Physical fitness, BMI and sickness absence in male military personnel

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Background In modern society, decreased physical activity and/or changes in quality and quantity of nutritional intake contribute to obesity and lifestyle diseases that result in economic costs, both to society and to individuals.

Aims To measure physical fitness and body mass index (BMI) and to assess their association with sickness absence in male soldiers.

Methods Data regarding BMI and physical fitness (aerobic endurance and muscle fitness) were collected for male Finnish military personnel and combined with sickness absence data collected in the year 2004. The duration and costs of sickness absence were obtained from the personnel administration.

Results A total of 7179 male military personnel (mean age 37, range 18–59; mean BMI 26.0, range 17–50) participated. There were large inter-individual variations in physical fitness and body mass. The group with the longest sickness absences (>7 days) exhibited lower muscle fitness in three of four tests and shorter running distance compared to the groups with shorter sickness absence (P < 0.001). In addition, high BMI, poor muscle fitness and poor aerobic endurance were associated with increased sickness absence.

Conclusions The present results showed that poor muscle fitness and endurance as well as high BMI are risk factors for productivity loss causing additional costs for the employer. Therefore, workers at a greater risk should be offered more multifaceted information about potential health risks, as well as motivational support to improve their lifestyle.

Key words BMI; health; military; physical fitness.

Introduction

Regular physical activity is associated with a lower risk of coronary diseases, hypertension, osteoporosis, diabetes, metabolic syndrome and many other diseases [1]. Thus, physical activity has positive effects on blood lipid profile [2], glucose metabolism and insulin sensitivity [1], hypertension [3], autonomic nervous and cardiovascular functions [1] and metabolic syndrome [4]. Furthermore, sedentary people with good physical fitness seem to be at a lower risk of cardiovascular diseases compared to their less fit counterparts [5]. Accordingly, physically active people have significantly less sickness absence [6] and produce a higher quality of work [7] than their sedentary counterparts.

It is well known that the prevalence of obesity has increased across all age and social groups during the last 20 years [8]. Obesity, which has been shown to be associated with many of the above-mentioned diseases, has widely been evaluated by measurements of body mass index (BMI), fat percentage and waist circumference [9]. With regards to metabolic syndrome, obesity has been shown to be the most important risk factor [4]. Obesity is more common in physically inactive people than in their active counterparts, which suggests that physical activity is a very effective method of reducing obesity [10]. Although BMI does not change, exercise decreases fat mass, waist circumference [11] and visceral fat [10]. The importance of exercise should thus be strongly emphasized due to its positive effects on health [11].
From an economical point of view, obesity and other associated diseases result in significant costs to society and to individuals. For example, in 1995 the total economic cost attributable to obesity was estimated at $99 billion in the USA [12]. In several developed countries, obesity has been estimated to account for 2–7% of the total health care costs [13]. In addition to the direct costs of obesity, individual costs (sickness and reduced quality of life) and social costs (loss of productivity due to sickness absence and premature pensions) are enormous [14].

It has previously been shown that employees active in their leisure time at least twice per week have less sickness absence compared to inactive people, mainly due to a lower frequency of musculoskeletal disorders [15]. Although numerous studies have been published about BMI, physical activity and exercise in relation to health factors, there is a lack of information about the association between economic consequences of sick leave, BMI and physical fitness. Therefore, the purpose of the present study was to measure physical fitness and BMI and to assess their association with sickness absence costs in male soldiers.

**Methods**

The fitness tests, which are compulsory for all Finnish soldiers, were carried out during 2004. The soldiers’ work consisted of both physical and office work, whereby ~1000 people worked predominantly in tasks requiring moderate or heavy daily physical activity. The subjects gave written informed consent to participate in the tests after health care examinations were carried out by medical doctors. All subjects were fully informed of the procedures and possible risks of the experiment. They were also advised that the data saved in the personnel administration data programme, where they were combined with sickness absence data. The physical fitness results were then assessed by performing a comparison of the three groups based on the duration of sickness absence (none, 1–7 and >7 days). These categories were based on benefits of sickness absence paid by the Finnish social insurance. The total costs per lost working day included salary and supplementary social welfare expenses. Sickness absence in Finland requires medical certification, and sick leave data are gathered for the purpose of salary payment. This data can therefore be considered as both a reliable and a valid measure.

The physical fitness test results were transferred to the personnel administration data programme, where they were analyzed to determine age-adjusted costs of sickness absence days. The physical fitness results were then assessed by performing a comparison of the three groups based on the duration of sickness absence (none, 1–7 and >7 days). These categories were based on benefits of sickness absence paid by the Finnish social insurance. The total costs per lost working day included salary and supplementary social welfare expenses. Sickness absence in Finland requires medical certification, and sick leave data are gathered for the purpose of salary payment. This data can therefore be considered as both a reliable and a valid measure.

The results were expressed as mean values, as well as standard deviation (SD) or range. As the data for costs were highly skewed, bias correction and accelerated bootstrap estimation were used to derive 95% confidence intervals (CIs). Differences between the means were tested by analyses of variance, and post hoc testing of several univariate comparisons was performed with Hochberg's GT2, adjusted to a significance level of 0.05. Continuation ratio models for ordinal responses were used to investigate the age-adjusted risk of sickness absence (scored: 0 = 0 days, 1 = 1–7 days and 2 = >7 days) [19]. Bootstrap-type regression analysis was used to determine age-adjusted costs of sickness absence days in terms of salary.

**Results**

Fitness test results were available for 7179 male soldiers, representing ~95% of the whole occupation group in Finland. The remaining 5% were not able to participate due to medical reasons or service abroad. Table 1 shows the mean (±SD) age, body height, mass and BMI of three different groups, which were formed according to the duration of sickness absence.

The mean (±SD) running distance in the 12-min test was 2598 ± 369 m (n = 5414), and mean VO2max was 54.2 ± 8.2 ml/kg/min (n = 1853). The results of the muscle fitness tests were as follows: 32 ± 17 push-ups, 34 ± 15 sit-ups, 50 ± 18 repeated squats in 60 s and 57.7 ± 19.0 kg grip strength. BMI was 26.0 ± 3.3 (range 16.4–50.0).
with muscle index (528–594). With increasing BMI, the costs increased work disability per person in the observed year were 0.001) quartiles (Figure 1). The mean (95% CI) costs of year was linearly associated with BMI (528). The decreases in muscle fitness increased the costs from €481 (426–540) to €710 (626–807), and the decrease in aerobic endurance resulted in an increase from €443 (398–498) to €692 (620–773).

### Table 1. Physical characteristics of the present subjects (n = 7179) according to the length of their sick leaves.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Length of sick leaves</th>
<th>P-value between groups (multiple comparisons)(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None (SD), n = 3540</td>
<td>1–7 days, n = 2449 &gt;7 days, n = 1190</td>
</tr>
<tr>
<td>Age, years</td>
<td>37 (8)</td>
<td>36 (8)</td>
</tr>
<tr>
<td>Body height, m</td>
<td>1.80 (0.06)</td>
<td>1.80 (0.06)</td>
</tr>
<tr>
<td>Body mass, kg</td>
<td>83.7 (11.8)</td>
<td>84.0 (12.4)</td>
</tr>
<tr>
<td>BMI, kg/m(^2)</td>
<td>25.8 (3.2)</td>
<td>26.0 (3.3)</td>
</tr>
<tr>
<td>Muscle fitness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Push-ups, reps</td>
<td>34.8 (14.7)</td>
<td>34.6 (14.6)</td>
</tr>
<tr>
<td>Sit-ups, reps</td>
<td>37.4 (11.4)</td>
<td>37.2 (11.7)</td>
</tr>
<tr>
<td>Squats, reps</td>
<td>55.0 (10.4)</td>
<td>54.7 (10.9)</td>
</tr>
<tr>
<td>Grip strength, kg</td>
<td>62.7 (8.8)</td>
<td>62.7 (9.0)</td>
</tr>
<tr>
<td>Endurance fitness</td>
<td>12-min running test(^b), m</td>
<td>2633 (354)</td>
</tr>
<tr>
<td>Cycling test(^c), ml/kg/min</td>
<td>45.8 (8.0)</td>
<td>44.9 (8.3)</td>
</tr>
<tr>
<td>Combinant VO(_2)max, ml/kg/min</td>
<td>47.1 (7.9)</td>
<td>46.2 (8.2)</td>
</tr>
</tbody>
</table>

\(^a\)Hochberg’s GT2 test. \(^b\)n = 1827. \(^c\)n = 5375.

Fifty-one per cent of soldiers had some form of sickness absence during the year 2004. Of those people, 17% took a long sickness absence (>7 days) and 34% took a short absence (≤7 days). Of all the subjects who had sickness absence, the mean (95% CI) duration was 4.9 (4.6–5.2) days. Only 2% of absences were due to accidents. Table 1 shows that the mean (±SD) values of body mass and BMI were higher in the group with the longest sickness absence (>7 days). In the whole sample, the mean BMI (±SD) was 26.0 ± 3.3, while 10% were obese (BMI > 30) and 46% were overweight (25.0–29.9).

The subgroups significantly differed in muscle fitness and aerobic endurance. In all tests, the poorest results were found in the group with the longest sickness absence (>7 days). The number of sickness absence days in the year was linearly associated with BMI (P < 0.001) and with muscle index (P < 0.001) and endurance index (P < 0.001) quartiles (Figure 1). The mean (95% CI) costs of work disability per person in the observed year were €559 (528–594). With increasing BMI, the costs increased from €462 (445–525) to €710 (626–807) (Figure 2). The decreases in muscle fitness increased the costs from €481 (426–540) to €710 (626–807), and the decrease in aerobic endurance resulted in an increase from €443 (398–498) to €692 (620–773).

### Discussion

The primary finding of the present study was that the male Finnish soldiers were generally in good physical condition, however, large inter-individual variations were observed in physical fitness and body mass. The present results further emphasize that poor muscle fitness and aerobic endurance, as well as high BMI, are risk factors for sickness absence and may thus incur additional costs to the employer. Unfortunately, there were no data available of reasons for sickness absence due to confidentiality, which may partly affect the accuracy of conclusions. Although the incidence of accidents was only 2% in the present study, there may also have been incidences of musculoskeletal injury, which would lead to decreased fitness and possible gains in weight.

It has been shown that performing physical activity at a vigorous intensity at least three times a week (American College of Sports Medicine recommendation) decreases the duration of sickness absence [20]. Furthermore, associations with health status were more favourable in people who met the sufficient physical activity guidelines than in those who did not [21]. Thus, physical fitness testing can be a useful tool to increase the awareness of individuals about their fitness level, which was the case in the present group of military personnel. Cardiovascular fitness is not the only important outcome of physical activity [22], as resistance exercise has also become increasingly recognized for its ability to promote health and prevent disease [23]. Therefore, endurance and resistance training both contribute to the prevention of many diseases as well as obesity [24], by increasing muscle quantity and insulin action and by reducing visceral adipose tissue [25]. Consequently, it is reasonable to include both aerobic and muscle strength tests when determining an overall physical fitness profile, as occurred in the present study. However,
This study did not assess the contributions of chronic diseases, smoking, nutrition and drinking habits to interactions between physical fitness, BMI and sickness absence. It is noteworthy that the costs incurred due to sickness absence are huge but, however, it is difficult to analyse the contribution of physical fitness and/or overweight in them. In the present study, the average number of 4.9 sickness absence days led to a corresponding mean cost of €559 per person in the observed year, and the total cost was €4,016,296 for 7179 workers. It has previously been found that health care costs are consistently higher for employees with higher BMI [26]. In the Swedish female population, the costs due to sickness absence and disability pensions related to obesity and obesity-related diseases have been estimated to be ~10%, which corresponds to approximately €1.6 million during 1 year [14]. Based on a survey study carried out in the UK, the amount of sickness absence taken could be reduced by two million days if staff took more exercise. According to this study, those who exercised for fewer than the recommended 150 min/week took an average of 3.5 days of sickness absence [27]. However, reliable comparisons between sickness absence costs calculated in the present study and previous studies are difficult.

In the future, it is obvious that the prevalence of diseases (e.g. metabolic syndrome) induced by inactivity and excessive energy intake will continue to increase. Obesity is more common in inactive people than those who exercise at work or recreationally [9]. Lahti-Koski et al. [28] observed that between 1982 and 1997, mean BMI increased in men and women in Finland. Obesity has large socio-economic and health implications such as limited daily exercise, increased morbidity and early retirement [29]. It has been shown that the risk of ‘lifestyle diseases’ increases significantly when BMI is >25, and the risk of arterial disease, type 2 diabetes and hypertension is already increased when BMI is above 22–23 [30]. The present study strongly supports these findings, although the diagnoses of diseases are not known. It should be remembered, however, that BMI is not the best indicator of obesity-related health risks, as BMI is partly attributable to muscle mass [9,11]. If increasing body fat is a significant problem, various methods should be developed to support and encourage regular physical activity, both during working hours and leisure time, and emphasis should be placed on improving dietary intake. The present subjects were allowed to use two working hours per week for physical training. Furthermore, the employer created good facilities for leisure time activities and enabled the possibility to consume healthy food on a regular basis.

Many employers currently use physical examination as part of preventative medicine. Frequent fitness testing, which was undertaken in the present study, is an exceptional method in this regard. Despite the fact that the employer in this study offered regular fitness testing and facilities, allowed the use of limited working hours each week to maintain fitness and enabled the possibility of low-cost healthy meals, the present study revealed that there were overweight and unfit workers who were associated with longer sickness absences. Therefore, it is
recommended that those workers at a higher risk of sickness absence should be assisted in order to obtain more detailed screening and lifestyle education in the future. At the same time, more scientific information is needed in this regard.

Key points

- High BMI, poor muscle fitness and poor aerobic endurance are associated with increased sickness absence.
- Poor muscle fitness and endurance as well as high BMI may cause additional costs for the employer due to productivity loss.
- Workers at a greater health risk due to poor fitness and/or obesity should be advised to improve their daily lifestyle.

Conflicts of interest

None declared.

References

25. Park SK, Park JH, Kwon YG, Kim HS, Yoon MS, Park HT. The effect of combined aerobic and resistance exercise...


