Greek adolescents, fitness, fatness, fat intake, activity, and coronary heart disease risk

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Background: A dramatic increase in adult mortality rates from coronary heart disease (CHD) in Greece, accompanied by increased prevalence of CHD risk factors in children, has been documented. However, there is controversy about the independent effects of certain lifestyle parameters on primary CHD risk factors.

Aims and Methods: To examine the association between CHD risk factors (HDL-C, LDL-C, HDL-C/TC, triglycerides, systolic and diastolic blood pressure) and lifestyle parameters (fitness, fatness, fat intake, and physical activity) in 210 12-year old Greek pupils.

Results: Correcting for the fixed factors of gender and maturation, analyses of covariance (ANCOVA) with backward elimination of the lifestyle covariates revealed significant associations between three CHD risk factors (HDL-C, HDL-C/TC, systolic blood pressure) and physical activity levels. In contrast, the covariates aerobic fitness, fatness and fat intake failed to reach significance with any of the CHD risk factors.

Conclusions: In Greek schoolchildren, primary CHD risk factors are mainly associated with physical activity levels, independently of fitness, fatness, and/or fat intake. Prevention strategies should concentrate on enhancing physical activity early in life, if the increased prevalence of Greek adult CHD mortality is to be diminished.

METHODS

This study is part of a longitudinal investigation of CHD risk factors in Greek children. We present a cross sectional analysis of the effects of a variety of lifestyle determinants on CHD risk factors. The original baseline survey, which provides the basis for the current investigation, was completed in 1999.12
**Aerobic fitness**
Defined as the maximal oxygen uptake (VO₂ max), or the greatest rate at which oxygen can be taken in during exercise, aerobic fitness was assessed using the children’s validated 20 metre shuttle run test. Subjects had to run back and forth between two lines set 20 metres apart. Running pace was determined by audio signals, emitted from a pre-recorded cassette tape, with the initial velocity being 8.5 km/h. Running speed was increased at regular intervals of 0.5 km/h every minute. The test was terminated when children failed to reach the lines concurrent with the audio signals on two consecutive occasions. VO₂ max was then predicted from the number of “laps” completed.

**Fat intake**
Information on dietary fat intake was obtained by means of a seven day dietary diary. Photographs illustrating portion sizes of the most commonly consumed food items and beverages were used while keeping the diaries. Both pupils and their parents were instructed on how to keep a record of the amount and type of food and beverages consumed on seven consecutive days. After collection, each diary was checked by the principal investigator and the child involved to ensure accuracy of the recorded information. Using the Food Composition Tables for Greek food, fat intake was estimated and expressed as percentage of total energy intake.

**Physical activity**
For the assessment of physical activity levels, the Past Year Physical Activity Recall Questionnaire of Aaron et al was utilised. This questionnaire has been shown to yield reproducible and valid estimates of past year physical activity in adolescents aged 12–17 years. Briefly, subjects were asked to indicate all organised physical activities as a member of any sports club, including school PE, and all leisure time physical activities (for example, walking, cycling, stair climbing, etc) in which they participated during the past year. They also had to give detailed information regarding the frequency and duration of each individual activity. The metabolic cost of each activity was then used to calculate a frequency and duration of each individual activity. The level of statistical significant was set at p<0.05.

**RESULTS**
Fifty six per cent of the present subjects were males and 44% were females. χ² analysis revealed that there was no significant difference in the percentages of male and female participants ($\chi^2 = 2.74$, $p = 0.098$).

Table 1 presents descriptive data for all studied parameters. Apart from percentage body fat, which was higher, all other parameters were lower than internationally proposed cut-off points of selected CHD risk indicators in children. Table 2 shows the Pearson’s product moment correlation coefficients among fitness, fatness, and physical activity. All these parameters were found to be modestly correlated at p<0.01.

Analyses of covariance revealed that, compared to lifestyle parameters of fitness, fatness, fat intake, and physical activity, only physical activity was significantly associated with selected CHD risk factors. Specifically, physical activity was associated positively with HDL-C ($p<0.001$) and HDL-C/TG ($p<0.001$), and negatively with systolic blood pressure ($p<0.001$).

**DISCUSSION**
Over the past 30 years, increased mortality rates from CHD have been observed in Greek adults. This upward trend is reflected by lifestyle changes and a high prevalence of CHD risk factors in Greek children. However, the independent contribution of lifestyle parameters (for example, fitness, fatness, diet, and habitual physical activity levels)
on primary CHD risk factors (for example, blood lipids and blood pressure) remains unclear. The purpose of this study was to further explore this issue focusing on Greek children. We found associations between physical activity and CHD risk factors to be stronger than between fatness, fitness, and fat intake and the same CHD risk factors. Specifically, correcting for the fixed factors of gender and maturation, analyses of covariance with backward elimination of the lifestyle covariates revealed three significant associations between the CHD risk factors (HDL-C, HDL-C/TC, and systolic blood pressure) and physical activity levels. In contrast, the covariates aerobic fitness, fatness, and fat intake failed to reach significance with any of the CHD risk factors. We did not find any associations between LDL-C, TG, diastolic blood pressure, and the lifestyle parameters, which may be attributed to genetic and metabolic factors and/or to low baseline values. In general, these findings suggest that physical activity is the most significant lifestyle predictor for CHD risk factors in Greek children. This is despite the fact that our subjects revealed lower physical activity levels (45 kcal/kg/day) than those previously reported for other paediatric populations (58 kcal/kg/day). Nevertheless, as young people assume responsibility for their own health related behaviour and attitudes, the present findings may be particularly useful to health promotion strategists.

The present study complements previous reports showing strong associations between inadequate levels of physical activity and the atherogenicity of high lipid levels and raised blood pressure. Our data are also in line with a comprehensive recent review where aerobic fitness appeared not to be related to plasma lipids or lipoproteins. The fact that a different pattern has been established for activity and fitness in relation to blood lipid and blood pressure parameters, supports the call for a distinction between these two attributes in children. This is probably because, while physical activity is considered to be linked to behaviour— and hence to lifestyle—children’s aerobic fitness is an attribute with a strong genetic component. Furthermore, unlike fitness, physical activity appears to be an important determinant of certain lipid metabolic adaptations expected to confer a reduced risk of cardiovascular disease. The activities of the lipid metabolism enzymes lipoprotein lipase (LP), lecithin-cholesterol acyltransferase (LCAT), and hepatic lipase (HL) seem to increase in parallel with increases in physical activity levels.

In general, while physically active adults are usually regarded as being fit, a similar relation with children has not yet been firmly established. Although there are several different methods to assess physical activity levels in children, none has proven sufficiently practical and valid to emerge as a standard method. Furthermore, interpretation of correlational studies is difficult because of differences in subject characteristics (including social and cultural backgrounds), in methods employed to assess fitness related parameters, and in statistical techniques employed to analyse multivariate data.

It is noteworthy that the present data contradict recent reports citing obesity as the single most important contributor in the pathogenesis of CHD during childhood. Part of the explanation for this discrepancy may be that fitness, fatness, and physical activity levels are interrelated, which has likewise been established by the present data. Although not directly monitored, social and cultural differences between the children studied may also account for the observed discrepancies.

Confirming a previous report in Greek children, we found that the CHD risk factors studied were not substantially affected by qualitative aspects of diet. The relatively low baseline data found in the present study and/or the methodology used may account for this. For instance, the mean dietary fat intake of 25% of the total energy intake was lower than the 30% recommended for children of this age group.

In conclusion, and within the study’s limitations, primary CHD risk factors in Greek schoolchildren are mainly associated with physical activity levels, independent of fitness, fatness, and/or fat intake. As reduced activity is a well established CHD risk factor in adults, concern about the long term health implications in children is justified. CHD primary preventive strategies should aim at effective habitual physical activity interventions if the future CHD risk of the Greek population is to be reduced.

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REFERENCES

Progressive fibrosis of the quadriceps muscle

This 15 year old boy presented when 3 years old because of maternal concern about “not walking right”. He was born at term weighing 2.4 kg, was admitted to the special care baby unit, and treated for septicemia with intramuscular benzylpenicillin four times daily and gentamicin twice daily, for nine and ten days respectively. He subsequently received intramuscular immunisations.

Initial examination revealed limitation of flexion in both knees. A muscle biopsy showed no acute inflammation and a predominance of type 1 fibres. Muscle enzymes and EMG tests revealed progressive fibrosis of the quadriceps muscle secondary to intramuscular injections was made. Reduction in flexion at both knee joints progressed rapidly. Bilateral quadroplasty was performed with the rectus femoris mainly affected.

Magnetic resonance imaging of his quadriceps (see fig) showed patchy fibrosis and fatty infiltration, especially of the vastus lateralis and intermedius. He currently has about 90° of flexion in both knees.

Progressive fibrosis of skeletal muscle is a well recognised condition. Several case reports have shown a link with intramuscular injections. Typically the vastus intermedius and lateralis components of the quadriceps are affected. The vastus intermedius is enclosed in an osteofascial compartment and has a relatively poor blood supply. It is postulated that injection of large volumes of fluid into this confined space causes ischaemia, followed by necrosis, then fibrosis. Treatment involves early intensive physiotherapy and surgical intervention if severe.