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Muscle strength and history of heavy manual work among elderly trained women and randomly chosen sample population

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Summary. The association between a history of heavy work and muscle strength was studied among 51 physically active women aged 66–85 years trained in sports and 41 women aged 70–81 years selected randomly from the population register. Maximal isometric muscle strength of hand grip, arm flexion, leg extension and trunk flexion and extension were measured using specially constructed dynamometers. The capacity of the abdominal muscles was evaluated by means of a sit-up test. The study included an interview dealing with the subjects' histories of heavy manual employment. The mean histories of heavy work for the trained and untrained women were 24 and 36 years, respectively. The trained women showed significantly greater maximal isometric muscle strength and abdominal muscle capacity than the untrained women. Among the trained women there was no correlation between the amount of heavy work and muscle performance. Among the untrained women the amount of heavy work correlated positively with maximal isometric trunk extension strength. The results would suggest that among elderly women, whether physically active or not, a history of heavy work has no systematic associaton with muscle strength.

Key words: Isometric force – Muscle performance – Occupation – Veteran sports – Aging

Introduction

One of the characteristics of the human aging process is a progressive decline in muscle strength. This can be explained in part by disuse and inactivity. In longitudinal studies, the loss of handgrip strength has been shown to be proportionately smaller among elderly women than among men (Clement 1974; Lundgren-Lindqvist and Sperling 1983), probably as a function of a less age-dependent decline in physical activity (Lundgren-Lindqvist and Sperling 1983). People who have had an habitually physically active way of life have better muscle strength compared to their sedentary counterparts (Borkan and Norris 1980; Rikli and Busch 1986; Sipilä et al. 1991; Rantanen et al. 1992).

The association between occupation and strength has been studied in different age groups. Young male workers in physically strenuous occupations have been shown to have better muscle strength than workers in lighter occupations (Era et al. 1992). In middle and old age the situation is reversed: elderly workers in physically demanding occupations perform equally or worse in terms of muscle performance compared to those in lighter occupations. Nygård et al. (1988) have found that among middle-aged women, those with a high work-load had systematically less muscle strength than those with a lower work load. Aniansson et al. (1980) have found an inverse correlation between quadriceps muscle strength and previous occupational activity among 70-year-old men but not among a corresponding group of women.

Women's work has, in most cases, traditionally been physically demanding. The purpose of this study was to examine the association between heavy manual work and muscle strength among trained elderly women and a sample from the general population.

Methods

Subjects. The athletes were selected on the basis of a preliminary postal questionnaire, which included questions about the subject's past and present levels of physical activity. It was sent to 600 veteran members of Finnish sports organisations. A total of 60 active female athletes aged 66–85 years from various sports (long-distance running, cross-country skiing, track and field and traditional Finnish women's gymnastics) were selected. Of these subjects 52 (87%) participated in the laboratory examinations. The sample from the general population consisted of 71 women aged 70–81 years randomly drawn from the population register of the rural municipality of Jyväskylä. Of this sample 42 (59%) participated in the laboratory examinations. Written informed consent was obtained in all cases. Average age and body height did

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Table 1. Physical characteristics among trained women and sample from the general population aged 66–85 years

Variable	Trained ($n=52$)		Population sample ($n=42$)		Student's t-test
	mean	SD	mean	SD	P
Age (years)	73.9	(4.3)	74.6	(3.1)	0.373
Body height (cm)	159	(5.4)	157	(4.4)	0.062
Body mass (kg)	61.3	(10.3)	72.3	(13.4)	<0.001

not differ between the groups (Table 1), whereas mean body mass was greater in the population sample.

The average history of habitual physical exercise was 50 years (range 3–74) among the physically active group. At the time 70% were still training intensively (becoming breathless and sweating) more than three times a week and many were still active in competitive sports. The population sample was quite sedentary with none of the group taking any specific physical exercise. For most of them (90%), their current physical activity consisted of everyday household activities or easy walks.

Background information and work history. Background information was studied by means of a postal questionnaire, which was completed at home and checked at the laboratory examination. Information about work history was ascertained from an interview. The subject was asked to recall her employment during her life-span. She was asked if she had been employed in a job involving lifting, moving or carrying heavy objects or chopping wood or digging. The following jobs were classified as physically heavy: (1) farming, (2) forestry, (3) construction, (4) factory, warehouse, bakery, (5) household, gardening (e.g. cultivation), (6) nursing, physiotherapy, (7) services (household, retail trade, catering, the forces), (8) cleaning work. The starting age and length of employment were recorded.

Muscle strength. The maximal isometric strengths of handgrip, forearm flexion and leg extension were measured on the dominant side in a sitting position using a custom-made dynamometer chair constructed at the Department of Health Sciences (Viitasalo et al. 1985; Sipilä et al. 1991). Handgrip strength was measured with a dynamometer fixed to the arm of the chair. Elbow flexion strength was measured at an angle of 90° with the elbow supported comfortably and the wrist attached in a supinated position at the level of the styloid processes by belts connected to a strain-gauge system. Knee extension strength was measured at an angle of 60° from full extension with the ankle also fastened by a belt to a strain-gauge system. Maximal isometric body flexion and extension strengths were measured in a standing position according to Viitasalo et al. (1977). The best performance of three trials was accepted as the result.

The capacity of the abdominal muscles was evaluated by means of a sit-up test. The test started from the sitting position. The hands were extended in front of the body with the elbows at knee level. Knees were bent at 90° and the ankles were held down. From the starting position the subject lowered her upper body until her shoulders touched the floor and then raised herself again to the starting position. The subject was allowed 30 s to perform as many sit-ups as possible.

Statistical methods. Differences between the means were analysed by Student's t-test (two-tailed), one-way analyses of variance followed by a least significant difference-test (LSD) or two-way analyses of variance. The associations between the work history and strength measures were analysed by Pearson's product-moment correlations.

Results

Socio-demographic characteristics varied between the groups. The level of education was higher among the trained women athletes of whom more than half had received at least lower secondary education (Table 2). Among the general population sample no one had received more than an elementary education. The mean history of heavy work was 36 years (SD 20) among the general population sample and 24 years (SD 24) among the trained group. The median value for the trained women was 14 years (range 0–73) as against 38 years for the population sample (range 0–66).

Maximal isometric handgrip, knee extension and trunk flexion and extension forces were significantly greater among the trained women, who also had greater abdominal muscle capacity than the untrained women (Table 3).

The correlation coefficients between the number of years of heavy work and muscle force were calculated for the trained women and population sample separately (Table 4). Statistically significant positive correlation was observed among the population sample for trunk extension force. Among the trained women the correlation coefficients were not statistically significant.

To examine this association in more detail both groups were divided into three subgroups according to the length of the history of heavy work, viz less than 20 years of heavy work, from 20 to 49 years of heavy work and 50 or more years of heavy work. About half (58%)

Table 2. Educational background among trained women and years a sample from the general population aged 66–85

Level of education	Trained ($n=52$) %	Population sample ($n=41$) %
Less than elementary school	0	5
Elementary school	44	95
Lower secondary school	39	0
Upper secondary school	17	0

Table 3. Maximal isometric muscle force for five muscle groups and abdominal muscle capacity in trained women and a sample from the general population aged 66–85 years

Variable	Trained ($n=51$–49)		Population sample ($n=41$–35)		Student's t-test
	mean	SD	mean	SD	P
Hand grip (N)	240	(45)	213	(54)	0.009
Elbow flexion (N)	181	(34)	165	(51)	0.089
Knee extension (N)	299	(71)	257	(88)	0.012
Trunk flexion (N)	374	(95)	324	(128)	0.044
Trunk extension (N)	453	(126)	354	(158)	0.002
Sit-ups per 30 s	14.4	(3.8)	5.5	(4.9)	<0.001

Table 4. Correlations between histories of heavy work and muscle strength in trained women and a sample from the general population aged 66–85 years

Variable	Trained (n=49–47)		Population sample (n=40–34)	
	r	P	r	P
Hand grip	−0.087	0.548	0.098	0.541
Elbow flexion	0.029	0.841	0.178	0.266
Knee extension	−0.005	0.976	0.207	0.200
Trunk flexion	0.016	0.913	0.211	0.217
Trunk extension	−0.114	0.422	0.425	0.010
Sit-ups per 30 s	0.077	0.606	−0.199	0.260

of the trained women belonged to the first group (Table 5). Two-way analysis of variance produced no significant association between work history and any of the strength variables.

Discussion

The aim of this study was to examine the association between a history of heavy manual work and muscle strength among elderly trained women and sample from the general population. The main result was that the length of the history of heavy work was not systematically associated with strength in either group. The elderly trained women had greater muscle strength than the sedentary women even though the sedentary women were heavier. The greatest difference between the groups was observed in the performance of sit-ups, lower body mass being favourable for this.

Greater muscle strength among the physically active has also been observed previously (Borkan and Norris 1980; Rikli and Busch 1986; Sipilä et al. 1991; Rantanen et al. 1992). Leisure time physical activity has been shown to be more common among people having a long educational background and high occupational status doing physically light work compared with those of lower educational and occupational status doing heavy work (Aro et al. 1985; Vuolle et la. 1986). Consequently, it is necessary to consider the level of physi-

Table 5. Muscle strength by groups according to history of heavy work among trained women and a sample from the general population aged 66–85 years (Two-way analysis of variance)

Variable	0–19 years		20–49 years		50 years		Source of variance	
	mean	SD	mean	SD	mean	SD	Training F	Work F
Hand grip (N)							4.9*	0.2
Trained	245	(35)	215	(56)	244	(50)		
n	29		10		11			
Population sample	207	(51)	223	(56)	205	(54)		
n	11		16		14			
Elbow flexion (N)							3.5	0.2
Trained	182	(30)	167	(31)	187	(47)		
n	29		10		11			
Population sample	148	(39)	175	(65)	166	(39)		
n	11		16		14			
Knee extension (N)							7.1**	0.3
Trained	311	(62)	254	(58)	318	(85)		
n	29		10		11			
Population sample	220	(77)	278	(102)	262	(72)		
n	11		16		13			
Trunk flexion (N)							3.9*	0.3
Trained	383	(72)	328	(116)	390	(127)		
n	28		9		11			
Population sample	273	(84)	344	(171)	338	(65)		
n	9		16		11			
Trunk extension (N)							9.3**	0.3
Trained	472	(120)	391	(142)	437	(112)		
n	28		9		11			
Population sample	253	(92)	378	(171)	402	(156)		
n	9		16		11			
Sit-ups/30 s.							85.4***	1.8
Trained	14.1	(4.0)	15.2	(4.6)	14.5	(2.7)		
n	28		9		11			
Populations sample	5.4	(5.4)	7.1	(5.0)	3.3	(3.5)		
n	9		15		11			

* $P<0.05$, ** $P<0.01$, *** $P<0.01$; F, Fisher's F-ratio

cal exercise in studies on the strength or functional capacity of employees in various occupations.

In the present study, the group of trained women had a life-long history of physical exercise. Of this group 70% were exercising intensively at least three times each week. The level of physical activity of the population sample, consisting mainly of everyday household activities and easy walks, can be considered to be representative of the age cohort (Rantanen et al. unpublished work).

The association between occupation and muscle strength seems to vary in different age groups among women. Nygård et al. (1988) have found that middle-aged women having a high work load showed systematically lower muscle strength when compared to a group with a low work load, probably due to a higher prevalence of musculoskeletal problems or lower level of leisure time physical activity. Also middle-aged women with a long educational background have been observed to have greater muscle strength than less educated women even after standardisation for the level of physical exercise (Rantanen et al. 1992). The present results accord with those of Aniansson et al. (1980) who have also found no correlation between quadriceps muscle strength and previous occupational activity among women aged 70 years.

The disappearance of the association between work and strength in the higher age groups may, at least in part, be explained by selection factors. One type of selection factor operates at the time of entering employment. It is likely that a heavy job will attract those whose health and strength fall above some threshold for such work. A secondary selection factor intervenes later when a worker changes her occupation because she is no longer fit enough for here previous heavy job (for review see Östlin 1989). Mortality has also been found to be greater among individuals at lower socioeconomic levels, and in general the weaker to be more likely to die earlier (Clement 1974).

The selection theory may be supported by the statistically significant positive correlation between work history and trunk extension force. Women who have not been forced to transfer into lighter professions may be innately stronger. On the other hand, people who are familiar with strenuous physical work may have some advantage in maximal performance measurements compared to those who are not used to performing feats of strength in their lighter jobs. However, the association between trunk extension strength and heavy work should be studied in more detail. The problem here was that the women were retired, and in some cases several years had passed since they had last worked.

The present results would support the earlier studies according to which a history of heavy work does not maintain muscle strength in old age. On the other hand, in our study 50 or more years of heavy work among those who had reached 70–81 years did not seem to reduce muscle strength.

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