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Physical Fitness in Young Men Between 1975-2015 with a Focus on the Years 2005-2015

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Abstract

Purpose. The purpose of the present study was to investigate changes in physical fitness and anthropometry of young men entering the military service in Finland during the years 1975-2015. **Methods.** The study included the fitness test results of 627,142 healthy young male conscripts (age 19.1 ± 0.4 yrs.). Data included results of aerobic capacity, muscle fitness tests, and anthropometric characteristics. **Results.** The results show that the increase in mean body mass of young men has slowed down during the last ten years. However, the total increase in body mass was 6.8 kg (8.8%, $p\leq 0.001$) between 1993 and 2015. The mean distance achieved in the 12-minute running test decreased by 337 meters (12.2%, $p\leq 0.001$) between the peak in 1980 and 2015. The relative number of conscripts who ran less than 2200 meters increased from 3.6% to 25.9% ($p\leq 0.001$) between 1980 and 2015, and the proportion who ran more than 3000 meters decreased from 25.1% to 6.5% ($p\leq 0.001$). The relative number of conscripts who achieved an excellent or good muscle fitness index (MFI) decreased from 66.8% to 40.1% ($p\leq 0.001$) between 1992 and 2000, and remained unchanged between 2000 and 2010. However, the proportion who achieved a poor MFI increased from 8.1% to 31.4% ($p\leq 0.001$) between 1992 and 2010. **Discussion.** The present study shows that the increase in mean body mass of young male conscripts has slowed down during the last ten years. However, their aerobic capacity has still decreased during recent decades. In addition, the proportion of conscripts with poor muscle fitness has increased. From the national defense and health perspective, more initiatives are needed to encourage young men to increase their level of daily physical activity in order to be fit and ready for operations.

Keywords: Aerobic capacity, muscle fitness, body weight, body mass, BMI

1 INTRODUCTION

2 Regular physical activity, including training of aerobic capacity and muscle fitness, enhances
3 physical performance, well-being and functional capacity. All of the above-mentioned factors are
4 associated with a better quality of life, lower mortality, and lower risk of developing lifestyle-
5 related diseases (1, 2, 3). Several studies have demonstrated that across all age groups, the level of
6 daily physical activity is too low to even maintain health and physical fitness (2, 3, 4). Alarminglly,
7 a sedentary lifestyle combined with a lot of daily sitting time, especially TV-viewing, increases the
8 risk of premature death (2). Furthermore, inactivity has become an even bigger threat to human
9 health than obesity and smoking (4).

10

11 Inactivity seems to have a negative impact on the physical fitness of young soldiers. Santtila et al.
12 (5) reported that aerobic and muscle fitness of 20-year old men decreased and body mass increased
13 between 1975 and 2004 in Finland. This trend has also been observed in Norway, where researchers
14 found that the maximal oxygen uptake of conscripts entering military service decreased and the
15 proportion who were overweight increased between 1980 and 2002 (6). The same phenomena have
16 been observed in other Nordic Countries and in Germany (7, 8, 9). In addition, Tomczak et al. (10)
17 reported that the average time on the 1000 meter running test increased and pull-up performance
18 decreased in Polish Army recruits enrolled between 1971 and 2007.

19

20 Interestingly, some contradictory findings exist. For example, Sharp et al. (11) did not observe any
21 dramatic changes in the physical fitness of U.S. Army recruits between 1978 and 1998. However,
22 they found some increases in body mass, body fat%, fat free mass and muscle strength of the
23 recruits, but no changes in aerobic capacity. Some years later, Knapik et al. (12) reported slower
24 running test times, indicating a decline in aerobic fitness of recruits between 1987 and 2003.
25 However, they did not observe any changes in maximal oxygen uptake between 1975 and 1998.
26 Recently, Knapik et al. (13) reported that body weight increased, endurance performance declined
27 and muscle fitness remained unaltered or even increased in U.S. Army recruits between 1975 and
28 2013. Furthermore, Fain et al. (14) reported that grip strength of young U.S. men was lower than in
29 men of the same age 30 years previously. It should be kept in mind, however, that a comparison
30 between conscripts in compulsory military service and recruits in professional armies is not
31 appropriate because recruits from professional armies do not represent the general population of a

32 given age group. In general, there seems to be a lack of research concerning the physical fitness
33 development of adolescents during the last ten years.

34

35 It is well known that military training and operations are mentally and physically very demanding,
36 consisting of **tasks** like lifting or carrying heavy loads, digging and shoveling, climbing obstacles
37 and sprinting, which necessitates a high level of physical fitness (15). General conscription service
38 is still a foundation of the national defence in Finland. Annually, approximately 25,000 young men,
39 which is about 70% of the age group, perform military service. The present study is a follow-up
40 study related to the report of Santtila et al. (5), representing a population-based sample of Finnish
41 men at the age of 20. The purpose of the present study was to investigate the secular changes in
42 physical fitness and body anthropometry of young men entering compulsory military service in
43 Finland between 1975 and 2015. The particular focus of the present study was the period between
44 2005 and 2015. Aerobic capacity data were collected between 1975 and 2015, muscle fitness data
45 between 1982 and 2015, and body composition data between 1993 and 2015 among Finnish
46 conscripts. Based on earlier trends of aerobic fitness of conscripts, we also computed future
47 predictions of aerobic fitness levels up until the year 2030.

48

49 **METHODS**

50 Sample and data collection. The present dataset consisted of the fitness test results of 627,142
51 healthy young male conscripts. Mean (\pm SD) age of the whole subject group was 19.1 ± 0.4 yrs. Data
52 for aerobic capacity and muscle fitness included 627,142 and 513,067 test results, respectively. The
53 present data were annually collected from all military units around Finland. The fitness tests were
54 conducted by local educated fitness officers during the first two weeks of military service. After the
55 tests, fitness officers imported the results to the data system according to the standards determined
56 by the Training Division of the Defence Command. During the years of 1975-2004, the data were
57 reported only by weighted means normalized to the number of subjects in each unit, the mean of
58 units, and by the number of soldiers who were classified as poor-to-excellent. Thereafter, data
59 archived to the database in the Training Division of Defence Staff. The database system was not the
60 same during the entire study period. Therefore, the sample size of measured variables varied
61 between years. Individual data were available between 2005 and 2015.

62

63 Aerobic capacity data (n = 627,142) were collected between 1975 and 2015. Muscle fitness index
64 (MFI) data (n= 513,067) were collected between 1982 and 2010. Detailed information concerning
65 the sample size of aerobic capacity and muscle fitness tests and body anthropometry between 1975
66 and 2004 have been published by Santtila et al. (5). The sample size of aerobic capacity test varied
67 from 18,876 to 24,268 between 2005 and 2015. A sample size of MFI varied from 21,533 to 25,020
68 between 2005 and 2010. MFI data from 2011 to 2015 are not reported in the present study, as the
69 testing protocol changed significantly in 2011. Body mass and height data were collected between
70 1993 and 2015, and sample size varied from 7507 to 27037. Individual data including body mass
71 and height, body mass index (BMI), and results from the aerobic test and single muscle fitness tests
72 were collected between 2005 and 2015.

73

74 The conscripts gave their written informed consent to participate in military service, including the
75 present tests, after a physical examination by medical doctors. Fitness tests are an essential part of
76 military training. Safety instructions were given to conscripts before each fitness test, and they were
77 advised of their right to voluntarily interruption the test at any time. The test termination criteria
78 included the following indications: onset of angina-like symptoms, shortness of breath, wheezing,
79 leg cramps, claudication, light-headedness, confusion, or nausea according to the Fitness Test
80 Manual of the Finnish Defence Forces (16). All subjects were fully informed of the procedures and
81 possible risks associated with the fitness tests. This study was conducted according to the 1975
82 declaration of Helsinki.

83

84 Measurements. Anthropometric measurements were performed by a physician during the medical
85 check at the beginning of military service. The conscripts were barefoot and wore shorts during the
86 measurements. Body mass was measured using commercial scales to nearest 100 g. Height was
87 measured in a standing position using a tape measure with an accuracy of 5 mm. Thereafter, body
88 mass index (BMI) was calculated.

89

90 All physical fitness tests, protocols and techniques were standardized according to the Fitness Test
91 Manual of the Finnish Defence, which has been regularly updated since 1975. The tests were
92 supervised and demonstrated by educated instructors. Endurance capacity of the conscripts was
93 assessed using the 12-min running test (17). Tests were conducted on outdoor tracks during summer
94 and on indoor circular tracks during winter. Conscripts were encouraged to run with maximal effort

95 at a progressively increasing running speed. The test results were recorded with an accuracy of 10
96 meters.

97

98 Muscle fitness tests consisted of five tests as follows: sit-ups and back for trunk and hip-flexor
99 muscles; push-ups and pull-ups for the upper extremities; and standing long jump for the lower
100 extremities. Results from sit-ups, back raises and push-ups were recorded as the number of
101 repetitions completed in 60 s. The result for pull-ups was recorded as the number of continuous
102 repetitions completed without a time limit. The result for standing long jump was expressed in
103 meters from the longest jump of three trials, measured from the starting line to the landing point.
104 The conscripts were advised to have at least a 5-minute recovery time between the tests. The results
105 of each muscle fitness test were categorized from 0 (poor) to 3 (excellent). Thereafter, the sum of
106 five muscle fitness test results formed the muscle fitness index (MFI). Detailed information about
107 the muscle fitness tests and an MFI scoring table have been published by Santtila et al. (5).

108

109 Statistical analysis. Data are presented as means of the weighted means between 1975 and 2015,
110 and with standard deviations (\pm SD) from 2005 onwards. The analyses between 2005 and 2015 are
111 based on values from individual conscripts. Logistic regressions were utilized when assessing the
112 “good” or “poor” level as a function of year, with the first study year used as a reference.
113 Regression analyses with linear or exponential fits were used for continuous variables and future
114 predictions with three different prediction time spans. In addition, simple contrasts were used, to see
115 if there was a change from the first year. Yearly averages of continuous variables were compared
116 using ANOVA with Tukey Post Hoc test, when appropriate. Pearson correlation coefficients were
117 calculated to find associations between the yearly means of the measured parameters. P-values less
118 than 0.05 were defined as significant.

119

120 **RESULTS**

121 Body anthropometry. The mean (\pm SD) body mass of the conscripts increased by **6.8 kg** (8.8%,
122 $p \leq 0.001$) from 1992 to 2015. At the same time the mean height increased by **1.5 cm** ($p \leq 0.001$;
123 Figure 1). Mean body mass remained unchanged between 2005 and 2015 (Table 1). Mean BMI
124 values and the proportion of conscripts who were overweight and obese varied between 2005 and
125 2015 (Figure 2). During 2009 and 2013-2015, the proportions of overweight ($p \leq 0.001$) and obese
126 ($p \leq 0.001$) conscripts were higher compared to 2005.

127 Aerobic capacity. The mean running distance achieved in the 12-minute running test improved
128 between 1975 and 1979 (detailed results presented in Santtila et al. (5). Thereafter, the mean
129 distance decreased by 337 meters (12.2%, $p \leq 0.001$) between 1980 and 2015 (Figure 3). During the
130 years 2005-2015, the mean running distance decreased by 75 meters (3.1%, $p \leq 0.001$). The running
131 test results from 2005 to 2015 are presented in Table 1. The relative number of conscripts who ran
132 less than 2200 meters (poor fitness class) increased from 3.6% to 25.9% ($p \leq 0.001$) between 1980
133 and 2015. At the same time (1979-2015), the proportion of conscripts who ran more than 3000
134 meters (excellent fitness class) decreased from 25.1% to 6.5% ($p \leq 0.001$).

135

136 Muscle fitness. The relative number of conscripts who achieved an excellent or good MFI increased
137 from 56.2% to 66.8% ($p \leq 0.001$) between 1982 and 1992, followed by a decrease to 40.1%
138 ($p \leq 0.001$) between 1992 and 2000. Between 2000 and 2010, the relative number of conscripts who
139 achieved an excellent or good MFI remained unchanged, varying between 40.1% and 45.2%
140 (Figure 4). The relative number of conscripts who achieved a poor MFI decreased from 16.5% to
141 8.1% ($p \leq 0.001$) between 1982 and 1992, and then increased to 31.4% ($p \leq 0.001$) between 1992 and
142 2010.

143

144 The mean muscle fitness test results for standing long jump, sit-ups and push-ups during the years
145 2005-2015 are presented in Table 1. No changes were observed in the mean values of the muscle
146 fitness test results except for the standing long jump, which improved ($p \leq 0.001$) during the years
147 2013-2015 compared to 2005-2012.

148

149 Associations and predictions. Body mass was inversely associated with 12-minute running test
150 distance ($r = -0.85$, $p \leq 0.001$), running test class ($r = -0.80$, $p \leq 0.001$), and MFI class ($r = -0.65$, $p \leq 0.01$).
151 BMI correlated inversely with mean 12-minute running test distance ($r = -0.38$, $p \leq 0.001$) and with
152 MFI ($r = -0.28$, $p \leq 0.001$). Excellent/good class in MFI correlated inversely with mean 12-minute
153 running test distance ($r = -0.64$, $p \leq 0.05$), whereas poor class in MFI correlated with a poor result on
154 the 12-minute running test ($r = 0.85$, $p \leq 0.01$).

155

156 Predictions based on the mean values in the 12-minute running tests suggest that the aerobic
157 capacity of conscripts will decrease between 2015 and 2030 (Figure 5). A shorter term prediction

158 model (2000-2015) led to a less steep angle of decline in running test results compared to longer
159 term prediction (1975-2015). Based on the trend for 2000-2015, the mean running test values are
160 predicted to decrease from 2480 to 2398 m by the year 2030. Based on the trend for 1975-2015, the
161 mean values will decrease from 2667 to 2261 m by the year 2030.

162

163 **DISCUSSION**

164 The present study demonstrates that the mean body mass of young men (conscripts) entering
165 Finnish military service has increased and aerobic capacity has decreased during the last 20-35
166 years. In addition, the proportion of conscripts classified as having poor aerobic and muscle fitness
167 has linearly increased up to 2015. Mean body mass increased by almost 7 kg between 1993 and
168 2015. Importantly, no significant changes in mean body mass were observed between 2005 and
169 2015, indicating a plateau in the long-term negative development of body mass in young men. The
170 findings of the present study regarding body mass are in line with those of the FINRISK 2012
171 study, which reported that Finland is one of the first countries to observe a flattening of the trend
172 towards an increasing proportion of overweight adults during the years 2007-2012 (18). However,
173 at the global level, the obesity trend is still increasing (19).

174

175 Aerobic capacity of Finnish conscripts has dramatically decreased since 1980. During this time, the
176 relative number of conscripts with excellent aerobic fitness has decreased four-fold, with a
177 concurrent seven-fold increase in the proportion of conscripts classified as having poor aerobic
178 fitness. Furthermore, according to the prediction analysis performed in this study, aerobic fitness is
179 expected to continue to decline in the future. However, our prediction based on extrapolating
180 existing regression lines contains uncertainty, although it is known that the overweight and obesity
181 epidemic of children and adolescents in Finland has not shown any improvements. Poor aerobic
182 capacity was associated with higher body mass, BMI and lower muscle fitness based on yearly
183 means of the measured parameters. Outside of Finland, declining physical fitness of military
184 recruits/conscripts also seems to be a challenge, especially in Europe (5, 6, 7, 10).

185

186 One of the reasons for the decline in aerobic capacity might be an increase in physical inactivity
187 combined with a sedentary lifestyle. Kyröläinen et al. (20) reported that levels of physical inactivity
188 have increased, especially among young girls and boys between the ages of 15 and 21, which
189 coincides with the mean age of the conscripts in the present study. In addition, Liukkonen et al. (21)

190 recently reported that objectively measured sedentary time (11-15 years) was very high among
191 Finnish school-aged children, varying between 5 and 9 hours a day. At the same time, only 24% of
192 children met the 60-min minimal recommendation for daily physical activity. Husu et al. (22) also
193 reported that 7-14 year old school children spent on average 54% of their waking hours mainly
194 sitting, which is consistent with the findings of Tammelin et al. (23), who also found that TV
195 viewing time of adolescents has generally exceeded the recommendation of no more than two hours
196 per day. In addition, only 23% of boys and 10% of girls met the minimal requirements for daily
197 physical activity, which was at least one hour per day (23). Based on these findings, it seems likely
198 that the decreasing aerobic fitness of young men is a consequence of an increasingly sedentary
199 lifestyle before entering military service.

200

201 The relative number of conscripts with an excellent or good MFI decreased by 26% between 1992
202 and 2000. However, no significant changes were observed in MFI between 2000 and 2015.
203 Concurrently, the relative number of conscripts with a poor MFI increased by almost four-fold. On
204 the other hand, no changes were in the mean values of the individual muscle fitness test results
205 between 2005 and 2015, except for improved standing long jump performance during the last three
206 years. This indicates a plateau in muscle fitness of conscripts during the last ten years. Military
207 tasks typically consist of carrying and lifting heavy loads, which necessitate an adequate level of
208 muscle fitness. A good level of muscle fitness and higher fat free mass have been shown to correlate
209 with better success in military training and operations (15).

210

211 Declining physical fitness of the conscripts entering military service is a challenge for the Finnish
212 Defence Forces. In particular, it is difficult to select training methods to maximize the capability of
213 soldiers in various military duties. There is also an increasing trend of premature discharge from
214 military service for reasons such as being overweight and incurring musculoskeletal injuries (24). In
215 the present study, 20% of conscripts entering military service between 1982 and 2015 had poor
216 levels of aerobic and muscle fitness. Taanila et al. (25) found that low physical fitness and being
217 overweight were risk factors for musculoskeletal injuries. In addition, Larsson et al. (26) found that
218 the same factors also increased the risk of premature discharge from military service. The authors of
219 both studies suggested pre-training programs for recruits to improve their physical fitness before
220 entering military service. Taanila et al. (25) also reported that muscle endurance exercises 2-3 times
221 a week at the beginning of military service decreased the incidence of low back pain symptoms and
222 lower body injuries in conscripts.

223 Decreasing aerobic fitness and increasing obesity in early age can also be harmful to national health
224 and the associated budget. A low level of aerobic fitness is known to be associated with a higher
225 risk of cardiovascular diseases, premature mortality and various cancers (27). Thus, a 12 %
226 decrease in aerobic fitness in Finnish young men could increase the incidence of cardiovascular
227 diseases and even mortality (28). Compulsory military service represents an excellent opportunity
228 to raise awareness, and to appeal to young men to improve their physical fitness, body composition
229 and even health-related behavior. Santtila et al. (29) observed that previously inactive conscripts
230 achieved the greatest improvements (19%) in VO₂max after 8-weeks of basic training. Accordingly,
231 the difference in mean VO₂max values between previously active and inactive conscripts decreased
232 in comparison to the pre-training values. Mikkola et al. (30) found positive changes in body
233 composition of conscripts, which were also associated with improved aerobic fitness. In addition,
234 these positive results were more pronounced among unfit and overweight conscripts. Therefore, the
235 authors suggested that military service may have positive health effects at the population level, such
236 as reduced incidence of overweight and morbidity. These beneficial health and physical
237 performance related findings could also be used in communication or marketing to improve the
238 intrinsic motivation of call-up age, especially those with higher body mass and lower levels of
239 physical fitness.

240

241 The present study demonstrated population level changes in physical fitness of young Finnish men
242 between 1975 and 2015. The sample sizes were representative during most of the reported years.
243 However, large variation in the sample sizes between the years can be seen as a weakness of the
244 present study.

245

246 **CONCLUSION**

247 The present study demonstrates that the mean body mass of young men entering Finnish military
248 service has increased significantly since the early 1990's, although this trend has slowed during the
249 last 10 years. At the same time, aerobic capacity has dramatically declined. In addition, the relative
250 number of conscripts with poor aerobic and muscle fitness has still increased, whereby one in four
251 young men have poor fitness levels at the beginning of military service. Decreasing physical fitness
252 may be a big challenge for the military readiness of the Finnish Defence Forces. Physical training of
253 conscripts before entering military service may be one possible solution. In addition, from the

254 national health perspective, more initiatives are needed to encourage adolescents to increase their
255 levels of daily physical activity, and improve their health awareness.

256

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260

261 **Conflict of Interest**

262 There are no conflicts of interest, financially or otherwise, among any of the authors of this article.
263 The results of the study are presented clearly, honestly, and without fabrication, falsification, or
264 inappropriate data manipulation. All authors contributed to the formulation of the idea of the
265 present study and contributed significantly to the writing of, and also approved, the final article. The
266 results of the present study do not constitute endorsement by the ACSM.

267

268

269

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Figure legends

Figure 1. Mean body mass (left y-axis, solid black line) and height (right y-axis, dashed line) of the conscripts during the years 1993-2015.

Figure 2. The relative distribution of BMI values between 2005 and 2015, categorized as follows: overweight 25.01-30.00 and obese > 30.00. Bars marked with asterisks (**overweight and obese together**) differ significantly from all those without asterisks (*. $p \leq 0.01$).

Figure 3. Mean values from the 12-minute running tests (black solid line). The dashed line with black squares represents the relative distribution of excellent results. The dashed line with black dots represents those with poor results. All values were compared to the results from 1975.

Figure 4. The distribution of MFI results during the years 1982–2010. The solid black line represents excellent and good results combined. The dashed line with dots represents poor results.

Figure 5. Predicted 12-minute running test results for the years 2015-2030. The black solid line represents the measured mean values of the 12-minute running tests between 1975 and 2015. The longer dashed line represents predicted 12-minute running test distance based on results between 1975 and 2015, whereas the shorter dashed line represents a prediction based only on the data from 2000 to 2015.

Year	Body mass (kg)	Running distance (m)	Standing long jump (cm)	Sit-ups (reps/min)	Push-ups (reps/min)
2005	76±13	2493±368	217±25	37±11	31±13
2006	77±14	2486±371	216±25	37±11	31±13
2007	77±13	2464±367*	216±25	37±11	31±13
2008	77±13	2463±362*	216±25	37±11	31±13
2009	77±13	2474±358*	217±25	37±11	32±13
2010	77±13	2475±365*	217±26	37±11	32±14
2011	77±13	2467±360*	217±26	37±11	32±14
2012	77±13	2450±365*	219±27	37±11	33±14
2013	77±13	2440±362*	221±28*	37±11	33±14
2014	78±14	2428±369*	221±28*	37±11	33±15
2015	77±14	2418±369*	222±28*	37±11	32±14

Table 1. Mean (\pm SD) muscle fitness test results between 2005 and 2015 (sample size, n, varied between 19,371 and 23,355; *, $p \leq 0.01$).

Figure 1.

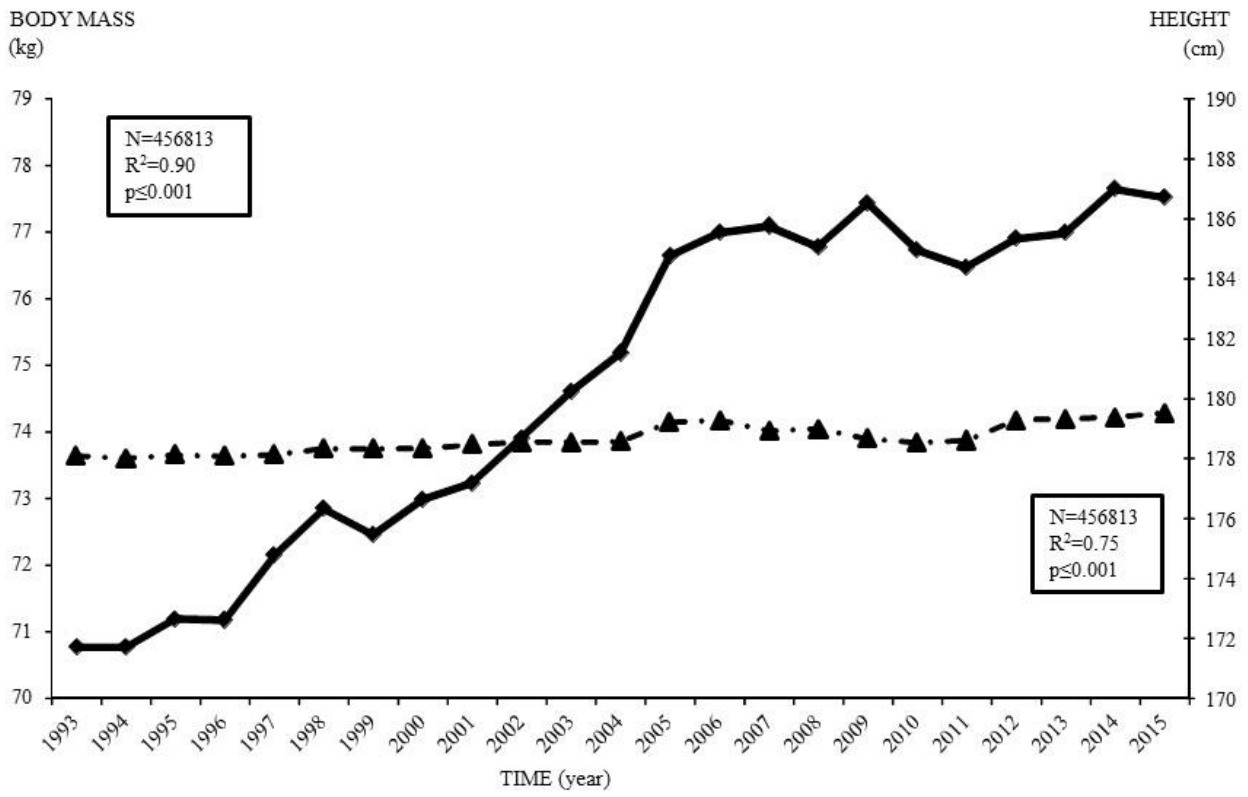


Figure 2.

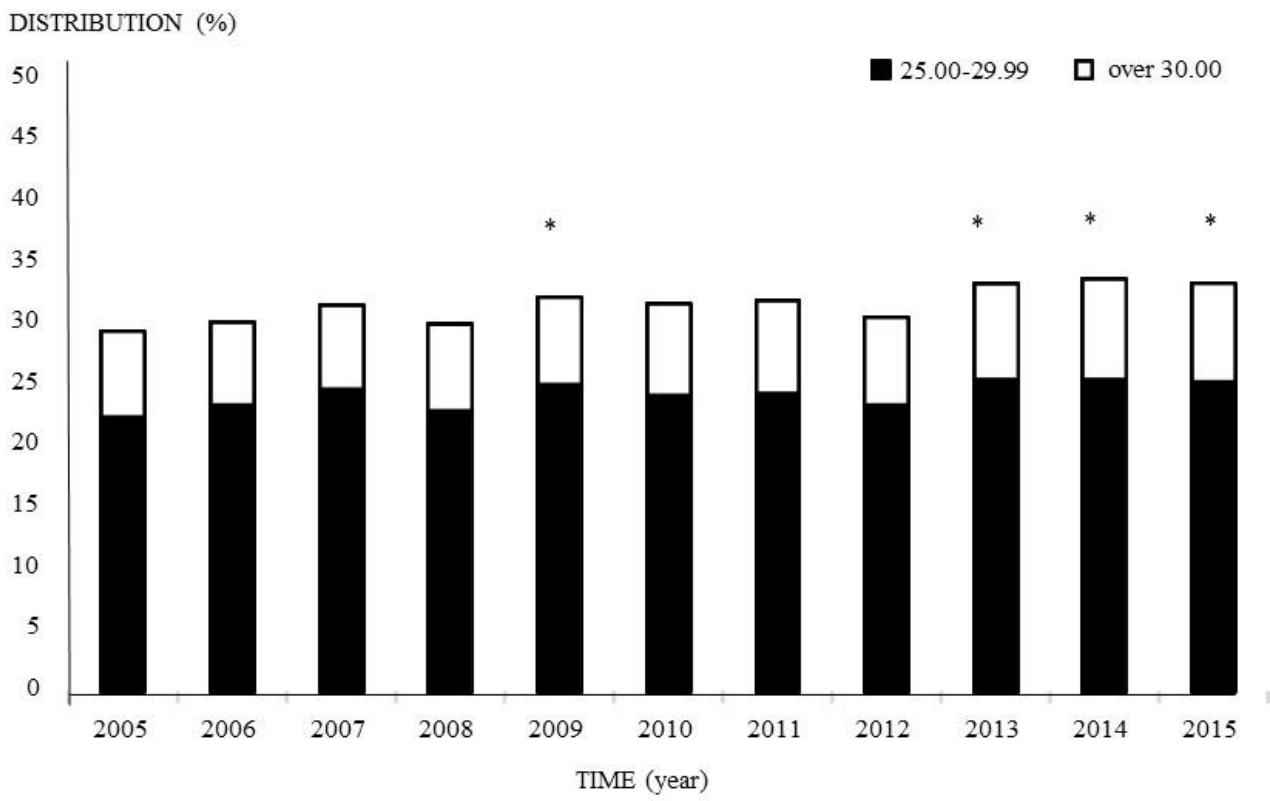


Figure 3.

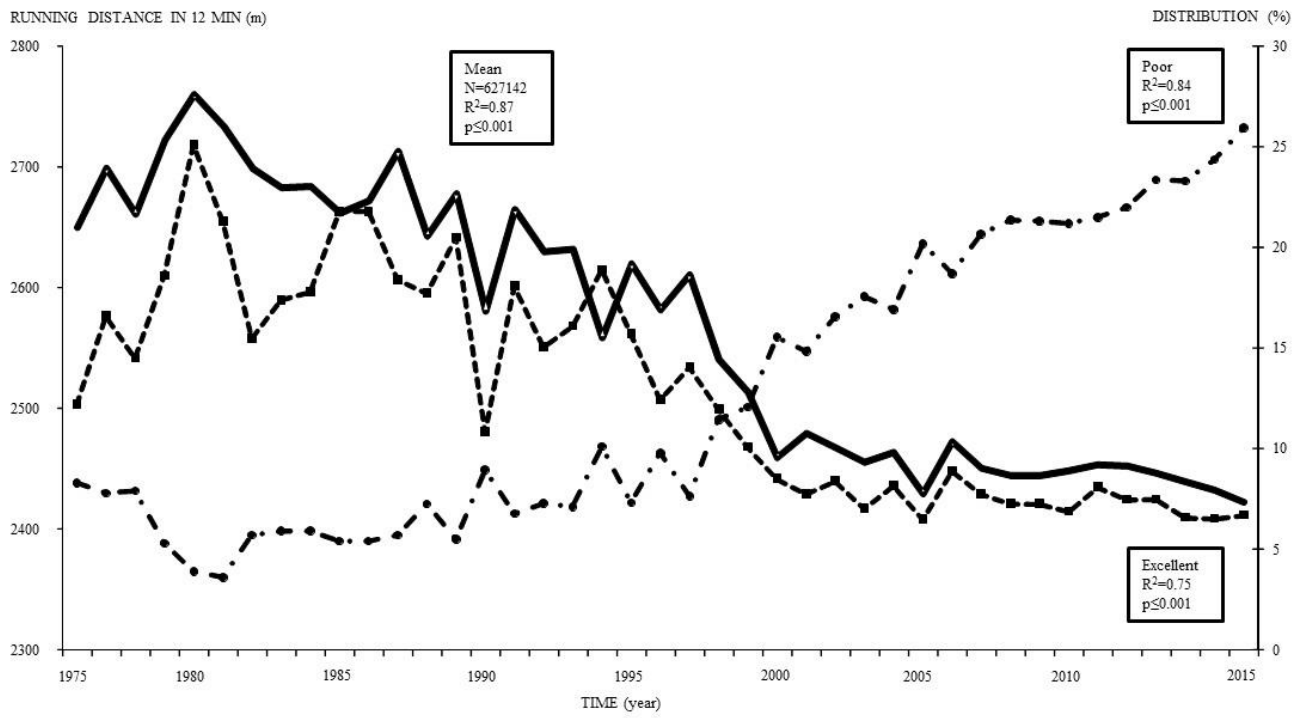


Figure 4

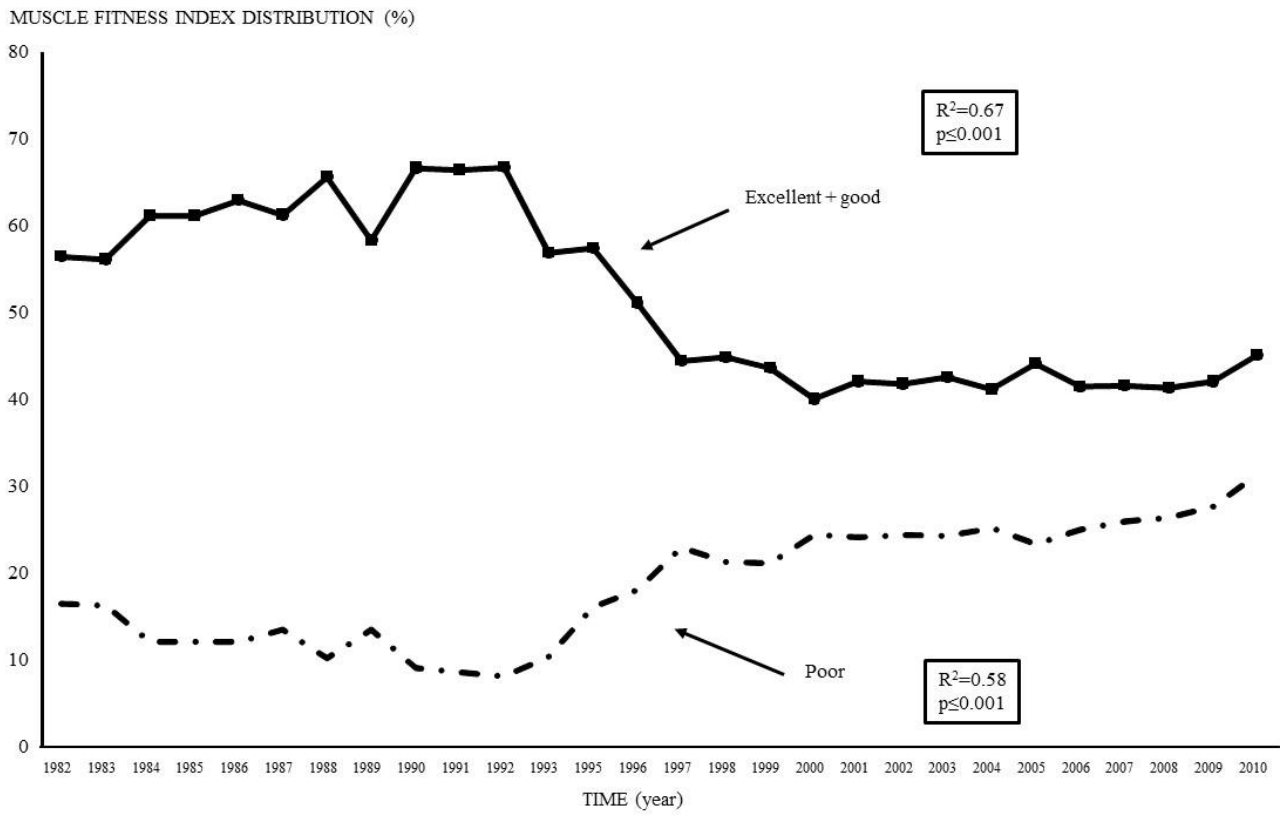


Figure 5

