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Cardiorespiratory and muscular fitness in young adult Finnish men between 2003 and 2015

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Abstract

Introduction: Physical fitness is strongly related to health and may offer valuable information about public health. We investigated trends in physical fitness, leisure-time physical activity (LTPA) and anthropometry of young healthy adult Finnish men in representative population based samples between 2003 and 2015.

Methods: Three independent cross-sectional samples of 18-35 year old Finnish men were assessed in 2003 (n=889), 2008 (n=803) and 2015 (n=690). Cardiorespiratory (VO_2max) and muscular fitness (1-min sit-ups and push-ups), body mass and height and were measured. Self-reported LTPA was assessed.

Results:

After adjusting for age, education, and smoking, cardiorespiratory fitness was higher in 2003 (mean: 43.5, 95%CI: 42.9-44.1 ml/kg/min) compared to 2008 (41.3, 95%CI: 40.7-41.9 ml/kg/min) and 2015 (40.6, 95%CI: 40.0-41.2 ml/kg/min) (p<0.001), whereas no difference was observed between 2008 and 2015. The lowest values in muscular fitness were observed in 2003, while no clear trends were further noticed. The adjusted BMI was higher in 2008 (25.1, 95%CI: 24.9-25.4) and 2015 (25.3, 95%CI: 25.3, 95%CI: 25.0-25.6) compared to 2003 (24.5, 95%CI: 24.3-24.8) (p<0.005). In 2015, a higher proportion of individuals exercised at least 4 times per week compared to 2003 and 2008 (p<0.05).

Conclusion: The decrease of cardiorespiratory fitness that took place between 2003 and 2008 plateaued after 2008. The plateau is in accordance with the previously observed trend of 5-10 years younger Finnish men. Moreover, muscular fitness was for the most part higher in 2008 and 2015 compared to 2003. Efforts directed to promote regular physical activity and improve physical fitness are needed.

Keywords: physical fitness, muscular endurance, leisure-time physical activity, body mass index, secular trends

Introduction

Physical activity (PA) and fitness are related to many beneficial health outcomes.[1] Cardiorespiratory fitness, in particular, has been shown to be a strong predictor of health.[2-4] Therefore, from the public health perspective, it is important to monitor and collect data on fitness variables in nationally representative study samples in different age groups. Measured fitness variables over time have mainly been studied in children and adolescents[5] and to a less extent in adults. In Finland, previous large-scale studies based on population representative samples of young men aged 18-20 yrs. have observed a decline in cardiorespiratory fitness 12% from 1979 to 2004.[6] Interestingly, the decline in cardiorespiratory fitness in Finnish young men seems to show a diminishing and stabilizing trend over the last decade[7], similar to some of the findings reported in children.[5] Moreover, the recent results observed in Swiss conscripts, representing a population based sample of young adult Swiss men aged 18-21 years, showed no difference in cardiorespiratory fitness during 2006-2015.[8]

In the current literature, there is a lack of data on temporal trends in muscular fitness, although muscular fitness is closely linked to health outcomes.[9] Similar to cardiorespiratory fitness, the majority of existing studies monitoring muscular fitness trends over time have focused on children.[10-11] In Finland, the prevalence of young adult men with good or excellent muscular fitness decreased between 1992 and 2004[6] and plateaued thereafter[7] in young adult men. Wyss et al. (2018) observed no change in either lower or upper body muscular fitness during 2006-2015 in young adult Swiss men, however, trunk muscle strength improved over the study period.[8]

The main aim of the present study is to assess time trends in both cardiorespiratory and muscular fitness in young adult Finnish men (24-28 years), who were approximately 5-10 years older compared to other previous large-scale studies in younger adult men.[6-8] Three cross-sectional study samples, representative of healthy young adult Finnish men from the years 2003, 2008, and 2015, were used for the analysis. In addition to physical fitness, trends in leisure-time physical activity and body composition were also studied.

Materials and methods

The data of three cross-sectional studies conducted in the years of 2003, 2008, and 2015 were used to assess differences in physical fitness, physical activity, and body composition. A similar study design and procedures were used in all previous cross-sectional measurements[12-13]. The participants were young adult men who were called up to the military refresher training organized by the Finnish Defence Forces. In Finland, according to the law of national defense, conscription time starts at the age of 18 and compulsory military service must be performed by the age of 30 years. Each year, 70-75 % of all young Finnish men perform their military service (~ 20 000 men). After the military service, they continue with their normal civilian life, but as reservists they can be called up to military refresher training lasting 4-10 days. The representativeness of the present study samples to young adult Finnish men was assessed by comparing education and place of residence to nation-wide population statistics about 20-35 year old Finnish men (Statistics Finland). The present study samples represent young adult Finnish men, although a few limitations exist. The present study sample was more educated and geographically not fully representative, since in 2008 Northern Finland was slightly under-represented and in 2015 Southern and Northern Finland were slightly over-represented compared 20-35 year old Finnish men at population level.

Reservists in the present study were measured at the beginning of the military refresher training in 2003, 2008, and 2015. Detailed information about study participants and study procedures has been published earlier.[12-13] Briefly, in each cross-sectional study, reservists arrived at the garrisons by 14:00 o'clock and had a standardized dinner. During the first evening, they filled in PA and health questionnaires. The next morning, after an overnight fast, body composition was measured and followed by a light breakfast including a maximum of 1 cup of coffee or tea to limit caffeine consumption. After the breakfast, physical fitness tests were performed.

Participants

After non-participation to the military refresher training and non-participation to the study 974, 846, and 777 reservists participated in 2003, 2008, and 2015, respectively. Participants with (nonsevere) hypertension, occasional symptoms of asthma or allergy, diabetes or musculoskeletal symptoms not interfering with maximal exercise were included. Women and older reservists (≥35 years) were excluded. The proportions of women and older reservists excluded consisted of 8.5%, 5.1%, and 10.3% of the study samples for years 2003, 2008, and 2015, respectively. Participant flow and the final study samples used in the analysis are shown in the figure 1.

Physical fitness was assessed with tests of cardiorespiratory and muscular fitness. *Cardiorespiratory fitness* (VO_2max) was determined using an indirect graded cycle ergometer test (Ergoline 800S, Ergoselect 100K, Ergoselect 200K, Bitz, Germany) until exhaustion. A progressive protocol was used, which initially started at a power output of 50 W and was increased 25 W every 2 min until exhaustion. Heart rate (HR) was continuously recorded during the test (Polar Vantage NV,S610, S710, or S810, Kempele, Finland). Predicted VO_2max was estimated from HR and maximal power (W) (Fitware, Mikkeli, Finland) with the following equation: $VO_2max\ (ml \cdot kg^{-1} \cdot min^{-1}) = 12.35 \times Pmax/kg + 3.5$, where Pmax is maximal power and kg is body mass in kg. The intraclass correlation has been reported to be high (ICC:0.82-0.94) with this method.[14]

Muscular fitness was assessed by push-up and sit-up (repetitions/minute) tests.[12] The participants were instructed to perform a standardized technique, and were encouraged to perform as many repetitions as they were able to during 60 seconds. A 5-minute recovery period separated the tests. During the test, experienced fitness instructors monitored the technique of the participants and only repetitions completed with correct technique were counted.

Self-reported leisure time physical activity (LTPA) was determined with the frequency and intensity of weekly LTPA using the following validated question[12]: “In which of the following leisure time physical activity group are you engaged to? - (“Think of the last three months and consider all leisure time physical activity that has lasted at least 20 minutes per session”). Response categories were: (1) no physical activity at all, (2) some physical activity without feeling out of breath or sweating, (3) physical activity with feeling out of breath or sweating once a week, (4) physical activity with feeling out of breath or sweating twice a week, (5) physical activity with feeling out of breath or sweating three times a week, and (6) physical activity with feeling out of breath or sweating at least four times a week. Based on the responses to the LTPA questionnaire, participants were divided into low, moderate, and high PA categories. The low PA level was classified by LTPA response categories 1-2, while the moderate and high PA levels were classified by LTPA response categories 3-4, and 5-6, respectively.

Body mass and height were measured with commercial scales with precision of 0.1 kg and 0.1 cm. BMI was calculated from these values.

Demographic and background variables were age, education (≤ 9 yrs., 10-12 yrs., 13-15 yrs., ≥ 16 yrs.) and smoking, which were assessed with a questionnaire.

Statistics

Data was analyzed with PASW-software (PASW for Windows 18.0.1). Descriptive statistics as means, standard deviations (SD), and 95% confidence intervals were calculated. Analyses of variance with LSD post hoc analyses were used to compare background variables as well as parameters of physical fitness, body composition, and leisure-time physical activity (LTPA). In addition, data were divided to 10 th, 25 th, median, 75th, and 90 th percentiles for physical fitness variables to describe distributions of fitness within different studied years. The participants were on average 4 years older in the 2003 study sample compared to 2008 and 2015 study samples, while smoking was less frequent in 2015 compared to previous years ($p<0.001$). In addition, there were more participants with 13-15 years of education and less of those individuals with education of more than 15 years in 2008 and 2015 compared to 2003 ($p<0.001$) (table 1). Therefore, analyses of covariance with LSD post hoc analyses were used for comparisons between the study years to account for potential confounding factors (age, education, smoking). The comparisons of proportions in smoking, LTPA and BMI subgroups were analyzed with Chi^2 -tests.

Results

The unadjusted results (table 1) revealed that relative and absolute cardiorespiratory fitness was better in 2003 compared to 2008 and 2015 ($p<0.001$), whereas no difference was observed between the years 2008 and 2015 (table 1). After adjusting for age, education and smoking, the results remained for relative cardiorespiratory fitness, whereas absolute cardiorespiratory fitness was worse in 2015 compared to 2003 ($p=0.001$) and 2008 ($p=0.041$) (figure 2). In addition, all of the lowest and highest percentiles revealed a decreasing trend across the studied years both in relative and absolute cardiorespiratory fitness (table 3). The relative change in cardiorespiratory fitness from 2003 was greater for the lowest 10^{th} percentiles varying between –7% and –9%, whereas the highest 10^{th} percentiles were less affected being at highest –1% in 2008 and 2015 (table 3). In addition, the relative change from 2003 among all the percentiles were similar between 2008 and 2015 (table 3).

After the adjustments for age, education and smoking, the results of sit-up test were better in 2008 compared to other study samples ($p<0.001$) and the results of push-up test were better in 2008 and 2015 compared to 2003 ($p<0.001$) (figure 2). Moreover, the statistical differences in muscular fitness test results also remained when related to body weight (tables 1 & 2). The relative change in push-up and sit-up performances from 2003 was rather similar in the highest percentiles, which all were at higher level compared to 2003. However, the lowest percentiles were at higher level in 2008, whereas also lower values were observed in the lowest percentiles in sit-ups in 2015. (table 3).

After the adjustments for age, education, and smoking, compared to 2003, BMI was higher in 2008 ($p=0.005$) and 2015 ($p=0.001$) (figure 3). The unadjusted differences are shown in the table 1. Comparison of LTPA subgroups showed that in 2015 there was a higher proportion of individuals who exercised at least 4 times per week in their leisure time when compared to 2003 and 2008

($p<0.05$), whereas no differences were observed in those reporting no physical activity in their leisure-time.

Discussion

The main findings of the present study revealed that cardiorespiratory fitness was lower in 2008 and 2015 compared to 2003, whereas no difference was found between 2008 and 2015. In addition, no clear trends were observed in muscular fitness but all statistical differences examined indicated higher values from 2003 onwards. The present results suggest that the previously observed diminishing and stabilizing decreasing trend in cardiorespiratory fitness in 18-20 years old Finnish young adult men[7] is also supported by findings within the 5-10 years older Finnish men in the present study.

The observed similarity in relative cardiorespiratory fitness and clinically small differences in absolute cardiorespiratory fitness between 2008 and 2015 in the present study is similar to previous findings in younger adult men in Switzerland and in Finland.[7,8] A recent review[15] reported a decrease (-8%) in cardiorespiratory fitness between 1967 and 2016 including over 2.5 million adult participants from eight countries. Furthermore, an average of 17 % decline in cardiorespiratory fitness has been observed in Asian adolescents (9-17 yrs.) between the years 1964-2009.[16] Interestingly, the greatest decline in cardiorespiratory fitness seems to have occurred some decades ago, and the trend for the decline in recent two decades has diminished or even stabilized. Systematic reviews have reported a plateau in cardiorespiratory fitness in children and adolescents after the early 2000s[15,17,18], and the very few studies in young adults show similar trends.[7,8] Interestingly, it was observed in the present study that the level of cardiorespiratory fitness in the highest percentiles was relatively unchanged from 2003, whereas decreases were larger towards the lower percentiles reaching nearly a decrease of 10 % in the lowest percentile. These findings therefore shows that although the majority of the present study sample have lower cardiorespiratory fitness compared to 2003 there exist the highest centile that do not show decreasing trend.

As relative VO_2max includes the effect of body mass, the trends observed in previous studies may partly be due to the trend of increasing body mass and obesity. A recent study in Swedish working aged adults, for example, observed a decline in cardiorespiratory fitness of 7 % in absolute VO_2max and 11% in relative VO_2max from 1995 to 2017.[19] They further reported that the decline in relative cardiorespiratory fitness was explained in part, by a one-third of an increase in body mass. Another study in children and adolescents matched participants by body fat content and observed that changes in body fat may contribute to roughly 29-61 % of the change in cardiorespiratory fitness.[20] In the present study, the age, education, and smoking adjusted results showed that body mass was approximately 3 kg higher in 2008 and 2015 compared to 2003. It seems likely that this difference also contributes to the lower relative VO_2max in 2008 and 2015 compared to 2003. Nevertheless, whether the higher body mass in 2008 and 2015 constitutes of body fat or muscle mass is not known and therefore, limits further speculation. Furthermore, absolute VO_2max, which is not affected of body mass but rather body size, revealed a small linear decreasing trend across the studied years. This could speculatively indicate that the differences in relative VO_2max is not only result of differences in body mass but also directly, related to diminished cardiorespiratory capacity.

In the current literature, temporal trends in muscular fitness are much less studied compared to data on cardiorespiratory fitness, although muscular fitness is also closely linked to health outcomes and physical functioning. In the present study, no clear trends for push-up or sit-up performance were found. Nevertheless, all statistical differences observed in muscular fitness indicated higher values from 2003 onwards. Although, age, education, and smoking adjusted results revealed higher body mass in 2008 and 2015, muscular fitness results were not worse. Speculatively, this could indicate that the higher body mass is at least partly consisting of muscle mass and therefore reflects improved or maintained muscular fitness levels given the strong relationship between muscle mass and muscular fitness.

Collectively, the previous studies about muscular fitness trends in children and adolescents show mostly a decreasing trend, whereas it seems not to be evident in young adults. In Finnish young men aged 18-20 years it has been observed, similar to cardiorespiratory fitness, that the steepest decline has occurred earlier than the recent decades.[6,7] In young Finnish adult men Santtila et al. (2018) observed that the prevalence of individuals with good or excellent muscular fitness index decreased between 1992 and 2000 and plateaued thereafter.[7] Nevertheless, the mean values in each specific muscle fitness tests were not decreased from 2005 to 2015 similar to the present study.[7] In addition, Wyss et al. (2018) observed no change in the mean values of either lower or upper body muscular fitness during 2006-2015 in young adult Swiss men, however, trunk muscle strength improved over the study period.[8]

Interestingly, in the present study the relative difference in muscular endurance from 2003 was rather similar in the highest percentiles in 2008 and 2015, which all were at higher level compared to 2003. The lowest percentiles were higher in 2008, whereas also lower values were observed in the lowest percentiles in sit-ups in 2015. These findings indicate, for the most part, an increase in muscular endurance performance across all muscular fitness levels, with the exception of sit-up performance in 2015 compared to 2003. Therefore no clear signs of polarization exists in muscular endurance

A majority of the studies monitoring muscular fitness trends over time have focused on children. Most of these studies show a decreasing trend in muscular fitness[10-11,21-23], although, similar to the present study findings, no changes have also been observed[24-25], while one study reported an increase[26]. Furthermore, the mean sit-up results were 37 reps/min for 18-20 years Finnish men[7] and 34-38 repetitions in present 5-10 years older study sample. Similarly, the mean push-up performance varied between 31-33 reps./min in the study by Santtila et al.[7], whereas the range of mean values was

24-29 in the present study. This indicates that muscular endurance performance may decrease already during young adulthood.

Physical activity behavior is associated with physical fitness and body composition and therefore, the results of the LTPA in the present study offer interesting possible underlying factors to explain the differences observed in BMI and physical fitness variables. The current study observed a higher engagement to vigorous LTPA of at least 4 times per week in 2008 and 2015 compared to 2003. Furthermore, there was a clear difference (10 % -units) between 2008 and 2015. While increase in LTPA was not reflected as improved physical fitness or BMI in the present study, it can be speculated that increase in LTPA has occurred in such sport disciplines, which stimulate the cardiovascular system to a lesser extent. On the other hand, as we were not able to study differences in other PA domains, such as commuting and occupational PA it may also be that the total PA including all PA domains has not decreased. In line with this speculation are the results among a population-based sample of adults between 1982-2012, where LTPA has increased and commuting as well as occupational physical activity have decreased during the past decades with no change in total physical activity level.[28] Interestingly, the proportion of those who reported no LTPA was constant over the studied years and in the present study indicating a proportion of approximately 10 % of individuals are physically inactive in their leisure-time. The previous self-reported physical activity surveillances have indicated for the most part an increase in leisure-time physical activity in Finland[27], Denmark[29], Spain[30] and in Canada[31].

In the present study, the age, education, and smoking adjusted results showed that the body mass and BMI were higher in 2008 and 2015 compared to 2003. As discussed earlier, the content of the higher body mass could therefore, in part, be muscle mass. Recently, a large meta-analysis[32] reported 47 % and 28 % increases in prevalence of overweight and obesity during 1980-2013 worldwide in children and adults, respectively. Furthermore, a previous study in young adult Swiss men showed an increase in BMI by 2% during 2006-2010, after which it remained stable until 2015.[8] In Finland, BMI has been rather stable in approximately 19-year old young men during 2005-2015.[7] The differences between the present and earlier Finnish study may be caused by the older age of the participants in the present study. Nevertheless, we did not observe differences in the proportion of individuals with overweight or obesity across the studied years in the current study.

Strengths and limitations

The strengths of the present study that covers a more than 10-year time period includes the targeted study samples of young adult men, who often are a hard-to-reach group in research. The present study included measures of both cardiorespiratory fitness and muscular fitness. The latter has been studied much less in terms of temporal trends. Furthermore, all of the physical fitness tests were performed until exhaustion, which is more reliable compared to e.g. sub-maximal tests. Moreover, physical activity assessment and body composition variables were assessed, which enabled us to also describe possible underlying factors related to physical fitness trends. Nevertheless, the present study has some limitations. Because of the cross-sectional study samples from three different years, confounding factors may be present. We attempted to control for confounding factors, which included education, smoking, and age. Nevertheless, some residual confounding factors may still be present as in all observational studies. To our observation and discussion with participants, they were motivated to physical fitness tests, however, a limitation of the study includes that no objective measure of motivation or rate of perceived exertion assessment was used. We assessed only leisure-time physical activity at all time points, thus with regard overall physical activity levels our results are not conclusive (occupational and commuting physical activity were not assessed). Furthermore, assessment of sedentary behavior would have added more information on the continuum of physical activity, which is associated with body composition and physical fitness.

Perspective

The present study revealed that cardiorespiratory fitness was lower in 2008 and 2015 compared to 2003, whereas no difference was found between 2008 and 2015. No clear trends were observed in muscular fitness, however, the lowest values were noticed in 2003. The present study findings are in line and confirmatory to the findings of previous very few studies in 5-10 years younger adult men in Finland and Switzerland.[5,6] Based on the present study and the previous study findings[7,8] it seems that the decreasing trend in physical fitness is diminishing during the recent decades and interestingly, the greatest decline in cardiorespiratory fitness seems to have occurred some decades ago. [6,15,19] Similar diminishing decreased trends have also been observed in children during the last two decades.[5]

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Table 1. The group comparisons between the years 2003, 2008 and 2015 (mean + SD or %) (95% CI).

	2003	**2008**	**2015**
Demographic variables			
Age (yrs.)	28.1±2.8 (27.9-28.3)	24.2±2.9 (24.0-24.5) ***	24.5±3.6 (24.2-24.7) ***
Smokers (%)	36.4 (322)	39.2 (314)	26.8 (181) *** ≠≠≠
Years of education $p<0.001$			
9 years or less (%)	4.9	2.6 *	3.1
10-12 years (%)	35.4	34.4	36.4
13-15 years (%)	29.6	40.5 ***	42.2 ***
> 15 years (%)	30.1	22.5 ***	18.2 *** ≠
Physical Performance			
Relative maximal oxygen uptake (ml/kg/min)	42.8±7.2 (42.3-43.4)	41.6±8.1 (41.0-42.1) ***	41.2±7.9 (40.6-41.8)***
Absolute maximal oxygen uptake (L/min)	3.40±0.54 (3.36-3.44)	3.28±0.58 (3.24-3.33) ***	3.26±0.58 (3.21-3.30) ***
Sit-ups (reps/min)	34±10 (33-35)	38±10 (37-39) ***	35±12 (35-36) * ≠≠≠
Sit-ups (reps/min / body mass)	0.44±0.15 (0.43-0.45)	0.49±0.16 (0.48-0.51) ***	0.46±0.18 (0.45-0.47)* ≠≠≠
Push-ups (reps/min)	24±11 (23-25)	29±13 (28-30) ***	28±14 (27-29) ***
Push-ups (reps/min / body mass)	0.31±0.16 (0.30-0.32)	0.38±0.19 (0.36-0.39) ***	0.37±0.20 (0.36-0.39) ***
Leisure-time physical activity $p<0.001$			
I: No physical activity (%)	14.6	13.2	12.1
II: No vigorous, some moderate (%)	25.7	19.1 ***	17.8 ***
III: Vigorous 1 x week (%)	13.0	19.1 ***	9.6 * ≠≠≠
IV: Vigorous 2 x week (%)	19.8	19.5	19.9

V: Vigorous 3 x week (%)	18.2	17.3	19.0
VI: Vigorous ≥ 4 x week (%)	8.6	11.8 *	21.6 *** ≠≠≠
Low (I-II) (%)	42.3	32.3 ***	29.9 ***
Moderate (III-IV) (%)	32.8	38.5 *	29.5 ≠≠≠
High (V-VI) (%)	26.8	29.2	40.6 *** ≠≠≠
Body Composition			
Height (cm)	179.1±6.5 (178.6-179.5)	180.2±6.3 (179.7-180.6) ***	179.4±6.5 (178.9-179.9)≠
Body mass (kg)	80.8±13.5 (79.8-81.7)	80.5±13.5 (79.5-81.4)	80.5±15.1 (79.4-81.5)
Body mass index	25.2±3.8 (24.9-25.4)	24.7±3.8 (24.5-25.0) *	24.9±4.1 (24.6-25.2)
Underweight (<18.5) (%)	1.5	1.4	2.2
Normal weight (18.5-24.99) (%)	53.1	58.5 *	55.0
Overweight (25-29.99) (%)	34.2	31.4	30.9
Obese (>30) (%)	11.2	8.8	11.8

*** p<0.001 compared to 2003, * p<0.05 compared to 2003
≠ ≠ ≠ p<0.001 compared to 2008, ≠ p<0.05 compared to 2008

Table 2. The group comparisons between the years 2003, 2008 and 2015 (mean + s.e.) (95% CI) in body composition, physical activity and physical fitness adjusted for age, smoking and education.

	2003	**2008**	**2015**
Physical Performance			
Relative maximal oxygen uptake (ml/kg/min)	43.5±0.29 (42.9-44.1)	41.3±0.29 (40.7-41.9) ***	40.6± 0.30 (40.0-41.2) ***
Absolute maximal oxygen uptake (L/min)	3.37±0.02 (3.33-3.41)	3.32±0.02 (3.28-3.36)	3.26±0.02 (3.21-3.30) ≠ ***
Sit-ups (reps/min)	35±10 (34-36)	38±10 (37-39) ***	35± 12 (34-36) ≠ ≠ ≠
Sit-ups (reps/min / body mass)	0.46±0.01 (0.45-0.47)	0.48±0.01 (0.47-0.50) *	0.45±0.01 (0.43-0.46) ≠ ≠ ≠
Push-ups (reps/min)	24±1 (23-25)	29±1 (28-30) ***	28±1 (27-29) ***
Push-ups (reps/min /body mass)	0.32±0.01 (0.30-0.33)	0.37±0.01 (0.36-0.39) ***	0.37±0.01 (0.35-0.38) ***
Body Composition			
Height (cm)	179.0±0.2 (178.5-179.5)	180.2±0.2 (179.8-180.7) ***	179.5±0.3 (179.0-180.0) ≠
Body mass (kg)	78.6±0.5 (77.6-79.7)	81.8±0.5 (80.8-82.8) ***	81.7±0.6 (80.6-82.7) ***
Body mass index	24.5± 0.15 (24.3-24.8)	25.1±0.14 (24.9-25.4) **	25.3±0.15 (25.0-25.6) ***

*** p<0.001 compared to 2003, ** p<0.005 compared to 2003, * p<0.05 compared to 2003
≠ ≠ ≠ p<0.001 compared to 2008, ≠ p<0.05 compared to 2008

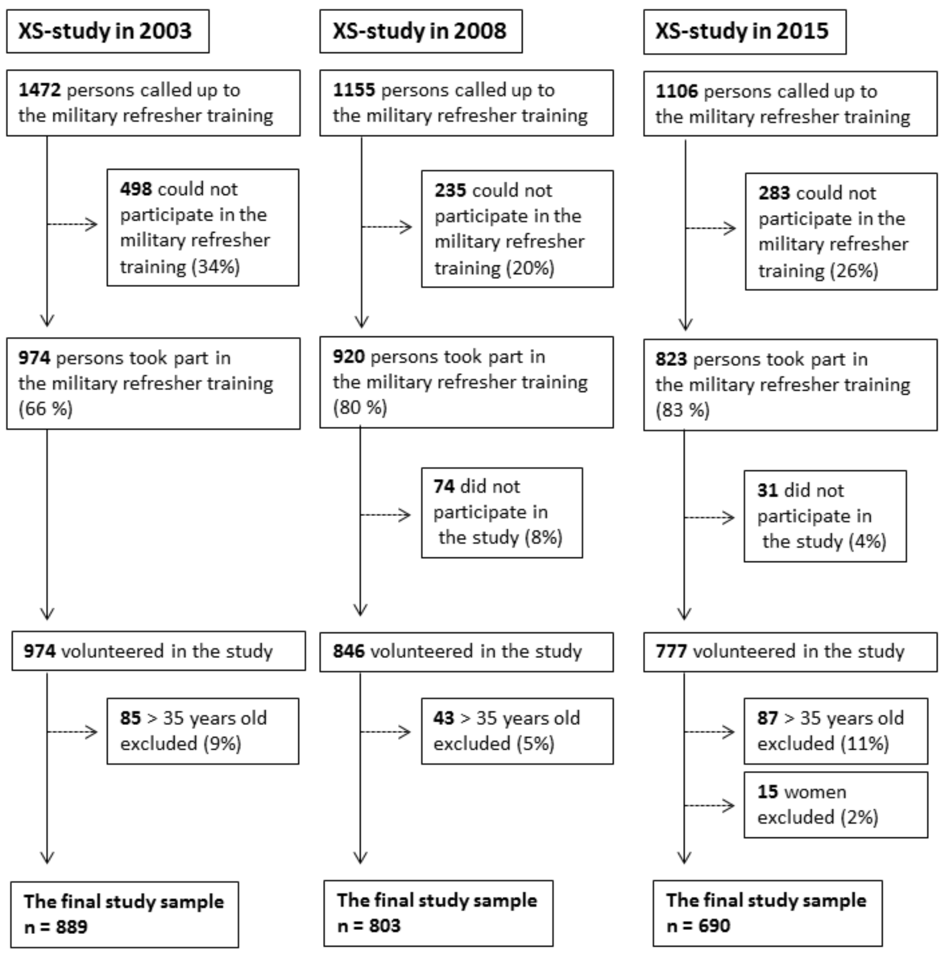
Table 3. 10th, 25th, median, 75th and 90th percentiles for physical fitness indices in 2003, 2008 and 2015 [relative difference (Δ%) compared to 2003 values].

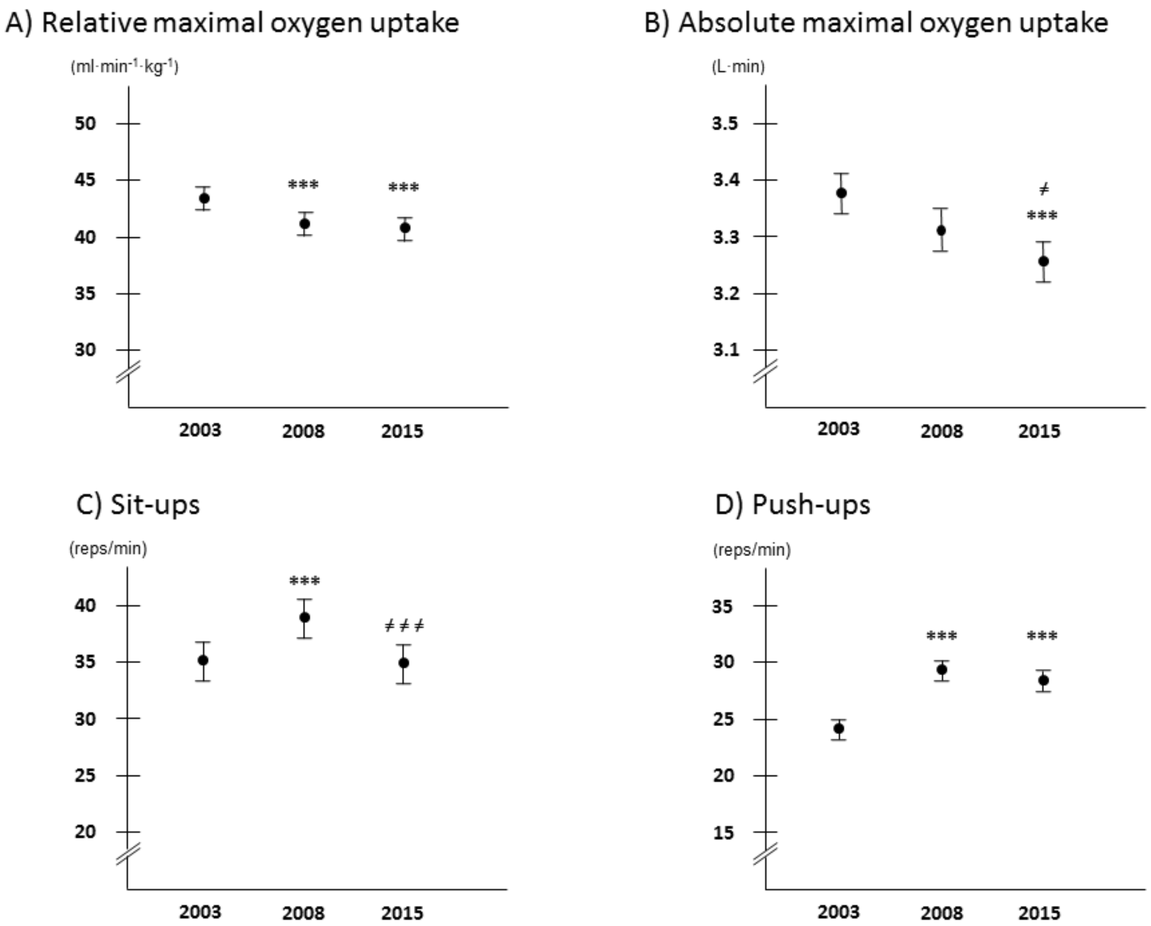
	2003	2008	2015
Relative maximal oxygen uptake (ml/kg/min)			
lowest 10th percentile	33.8	31.4 (–7%)	30.8 (–9%)
lowest 25th percentile	37.7	36.0 (–5%)	35.7 (–5%)
Median	42.6	41.1 (–4%)	41.3 (–3%)
Highest 25th percentile	47.6	46.9 (–2%)	46.1 (–3%)
Highest 10th percentile	52.1	52.2 (0%)	51.7 (–1%)
Absolute maximal oxygen uptake (L/min)			
lowest 10th percentile	2.71	2.53 (–7%)	2.50 (–8%)
lowest 25th percentile	3.02	2.85 (–6%)	2.86 (–5%)
Median	3.35	3.25 (–3%)	3.23 (–4%)
Highest 25th percentile	3.76	3.69 (–2%)	3.68 (–2%)
Highest 10th percentile	4.13	4.05 (–2%)	4.01 (–3%)
Push-ups (reps/min)			
lowest 10th percentile	10	13 (+30%)	11 (+10%)
lowest 25th percentile	16	19 (+19%)	18 (+13%)
Median	23	27 (+17%)	28 (+22%)
Highest 25th percentile	31	37 (+19%)	37 (+19%)
Highest 10th percentile	40	46 (+15%)	47 (+18%)
Sit-ups (reps/min)			
lowest 10th percentile	22	25 (+14%)	20 (–9%)
lowest 25th percentile	28	31 (+11%)	27 (–4%)
Median	34	39 (+15%)	36 (+6%)
Highest 25th percentile	40	45 (+13%)	44 (+10%)
Highest 10th percentile	47	51 (+9%)	50 (+6%)

Figure 1. Flow chart of the participants.

Figure 2. The group comparisons between the years 2003, 2008 and 2015 (mean + 95% CI) in physical fitness adjusted for age, smoking and education.

Figure 3. The group comparisons between the years 2003, 2008 and 2015 (mean + 95% CI) in BMI adjusted for age, smoking and education.




A) Relative maximal oxygen uptake
(ml·min-1·kg-1)
50
45
40
35
30
2003
2008
2015
***
***
B) Absolute maximal oxygen uptake
(L·min)
3.5
3.4
3.3
3.2
3.1
2003
2008
2015
≠
***
C) Sit-ups
(reps/min)
40
35
30
25
20
2003
2008
2015
***
≠≠≠
D) Push-ups
(reps/min)
35
30
25
20
15
2003
2008
2015
***
***

Body mass index