ORIGINAL RESEARCH

Respiratory Function and Muscle Strength Vs. Past Work Type: a Cross-Sectional Study Among Retirees

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ABSTRACT

Objectives

The aim of this cross-sectional study was to assess the effects of past occupational activity on muscle strength and respiratory function among retirees.

Methods

A total of 205 community-dwelling older adults participated in the study. Age (≥60 years) and cessation of professional activity (retirement) constituted the inclusion criteria. The International Standardized Classification of Occupations (ISCO-08) was used to stratify the participants into white- or blue-collar groups. Forced vital capacity (FVC), forced expiratory volume (FEV) in the first second, inspiratory vital capacity (IVC) parameters, and hand grip strength were tested.

Results

Statistically significant differences in IVC and FVC scores were found in white- and blue-collar workers after adjusting for sex and age (ANCOVA). White-collar men had significantly higher IVC as compared to blue-collar men.

Conclusions

Blue-collar male workers may be prone to deteriorating respiratory function in older age. It is vital to promote physical activity and educate blue-collar workers about the need to use respiratory protective equipment.

Key words: retirement, occupation, handgrip strength, spirometry

INTRODUCTION

Recent decades have witnessed disadvantageous changes in the age structure of the developed countries worldwide, with ageing societies being especially visible in Europe. It has been estimated that by 2100, the number of people over 80 years of age will have increased from 5.6% (in 2018) to 14.6%, whereas individuals over 65 years of age will have constituted approximately one-third of the entire population of the European Union.(1)

A rising number of retirees is a natural consequence of the aforementioned changes in the age structure.(2) Professional work, which typically engages a person for one-third of a day for most years of their life, seems to exert a significant influence on the health and fitness of all people, especially older adults, who experience age-related adverse changes in the organ function.(3) The relationship between mortality and health has been well-documented in the literature.(4,5) Smith *et al*.(5) demonstrated that occupational social class is strongly associated with mortality among middle-aged men. These authors reported higher mortality rates among manual workers as compared to non-manual workers. In an analysis by Case and Deaton,(6) self-reported health condition was worse among manual as compared to non-manual workers. The literature lacks conclusive data on whether the type of work (white- or blue-collar) affects the physical functioning after reaching full retirement age. Loss of body mass and decreasing muscle strength are one of the most typical symptoms of ageing.(7) Lower body mass and muscle strength not only lead to impaired daily living activities, thus lowering the quality of life, but they also constitute important predictors for developing a serious disease, the need for hospitalization, or death.(8,9) Hand grip strength (HGS) test, performed using a hand dynamometer, is a useful tool for assessing the hand grip strength, but it is also an indicator of the overall muscle strength.(9,10)

The process of ageing negatively affects the respiratory system function. Lung function declines 1% per year after the age of 25 years(11) due to a number of factors, such as loss of elasticity of the pulmonary alveoli, disturbed respiratory mechanics caused by altered thoracic shape resulting from a progressing spinal kyphosis, higher stiffness of the thorax, and deteriorated diaphragmatic function due to muscle atrophy.(12,13)

Studies among retirees predominantly focus on the effects of retirement on their health and well-being. Meng *et al*.(14) in their systematic review analyzed seven studies on the changes in cognitive function, but reported conflicting results and failed to establish whether retirement affected cognitive abilities of the retirees. Segel-Karpas *et al*.[15] found that retirement may be a promoting factor for depression, while Bloemen *et al*.[16] reported that earlier retirement lowered the mortality risk.

The above-mentioned studies, as well as other sources which investigated various aspects of health status after retirement,[17–20] did not provide unambiguous answers to the question whether type of work affected the functional status and health of the retirees. To the best of our knowledge, only two studies about the effects of white- and blue-collar work on HGS after retirement have been published so far.[21,22]

The aim of the study was to assess the effects of past occupational activity on muscle strength and respiratory function in retirement.

METHODS

A total of 205 volunteers (93 men and 112 women aged 70.02±6.53) were included in this cross-sectional study. The participants were recruited from the general population of the Wielkopolska Region (Poland) using radio and Internet campaigns, flyers, and various organizations for seniors (e.g., the University of the Third Age). Written informed consent was obtained from all participants.

The study was conducted between December 2018 and October 2019. The requirements of the Declaration of Helsinki were followed. Local Ethics Committee approved the study protocol (No. 250/19). Age ≥60 years, which is the age threshold for retirement eligibility, and cessation of professional activity (retirement) constituted the inclusion criteria. The volunteers were interviewed to identify possible exclusion criteria such as diseases and injuries which might negatively affect the upper limb performance and/or respiratory tract function (e.g., stroke, asthma, COPD, history of thoracic surgery, upper limb fracture, brachial plexus injury, brachialgia, history of pulmonary surgery), smoking (volunteers were excluded if they had smoked 20 or more packs of cigarettes or 360 g or more tobacco during their life time),[23] and impaired cognitive function. The flow of the participants is presented in Figure 1. Cognitive functioning was assessed with the Mini-Cog test,[24] which is an easy and fast screening tool to detect cognitive impairment.[25] Mini-Cog consists of two components: short-term recall of three words to test short-term memory and the clock drawing test, with 5 points as the maximum score. The score of <3 points may be indicative of cognitive impairment, so it was used as one the exclusion criteria in the present study. Permission to use the Mini-Cog test was obtained.

The participants were stratified to the white-collar or blue-collar groups, depending on the type of past occupational activity reported during the interview. Participant data (age, height, weight, dominant hand) were collected. The International Standardized Classification of Occupations (ISCO-08) was used to stratify the subjects into the occupational groups.[26] The blue-collar group included subjects who worked as craftsmen, assemblers, soldiers, farmers, mechanics, electricians, and builders, whereas the white-collar group comprised engineers, accountants, managers, physicians, and office workers.

HGS for the dominant and non-dominant hand was tested using the JAMAR hydraulic hand dynamometer. The test was performed in accordance with the American Society of Hand Therapists[27] gold standard. During the test, the subject was sitting in a chair without a backrest and armrests, with both feet resting on the floor, parallel to each other, hip and knee joints

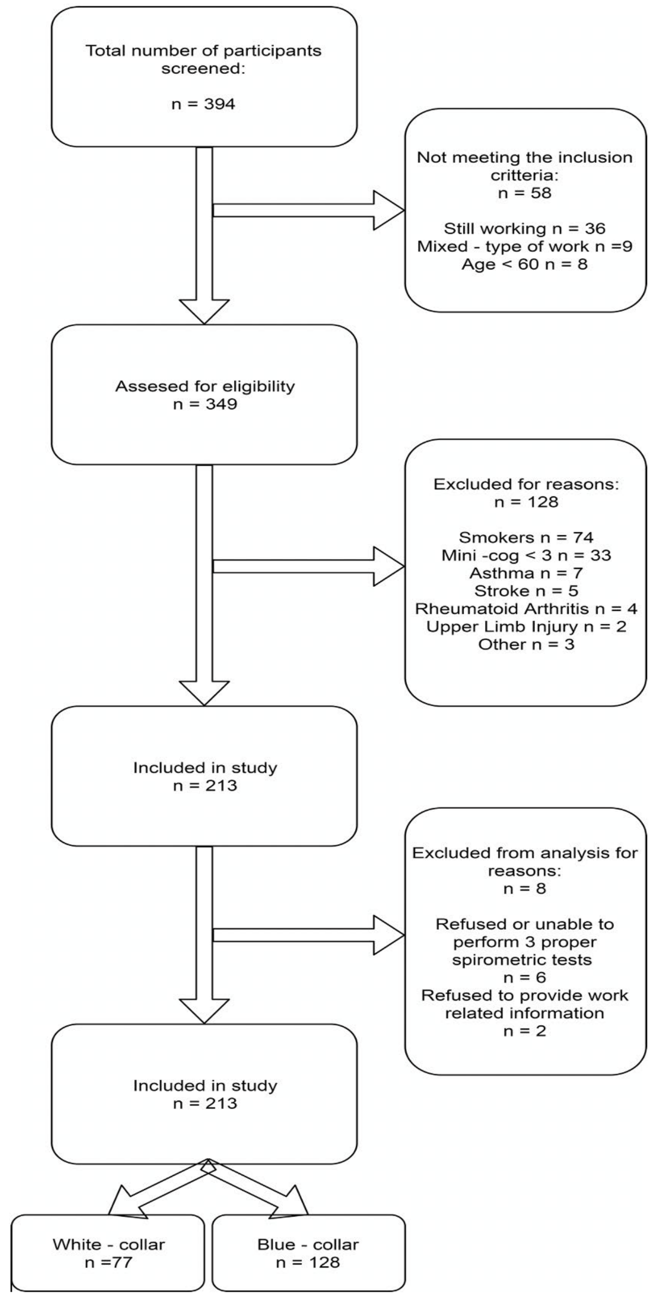

FIGURE 1. Participant flowchart showing number of participants at all study stages and reasons for non-participation at each stage

set at the right angles, arms adducted and touching the torso, elbow joint bent to 90°, forearm in a neutral position, wrist straightened in the range of 0° to 30°. The subject performed a maximum handgrip and held it for 6 sec. During the test, the participants were encouraged by the technician to give it their best effort. Each hand was tested three times, with a one-minute break between each measurement. The best result out of the three attempts was used for further analysis. Spirometry was performed using non-turbine Piston PDD 301 spirometer, in accordance with the American Thoracic Society and European Respiratory Society recommendations.[28] Single-use disposable filter mouthpieces were used. Spirometer software indicated whether the measurement was correct, and the test was valid, or if repeat test was required. FVC (forced vital capacity), FEV*1(forced expiratory volume in the 1st sec), and IVC (inspiratory vital capacity) parameters were tested. During the tests, the subjects were vigorously encouraged by the technician to give it their best effort while inhaling and exhaling. The test was repeated up to eight times (with 1-min break between the maneuvers) until three correct measurements were achieved; mean score was used for further analysis. The results were adjusted for age, sex, height, and weight.

To minimize the risk of bias, all spirometry tests were performed by the same technician, blinded to the group allocation, whereas the interview and HGS test were conducted by the second researcher. This study is a part of the "Type of past work and physical fitness in retirement" project.

Statistical Analysis

Statistica 12 (Informer Technologies, Inc., Los Angeles, CA) was used for statistical analysis. The Shapiro–Wilk test was applied to check the normality of the distribution. The Levene's test was used to assess variance homogeneity. The Mann-Whitney test was used to analyze the differences between white- and blue-collar workers due to the non-parametric distribution of the variables. Analysis of variance of the depended variables, adjusted for age, sex, and height, was conducted using ANCOVA. The p value of $<.05$ was considered as statistically significant.

RESULTS

The participant flowchart, which contains the number of the participants at all stages of the study and reasons for non-participating at each stage, is presented in Figure 1. A total of 213 subjects were deemed eligible for the study, out of which eight failed to complete the full course of the study. Overall, 205 subjects (77 [37.6% white-collar] and 128 [62.4% blue-collar] workers) were analyzed. In the white-collar group, the participants were recruited as follows: 12 (15.6%) from University of the Third Age, 18 (23.4%) from senior social clubs, 36 (46.7%) from media (internet/radio) campaigns, 11 (14.3%) from flyers. In the blue-collar group, the participants were recruited as follows: 15 (11.7%), University of the Third Age; 36 (28.1%), senior social clubs; 55 (43%), media (Internet/radio) campaigns; 22 (17.2%), flyers.

No statistically significant differences were found between blue- and white-collar workers as far as retirement duration was concerned ($p = .18$, 10.46 ± 8.75 and 12.09 ± 9.53, respectively). Participant demographics, test results, and differences between white- and blue-collar workers, white- and blue-collar females, and white- and blue-collar males are presented in Table 1.

Preliminary analysis revealed no statistically significant differences in HGS and spirometry results between white- and blue-collar workers (Table 1). Statistically significant differences in IVC ($p = .009$) and FVC ($p = .006$) scores were found in white- and blue-collar worker groups after adjusting for sex and age (ANCOVA). No statistically significant differences in HGS between these groups were found (Table 2). White-collar men had statistically significantly higher IVC as compared to blue-collar men (mean 3.78L±0.58 to 3.38L±0.98, respectively, $p < .05$).

Similar results were obtained for FVC (3.85L±0.76 for white- and 3.44L±0.96 for blue-collar men). The results are presented in Table 3. A comparison of the remaining work-related parameters in men revealed no statistically significant differences. None of the parameters differed significantly between the white- and blue-collar women (Table 2.)

DISCUSSION

To the best of our knowledge, this has been the first study to evaluate the type of occupational activity before retirement and its effect on HGS and spirometry values among retirees. The statistically significant influence of sex, both on HGS and spirometry, is consistent with the findings of other researchers, and results from anatomical and physiological differences between both sexes.[29,30,31] Also, the observed relationships between spirometry values and age were both expected and consistent with the literature.[29,32–34] The type of occupational activity affected only two of the investigated spirometry parameters: IVC and FVC, and only among men. Household chores, which are more often performed by women, might be the reason why none of the parameters differed significantly between the white- and blue-collar women. Consequently, higher chore-related physical effort as compared to men may be obliterate the differences between HGS and spirometry values among female retirees.

Lack of differences between HGS and white- and blue-collar workers after retirement has been reported by Pieczyńska *et al*.,[22] and may also be explained by the lifestyle changes. Bertoni *et al*.[21] observed that blue-collar workers have a tendency to cease or limit their physical activity after retiring, whereas white-collar workers tend to maintain similar intensity of physical activity in their leisure time even after they retire. In their study, the initial increase in HGS in blue-collar workers after retirement was soon substituted with a more dramatic drop in HGS values as compared to white-collar workers.

Sex-adjusted analysis demonstrated higher IVC and FVC values among white- as compared to blue-collar workers. Post

Table 1.
Demographic data, measurements values, and differences between women and men and between white- and blue- collar workers

Variable (mean±SD)	*Blue-Collar*			*White-Collar*			*P value Total*[a]	*P value Males*[b]	*P value Females*[c]
	Total n=128	*Females n=62*	*Males n=66*	*Total n=77*	*Females n=50*	*Males n=27*			
Age (years)	69.31 (6.62)	68.98 (6.07)	69.62 (7.12)	71.19 (6.26)	69.58 (5.43)	74.19 (6.70)	0.016	0.002	0.393
Weight (kg)	78.97 (10.66)	74.32 (10.88)	83.33 (8.42)	78.44 (16.31)	70.10 (11.58)	93.89 (11.99)	0.346	0.000	0.028
Height (cm)	167.97 (8.01)	162.23 (6.87)	173.36 (4.47)	166.09 (8.80)	161.08 (5.76)	175.37 (5.12)	0.096	0.014	0.278
IVC (L)	3.07 (0.88)	2.73 (0.64)	3.38 (0.96)	2.93 (0.78)	2.54 (0.56)	3.78 (0.58)	0.247	0.326	0.205
FVC (L)	3.17 (0.92)	2.76 (0.65)	3.44 (0.96)	3.00 (0.88)	2.57 (0.60)	3.85 (0.76)	0.220	0.257	0.295
FEV1 (L)	2.37 (0.75)	1.97 (0.55)	2.74 (0.71)	3.49 (11.51)	3.92 (14.31)	2.70 (0.58)	0.113	0.916	0.484
HGS—dominant (kg)	29.97 (10.46)	22.58 (6.59)	36.91 (8.48)	27.44 (10.31)	21.34 (5.30)	38.74 (7.32)	0.057	0.341	0.241
HGS—non-dominant (kg)	28.66 (11.48)	21.00 (6.89)	35.85 (10.21)	26.47 (9.86)	20.76 (5.36)	37.04 (7.15)	0.163	0.474	0.633

[a]Comparison between blue - and white - collar workers (not regarding sex).
[b]Comparison between blue- and white- collar men.
[c]Comparison between blue- and white- collar women.
IVC = inspiratory vital capacity; FVC = forced vital capacity; FEV*1 = forced expiratory volume in 1st sec.; HGS = hand grip strength.

hoc analysis revealed that the differences were statistically significant only in men ($p = .03$).

Sitting position is less beneficial for the respiratory system as compared to an upright position. In the latter position, gravity forces internal organs in the abdominal cavity to drop which lowers the upward pressure on the diaphragm, thus facilitating its contraction. Additionally, the mediastinum is also pushed downwards, which increases the space for lung decompression. In a sitting position, the pressure of the internal organs on the diaphragm is increased, and the abdominal muscles are in a less favorable position in the length-tension curve as compared to the upright position. Leaning on the backrest of a chair or an armchair may hinder proper thoracic mechanics. The abovementioned mechanisms allow a person to inhale a larger volume of air with less effort in an upright as opposed to sitting position.(35) Prolonged sitting position, which is associated with white-collar work, may be expected to fix the negative changes in respiratory mechanics, contributing to decreased pulmonary function. At the same time, blue-collar work is most often associated with physical activity and upright position, frequently also with physical exertion, which provides beneficial stimulation for the respiratory system. However, the results of the present study (mean difference 0.40L and 0.41L, respectively, for IVC and FVC, in favor of the white-collar men as compared to blue-collar men) seem not to confirm these hypotheses.

TABLE 2.
Results adjusted for age, sex and type of work (ANCOVA)

Variable	*Mean Square*	*F*	*p*
	ANCOVA - IVC		
Sex	13.35	27.12	<0.001
Age	14.92	32.78	<0.001
Type of work by sex	3.17	6.97	0.009
	ANCOVA – FVC		
Sex	8.82	22.61	<0.001
Age	25.97	66.55	<0.001
Type of work by sex	3.07	7.88	0.006
	*ANCOVA - FEV*1*		
Sex	7.55	27.15	<0.001
Age	13.58	48.87	<0.001
Type of work by sex	0.19	0.98	0.412
	ANCOVA—HGS Dominant Hand		
Sex	3295.92	68.63	<0.001
Age	56.92	1.19	0.278
Type of work by sex	72.57	1.51	0.220
	ANCOVA—HGS Non-Dominant Hand		
Sex	3657.1	60.81	<0.001
Age	149.07	2.48	0.117
Type of work by sex	20.08	0.33	0.564

IVC = inspiratory vital capacity; FVC = forced vital capacity; FEV*1 = forced expiratory volume in 1st sec.; HGS = hand grip strength.

TABLE 3.
Post hoc comparisons for IVC and FVC; means expressed in liters

Post Hoc Comparisons IVC: Sex by Type of Work							
Sex	*Type of Work*	*Sex*	*Type of Work*	*Mean Difference*	*SE*	*t*	*p value*
Female	White - collar	Female	Blue - collar	-0.14	0.13	-1.1	0.273
Female	White - collar	Male	White - collar	-1.06	0.21	-5.11	<0.001
Female	White - collar	Male	Blue - collar	-0.66	0.17	-3.99	<0.001
Female	Blue - collar	Male	White - collar	-0.92	0.2	-4.63	<0.001
Female	Blue - collar	Male	Blue - collar	-0.52	0.16	-3.37	0.003
Male	White - collar	Male	Blue - collar	0.4	0.16	2.51	0.026
Post Hoc Comparisons FVC: Sex by Type of Work							
Sex	*Type of Work*	*Sex*	*Type of Work*	*Mean Difference*	*SE*	*t*	*p value*
Female	White - collar	Female	Blue - collar	-0.12	0.12	-1.03	0.304
Female	White - collar	Male	White - collar	-0.93	0.19	-4.84	<0.001
Female	White - collar	Male	Blue - collar	-0.52	0.15	-3.42	0.003
Female	Blue - collar	Male	White - collar	-0.81	0.18	-4.38	<0.001
Female	Blue - collar	Male	Blue - collar	-0.4	0.14	-2.79	0.017
Male	White - collar	Male	Blue - collar	0.41	0.15	2.78	0.017

IVC = inspiratory vital capacity; FVC = forced vital capacity.

The literature offers a considerable amount of data about respiratory hazards typical for blue-collar workers. Stoleski *et al*.,[36] in a cross-sectional study among 75 farmers and 75 office-workers, demonstrated that exposure to farming-related irritants increased the incidence of respiratory tract symptoms (e.g., cough) and intensified airflow limitation. Thanh *et al*.,[37] in a systematic review and a meta-analysis, listed blue-collar occupation types such as farming, construction, mining, and work in the manufacturing industry as those at particularly high risk for respiratory hazard. These authors emphasize the need to use respiratory protective equipment in order to minimize the adverse effects of exposure at a workplace on the health of the workers.

In contrast, Schaubauer-Berigan *et al*.[38] conducted a cross-sectional study about carbon nanotube and nanofiber (CNT/F) exposure among 108 employees of 12 US CNT/F facilities and found no statistically significant relationship between different respiratory parameters and time of exposure to CNT/F at a work place. However, those authors emphasized that the CNT/F concentration in the air was relatively low.

Jaakkola and Jaakkola[39] pointed out that impaired respiratory function due to exposure in the work place may occur also among white-collar workers. In their population-based study, they identified paper dust and carbonless copy paper as hazardous exposures.

Even though sitting position—typical for white-collar work—is unfavorable for the respiratory system and that the working environment is not free from harmful particles, in the present study statistically significantly lower IVC and FVC values were observed in blue-collar workers. Possibly blue-collar occupation respiratory hazard causes more damage to the respiratory system, and the adverse consequences are more persistent after retirement as compared to white-collar workers. Importantly, the abovementioned tendency to alter the level and intensity of physical activity after retiring may also be a contributing factor.[21] Persons with reduced vital capacity are more prone to adverse health effects. Reduced vital capacity may increase the risk for mortality, not only among patients with respiratory problems but also among the general population.[40] Reduced vital capacity is also associated with decreased exercise capacity,[41] which in turn may result in limited engagement in physical activity, and adverse health and functional consequences. Notably, reduced vital capacity increases the risk for dyspnea, which is particularly important in case of older people, as in that group dyspnea causes more limitations in daily activities and engagement in physical activity as compared to younger populations.[42]

The present study has a number of strengths, chief among them rigorous inclusion criteria and the fact that, to the best of our knowledge, it has been the first analysis of the effects of past occupational activity on HGS and spirometry values in retirees. However, this study is not without limitations. Caution must be exercised in generalizing the results of this study due to the exclusion criteria which aimed to lower the risk of bias. In order to comply with the rigorous inclusion/exclusion criteria, individuals with asthma were excluded so as not to confound spirometry values. In consequence, it was not possible to investigate whether the type of occupational activity may have contributed to the development of asthma. Also, only types of occupational activity were taken into consideration in the present study. Types and forms of physical activity during the entire life, which may have shaped physical fitness among retirees, were not taken into account. Further research ought to take into consideration the effects of diseases and physical activity on HGS and pulmonary function, which might be helpful in generalizing the findings.

CONCLUSIONS

Based on the results of the present study and the available literature, it seems that blue-collar working men, as opposed to women, could be predisposed to deteriorated respiratory function in older age. In the study group, a significant relationship between type of past work and respiratory function, but not HGS, was found among men. In light of the above, it seems vital to educate blue-collar workers about the need to use respiratory protective equipment, emphasizing the risk for significantly deteriorated function of the respiratory system after retirement, and to promote physical activity among retirees, especially blue-collar workers. Further research among retirees, with larger sample size, including healthy and unhealthy subjects, and taking into consideration all types of physical activity in which they engaged over the course of their life, not just work-related, is necessary.

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CONFLICT OF INTEREST DISCLOSURES

The authors declare that no conflicts of interest exist.

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