work ability and risk of LTSA. The fully adjusted model 2 shows that the number of chronic diseases is progressively associated with the risk of LTSA. Having 1, 2 or ≥3 chronic diseases in combination with poor PWA or MWA increased the risk for LTSA compared to having the same number of chronic diseases but good work ability (HR 1.56–3.69). For instance, the risk estimate increased from 1.18 with one chronic disease and good PWA to 2.37 with one chronic disease and poor PWA. Further, the risk estimate increased from 1.95 with ≥3 chronic diseases and good PWA to 3.60 with ≥3 chronic diseases and poor PWA. Similar results were observed for number of chronic diseases and good versus poor MWA. Overall, the joint association of chronic disease and work ability with LTSA appears to be additive.

Table 5 shows prospective associations between depression and/or back disorders combined with good or poor work ability and risk of LTSA. The risk estimate for LTSA was 2.36 when having either depression or a back disorder in combination with poor PWA and 1.57 when having either depression or back disorders in combination with good PWA. When having both depression and back disorders in combination with poor PWA, the risk estimate was 4.32, whereas it was 1.77 when having both conditions but good PWA. Similar results were observed for MWA and risk of LTSA. In general, having poor compared with good work ability and the same combination of chronic diseases (depression or back disorders) increased the risk for LTSA. Overall, the joint association of depression, back disorders and work ability with LTSA appears to be additive.

Table 2. Absolute prevalence of LTSA (in percent) in the follow-up period for individuals in each subgroup. [WA=work ability].

	Physical WA		Mental WA	
	Good	Poor	Good	Poor
Number of chronic diseases				
0	5.8	14.3	5.7	14.7
1	8.2	23.1	8.6	15.5
2	11.7	23.8	12.2	21.4
≥3	15.3	31.2	16.6	30.0
Status				
No depression or back disease	6.6	18.9	6.7	16.3
Either depression or back disorder	12.7	24.8	13.5	20.6
Both depression and back disorder	16.3	41.7	19.4	33.3

Table 3. Risk of long-term sickness absence (≥6 weeks) during 2-year follow-up in relation to the different chronic diseases. All models were mutually adjusted for other types of chronic diseases, eg, hazard ratios (HR) for depression is adjusted for 8 other chronic diseases. [95%CI=95% confidence interval.]

	N	%	Model 1 [a]		Model 2 [b]	
			HR	95% CI	HR	95% CI
Depression	1272	12.5	1.93	1.66–2.26	1.62	1.36–1.94
Asthma	1007	9.9	1.01	0.82–1.24	0.94	0.74–1.19
Diabetes	316	3.1	1.32	0.97–1.79	1.28	0.90–1.83
Cardiovascular disease	489	4.8	1.13	0.87–1.46	1.01	0.74–1.36
Cancer	331	3.2	1.60	1.22–2.09	1.48	1.09–2.01
Impaired hearing	1038	10.2	1.07	0.88–1.31	1.04	0.82–1.31
Eczema	2001	19.6	1.06	0.90–1.24	1.11	0.93–1.33
Back disorder	1650	16.2	1.58	1.35–1.84	1.41	1.18–1.68
Other	1448	14.2	1.44	1.23–1.69	1.27	1.06–1.52

[a] Adjusted for age and gender.

[b] Model 1 + job group, psychosocial work environment (influence at work, emotional demands, support from colleagues, support from leader), lifestyle (smoking, leisure physical activity, body mass index), and previous long-term sickness absence.

Discussion

The study shows that the joint effects of work ability and number of chronic diseases were associated with the risk of LTSA in the general working population. Specifically, the number of chronic diseases was progressively associated with the risk of LTSA, and good work ability counteracted to some extent this increased risk. Initiatives to improve or maintain work ability should be highly prioritized to secure sustainable employability

Table 4. Risk of long-term sickness absence (≥6 weeks) during 2-year follow-up in relation to number of chronic diseases combined with poor/good work ability (WA). The categories of number of chronic diseases include all possible combinations (ie, participants belong to either 0, 1, 2, ≥3 diseases). [PWA=physical WA; MWA=mental WA. HR=hazards ratio; 95% CI=95% confidence interval.]

Number of chronic diseases	N	%	Model 1 [a]		Model 2 [b]	
			HR	95% CI	HR	95% CI
0 (good PWA)	4201	41.9	1		1	
1 (good PWA)	3073	30.7	1.39	1.17–1.66	1.18	0.97–1.44
2 (good PWA)	1397	13.9	1.98	1.63–2.42	1.57	1.25–1.97
≥3 (good PWA)	686	6.8	2.53	2.01–3.19	1.95	1.50–2.52
0 (poor PWA)	119	1.2	2.66	1.62–4.34	1.63	0.87–3.04
1 (poor PWA)	195	1.9	3.92	2.85–5.40	2.37	1.62–3.45
2 (poor PWA)	185	1.9	4.22	3.06–5.83	2.52	1.73–3.67
≥3 (poor PWA)	170	1.7	5.82	4.32–7.86	3.60	2.50–5.19
0 (good MWA)	4161	41.5	1		1	
1 (good MWA)	3045	30.4	1.49	1.25–1.77	1.27	1.04–1.54
2 (good MWA)	1412	14.1	2.10	1.72–2.55	1.68	1.35–2.11
≥3 (good MWA)	734	7.3	2.80	2.24–3.49	2.07	1.61–2.66
0 (poor MWA)	163	1.6	2.72	1.79–4.14	1.92	1.16–3.19
1 (poor MWA)	219	2.2	2.69	1.87–3.85	1.56	1.01–2.40
2 (poor MWA)	168	1.7	3.91	2.75–5.55	2.11	1.36–3.28
≥3 (poor MWA)	120	1.2	5.62	3.95–7.99	3.69	2.41–5.65

[b] Adjusted for age and gender.

[b] Model 1 + job group, psychosocial work environment (influence at work, emotional demands, support from colleagues, support from leader), lifestyle (smoking, leisure physical activity, body mass index), and previous long-term sickness absence.

among workers with one or more chronic diseases.

Of the eight specific chronic diseases included in the questionnaire only depression, cancer and back disorders were significant predictors for LTSA (table 3). The prevalence of depression and back disorders was relatively high, 12.5% and 16.2% respectively, whereas cancer had only been diagnosed among 3.2% of the general working population (table 2). This is in agreement with a previous study including >160 000 Danes, reporting prevalence rates of 13.3% for back disorders and 2.6% for cancer (2). In opposition, studies using hospitalization registers to assess depression in Denmark suggest a prevalence of depression of 3–5% of the Danish population (34), and according to the Danish medical statistics, 8.3% (>460 000 Danes) of the population was prescribed antidepressants in 2011 (35). These rates are lower than those presented in the present study, which may be related to different factors. First, the validity of using self-reports for measuring prevalence of depression can be questioned (using a single question on diagnosed depression by a doctor instead of a depressive symptom scale or medical registers). Second, the hospitalization register showing a prevalence of 3–5% accounts only for those individuals who have been hospitalized due to their depression, ie, relatively serious cases, which may underestimate the number of all cases of depression. Thus, while self-reports of some diseases appears to be accurate, future studies could verify self-reports of depression for example by the use of medical records (36, 37).

Table 5. Risk of long-term sickness absence (≥6 weeks) during 2-year follow-up in relation to depression and/or back disorders combined with poor/good work ability (WA). All the models were mutually adjusted for the 7 types of chronic diseases other than depression and back disease. [PWA=physical WA); MWA=mental WA; HR=hazards ratio; 95% CI=95% confidence interval.]

Presence of depression or back disorder	N	%	Model 1 [a]		Model 2 [b]	
			HR	95% CI	HR	95% CI
No (good PWA)	7144	71.3	1		1	
Either (good PWA)	1972	19.7	1.84	1.57–2.15	1.57	1.32–1.88
Both (good PWA)	240	2.4	2.23	1.60–3.10	1.77	1.21–2.58
No (poor PWA)	318	3.2	2.71	2.06–3.56	1.87	1.34–2.61
Either (poor PWA)	278	2.8	3.53	2.72–4.58	2.36	1.74–3.20
Both (poor PWA)	72	0.7	6.15	4.19–9.05	4.32	2.72–6.86
No (good MWA)	7099	70.9	1		1	
Either (good MWA)	2004	20.0	1.90	1.63–2.21	1.65	1.39–1.96
Both (good MWA)	248	2.5	2.53	1.87–3.43	1.98	1.40–2.82
No (poor MWA)	363	3.6	2.40	1.83–3.15	1.75	1.25–2.44
Either (poor MWA)	243	2.4	2.91	2.17–3.91	1.79	1.24–2.57
Both (poor MWA)	63	0.6	4.79	3.06–7.48	3.41	2.00–5.83

[a] Adjusted for age and gender.

[b] Model 1 + job group, psychosocial work environment (influence at work, emotional demands, support from colleagues, support from leader), lifestyle (smoking, leisure physical activity, body mass index), and previous long-term sickness absence.

Both diabetes and cardiovascular disease (CVD) are two of the greatest health challenges worldwide. In the present study, these diseases were present in <5% of the workers, but they did not influence the risk estimates for LTSA significantly (table 3). Previous studies have reported increased sickness absence rates in people with diabetes compared with diabetes-free subjects (38, 39), and CVD has been shown to be responsible for more deaths worldwide than any other condition (40). It could be speculated, that the results of the present study are influenced by a healthy workers effect, suggesting that those with a severe CVD or diabetes might already have left the labor market or shifted to a job with a better match between work demands and individual capacity. Altogether, this could lower the risk estimates for the remaining workers with chronic disease and poor work ability, and our estimates may therefore be conservative. Another possibility is that the presence of these diseases occurred some years ago and that the disease is now under control, eg, blood sugar levels are typically well controlled in Denmark after a diagnosis has been made.

Asthma was present in 9.9% of the respondents, but it did not seem to increase the risk for LTSA. Thus it could be speculated that, for most asthmatic persons, the disease can be controlled by proper treatment and will therefore not affect work participation.

In the present study eczema and hearing loss (ie, impaired hearing) were very common in the general working population, but they did not influence LTSA to any significant extent. Hence it seems that these conditions in general, do not decrease work ability to an extent that require days away from work.

Most research on multimorbidity has been conducted on either specific patient groups or on older individuals, whereas only few studies on the general workforce have focused on the coexistence of several chronic diseases. Casimirri and co-workers found an association between sickness absence days and the presence of ≥2 chronic diseases in a cross-sectional study among 514 sick-listed and not sick-listed Italian workers (41). Likewise, Ubalde-Lopez found that the greater the number of health conditions, the higher the risk of sickness absence in a cross sectional study of 72 370 Spanish workers (7). Our study elaborates on these previous findings by showing that the number of chronic diseases is progressively associated with the risk of LTSA. In addition, we observed that 15.8% and 8.6% of the participants had 2, or ≥3 chronic diseases, respectively. This highlights the need for initiatives targeting rehabilitation and prevention of multimorbidity among the general working population.

The balance between capacity of the worker and work demands, reflected by work ability, has shown to be impaired among individuals with a chronic disease (20, 21, 25). For instance, Koolhaas et al found that ageing workers (≥45 years) with a chronic disease experienced lower work ability and suggested that these workers might benefit most from a policy focusing on enhancing associated variables such as psychosocial factors and perceived health status (25). However, to our knowledge, no previous study has investigated whether good MWA and PWA in combination with chronic disease could reduce the consequence of the condition (ie, lower the risk for LTSA). In the present study, we observed that having ≥1 chronic diseases in combination with either poor PWA or MWA increased the risk of LTSA compared with having the same number of chronic diseases but good work ability (table 4). Specifically, the analysis presented in table 4 shows the additional risk of having poor versus good work ability, underlining the rehabilitation potential for improving work ability among workers with ≥1 chronic diseases. Overall taken, it seems that good work ability protects against the consequence of having ≥1 chronic diseases by lowering the risk of transition into LTSA. It should be remembered that poor MWA or PWA in combination with ≥1 chronic diseases was present for only a small percentage of the participants, but for those with poor work ability and a chronic disease, the consequences seem to be substantial. This is further acknowledged in the raw percentages of table 2, showing that >30% of those with ≥3 chronic diseases and poor work ability (physical or mental) had ≥1 episode of LTSA in the follow-up period.

The high prevalence of depression and back disorders in combination with their high prospective association with LTSA (table 3) led to the analysis illustrated in table 5. There we estimated the joint association of depression and/or back disorders and work ability with the risk of LTSA. It is not surprising that specifically depression and back disorders are both prevalent and caused the highest risk of LTSA. Both depression and low-back pain are listed as the global leading causes of years lived with disability (42) and the coexistence of depression and low-back pain have been reported in numerous studies (43–45). Lloyd and coworkers showed that individuals with depression comorbid with a musculoskeletal disorder (MSD) were at higher labor force disadvantage than people with MSD alone, and that having a comorbid disease such as depression amplifies the negative impact of having a single MSD on labor force activity (46). Likewise, Waghorn and coworkers showed that back problems and comorbid depression led to the highest negative impact on employment and work participation (46, 47). In the present study, we found that the probability of LTSA was higher when having both depression and back disorders in combination with poor PWA or MWA (HR 4.32 and 3.41, respectively), compared with having both conditions but good PWA or MWA (HR 1.77 and 1.98, respectively). This consequence is further acknowledged by the fact that >40% of those with poor PWA in combination with both disorders had ≥1 episode of LTSA in the follow-up period (table 2). Overall taken, it seems that the consequences of poor PWA are more pronounced than those for poor MWA. The present results highlight the need for additional treatment for workers with comorbid back disorders and depression. Improving PWA and MWA seems to be a key treatment goal which should be an integrated part of occupational rehabilitation for workers with multimorbidity.

Even though many previous studies have reported no or only minor effects of interventions aiming to improve work ability, several recent studies shows that physical exercise at the workplace have the ability to influence work ability (48, 49). For instance, ten weeks of strength training improved work ability in relation to physical and mental demands of the job – ie, the same questions as used in the present study – in both slaughterhouse workers with chronic pain and work disability and in healthcare workers (48, 49). Future research should investigate the effect of interventions aimed at increasing physical and mental capacity (eg, by physical activity and cognitive training), and reducing the physical and mental demands of the job (eg, by adjusting the work demands to the capacity of the workers), in workers with multiple chronic diseases and poor work ability. Overall taken, work ability seems to be a factor that can be enhanced (either by adjusting the work demands and/or by increasing physical and mental resources) and workplace initiatives to improve or maintain work ability should be highly prioritized to secure sustainable employability among workers with chronic diseases.

Strength and limitations

In the present study we adjusted for previous LTSA in model 2, which changes the outcome of the analyses from future sickness absence to future sickness absence that is independent of previous sickness absence, corresponding to the change in LTSA from baseline to follow-up (50). The results should be interpreted with this in mind. Having a chronic disease was self-reported and could therefore have been influenced by recall or reporting bias. However, the questionnaire specifically stated that the chronic disease should have been diagnosed by a physician, which likely reduces reporting bias. A limitation is that we did not ask about when the disease was diagnosed, thus for some diseases the lack of association with LTSA may be due to proper control of the respective disease. In the present study we did not ask about 'current' chronic diseases, but 'ever' having a chronic disease. Because chronic diseases may not necessarily be for life, this may partially explain the relatively high percentage of at least one chronic disease (56.8%). At the same time this may be a strength as it reflects the overall impact of a certain disease on LTSA seen in the long perspective. Further, the proportion of participants with a specific chronic disease (e.g. back disorders and cancer) were comparable with previous studies including a larger sample of the Danish adult population for most of the chronic diseases (2, 6), which strengthens the validity of the self-reports. However, specifically for depression the proportion of self-reports were higher than those previously determined based on registers of hospitalization or medicine. The categorization of chronic diseases makes it difficult to know the specific diagnosis for back disorders, CVD, and other diseases. Likely, back disorders diagnosed by a physician refers to diagnosis such as disc prolapse, degenerative disc disease and chronic low-back pain. However, the design of the study makes it impossible to conclude on the specific diagnosis. In addition, both the prevalence and the consequence (ie, risk for LTSA) of "other chronic disease" was high in the present study, but the specific diagnoses included in this category remains unknown. In the present analyses, work ability was dichotomized into "good" (excellent, very good and good) or "poor" (fair and poor) to obtain more statistical power. As this was not based on clinical relevance, one should be aware of this in the interpretation of the results – especially regarding the practical implications of the study. However, the cut-off was inspired by the classification of work ability by Tuomi and coworkers (30), who have argued that the objective of initiatives for workers with poor to moderate work ability is to improve or restore work ability, whereas the objective for workers with good to excellent work ability is to support or maintain work ability. A strength of the study is the use of information on sickness absence derived from the DREAM register. The DREAM register has high validity as employers have an economic incentive to report sickness absence since employers can apply for compensation of employee sickness absence costs after 30 days of sickness absence. This inherently eliminates any reporting or recall bias. Finally, the use of a representative sample of the general working population in Denmark increases the generalizability of the study.

In conclusion, this prospective cohort study shows that the joint effect of work ability and number of chronic diseases substantially affects the risk of LTSA in the general working population. The number of chronic diseases was progressively associated with the risk of LTSA and good work ability counteracted to some extent this increased risk. Overall, the joint association of chronic disease and work ability with LTSA appears to be additive. The study suggests that initiatives to improve or maintain work ability should be highly prioritized to secure sustainable employability among workers with chronic diseases, especially among those with a comorbidity of back disorders and depression.

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