Educational differences in estimated and measured physical fitness

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Background: Available information about the association between education and physical fitness (PF) is scarce. The purpose of this study was to examine educational differences in PF in the working age population using different methods to assess PF. Methods: The Health 2000 Survey was carried out for adults aged ≥30 years (n = 8028) in Finland. For this study, 30–54-year-old men and women with data on PF and physical activity (PA) were selected (n = 3724). PF was assessed by self-estimated overall physical fitness and running ability, a physician’s estimation of a participant’s working capacity, the trunk extensors’ endurance and hand grip strength tests. The highest educational qualification taken by the participant was used as a measure of education. The analyses were adjusted for age, PA, BMI, smoking and chronic diseases. Results: PF was best in the high-educated men and women. The educational differences were minor in self-estimated overall PF. Adjusting for the covariates, the differences in self-estimated running ability and working capacity decreased. The educational differences in the trunk extensors’ endurance test were independent of covariates. PA and other health behaviours contributed most to the differences. Conclusion: People with high education had better PF irrespective of the method used to assess PF. A large amount of the educational differences could be explained by PA and other health behaviours. More research is needed to understand the determinants of educational differences in PF.
Methods

The Health 2000 Survey was carried out by the National Institute for Health and Welfare (THL) (former Public Health Institute; KTL) in 2000–01. The study involved a regionally stratified two-stage cluster sampling frame of Finnish adults aged ≥30 years (see Statistical Analyses). The data comprised 8028 participants. For this study, 30–54-year-old men and women were selected (n = 4589) because the results of a trunk extensors’ endurance test were available for this age group. Those with missing data on PF and PA were excluded (n = 865), and the final sample comprised 3724 participants. All the participants completed self-administered questionnaires and participated in interviews, a health examination and different physiological tests. The participation rate was 81%. The Health 2000 Study was approved by the Ethics Committee of THL in 1999 and by the Epidemiological and Public Health Ethics Committee of the Helsinki and Uusimaa Hospital District in 2000. All participants signed a written informed consent.

Education

The participants’ education was obtained from Statistics Finland. For the analysis, the highest educational qualification achieved by the participant was used. The categories were high education (technical college, university, post-graduate and higher vocational degrees), middle education (secondary education and vocational training) and low education (primary education).

Estimated physical fitness

Information on overall self-estimated PF was collected with a self-administrated questionnaire and assessed with the question: ‘Is your physical condition good, rather good, moderate, rather poor or poor?’ The responses were categorized into two classes as high (good) and low (rather good, moderate, rather poor and poor). Self-estimated ability to run 500 m was assessed with a question: ‘Are you able to run a longer distance (about half a kilometre)?’ The response alternatives were (i) without difficulties, (ii) with minor difficulties, (iii) with major difficulties and (iv) not at all. The responses were categorized into two classes as high (i–ii) and low (iii–iv) running ability.

Based on medical examination of a participant, a study physician gave his/her estimation of the participant’s work capacity to work as a construction worker. This occupation was chosen because construction workers need good overall PF. The rating alternatives were (i) completely able to work, (ii) slightly reduced capacity, (iii) substantially reduced capacity, (iv) completely unable to work and (v) work capacity cannot be estimated (the last category was not used). The responses were categorized into two classes as high (i) versus low (ii–iv) working capacity. Several physicians performed the examination, and the k-values for the repeatability of diagnostic assessments were between 0.31 and 1.00.

Measured physical fitness

The trunk extensors’ endurance test was performed with the participant lying down in a prone position and his/her lower body on a low table and the upper body supported to the floor. The examiner sat astride the subject’s feet. The participant was asked to cross his/her hands behind the neck and to lift the upper body into a horizontal position and remain in this position for as long as possible, to a maximum time of 4 min. The time in seconds was the outcome measure of the test.

The hand grip strength test was performed with the dominant hand using a handheld dynamometer (Good Strength, IGS01, Metitur Oy, Jyväskylä, Finland). The participant was in the seated position with elbow flexed at 110°. The participant was instructed to squeeze the handle as hard as possible for 3–5 s. At least two maximal trials were performed. If the two results differed by >10%, a third trial was performed. The highest value (N, Newton) was used in the analyses.

Covariates

LTPA was asked with the item ‘How much do you exercise and strain yourself physically in your leisure time?’. Response alternatives were (i) I mainly read, watch television or do other activities that do not strain me physically; (ii) I mainly walk, cycle or move in other ways for at least 4 h/week; (iii) I do vigorous PA for ≥3 h/week; or (iv) I participate regularly in competitive sports. The first alternative was labelled as low activity, the second as moderate activity and the last two as high activity. CPA was asked with the item ‘How many minutes do you walk or cycle during your commute?’. Response alternatives were (i) I do not work or work is at home; (ii) I commute only by motor vehicle; (iii) <15 min/day; (iv) 15–29 min/day; (v) 30–59 min/day; (vi) 1–2 h/day; or (vii) ≥2 h/day. The first two alternatives were labelled as low activity, the third and fourth alternatives as moderate activity and the last three as high activity. OPa was asked with the item ‘How strenuous is your job physically?’ Response alternatives were (i) In my job, I mainly sit and do not walk much; (ii) I walk quite a bit in my job, but I do not need to lift or carry heavy items; (iii) In my job, I need to walk or lift quite a lot or climb stairs or walk up hill; and (iv) My job is heavy physical labour, and I have to lift or carry heavy items, dig, shovel, pound or do some other heavy labour. The first alternative was labelled as low activity, the second as moderate activity and the last two as high activity.

Based on the measured height and weight results, the participant’s body mass index (BMI) was calculated as weight in kilograms divided by height in squared metres (kg/m²). Smoking was assessed with a question ‘Do you smoke nowadays?’, and the response alternatives were (i) daily; (ii) occasionally; and (iii) not at all. The first alternative was classified as ‘current smoker’. The following physician-diagnosed chronic diseases were taken into account: cardiovascular diseases (angina pectoris, myocardial infarction, coronary bypass surgery, coronary angioplasty, heart failure, hypertension, cardiac arrhythmia, valvular regurgitation, intermittent claudication, cerebral haemorrhage), asthma, chronic obstructive pulmonary disease, rheumatoid arthritis, knee and hip osteoarthritis, chronic low back syndrome and diabetes.

Statistical analyses

Analyses were conducted separately for men and women. The complex sampling design and the post-stratification weights, which accounted for the oversampling and non-response, were accounted for using linearized variance estimates implemented in the survey procedures of the SAS/STAT statistical software version 9.1.3 (SAS Institute Inc., Cart, NC, USA). Descriptive statistics were computed to measure distributions in education groups. A logistic regression model was used to estimate the association of education on self-estimated overall PF, self-estimated running ability and working capacity. A linear regression model with post-hoc pair-wise testing was used to estimate the association of education on trunk extensors’ endurance time and hand grip strength. Models were adjusted for age and additively for PA, health behaviours (BMI, smoking) and chronic diseases. All PA measures (LTPA, CPA and OPA) were included in the model simultaneously. Proportional odds assumption was satisfied. Results are presented in odds ratios (ORs) with 95% confidence intervals (95% CI) and P-values (P < 0.05).

Results

The characteristics of the educational groups are described in table 1. In men, there were no differences in the age-adjusted prevalence of self-estimated overall PF between the educational groups (table 2).
The educational differences in self-estimated overall PF was observed only in women, and the differences were smaller compared with those obtained with other methods. Adjusting for PA, the differences disappeared also in women. One possible explanation for the weaker educational differences could be the measurement method itself, as people may compare their current fitness with their own previous fitness level or they may compare it with people of the same age or with people with the same SEP.9–11,21

Self-estimated ability to run 500 m is a more concrete question than the self-estimated overall PF, and it focuses the estimation on a person’s own performance.9 The results showed in both men and women that self-estimated running difficulties were more than twice as common in those with low education than in those with high education. This difference decreased in both genders after controlling for PA and other health behaviours, although the difference between the men with high and low education remained unexplained even after controlling for all covariates. The result is supported by an earlier finding that those with the low education have been shown to have an increased risk to mobility limitations owing to a higher prevalence of obesity, chronic conditions and a physically strenuous work history.20 It is also important to remember that the question of the ability to run 500 m should estimate running difficulties based on poor aerobic capacity, but some people may also consider their musculoskeletal problems.

Working as a construction worker demands good overall PF, albeit that more emphasis is on good musculoskeletal fitness and physical functioning than aerobic capacity. The results showed that

<table>
<thead>
<tr>
<th>Variable</th>
<th>Men</th>
<th>Women</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>High education</td>
<td>Middle education</td>
</tr>
<tr>
<td>n (%)</td>
<td>Mean (SD)/%</td>
<td>Mean (SD)/%</td>
</tr>
<tr>
<td>Age (years)</td>
<td>42.0 (7.2)</td>
<td>41.9 (7.1)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.2 (4.0)</td>
<td>26.9 (4.1)</td>
</tr>
<tr>
<td>Current smoker (%)</td>
<td>14.5</td>
<td>33.0</td>
</tr>
<tr>
<td>Chronic diseases (%)</td>
<td>21.2</td>
<td>26.2</td>
</tr>
<tr>
<td>Leisure time</td>
<td>23.4</td>
<td>28.2</td>
</tr>
<tr>
<td>Commuting</td>
<td>62.8</td>
<td>70.1</td>
</tr>
<tr>
<td>Self-estimated running ability</td>
<td>&lt;0.001</td>
<td>70.4</td>
</tr>
<tr>
<td>High</td>
<td>86.1</td>
<td>78.6</td>
</tr>
<tr>
<td>Low</td>
<td>9.7</td>
<td>21.4</td>
</tr>
<tr>
<td>Estimated working capacity (%)</td>
<td>&lt;0.001</td>
<td>78.5</td>
</tr>
<tr>
<td>High</td>
<td>87.2</td>
<td>77.5</td>
</tr>
<tr>
<td>Low</td>
<td>12.8</td>
<td>22.5</td>
</tr>
<tr>
<td>Trunk extensors’ endurance (s)</td>
<td>118.1 (42.2)</td>
<td>107.0 (46.8)</td>
</tr>
<tr>
<td>Hand grip strength (N)</td>
<td>514.7 (92.0)</td>
<td>524.6 (94.6)</td>
</tr>
</tbody>
</table>

Statistical significance between educational groups in men and in women. BMI = body mass index.

In women, age-adjusted prevalence of low self-estimated PF was more common in those with low education compared with those with high education. Adjusting for PA, the educational differences decreased (table 2).

The age-adjusted model of self-estimated ability to run 500 m indicated that the men with low education had nearly three times more often difficulties in running than those with high education. Adding PA into the model, the ORs substantially decreased. Other health behaviours, but not chronic diseases, attenuated the differences further. When all the covariates were adjusted for, the risk for running difficulties were still higher among the men with low education than those with high education. Women, the lowest educational group had also more than two times higher likelihood for low self-estimated running ability compared with the highest educational group. The educational differences diminished when adjusted for PA, but they remained statistically significant. After adjusting for other health behaviours and chronic diseases, the educational differences were no more statistically significant.

According to physician’s estimation, men and women with middle and low education had lower working capacity compared with the highest educational groups (table 2). The differences were partly explained by adjusting for PA and other health behaviours. After controlling for all covariates, low working capacity remained more common only in the men with low education compared with those with high education.

Among men and women, the age-adjusted trunk extensors’ endurance time was significantly longer in those with high education and the shortest in those with low education (table 2). The educational differences in the trunk extensors’ endurance test remained unexplained after controlling for all covariates. The age-adjusted maximal hand grip strength was the highest in men with middle education compared with the men with high and low education, but the differences were not statistically significant (results not shown). In women, the hand grip strength did not differ between the all three educational groups, although the women with low education had significantly lower hand grip strength compared with the women with high education (results not shown). This difference was not anymore significant after controlling for PA.

**Discussion**

In this study, we found that the educational differences in PF were dependent on the measurement method. Generally, low PF was more common in the lowest educational group compared with the highest. PA with other health behaviours (BMI and smoking) contributed more to the differences in PF than PA with chronic diseases among both men and women.

The educational differences in self-estimated overall PF was observed only in women, and the differences were smaller compared with those obtained with other methods. Adjusting for PA, the differences disappeared also in women. One possible explanation for the weaker educational differences could be the measurement method itself, as people may compare their current fitness with their own previous fitness level or they may compare it with people of the same age or with people with the same SEP.9–11,21

The ability to run 500 m is a more concrete question than the self-estimated overall PF, and it focuses the estimation on a person’s own performance.9 The results showed in both men and women that self-estimated running difficulties were more than twice as common in those with low education than in those with high education. This difference decreased in both genders after controlling for PA and other health behaviours, although the difference between the men with high and low education remained unexplained even after controlling for all covariates. The result is supported by an earlier finding that those with the low education have been shown to have an increased risk to mobility limitations owing to a higher prevalence of obesity, chronic conditions and a physically strenuous work history.20 It is also important to remember that the question of the ability to run 500 m should estimate running difficulties based on poor aerobic capacity, but some people may also consider their musculoskeletal problems.

Working as a construction worker demands good overall PF, albeit that more emphasis is on good musculoskeletal fitness and physical functioning than aerobic capacity. The results showed that
Table 2 Differences in physical fitness between the education groups in men and women

<table>
<thead>
<tr>
<th>Models</th>
<th>Low self-estimated physical fitness</th>
<th>Low self-estimated running ability</th>
<th>Low work capacity (physician’s estimation)</th>
<th>Physical fitness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>Mean (SD)</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>M1</td>
<td>1.25 (0.94–1.66)</td>
<td>1.35 (0.95–1.91)</td>
<td>1.73 (1.92–4.44)</td>
<td>2.92 (1.38–2.97)</td>
</tr>
<tr>
<td>M2</td>
<td>1.24 (0.95–1.62)</td>
<td>1.16 (0.81–1.64)</td>
<td>1.37 (1.08–2.24)</td>
<td>1.56 (1.15–2.28)</td>
</tr>
<tr>
<td>M3</td>
<td>1.24 (0.95–1.62)</td>
<td>1.16 (0.81–1.64)</td>
<td>1.37 (1.08–2.24)</td>
<td>1.56 (1.15–2.28)</td>
</tr>
<tr>
<td>M4</td>
<td>1.24 (0.95–1.62)</td>
<td>1.16 (0.81–1.64)</td>
<td>1.37 (1.08–2.24)</td>
<td>1.56 (1.15–2.28)</td>
</tr>
</tbody>
</table>

Women    | Mean (SD) | OR (95% CI) | OR (95% CI) | OR (95% CI) | Mean (SD) |
| M1     | 1.25 (0.94–1.66) | 1.35 (0.95–1.91) | 1.73 (1.92–4.44) | 2.92 (1.38–2.97) | 96.3 <0.001 <0.001 <0.001 <0.001 |
| M2     | 1.24 (0.95–1.62) | 1.16 (0.81–1.64) | 1.37 (1.08–2.24) | 1.56 (1.15–2.28) | 110.1 <0.001 <0.001 <0.001 <0.001 |
| M3     | 1.24 (0.95–1.62) | 1.16 (0.81–1.64) | 1.37 (1.08–2.24) | 1.56 (1.15–2.28) | 110.1 <0.001 <0.001 <0.001 <0.001 |
| M4     | 1.24 (0.95–1.62) | 1.16 (0.81–1.64) | 1.37 (1.08–2.24) | 1.56 (1.15–2.28) | 110.1 <0.001 <0.001 <0.001 <0.001 |

A logistic regression, age-adjusted odds ratios (OR) and 95% confidence intervals (95% CI) for physical fitness. The reference group is high education group.

Men and women with middle and low education were about twice more likely to be estimated as having low working capacity than those with high education. After controlling for all covariates, the educational differences were attenuated in women, but they were still observed between men with high and low education. It is difficult to explain this difference, but one possible explanation could be that the study physicians have evaluated working capacity of those with low education more often to be lower than those with high education.

Several earlier studies have examined participants’ physical performance with different tests and reported better physical performance among the high educated than in the low educated.14–18 We used the objective and widely used trunk extensors’ endurance and hand grip strength tests to measure muscular fitness.24,26 In this study, the muscle endurance was weakest in men and women with low education. In addition, women had a longer endurance time than men, which is in line with previous studies.27 An interesting finding was that the covariates did not explain the educational differences in muscle endurance, although those with low education have poorer health behaviours, are more often overweight or obese and have more chronic diseases than those with high education.28,29

A good test result may also depend on a participant’s motivation or even sense of pain for how long she/he is able and willing to resist fatigue30,31 and, therefore, the educational differences remained unexplained.

The hand grip strength test showed only minor educational differences. This finding is supported by earlier studies, which have reported contradictory results about the educational differences in hand grip strength.14,15 Our muscular fitness tests gave slightly opposite results in regard to educational differences, which may have arisen from differences between the tests. The trunk extensors’ are a large muscle group, with the test measuring muscle endurance lasting for several minutes, while the hand muscles are quite a small muscle group, with the test measuring maximal muscle strength and lasting only 3–5 s. Perhaps the high educated are more motivated, and they want to achieve good results compared with the low educated, who may give up more easily if something feels too difficult or challenging. However, this educational difference between the tests is difficult to explain and needs further examination. Actual PF tests of different fitness components could have perhaps given more accurate information, but unfortunately more objective tests were not performed during the study.

We also acknowledge some limitations of this study. Unfortunately, no more objective PF tests were performed for this age group (30–54 years) during the study. We also acknowledge that the physician’s estimation is an external estimation; it is not a PF test, and it did not base on any actual results of the PF tests. The strength of the study was that the data had been obtained in the large population-based study, and it is a representative sample of Finnish population. Also the participation rate was very high in the Health 2000 Survey, and therefore, our results are generalized for the age group examined in our study.

In conclusion, the results confirmed our hypothesis that people with high education have better PF, and this result was obtained using different fitness measures. Our results also showed that educational differences in PF were dependent on the measurement method. The differences were partly explained by PA and other health behaviours (BMI and smoking) among both genders. However, the educational differences in the trunk extensors’ endurance test were independent of covariates, and only minor differences in hand grip strength were observed. Education creates more opportunities to obtain and understand information and to apply it in personal life. This may contribute to better PF, health and health behaviours among those with high education compared with those with low education.13,32 Therefore, opportunities should be created for people in lower SEP so that they could improve their overall health and health behaviours. Also more
research is needed to understand the determinants of educational differences in PF.

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**Conflicts of interest:** None declared.

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**Key points**

- Educational differences in PF differ depending on the measurement method, albeit people with high education have better PF despite the methods used.
- PA and other health behaviours (BMI and smoking) contributed most to the educational differences in PF among men and women.
- Opportunities should be created for people in lower SEP so that they could improve their overall health and health behaviours.

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**References**


