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Lifetime occupation and physical function: a prospective cohort study on persons aged 80 years and older living in a community

A Russo, G Onder, M Cesari, V Zamboni, C Barillaro, E Capoluongo, M Pahor, R Bernabei, F Landi

Background: Several studies have reported predictors for loss of mobility and impairments of physical performance among frail elderly people. Aim: To evaluate the relationship between lifetime occupation and physical function in persons aged 80 years or older.

Methods: Data are from baseline evaluation of 364 subjects enrolled in the iISIRENTE study (a prospective cohort study performed in a mountain community in Central Italy). Physical performance was assessed using the physical performance battery score, which is based on three timed tests: 4-metre walking speed, balance, and chair stand tests. Muscle strength was measured by hand grip strength. Lifetime occupation was categorised as manual or non-manual work.

Results: Mean age of participants was 85.9 (SD 4.9) years. Of the total sample, 273 subjects (75%) had a history of manual work and 91 subjects (25%) a history of non-manual work. Manual workers had significant lower grip strength and physical performance battery score (indicating worse performance) than non-manual workers. After adjustment for potential confounders (including age, gender, education, depression, cognitive performance scale score, physical activity, number of diseases, hearing impairment, history of alcohol abuse, smoking habit, and haemoglobin level), manual workers had significantly worse physical function (hand grip strength: non-manual workers 32.5 kg, SE 1.4, manual workers 28.2 kg, SE 0.8; physical performance battery score: non-manual workers 7.1, SE 0.4, manual workers 6.1, SE 0.2).

Conclusions: A history of manual work, especially when associated with high physical stress, is independently associated with low physical function and muscle strength in older persons.

Over the past two decades, several studies have reported predictors for loss of mobility and impairment of physical performance among frail elderly people. Functional dependence has been documented to be more prevalent among older subjects with multiple chronic diseases. Similarly some demographic characteristics (such as older age, being a woman, being of non-white race) have been associated with a faster functional decline. On the other hand, active lifestyle (such as regular exercise) and positive health behaviour (such as not smoking, drinking only a moderate amount of alcohol) were considered strong positive health behaviour (such as not smoking, drinking only a moderate amount of alcohol) in older persons aged 80 years or older enrolled in the “Invecchiamento e Longevità nel Sirente” (Aging and longevity in the Sirente geographic area, iISIRENTE) study.

Methods
The iISIRENTE study is a prospective cohort study performed in the mountain community living in the Sirente geographic area (L’Aquila, Abruzzo) in Central Italy. This study was designed by the Department of Gerontology and Geriatrics of the Catholic University of Sacred Heart (Rome, Italy) and by the teaching nursing home Opera Santa Maria della Pace (Fontecchio, L’Aquila, Italy) in a partnership with local administrators and primary care physicians of Sirente Mountain Community Municipalities. The Catholic University ethical committee ratified the entire study protocol. Details of the iISIRENTE study protocol and the relative database have been described in detail elsewhere.

Study population
A preliminary list of all persons living in the Sirente area was obtained at the end of October 2003 from the registry offices of the 13 municipalities involved in the study. From this preliminary list, potential study participants were identified by selecting all persons born in the Sirente area before 1 January 1924 and actually living in the area. Of the initial 514 subjects screened, 32 men and 53 women died or moved away from the area before the baseline assessment. Among those eligible (n = 429), the prevalence of refusal was very low (16%), without significant differences across gender or age groups. As a result, the overall sample population enrolled in the iISIRENTE study consisted of 364 subjects.
Data collection
Baseline participants’ assessments began in December 2003 and were completed in September 2004. Clinical interviews and functional assessments were conducted at the study clinics in each municipality by trained personnel (medical doctors and registered nurses). Subjects who could not come to the study clinic because of physical or cognitive problems were assessed in their own homes. All assessors were trained on how to perform each component of the *iSIRENTE* study protocol. The Minimum Data Set for Home Care (MDS-HC) form was administered to all study participants following the guidelines published in the MDS-HC manual. The MDS-HC contains over 350 data elements including sociodemographics, physical and cognitive status variables, as well as major clinical diagnoses. Moreover, the MDS-HC also includes information about an extensive array of signs, symptoms, syndromes, and treatments. A variety of different, multi-item summary scales are embedded in the MDS-HC, including the Cognitive Performance Scale (CPS). The MDS items have shown an excellent inter-rater and test-retest reliability when completed by nurses performing usual assessment duties (average weighted kappa = 0.8). Additional information about family history, lifestyle, lifetime occupation, physical activity, and behavioural factors was collected using specific questionnaires shared with the “Invecchiare in Chianti Study”. Physical activity was assessed by asking respondents about the frequency of light and high physical activity during their youth and adulthood. Responses to this item were used to classify participants into two mutually exclusive categories: light or moderate physical activity, and regular moderate to high physical activity. Alcohol consumption was assessed asking the participants about the number of glasses of wine drunk during a standard day. Alcohol abuse was defined as a consumption of more than half of litre of wine per day. Smoking status was assessed by asking the participants about the number of cigarettes actually smoked or smoked in the past. These variables shared with the inCHIANTI study questionnaire have already paved the way to provide a powerful tool for health researches.

Lifetime occupation
Occupation during their active life was collected during the baseline interviews. The information about the longest held occupation in the lifetime was collected directly from the family for the demented subjects or for those unable to respond (32 subjects with diagnosis of dementia and four subjects with aphasia). Only the occupation undertaken during the longest part of the active life was considered in this study. Classification of the occupation used in this study is based on the most widespread job classification. For the present research we use the following two classes: non-manual workers and manual workers. The non-manual workers include all managers, higher administrators, technicians and associated professionals, clerical employees, and shop and market sales workers. The manual workers include skilled and specialised workers, unskilled workers, as well as farm and forestry workers. Information about the duration in the principal job was also obtained.

Additional information on the physical stress of the longest occupation was also collected. For this purpose, we adopted a self-reported scale ranging from 0 (minimal physical stress) to 10 (maximum physical stress). This scale was very similar to the Borg-10 scale, widely used as a subjective assessment of fatigue during physical activity. Finally, on the basis of this scale, we categorised manual works into two groups: manual work with low/moderate physical stress (score 0–6) and manual work with high physical stress (score 7–10). The most frequent workers in the first group were craft workers, machine operators, and assemblers; agricultural and animal husbandry workers were more frequent in the second group. Among non-manual workers, only two subjects reported a high physical stress associated with the occupation.

Physical performance and muscle strength measures
Physical performance measures
Physical performance was assessed by the Short Physical Performance Battery score. This score is composed by three timed tests: 4-metre walking speed, balance, and chair stand tests. Timed results from each test were rescored from 0 (worst performers) to 4 (best performers). The sum of the results from the three categorised tests (ranging from 0 to 12) was used for the present analyses.

Walking speed was evaluated measuring the participant’s usual gait speed (in m/sec) over a 4-metre course. Participants unable to complete the task were scored 0. To assess the chair stand test, participants were asked to stand up from a chair with their arms folded across the chest five times in a row as quickly as possible. The time needed to complete the task was recorded. Subjects unable to complete the test received a score of 0. To assess the balance test, participants were asked to perform three increasingly challenging standing positions: side-by-side position, semi-tandem position, and tandem position. Participants were asked to hold each position for 10 seconds. Participants were scored as 1 if they were able to hold a side-by-side standing position for 10 seconds, but were unable to hold a semi-tandem position for 10 seconds; a score of 2 if they were able to hold a semi-tandem position for 10 seconds, but were unable to hold a tandem position for more than 2 seconds; a score of 3 if they were able to stand in tandem position for 3–9 seconds; and a score of 4 if they were able to hold the tandem position for 10 seconds. Participants unable to complete the test were scored 0.

Muscle strength measure
Muscle strength was assessed by hand grip strength measured by a dynamometer. One trial for each hand was done; the result of the stronger hand was used in the analyses. Hand grip strength has been shown to be predictive of major health related events in older persons.

Statistical analysis
Differences in proportions and means of covariates between persons manual workers and non-manual workers were assessed using Fisher’s exact test and t test statistics, respectively. Analysis of covariance (ANCOVA) was used to examine the effect of different type of work on the hand grip strength and on the Physical Performance Battery score after adjustment for potential confounding variables. Variables considered for adjustment were those thought to be clinically significant or showing a significant difference between manual and non-manual work at the univariate analysis. Final analyses were adjusted for age, gender, education, depression, cognitive performance scale score, sensory impairments, physical activity, history of alcohol abuse, smoking habit, haemoglobin level, and number of diseases. All analyses were performed using SPSS software (version 9.0, SPSS Inc., Chicago, IL).

RESULTS
Mean age of 364 subjects participating the study was 85.9 (SD 4.9) years; 244 (67.0%) were women. Of the total sample, 273 subjects (75%) presented a history of manual work and 91 subjects (25%) a history of non-manual work. Among manual workers, 96 subjects (35%) reported a high level of physical stress. Among non-manual workers only two
subjects reported a high physical stress associated with the principal occupation.

The main characteristics of the sample population stratified according to the different type of works are shown in table 1. Compared to participants with a history of manual work, those with a history of non-manual work were younger, more likely to be women, had a significant higher level of education, and had a significant lower rate of sensory impairment and alcohol abuse. In addition, non-manual workers showed a slightly lower haemoglobin level compared to manual workers (12.8 ± 1.8 versus 13.3 ± 1.7, respectively, \( p = 0.04 \)). A history of high intensity physical activity was more prevalent among manual workers compared to non-manual workers (50% versus 23%, respectively; \( p < 0.001 \)).

Finally, no significant differences were found for marital status, living alone, duration in the principal job, depression, cognitive performance, nutritional status, smoking status, and the presence of comorbidity according to the type of work.

Table 2 shows the relationship between outcome measures and type of the principal lifetime occupation. Manual workers had a significant lower grip strength and physical performance battery score (indicating worse performance) than other participants. After adjustment for potential confounders, which included age, gender, education, depression, cognitive performance scale score, physical activity, number of diseases, hearing impairment, history of alcohol abuse, smoking habit, and haemoglobin level, these association were stronger and statistically significant (hand grip strength: non-manual workers 32.5 kg, SE 1.4, manual

### Table 1 Characteristics of study population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Manual work</th>
<th>Non-manual work</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years (mean ± SD)</td>
<td>86.0 ± 4.8</td>
<td>85.2 ± 4.8</td>
<td>0.140</td>
</tr>
<tr>
<td>Female gender</td>
<td>175 (64.1)</td>
<td>69 (75.8)</td>
<td>0.250</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td>0.237</td>
</tr>
<tr>
<td>Married</td>
<td>82 (30.0)</td>
<td>19 (20.9)</td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>163 (59.7)</td>
<td>62 (68.1)</td>
<td></td>
</tr>
<tr>
<td>Never married</td>
<td>28 (10.3)</td>
<td>10 (11.0)</td>
<td></td>
</tr>
<tr>
<td>Living alone</td>
<td>75 (28.4)</td>
<td>28 (31.8)</td>
<td>0.773</td>
</tr>
<tr>
<td>Education, years (mean ± SD)</td>
<td>4.8 ± 0.9</td>
<td>5.8 ± 2.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Depression</td>
<td>65 (23.8)</td>
<td>27 (29.7)</td>
<td>0.894</td>
</tr>
<tr>
<td>Duration in principal job, years (mean ± SD)</td>
<td>45.5 ± 16.7</td>
<td>46.5 ± 15.7</td>
<td>0.663</td>
</tr>
<tr>
<td>Physical stress associated to job (mean ± SD)*</td>
<td>7.2 ± 1.0</td>
<td>4.5 ± 1.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Physical activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light-moderate</td>
<td>136 (50)</td>
<td>70 (77)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>137 (50)</td>
<td>21 (23)</td>
<td></td>
</tr>
<tr>
<td>CPS score (mean ± SD)</td>
<td>1.1 ± 1.7</td>
<td>0.9 ± 1.7</td>
<td>0.553</td>
</tr>
<tr>
<td>Diseases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>34 (12.5)</td>
<td>10 (11.0)</td>
<td>0.432</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>18 (6.6)</td>
<td>4 (4.4)</td>
<td>0.317</td>
</tr>
<tr>
<td>Hypertension</td>
<td>194 (71.1)</td>
<td>69 (75.8)</td>
<td>0.230</td>
</tr>
<tr>
<td>Stroke</td>
<td>12 (4.4)</td>
<td>5 (5.5)</td>
<td>0.770</td>
</tr>
<tr>
<td>Diabetes</td>
<td>84 (30.8)</td>
<td>25 (27.5)</td>
<td>0.324</td>
</tr>
<tr>
<td>COPD</td>
<td>39 (14.3)</td>
<td>10 (11.0)</td>
<td>0.272</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>4 (1.5)</td>
<td>2 (2.2)</td>
<td>0.832</td>
</tr>
<tr>
<td>Cancer</td>
<td>14 (5.1)</td>
<td>3 (3.3)</td>
<td>0.348</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>53 (19.4)</td>
<td>18 (19.8)</td>
<td>0.596</td>
</tr>
<tr>
<td>Recent hip fracture</td>
<td>13 (4.8)</td>
<td>9 (9.9)</td>
<td>0.974</td>
</tr>
<tr>
<td>Number of diseases (mean ± SD)</td>
<td>2.1 ± 1.3</td>
<td>2.2 ± 1.2</td>
<td>0.394</td>
</tr>
<tr>
<td>Body mass index, kg/m² (mean ± SD)</td>
<td>25.7 ± 4.5</td>
<td>25.3 ± 4.5</td>
<td>0.540</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>40 (15)</td>
<td>5 (6)</td>
<td>0.013</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>6 (2)</td>
<td>2 (2)</td>
<td></td>
</tr>
<tr>
<td>Past</td>
<td>61 (22)</td>
<td>15 (17)</td>
<td></td>
</tr>
<tr>
<td>Sensory impairment:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing</td>
<td>70 (25.6)</td>
<td>13 (14.3)</td>
<td>0.016</td>
</tr>
<tr>
<td>Vision</td>
<td>70 (25.6)</td>
<td>16 (17.6)</td>
<td>0.075</td>
</tr>
<tr>
<td>Haemoglobin, g/dl (mean ± SD)</td>
<td>13.3 ± 1.7</td>
<td>12.8 ± 1.8</td>
<td>0.048</td>
</tr>
<tr>
<td>Albumin, g/dl (mean ± SD)</td>
<td>4.1 ± 0.3</td>
<td>4.1 ± 0.4</td>
<td>0.527</td>
</tr>
<tr>
<td>Cholesterol, mg/dl (mean ± SD)</td>
<td>198.3 ± 44.5</td>
<td>192.3 ± 45.7</td>
<td>0.299</td>
</tr>
</tbody>
</table>

- Self-reported scale ranging from 0 (minimal physical stress) to 10 (maximum physical stress).
- Defined as MDS Depression Rating Scale >3.
- CPS, Cognitive Performance Scale; COPD: chronic obstructive pulmonary disease.

### Table 2 Association between physical function measures and the type of lifetime occupation

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted means (SE)</th>
<th>Adjusted means† (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manual work n = 237</td>
<td>Non-manual work n = 91</td>
</tr>
<tr>
<td></td>
<td>Manual work n = 237</td>
<td>Non-manual work n = 91</td>
</tr>
<tr>
<td>Hand grip strength (kg)</td>
<td>29.8 (0.8)</td>
<td>31.6 (1.7)</td>
</tr>
<tr>
<td>Physical performance battery score*</td>
<td>6.4 (0.2)</td>
<td>7.1 (0.4)</td>
</tr>
</tbody>
</table>

*The physical performance battery score (composed by usual gait speed, balance, and chair stand tests) ranges from 0 (worst performance) to 12 (best performance).
†Adjusted for age, gender, education, depression, cognitive performance scale score, physical activity, number of diseases, hearing impairment, history of alcohol abuse, smoking habit, and haemoglobin level.

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workers 28.2 kg, SE 0.8, p = 0.01; physical performance battery score: non-manual workers 7.1, SE 0.4, manual workers 6.1, SE 0.2, p = 0.03).

Figure 1 reports the associations of the outcome measures with the type of lifetime work coupled with the level of physical stress. As physical stress increases, both hand grip strength and physical performance battery score progressively decline (p for trend 0.02 and 0.05 respectively). In the fully adjusted models, no significant interaction of gender and type of lifetime occupation or physical stress of longest held occupation on physical function measures was observed (data not shown).

**DISCUSSION**

This is the first study assessing the association of longest held occupation in a lifetime with physical function among elderly subjects living in the community. We show that manual work is associated with impaired physical performance and muscle strength, irrespective of potential confounders, and that this association gets stronger with increasing physical stress associated with manual work.

To assess the effect of different types of work on physical function, we used the longest held employment in early adulthood, hand grip strength, and the physical performance battery score. The longest held occupation reflects a person’s lifetime employment and at the same time helps to show the influence, if any, of work conditions or other factors related to occupation on physical functioning in late life. In fact, the longest lifetime employment would always precede the development of functional decline in old age, permitting a causal interpretation of the results by time sequence.

The two measures of physical function used in this study provide a “multidimensional”, objective, and standardised assessment of older persons; they are able to identify more limitations in physical functioning than self-reported measures, and are consequently more sensible to changes leading to the disabling process. Physical function measures have gained increased acceptance and use for the clinical evaluation of older persons. In addition, it has been consistently demonstrated that measures of physical function can predict major health related outcomes in the elderly, such as disability, death, and institutionalisation.

The relationship between physical functioning decline and specific occupations observed in our study can be explained in several ways. Manual work, and in particular, manual work with high physical stress may have a “direct” impact on physical function as a consequence of lower socioeconomic status, more frequent physical hazards, and higher psychological stress.

Many studies have demonstrated that a low socioeconomic status indicated by educational level and personal income is associated with a decline in physical functioning. Our study is the first showing a direct impact on functional decline of lifetime occupation independent of other socioeconomic factors. However, we adjusted our analysis only for educational level and we cannot exclude an effect related to income.

Alternatively, physical hazards directly related to the occupation and its environment might have played an important role in the origin of physical decline. Manual occupations characterised by monotonous and repetitive movements and heavy manual work could lead to disability through a reduced range of joint movement or reflex inhibition of skeletal muscles, resulting in muscle weakness and impaired strength and physical performance. In this respect, it is possible that physical activity in a job is not the same of physical activity in leisure time. To confirm this hypothesis, Mansson and colleagues have previously documented that heavy manual work explained the excess disability due to diseases of the musculoskeletal system among blue collar workers. These musculoskeletal injuries might not produce direct functional impairment but could lead to physical decline and disability many years later.

Finally, another possible explanation for the higher physical impairment among manual occupational classes is related to psychological status. A low job satisfaction might have a negative impact on affective status, resulting in the development of depressive symptoms. As a consequence, depressive status might represent an important risk factor for neurological and cardiovascular diseases directly correlated to functional ability.

Some methodological issues may have influenced our results. As in all cohort studies, selective survival before entry to the cohort has to be taken into account. However, it is important to highlight that previous studies in developed countries have documented that survival is longer among professionals than among farmers. In this respect, if a selective survival is present, it would underestimate the risk of disability among manual workers compared with non-manual workers. Second, the cross-sectional design of the study does not allow clarification of any cause-effect mechanism. The ISIRENTE study gives us the opportunity to adjust our analyses for many health and disease related characteristics that are different between participants with a history of manual work and subjects with a history of non-manual work. However, there could be unmeasured confounders that we cannot adjust for. For example, we were not
able to adjust the analyses for job satisfaction, the presence of depressive symptoms at the time of early adulthood employment, and its related income. Finally, the iISIRENE sample population was composed of persons aged 80 years or older, so our results may not be applicable to other age groups.

In conclusion, although we were not able to control for all possible risk factors for disability, the present study suggests that among elderly subjects living in the community, a history of manual work is associated with impaired muscle strength and physical performance. Further studies that directly collect information on specific physical and psychological hazards of the different occupations would help to better interpret the effect of heavy manual work on physical function during later life.

ACKNOWLEDGEMENTS

We thank all the participants for their enthusiasm in participating in the project and their patience during the assessments. We are grateful to all the people working as volunteers in the “Protezione Civile” and in the Italian Red Cross of Abruzzo Region for their support. We sincerely thank the “Comunità Montana Sirentina” and in particular its President, who promoted and strongly supported the development of the project.

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Competing interests: none declared

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