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# How long does it take to become fit?

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## Summary and conclusions

To become fit an individual must generate optimal muscle strength and must develop cardiopulmonary reserve, or stamina. Physical fitness programmes require motivation, a graded series of appropriately designed exercises, and scientific surveillance. Motivation and efficiency in fitness programmes depends on early positive feedback to participants, confirming that stamina and strength are developing.

A practical field experiment was performed to determine the minimum time that healthy young adults require to reach an initial plateau in objective measures of fitness. Fifty male university undergraduates were studied during an annual volunteer military training camp. Thirty had volunteered to take part in the fitness programme; the remaining 20 had initially rejected the offer but underwent the programme as part of their military training and acted as unmotivated controls. All the subjects became fit within 14 days of starting training, with objective improvement in both absolute strength and pulse recovery times.

Non-motivated individuals, training with motivated individuals for 20 minutes each day, can therefore achieve levels of fitness indistinguishable from those of healthy highly motivated subjects. Fitness programmes must be carefully supervised, however, with medical examinations for those about to undergo vigorous exercise.

## Introduction

Current interest in physical fitness programmes is high. To become fit an individual must develop both optimal muscle strength and cardiopulmonary reserve or stamina. The

generation of, and tests for, these different facets of fitness are quite distinct but complementary.<sup>1</sup> To achieve these two prerequisites of fitness, an out-of-condition sedentary individual must have (a) motivation, (b) a suitable training and exercise environment,<sup>2</sup> and (c) an acceptance of some inevitable physical discomfort.

Persistence with a programme of fitness training depends largely on the certainty that success will be possible and on the presence of signs that improvement is occurring rapidly. For all but children and healthy young adults, exercise challenge should be gradual and unobtrusive<sup>3</sup> and medically supervised.<sup>4</sup> Analysis of motivational factors leading to participation in vigorous physical training has shown that a desire to keep fit and to achieve a subjective feeling of well being is the most important.<sup>3,5</sup> It is known, however, that positive attitudes towards physical education are not necessarily correlated with high scores of physical fitness.<sup>6</sup>

In the case of adolescents and young adults, motivation is quickly lost if results are not achieved. "How long does it take to get fit?" is thus an important question that the doctor is asked whenever he recommends that an individual start a training programme. I report here the results of a study to answer this question in subjects of both high and low initial motivation.

## Methods

**Background**—This study was undertaken during routine training in an annual army camp (Army Reserve) of 16 days' duration. Test subjects comprised 50 healthy male students aged 18-24 years.

**Physical fitness programme**—A standard 10-station training circuit<sup>7,8</sup> was established. Each station consisted of a standard physical task (Harvard step test, "chin-up" horizontal bar, body-press site, etc). Subjects set their own initial task baselines in standard fashion.<sup>4</sup> The fitness programme then consisted of three sequential circuits of the 10-station course, at maximum speed against a stopwatch. Each individual undertook the training session twice daily for 14 consecutive days, under close supervision. Course times varied from eight to 14 minutes (see fig 1). Unlike other combat conditioning courses,<sup>8</sup> subjects in this study were not involved in other strenuous physical activities during the duration of the tests. Normal warm-ups were

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not undertaken because of the known objective<sup>9 10</sup> and subjective<sup>11</sup> variable influence of this on physical performance.

**Subjects**—The nature of the study was explained to the 50 university undergraduates, 30 of whom had volunteered to undertake the programme. This highly motivated group formed the test group. The remaining 20 individuals, who had initially rejected the proffered programme, then comprised a control group and undertook the physical training as part of their normal military training. All 50 individuals were completely healthy by rigid and comprehensive Army selection standards. All individuals were medically examined before and during the study, and all (both test subjects and controls) completed the training programme.

**Measurement of fitness**—The time taken to complete each training circuit, pulse recovery curves (pulse rates at two, five, and 10 minutes), and weight were recorded individually for each session. A modified physical fitness index was developed using individual pulse recovery curves. The standard physical fitness index uses the Harvard step test, with pulse recovery curves sampled at one, two, and four minutes<sup>7</sup> after cessation of the submaximal effort. The bradycardia which develops with endurance training, even in children,<sup>12</sup> is the cause of a progressive increase in the physical fitness index. Because of evidence that suggests that indices of physical fitness are more sensitive indicators when used following an "all-out" test rather than a submaximal effort,<sup>13</sup> a modified index was developed for this study. This used the 8-14 minute maximum effort on the mixed-exercise circuit as the endurance challenge, with sampling of the pulse recovery curve at two, five, and 10 minutes after completion of the circuit. The formula comprised:

$$\text{modified physical fitness index} = \frac{30\,000}{P_2 + P_5 + P_{10}}$$

where P<sub>2</sub>, P<sub>5</sub>, and P<sub>10</sub> were the minute pulse rates 2, 5, and 10 minutes after completion.

## Results

Sequential improvement in strength and stamina is shown in fig 1. In these healthy subjects a twice-daily (8-14 minutes) vigorous training session produced significant improvement after six days; after 12 days of continuous training the improvement curve had started to flatten. Poorly motivated individuals performed less well initially, although when training was continued in a group setting they quickly caught up (fig 1). Within three days of the start of the

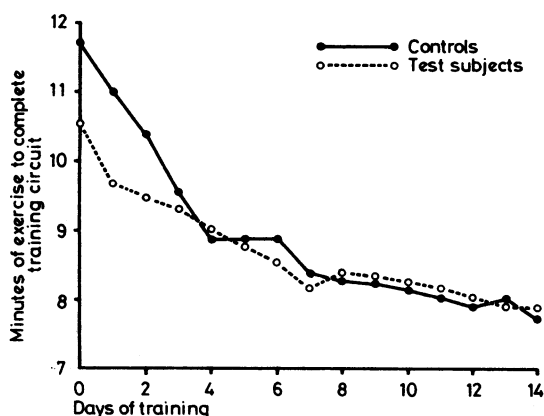


FIG 1—Sequential improvement in time required to complete training circuit in 30 highly motivated test subjects and 20 controls.

programme, and despite differences between the two groups, rates of improvement and objective times to complete the circuit were indistinguishable ( $p > 0.05$ ). Fig 2 shows that for the 30 highly motivated subjects pulse recovery times had improved significantly after 14 days' continuous training; the modified physical fitness index increased from a mean (for all 50 subjects) of 80 to 97 over this period. Fig 3 shows pulse recovery times in control and test subjects at the end of the 14-day training period. Despite initial differences in motivation, the pulse-recovery curves were indistinguishable. The interpretation of this finding is that six hours of circuit training, spread evenly over

14 days, will achieve a mean increase in physical fitness index of 20%, irrespective of initial enthusiasm and motivation. Retesting of strength performance at the end of the course showed a mean increase of 28% in the number of repetitions that could be achieved, again with no difference in such improvement between the control and test groups ( $p > 0.05$ ).

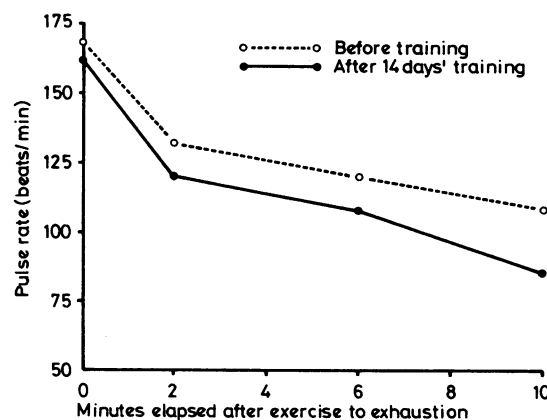


FIG 2—Mean pulse recovery curves (0-10 minutes) after maximum physical effort over 9-14 minutes in 30 healthy and highly motivated test subjects at the start and end of 14-day training programme.

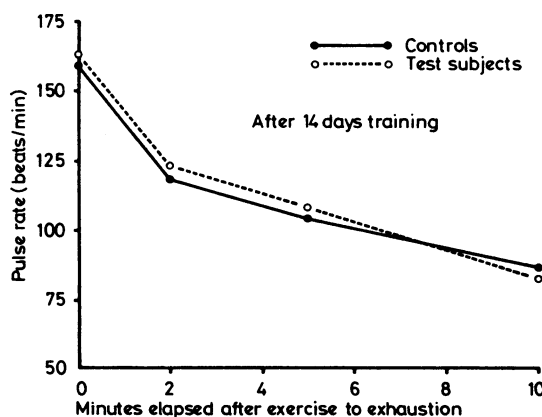


FIG 3—Mean pulse recovery curves after 14 days of training in physical fitness programme in 30 test and 20 control subjects.

## Discussion

An individual's motor performance depends on several invariable factors (height, hand-eye co-ordination, balance, genetically determined and predestined muscle-lever systems) and several factors which can be modified (motivation, static and dynamic power of individual muscle groups, and cardiopulmonary reserve<sup>4</sup>). For development of static and dynamic power both isometric and isotonic<sup>14</sup> exercises are required. Optimal improvement in cardiopulmonary endurance can be guaranteed only with a formally designed fitness training programme.<sup>15</sup> Feedback is important both in developing strength in single muscle groups,<sup>16</sup> and in developing endurance and stamina. For most individuals with suboptimal motivation group support is very important, as this and other studies<sup>2 17</sup> have shown.

Short-term benefits of successful programmes are well known,<sup>3 5</sup> although possible self-selection of participants makes claims for increased longevity difficult to interpret.<sup>3 18 19</sup> There is both subjective<sup>20</sup> and experimental<sup>21</sup> evidence to suggest that chronic physical exertion (within defined limits) provides some cross-adaptation for an individual's ability to cope with stress of novel environments.

Physical fitness programmes must be carefully supervised, and a preliminary medical examination is essential in cases where vigorous exertion (often to exhaustion) is undertaken by hitherto untrained subjects.<sup>3 4</sup> Sudden death during sport is well documented.<sup>22</sup> A family history of early heart attacks and antecedent symptoms of chest pain must be taken seriously.

Provided that such safeguards are observed, this study has shown that a healthy young man will achieve significant improvement in absolute strength (29-30%) and in stamina or cardio-pulmonary reserve (15-25%) within two weeks when training for 20 minutes a day. Prolonged training can improve a subject's physical fitness index from 80 to 120 over several months (Zatopek achieved an index of 172 when tested using a Harvard step test of 20 inches<sup>2</sup>); but just as fitness can be achieved quickly, once training stops regression occurs quickly. Five weeks after cessation of an efficient training course, endurance-produced electrocardiogram changes have already disappeared.<sup>13</sup>

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# Grey-scale ultrasonography and percutaneous transhepatic cholangiography in biliary tract disease

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## Summary and conclusions

Fifty-one patients with suspected obstructive jaundice and 14 without jaundice in whom disease of the biliary tract was suspected but infusion cholangiography had been unhelpful were examined by grey-scale ultrasonography and percutaneous transhepatic cholangiography and the findings analysed retrospectively. Grey-scale ultrasonography distinguished between obstructive and hepatocellular jaundice in 35 out of 46 patients (76%) and indicated the site of the obstruction in 27 (58%) and the cause of the obstruction in 13 (28%). Percutaneous transhepatic cholangiography distinguished between obstructive and hepatocellular jaundice in 42 of the patients (91%) and indicated the site of the obstruction in 42 (91%) and the cause in 29 (63%). In the 14 patients without jaundice percutaneous transhepatic cholangio-

graphy showed bile-duct stones in one and ampullary stenosis in three.

It is concluded that grey-scale ultrasonography and percutaneous transhepatic cholangiography are complementary examinations and that ultrasonography should always be undertaken first as it is a non-invasive procedure that may provide the surgeon with all the diagnostic information he requires. Percutaneous transhepatic cholangiography should be performed when grey-scale ultrasonography has shown dilated bile ducts but failed to provide adequate diagnostic information. Cholangiography is also required when preoperative percutaneous drainage of the bile duct is contemplated. In those patients in whom grey-scale ultrasonography shows non-dilated ducts endoscopic retrograde cholangiopancreatography is probably the contrast examination of choice.

## Introduction

Percutaneous transhepatic cholangiography is a reliable method of differentiating obstructive from hepatocellular jaundice with an accuracy of between 96% and 100%.<sup>1 2</sup> In one series the technique detected the cause of the obstruction in 71% of cases,<sup>3</sup> and in another was claimed to be 100% accurate in

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