

Published in final edited form as:

Occup Environ Med. 2016 April ; 73(4): 284–286. doi:10.1136/oemed-2015-103293.

HEAVY MANUAL WORK THROUGHOUT THE WORKING LIFETIME AND MUSCLE STRENGTH AMONG MEN AT RETIREMENT AGE

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Abstract

Introduction—Reductions in heavy manual work as a consequence of mechanisation might impact adversely on muscle strength at older ages. We investigated the association between grip strength at retirement age and lifetime occupational exposure to physically demanding activities. Grip strength is an important predictor of long-term health and physical function in older people.

Methods—Grip strength (maximum of three readings in each hand) was measured in men from the Hertfordshire Cohort Study at a single examination when their mean age was 65.8 (SD 2.9) years. Associations with lifetime occupational exposure (ascertained by questionnaire) to three activities (standing/walking 4 hours/day; lifting 25 kg; and energetic work sufficient to induce sweating) were assessed by multivariable linear regression with adjustment for various potential confounders.

Results—Complete data were available from 1,418 men who had worked for at least 20 years. After adjustment for age, height and weight, those with longer exposures to walking/standing and

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CONFLICT OF INTEREST:

All co-authors actively participated in the preparation of this manuscript. No co-authors have any conflict of interest to declare.

heavy lifting had lower grip strength, but the relationship disappeared after further adjustment for confounders. Working at physical intensity sufficient to induce sweating was not significantly associated with grip strength.

Conclusions—We found no evidence that physically demanding occupational activities increase hand grip strength at normal retirement age. Any advantages of regular physical occupational activity may have been obscured by unmeasured socio-economic confounders.

Keywords

Muscle strength; sarcopenia; occupation; manual work

BACKGROUND

As workplaces modernise, exposure to heavy manual work is reducing but it is unclear what, if any, impact this might have on the long-term health of workers. One measure of health and longevity in older people is grip strength. Epidemiological studies have shown that stronger grip strength in later life is associated with less disability, morbidity and mortality [1-2]. Leisure-time physical activity is an important positive determinant of muscle strength.[3-6] and therefore it could be that intensive occupational physical activity might also convey benefit for muscle strength in later life.

The aim of the current study was to test the hypothesis that cumulative lifetime manual work has a measureable benefit on grip strength in men at normal retirement age.

METHODS

Most aspects of the study design have been described elsewhere.[7] Briefly, during 1998-2003, we surveyed 1675 men born in Hertfordshire, UK 1931-1939, and still living there. Data were collected by questionnaire on (among other things): diet, smoking, age left full-time education, social class, physical activity (the Dallosso activity inventory) [8] and all jobs held for >1 year. For each job, participants were asked whether an average working day entailed standing/walking for 4 hours, lifting weights 25 kg, or energetic activity sufficient to cause sweating.

Grip strength was measured using a Jamar hand-held dynamometer according to a standardised protocol. Each participant made three attempts using each hand and the maximum of the six measurements was determined.

Statistical analysis was performed with Stata v.13.1 (Statacorp, College Station, Texas, USA). We focused on the duration of exposure (years) to three occupational risk factors – standing/walking for 4 hours per day, lifting weights 25 kg, and energetic physical work sufficient to cause sweating. Each variable was derived by summing the times spent in relevant jobs (with a correction factor of 0.5 for part-time employment), and non-zero values were classified to approximate thirds of their distribution in the study sample. Associations of maximum grip strength with these and other risk factors were assessed by linear regression, and characterised by estimates of mean difference in grip strength with 95% confidence intervals (CIs) from that in a reference category of low exposure. For each

occupational risk factor, estimates were derived with no adjustment (Model 1); adjustment for age, height and weight-adjusted-for-height residuals, which are known to be importantly associated with grip strength (Model 2); adjusted also for self-rated health (Model 3); and adjusted for age, anthropometry, social class (at birth and current), smoking, diet, leisure time physical activity, and age left full-time education (Model 4).

We repeated the same process to derive the number of years spent doing each of the activities when aged <40 years, 41-54 years and >55 years. These variables were not normally distributed so Spearman correlation coefficients were computed to assess the interrelation between occupational activities across the working lifetime.

Ethical approval was provided by the East and North Hertfordshire NHS Research Ethics Committees, and all patients gave written informed consent.

RESULTS

Analysis was based on 1418 men who provided complete information on grip strength, exposures during 20 years at work and potential confounders. A further 257 with incomplete data had similar grip strength but were slightly younger and more likely to rate their health 'fair/poor' 20.4% vs 11.9%, $p<0.001$). Those analysed had a mean age of 65.8 (SD 2.9) years, and 66.5% were current or past cigarette smokers. Approximately one-fifth (19.5%) had left full-time education before age 14 years, and only 27 (1.9%) were still in full-time work. Their mean hand grip strength was 44.0 (SD 7.6) kg.

Most men (93%) had held jobs entailing 4 hours standing/walking/day, the reported durations of such employment ranging from 2-47 years. However, 20.2% reported that they had never lifted weights 25kg at work and 26.6% that their work was never sufficiently energetic to cause sweating. We found that men whose work involved an activity between ages 41-54 years were significantly more likely to be doing the same activity at younger and older ages (all $p<0.001$). Men reporting the longest durations of physically demanding activities were more likely to have left full-time education age <14 years and were considerably over-represented in social classes IV-V. They tended also to be more active outside work.

In unadjusted analyses, the longest durations of exposure (standing/walking 4 hours/day for >47 years ($\beta = -1.48$, 95%CI -2.47 to -0.49 kg), lifting weights 25kg for >46 years ($\beta = -1.43$, 95%CI -2.53 to -0.32 kg) and doing energetic work sufficient to induce sweating for >44 years ($\beta = -1.17$, 95%CI -2.30 to -0.04 kg) were negatively associated with grip strength when compared with the shortest non-zero durations of exposure. Trends suggested an exposure-response relationship although only standing/walking showed a statistically significant negative relationship to grip strength when the group with moderate exposure (36.5-47 years) was compared to those with the lowest non-zero levels of exposure ($\beta = -1.0$, 95%CI -1.99 to -0.01 kg).

After adjustment for age and anthropometry, the crude associations were attenuated (Figure 1). However, men with higher exposures to walking/standing and heavy lifting again tended to have lower grip strength, and for moderate exposures, the differences from the reference

were statistically significant ($\beta = -0.92$, 95% CI -1.82 to -0.01 kg, and $\beta = -1.22$, 95% CI -2.17 to -0.26 kg respectively). After additional adjustment for self-rated health, the associations disappeared. Similarly, adjustment for socio-economic variables instead of self-rated health, eliminated the associations. Thus, in Model 4 (adjusted for age, anthropometry, social class (at birth and current), smoking, diet, leisure time physical activity, and age left full-time education), there were no statistically significant associations with grip strength.

DISCUSSION

We found that grip strength at retirement age was not positively associated with cumulative lifetime exposure to heavy physical work and if anything, there was some suggestion of the converse.

Grip strength is a simple, cheap, reproducible and widely-used clinical measure of muscle strength. It is a strength of the current study that we used an evidence-based, validated measurement protocol. However, the limitations of our data should be acknowledged. The ascertainment of occupational exposures, although more complete and detailed than in other studies, and encompassing jobs held across the whole working lifetime, was dependent on recall. There is no reason to expect that participants with higher grip strength would systematically remember activities less completely than those with weaker grip strength, but non-differential errors of recall may have biased risk estimates towards the null.

Our findings are consistent with those reported by others.[6,9-11] Although Russo et al measured grip strength considerably later in life (mean age 86 years) and they classified work as manual or non-manual according to recall of the occupation held for the longest duration during working life, they reported significantly poorer grip strength among manual workers (28.2kg) than non-manual workers (32.5kg).[9] Another study including 89 male and female Finnish workers (mean age 51.9 years) found that those with lowest perceived physical workload had stronger mean grip strength than those who perceived their workload as physically demanding.[10] Furthermore, when some of these workers were followed-up over 16 years, mean grip strength declined but the grip strengths of those with higher perceived baseline workload tended to remain weaker.[10] Among 902 metal workers, recruited in 1973 and followed-up in 2000 (when mean age was 62.6 years), follow-up grip strength was not measured but significantly lower scores for physical performance on the SF-36 physical functioning scale were found among those reporting the most strenuous work at baseline, with an exposure-response relationship.[6] These findings were robust after adjustment for baseline grip strength. Furthermore, better physical function at follow-up was associated with more vigorous leisure-time physical activity at baseline and this protective effect was independent of the negative effect of work strenuousness. A large Danish study reported no association between grip strength at age 59 years and occupational heavy lifting or duration of standing but reported a weakly positive association with years of kneeling among men, which they hypothesised might be explained by use of hand-held tools in occupations involving kneeling (e.g. carpenters and plumbers) [11]. Our study did not collect data on kneeling at work.

The apparent paradoxical difference in associations with leisure-time physical activity as compared with work might be explained if people who are very physically active at work participate less often in vigorous leisure-time physical activity. However, we found no evidence to suggest that the two were inversely associated. Occupational physical demands are different from leisure-time physical activities. The intensity, nature, duration and type of physical activity in leisure time is under the control of the individual, whereas occupational demands are often of longer duration, may be monotonous and repetitive, and are often outwith the individual's control. Moreover, such demands may be accompanied by other disadvantages of blue collar employment such as working in adverse weather conditions, receiving lower pay, and having less autonomy.

We found strong associations of physically demanding work with manual social class and leaving education before aged 14 years, and other researchers have found evidence suggesting a social gradient in grip strength.[12,13] It may be that manual occupations are associated with poorer health through effects of social inequalities, poor housing, and diet/lifestyle choices, such that any benefit of occupational activity is outweighed by a greater negative impact of these other factors.[12] Our finding that adjustment both for social class and self-rated health reduced the inverse associations between grip strength and occupational exposures lends support to this hypothesis.

In conclusion, grip strength at normal retirement age is not positively associated with cumulative lifetime exposure to manual work and may be inversely associated.

Mechanisation is unlikely negatively to affect workers' strength at retirement.

ACKNOWLEDGEMENTS

The Hertfordshire Cohort Study was supported by the Medical Research Council of Great Britain and Arthritis Research UK. We thank all of the men and women who took part in the Hertfordshire Cohort Study; the HCS Research Staff; and Vanessa Cox who managed the data.

We would like to thank Dr Clare Harris for her work coding the occupational exposures and Dr Richard Dodds for his support with the literature review for this manuscript.

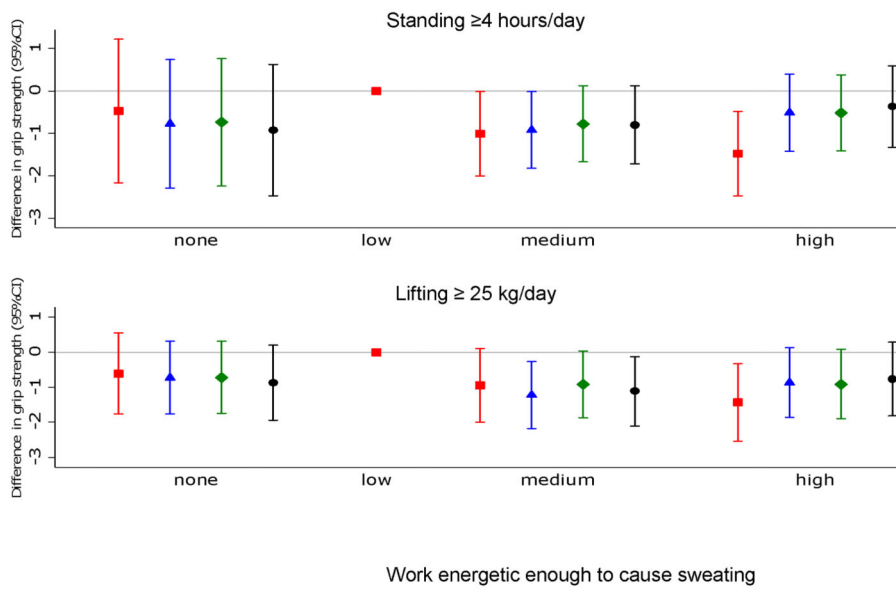
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What this paper adds

- Stronger grip strength in later life is associated with less disability, morbidity and mortality.
- Participation in leisure-time physical activity is positively associated with grip strength
- It is not currently known if lifetime physical workplace activities conveys similar benefit.
- We have shown that men undertaking heavy lifting, prolonged walking/standing and/or energetic activities sufficient to induce sweating over prolonged periods of their working life had lower grip strength than men doing less of these activities.
- Heavy work is not associated with greater grip strength at retirement age, perhaps because men working in these jobs are disadvantaged in other ways.



Model 1: Unadjusted
 Model 2: Adjusted for age, height and residual of weight adjusted for height
 Model 3: Adjusted for age, height, residual of weight adjusted for height, and self-rated health
 Model 4: Adjusted for age, height and residual of weight adjusted for height, social class (at birth and current), smoking, diet, leisure time physical activity, and age left full-time education".

Exposure categories were defined as follows:
 None: Never exposed
 Low: Lowest tertile of years of exposure to work involving standing ≥ 4 hours; lifting ≥ 25 kg or working energetically enough to induce sweating
 Medium: Medium tertile of years of exposure to work involving standing ≥ 4 hours; lifting ≥ 25 kg or working energetically enough to induce sweating
 High: Highest tertile of years of exposure to work involving standing ≥ 4 hours; lifting ≥ 25 kg or working energetically enough to induce sweating

Figure 1. Mean differences in grip strength (kg) according to cumulative lifetime exposure to physically demanding occupational activities