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A prospective cohort study of 70,820 adults aged 50 and older

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Original article

Handgrip strength and work limitations: A prospective cohort study of 70,820 adults aged 50 and older

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A R T I C L E I N F O

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A B S T R A C T

The purpose of the study was to investigate the association between handgrip strength and the incidence of work limitations in European adults aged 50 and older. We conducted a prospective cohort study among adults aged 50 and older from 27 European countries and Israel. Data were collected from the Survey of Health, Ageing and Retirement in Europe (SHARE) waves 1, 2, 4, 5, 6, and 7. Handgrip strength was measured using a hand dynamometer (Smedley, S Dynamometer, TTM) and participants replied to questions about work limitations. Cox regression was conducted for statistical analyses. A total of 70,820 older adults (mean age 61 ± 7.7 years; 54.3 % women) were followed during a mean of 3.8 ± 2.9 years. The fully adjusted model showed that participants with low handgrip strength (<16 kg in women and <27 kg in men) had a significantly higher risk of work limitations compared with participants with normal values of handgrip strength (hazard ratio: 1.36; 95 % confidence interval: 1.28–1.44). Kaplan-Meier trajectories revealed that the survival probability to experience work limitations in the normal handgrip category was 20 % lower than in the low handgrip category in most of the follow-up period. We identified low level of handgrip strength as a risk factor for work limitations in adults aged 50 years or older. This could be used as an accessible measure to screen workers at risk of developing work limitations.

1. Introduction

In recent years, the workforce has witnessed an increase in the number of older workers facing health problems. This trend can be attributed to population growth and ageing, which have resulted in a rise in life expectancy from 65.4 years in 1990 to 73.5 years in 2019 [1,2]. While some workers with health problems are compelled to leave the labour market before the statutory retirement age, others facing work disabilities and limitations strive to continue working [3]. However, this situation can have a negative impact on the productivity, growth, and economic development of companies and countries [4]. Work limitations, also referred to as reduced 'work ability,' principally occur due to mental and musculoskeletal disorders [3]. For instance, a study conducted in 195 countries from 1990 to 2017 demonstrated that mental disorders accounted for >14 % of years lived with disability for nearly three decades, with a prevalence of over 10 % in all 21 Global Burden of Disease regions covered in the study [1]. Similarly, musculoskeletal disorders have increased in the last 3 decades, affecting 322.75 million people worldwide and potentially contributing to 117,000 deaths in 2019 [5]. Additionally, musculoskeletal disorders are a leading cause of chronic disease [6], disability [7], and long-term sickness absence [8]. Furthermore, musculoskeletal pain [9], poor musculoskeletal capacity, and older age [10] are associated with decreased work ability, leading to loss of health-related employment or receipt of a disability pension [11].

Lifestyle behaviours play a crucial role in the emergence of mental and musculoskeletal disorders. Previous research demonstrates an association between healthy behaviours and a lower incidence of chronic diseases, reduced premature mortality, and increased life expectancy [12]. Physical activity, obesity, alcohol consumption, and cigarette

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smoking are among the most significant behavioural determinants of health [13]. However, an international research study reveals that 31 % of adults globally are physically inactive [14], 13 % are obese, and nearly one quarter (22 %) smoke tobacco [15]. These factors, along with malnutrition and the ageing process, contribute to muscle degeneration, resulting in a decrease in muscle strength [16]. Therefore, muscle strength, which is a determinant of healthy ageing, is significantly associated with the development of disability and the risk of mortality, making it an important public health indicator [17]. Specifically, the handgrip strength test is one of the most affordable, reliable, and valid methods for assessing overall muscular strength [18]. Several research studies have documented handgrip strength as an indispensable biomarker of physical function [19] and both current [20] and future [21] health, predicting the onset of morbidity and mortality among older adults [22]. In fact, numerous studies have shown how a decline in handgrip strength can indicate both health impairment and early ageing, leading to an increased risk of future disability and mortality [21].

Regarding the relationship between handgrip strength and work limitations, a previous study from England [23] revealed a substantial association between frailty (with handgrip strength being one the key indicators) and employment outcomes, including unemployment, diminished health-related quality of life (HRQOL), prolonged periods of sickness absence, significant decline in work-related activities, self-reported challenges in managing work demands, and negative perceptions related to work. However, despite the extensive literature on the relationship between handgrip strength and various health outcomes, to our knowledge, no previous study has investigated the association of handgrip strength with work limitations in different European countries. Therefore, the aim of this study was to assess the prospective association between handgrip strength and the incidence of work limitations among European older adults.

2. Methods

2.1. Study design and population

The present study included data from waves 1 (2004–2006), 2 (2006–2007), 4 (2011−2012), 5 (2013), 6 (2015–2016), and 7 (2017–2018) from the Survey of Health, Ageing and Retirement in Europe (SHARE) [24]. We did not consider wave 3 in the current study because data on the exposure of interest (i.e., handgrip strength) was lacking. Representativeness of SHARE waves is assured using a multi-stage stratified sampling design in which countries are divided into different strata according to their geographical area. Municipalities or zip codes within these strata served as primary sampling units [25]. Data collection was conducted through home computer-assisted personal interviews from February 2004 to January 2019. SHARE data were collected using ex-ante harmonised interviews, and new respondents were added in each wave to compensate for the attrition bias due to losses [25]. In the study, a total of 205,983 participants were initially included. However, 55,582 individuals were excluded from the analysis because they were younger than 50 years at the beginning of the study, and 50,073 participants experienced work limitations within the first two years of follow-up. Furthermore, 20,519 duplicate participants and 579 individuals outside the study date range were removed. Additionally, 8410 individuals with missing values in any study variable were excluded from the analyses. As a result, the final sample size for this study comprised 70,820 participants. The present study received the approval of the Ethics Committee of Research in Humans of the University of Valencia (registered code 1510464) and was reported according to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [26].

2.2. Handgrip strength (exposure)

Handgrip strength was measured twice for each hand using a handheld dynamometer (Smedley, S Dynamometer, TTM, Tokyo, 100 kg). Following the SHARE protocol, participants were instructed to set their elbow in a 90° angle flexion while either standing or sitting, keeping a neutral wrist position, and upper arm vertically set against the trunk. Trained interviewers verbally encouraged participants with standardised instructions to squeeze the dynamometer with maximum effort for several seconds. Handgrip strength was defined as the maximum value of either hand.

Handgrip strength was classified based on the latest criteria established by the European Working Group on Sarcopenia in Older People (EWGSOP2) [27], utilising sarcopenia cut-off points derived from European populations. Normative references were utilised to define low handgrip strength, indicating values below 16 kg in women and 27 kg in men [27]. Any values above these cut-off points were considered indicative of normal grip strength [27].

2.3. All-cause and work limitations (outcome)

Participants were followed throughout the study period to determine whether they experienced work limitations. This was determined through the following question to which participants responded in each SHARE wave: "*Do you have any health problem or disability that limits the kind or amount of paid work you can do?*" Possible answers included "Yes", "No", "Refuse" or "Don't know". Only participants with affirmative or negative answers were included in the study. Participants answering "Yes" to the referred question were considered to experience work limitations.

2.4. Covariates

Based on a literature review on the topic [28] we explored potential confounding pathways between handgrip strength and work limitations. Self-reported age and sex, country of residence at the time of the interview, education, body mass index, smoking and number of chronic diseases were identified as potential confounders (eTable 1). Education was self-reported by participants and thereafter coded using the 1997 version of the International Standard Classification of Education [29]. Body mass index was calculated from self-reported height and weight and subsequently grouped into four categories according to standards proposed by World Health Organization (WHO) [30]. Smoking habits were assessed through the following question: "Have you ever smoked cigarettes, cigars, cigarillos, or a pipe daily for a period of at least one year?". Finally, a number of chronic diseases were confirmed by participants from a list encompassing 13 chronic conditions.

2.5. Statistical analyses

We conducted all statistical analyses in Stata version 16.1 (StataCorp, Texas, USA). We used a Cox regression to estimate the hazard ratios (HRs) for work limitations. Time-on-study in months was used as the timescale. We examined the proportional hazards assumption by testing interactions with log(time) using stphplot command and found no evidence of assumption violation. Two models were tested: a model including gender and age at the time of the interview as confounder (Model A) and a fully adjusted model (Model B) that included covariates of Model A plus country, education, body mass index, smoking, and number of chronic conditions as confounders. To reduce the possibility of reverse causation bias, we removed participants who experienced work limitations within the first two years of follow-up. The results were visualised as forest plots of HRs with 95 % CIs and levels of significance were set at $p < 0.05$.

Furthermore, a Kaplan-Meier survival analysis was employed to investigate the duration of work limitations over time, aiming to assess the probability of participants remaining free from work limitations throughout the entire study period.

3. Results

Overall, 70,820 participants were followed-up during a mean of 3.8 years (SD 2.9) (265,634 persons/year), in which 11,776 experienced work limitations. At study entry, the sample included 38,448 women (54.3 %) and 32,372 men (45.7 %) and the average age was 61 years. Overall, 95.6 % and 4.4 % of the participants respectively showed a normal and a low handgrip level. Characteristics of study participants are in Table 1.

In the crude model (Model A) both, men and women who had low handgrip strength had a higher risk of work limitations compared with participants with normal values (reference) (HR, 1.84; 95 % CI, 1.74–1.96) (Fig. 1).

The fully adjusted model (Model B) (Fig. 2) had similar results, and participants in the low handgrip strength group had significantly higher risk for work limitations compared with the normal group (reference) (HR, 1.36; 95 % CI, 1.28–1.44).

The Kaplan-Meier survival analysis is shown in Fig. 3. We observed that the slope progressively decreased from month 25th until reaching month 100th, where the slope remained stable and unchanged. Although the two categories of handgrip showed similar survival trajectories, the reductions were most exacerbated in the low handgrip category, and a 20 % higher probability of survival was observed from 75th to 140th months of follow-up for the normal handgrip category in relation to the low handgrip category.

Table 1
Characteristics of participants at study entry.

N = 70,820	n (%)	Mean (SD)
Age (years)		61.0 (7.7)
Sex		
Men	32,372 (45.7)	
Women	38,448 (54.3)	
Body mass index (kg/m^2)		
Underweight (<18.5 kg/m^2)	703 (1.0)	
Normal (18.5–<25 kg/m^2)	25,074 (35.4)	
Overweight (25–<30 kg/m^2)	29,745 (42.0)	
Obese (≥30 kg/m^2)	15,298 (21.6)	
Education[a]		
None	1784 (2.5)	
Primary	9547 (13.5)	
Lower secondary	12,277 (17.3)	
Upper secondary	27,166 (38.4)	
Post-secondary non-tertiary	3601 (5.1)	
First stage of tertiary	15,879 (22.4)	
Second stage of tertiary	566 (0.8)	
Current smoking habit		
No	44,926 (63.4)	
Yes	25,894 (36.6)	
Country		
Austria	3202 (4.5)	
Belgium	4062 (5.7)	
Bulgaria	1098 (1.5)	
Croatia	1838 (2.6)	
Czech Republic	6177 (8.7)	
Denmark	3082 (4.3)	
Estonia	5283 (7.5)	
Finland	1119 (1.6)	
France	3756 (5.3)	
Germany	4177 (5.9)	
Greece	2656 (3.8)	
Hungary	2213 (3.1)	
Ireland	983 (1.4)	
Israel	1021 (1.4)	
Italy	4061 (5.7)	
Lithuania	992 (1.4)	
Luxembourg	1532 (2.2)	
Netherlands	2815 (4.0)	
Poland	4086 (5.8)	
Portugal	1237 (1.8)	
Romania	1459 (2.1)	
Slovakia	1592 (2.2)	
Slovenia	3619 (5.1)	
Spain	3691 (5.2)	
Switzerland	2696 (3.8)	
Sweden	2372 (3.4)	
Number of chronic diseases		1.49 (1.46)
Handgrip strength (kg)		
Normal	67,682 (95.6)	
Low	3138 (4.4)	

[a] Based on the 1997 International Standard Classification of Education (ISCED).

4. Discussion

The main finding of our study reveals an association between low levels of handgrip strength and an increased risk of experiencing work limitations in adults aged 50 years or older. We observed that individuals with lower handgrip strength have 36 % higher risk of experiencing work limitations compared to people with higher handgrip strength. Kaplan-Meier trajectories revealed differences of 20 % less survival probability for the low handgrip category when compared with the normal handgrip category.

While previous research has shown that decreased handgrip strength increases the risk of disability and dependence in older adults [31] and may elevate the risk of morbidity and disability [21], there is a lack of studies investigating the prospective association between handgrip strength and work limitations.

A related measure to assess work limitations among older people is functional disability. For instance, in adults aged 65 years and older, the prevalence of having disability in at least one daily activity is up to 53.5 % [32], and this prevalence increases with age [33], while muscle strength tends to decrease [34]. Also, in accordance with these findings, a study corroborated that handgrip strength predicts functional limitations and disability 25 years later in an initially healthy cohort of 45- to 68-year-old men [35]. In fact, a meta-analysis has shown the predictive value of handgrip strength for the development of daily activity dependence in older adults, with the lowest strength tertile displaying the greatest risk compared to the highest [36]. Similarly, a recent study with 18,810 Americans aged ≥50 years [37] revealed that individuals with handgrip weakness had a 42 % increased odds of future functional disability. Therefore, all this information suggests that higher muscle strength levels in midlife may protect people against the onset of future disability [35].

Among the most important factors influencing work limitations are mental disorders, which are the leading cause of long-term sickness absence and work incapacity [38]. In fact, depression is the main cause of global disability [39] and even sub-clinical levels can lead to poorer work performance [40]. Furthermore, the relationship between depression and handgrip strength has been studied in different longitudinal studies. For example, in a large sample of older adults from 24 countries [41], the authors observed an inverse relation between handgrip strength and depression for each kilogram increase in handgrip strength up to 40 kg in men and 27 kg in women. Likewise, a study among ageing Americans found that every 5 kg reduction in handgrip strength was associated with a 6 % higher risk of depression [42].

It is important to note that the ability to perform activities of daily living, including work, is determined by motor and cognitive capabilities [43]. However, as adults grow older, the cognitive demand for completing motor tasks increases [44] while cognitive deterioration occurs, which may influence the performance of such tasks [45]. As well, emerging evidence has revealed the influence of handgrip strength on each domain of cognitive function [46] and how handgrip strength could predict longitudinal changes in cognitive function, such as variations in cognitive performance up to 9 years later [47]. For example, a study among American adults [48], showed that weakness was associated with lower cognitive functioning and may predict accelerated

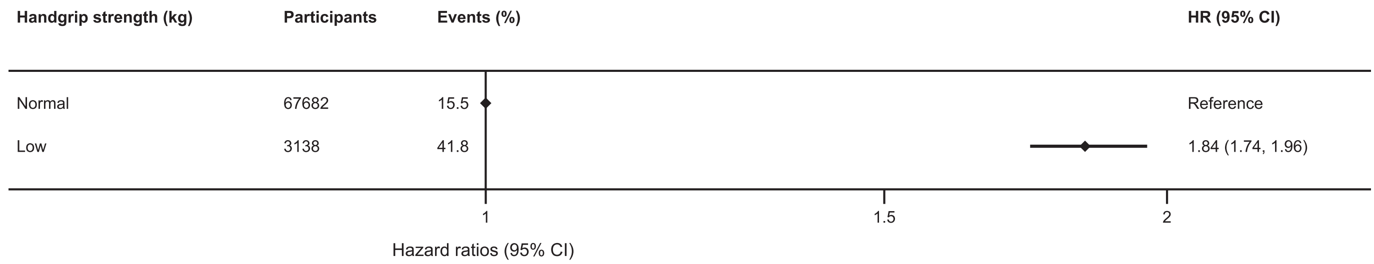

Fig. 1. Prospective associations between handgrip strength (kg) and work limitations (Crude model) (Model A).
Note: model adjusted for age and sex.

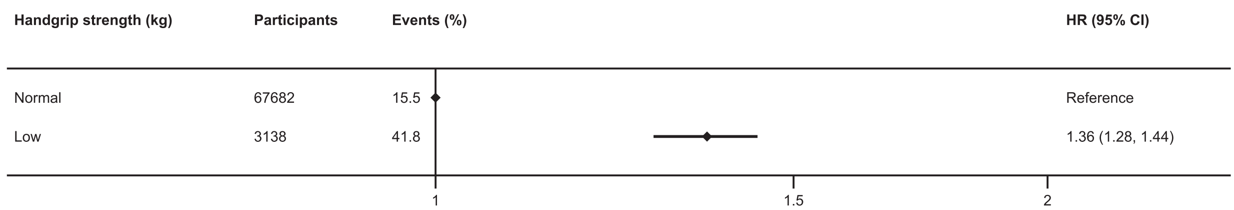

Fig. 2. Prospective associations between handgrip strength (kg) and work limitations (adjusted model) (Model B).
Note: model adjusted for age, sex, country, education, body mass index, smoking, and number of chronic diseases.

declines in cognitive functioning. These results are in accordance with participants from the UK Biobank, who reported that greater handgrip strength was associated not only with better cognitive functioning but also with higher life satisfaction, greater subjective well-being, and reduced symptoms of depression and anxiety [47]. With respect to brain structure, a decrease in handgrip strength has been linked to an increased number of cerebral white matter hyperintensities [49]. Further, higher values of handgrip strength are related to an increasing brain grey matter volume in specific regions associated with better mental health [47]. In contrast, grey matter atrophy is a principal characteristic of neurodegeneration [50]. Therefore, cognitive impairment can be considered as a major factor in work limitations, as cognitive functions are essential for goal concentration, strategic planning and task organisation, and even subtle cognitive deterioration can affect the performance of a wide range of tasks at work [51].

Regarding the results obtained from the Kaplan-Meier survival analysis, it is important to note that at the beginning of the study, the probability of not having work limitations was 100 % as participants who experienced work limitations within the first two years of follow-up were excluded. Furthermore, in the final months, the slope dropped abruptly because there were no longer subjects remaining at the end of the follow-up. Thus, the relevant information is that the probability of participants not experiencing any work limitations at 100 months was 60 %.

The results presented in our study are consistent with those of Palmer et al. [23], which demonstrated that frailty, defined by certain criteria

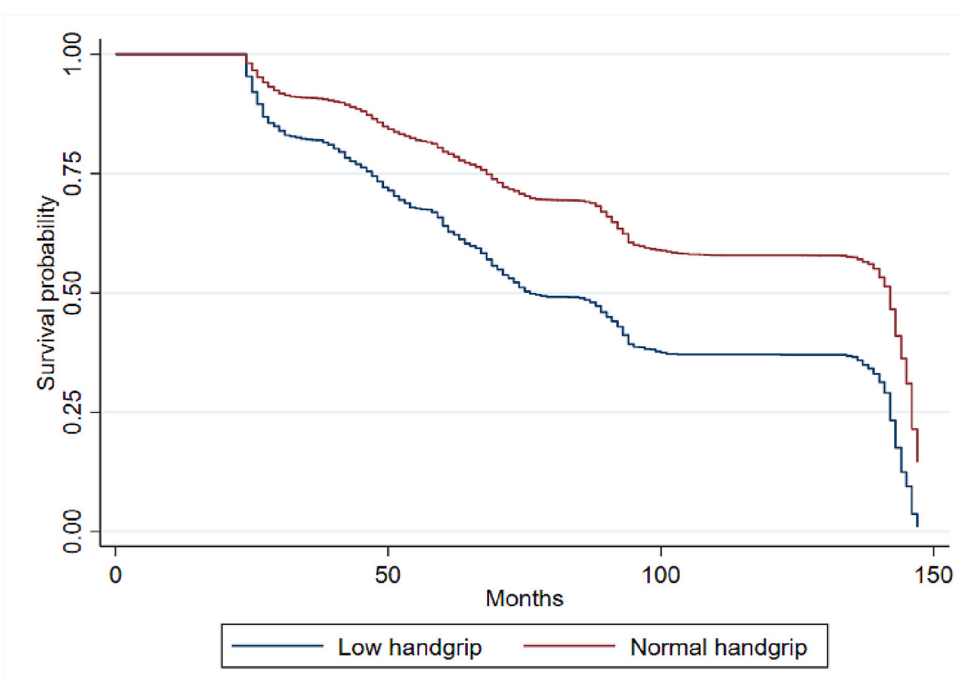

Fig. 3. Kaplan-Meier survival estimate for experiencing work limitations.

including weakness of handgrip strength, was associated with unfavourable employment outcomes. However, it is important to highlight that the method used to measure handgrip strength differed from our study, since authors employed questions assessing weakness of handgrip strength as moderate or severe difficulty in opening previously unopened jars. Consequently, direct and objective measurement was not possible, which represents a limitation since it is uncertain to what extent these questions accurately reflected what would have been observed with objective measurements. Furthermore, it is also noteworthy that the evaluation did not solely assess the relationship between handgrip strength and employment outcomes but rather considered it in conjunction with other assessment criteria such as exhaustion and slowness. Another difference between this study and the present one is that, despite having the same age range in the sample, the study was conducted solely with English participants, which makes comparison with findings from other countries difficult.

Our study uses a large representative data set from European countries and an objective measurement of the exposure. Furthermore, we adjusted our models for an important set of potential confounding factors, reducing the likelihood of confounding bias. However, this study also has limitations. First, due to the high number of participants with missing values, selection bias may potentially exist. Second, since the outcome variable is self-reported, a certain degree of misclassification bias is possible. Third, there is still a chance for residual confounding bias due to potential confounding variables not considered in our analyses. Fourth, an important limitation is the lack of information regarding the participants' occupational profiles within the low handgrip strength group, as it prevents us from discerning whether having below-average handgrip strength is associated with a lower socioeconomic status, potentially resulting in a higher likelihood of engaging in physically demanding and lower-paying jobs. Fifth, the possibility of a residual reverse causation bias should not fully be discarded. Finally, it must be considered that our results may not be relevant to older adults who are retired.

5. Conclusions

Low handgrip strength in European adults aged 50 years or older is linked to a higher risk of work limitations. Concretely, individuals with lower handgrip strength face a 36 % higher risk of encountering work limitations compared to those with higher handgrip strength. Integrating handgrip strength assessment into public health strategies offers a promising avenue for identifying individuals at risk and implementing targeted preventive programs, striving towards a healthier and more productive ageing workforce.

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Contributors

Álvaro Morera contributed to the conception and design of the study, and wrote the first draft of the manuscript.

Joaquín Calatayud contributed to the conception and design of the study, and wrote the first draft of the manuscript.

José Casaña contributed to the conception and design of the study.

Rodrigo Núñez-Cortés contributed to the conception and design of the study.

Lars L. Andersen contributed to the conception and design of the study.

Rubén López-Bueno contributed to the conception and design of the study, and performed material preparation, data collection and data analysis.

All authors provided comments on versions of the manuscript and revised it critically for important intellectual content. All authors have read and approved the final manuscript for submission.

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Ethical approval

The present study received the approval of the Ethics Committee of Research in Humans of the University of Valencia (registered code 1510464) and was reported according to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).

Provenance and peer review

This article was not commissioned and was externally peer reviewed.

Research data (data sharing and collaboration)

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Declaration of competing interest

The authors declare that they have no competing of interest.

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