Preventive Medicine **28,** 149–159 (1999)
Article ID pmed.1998.0388, available online at http://www.idealibrary.com on IDEAL®

Evaluation of a Health and Nutrition Education Program in Primary School Children of Crete over a Three-Year Period[1]

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Background. **No national policy for health education in schools exists to date in Greece. The first attempt to apply a school-based health education intervention program was launched in 1992 on all 4,171 pupils registered in the first grade in two counties of Crete. The 1,510 pupils registered in a third county served as controls.**

Methods. **The school-based intervention and the seminars organized for parents were primarily aimed at improving children's diet, fitness, and physical activity. Pupils in the first grade in a representative sample of 40 schools were examined prior to the intervention program on a variety of health knowledge, dietary, physical activity, fitness, anthropometric, and biochemical indices. The same measurements were taken after 3 years of the program on 288 intervention group and 183 control group pupils.**

Results. **Positive serum lipid level changes occurred to a greater extent in the intervention group than the control group. BMI increased less in the intervention group than for controls. The increase in health knowledge and physical activity and fitness levels occurred to a higher extent in the intervention group compared to controls.**

Conclusions. **The short-term changes observed in the present study are markedly encouraging and indicate great potential for progressive improvement. Continuation and expansion of such a program may prove to be beneficial in initiating long-term changes.**

Key Words: **children; health education; diet; physical fitness; physical activity; cholesterol.**

[1] This study was funded by the EU, the Europe Against Cancer program and the Mediterranean Integrated Program of Crete, General Secretary of the Periphery of Crete.

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INTRODUCTION

The seven country study data early in the 1960s indicated that the two islands of Greece studied (Crete and Corfu) had the lowest mortality due to cardiovascular diseases (CVD) compared to all selected areas from the other countries [*1,2*]. These findings had been attributed primarily to the dietary habits of the population. At the present time, however, Greece has one of the most rapidly rising death rates due to CVD, which now constitutes the primary cause of morbidity and mortality [*3–5*]. This trend has been attributed to the adoption of a more "westernized" lifestyle combined with limited awareness on health dietary issues, poor dietary habits, and the sedentary lifestyle of contemporary Greeks [*5–7*].

Although clinical manifestations of CVD seem to appear later in life, the accumulative body of evidence suggests that the major risk factors have their roots in childhood [*8*]. These risk factors are linked with certain behaviors such as cigarette smoking, sedentary lifestyles, high consumption of saturated fats, and general overconsumption of food, which in the main are learned in childhood and adolescence and have been established by young adulthood [*9*]. In particular, epidemiological studies in Greece have indicated a high prevalence of CVD risk factors in children and adolescents]*10–12*]. The preventive potential of school-based health and nutrition education programs in achieving both short-term and long-term behavioral changes [*13–17*] are well established. Despite the above, and positive results from a few small-scale initiatives [*7,18*], no national policy exists to date in Greece for the introduction of health education in schools as a means of combating the expected continuously rising rates of morbidity and mortality, resulting from chronic diseases.

Against this background, a 6-year comprehensive health education program was launched on the island of Crete in 1992 with the approval of the Greek Ministry

0091-7435/99 $30.00

of Education. The overall objective of the intervention program was to promote healthy dietary and lifestyle habits in children, with the ultimate aim being to minimize the risk of development of CVD in adult life. This program represents the first attempt in Greece to obtain adequate epidemiological data and to test the effectiveness of health education intervention in Greek primary schools.

The aims of the first 3 years of intervention were to increase the awareness of parents and children predominantly on issues related to healthy diet and regular physical activity and to encourage and support pupils to improve their dietary habits and physical fitness. A further aim was to establish an appropriate environment at both schools and home for support of the children's expected behavioral changes. This article presents details of the program design, intervention implementation, and preliminary outcomes following 3 years of the intervention program on targeted variables such as serum cholesterol, body fat, fitness indices, dietary intake, and exercising habits.

DESIGN AND METHODS

Development of the Program

The preparatory phase of the project involved the development of teaching materials that would be most suited to the characteristics and culture of Greece. For this purpose the health profile component of the "Know Your Body" school health promotion program of the American Health Foundation [*19–21*] was adapted, modified, and supplemented to suit our population. Multicomponent workbooks covering dietary issues, physical activity and fitness, dental health hygiene, smoking, and accident prevention were produced for grades 1 to 6 and each pupil was supplied once a year with a workbook appropriate for the developmental abilities of the pupils. In addition, teaching aids were provided to assist class teachers and PE instructors in the presentation of new materials and to reduce inherent variation between teachers (attitudes, enthusiasm, etc.) in the delivery of the materials. The teaching aids included posters, audio-taped fairy tales for classroom use, workbooks, and teaching manuals focusing on the principles of the intervention, all of which were designed and produced by the Preventive Medicine and Nutrition Clinic, at the University of Crete.

The health and nutritional components of the program were conducted by classroom teachers and incorporated 13 to 17 h of teaching over the academic year. The physical fitness and activity component of the program included practical sessions (two 45-min PE sessions per week in each year resulting in a total of about 60 classes per year) as well as classroom sessions (4 to 6 h of classroom material per year), both of which were delivered by PE instructors. The practical part was delivered in the playground where enjoyable, fitness-oriented (rather than motor-oriented) moderate intensity exercise sessions took place with total class participation. All sessions consisted of a short initial warm-up period with stretching exercises, followed by activities such as skipping, fitness stations, and several aerobic group games [*22,23*]. Little attention was placed on competition and verbal rewards were given for all levels of effort and ability [*24*]. When weather conditions did not permit outdoor physical activity sessions, the time was devoted to indoor health education intervention activities. Also, three to five workbook exercises per year were completed at home by pupils together with their parents.

The control group did not have any health education intervention. During the PE classes, pupils played freely under the supervision of their class teacher, as generally occurs in Greek schools for children in grades one to three.

Characteristics of the Program

A design characteristic of the educational intervention was that it was teacher delivered. In addition to the preparatory materials dealing with the health intervention, teacher orientation seminars were designed and conducted annually for teachers in the two intervention provinces. In cooperation with the Board of Education and the school counselors, four 3-h seminars were held in four different regions of the geographical intervention area. The aims of the seminars were to familiarize teachers and PE instructors with the objectives of the program and their role therein. The significance and benefits of incorporating health, nutrition and fitness in the curriculum was emphasized. Finally, teachers and PE instructors were provided with preparatory teaching and classroom materials. Members of the research team periodically visited schools in the intervention counties to monitor and assist educators in the delivery of the program materials. In addition, the research team collaborated with the county educational authorities' school inspectors in the intervention counties, who reported on conformity with the health promotion program as part of their routine work in monitoring teacher fidelity to the curriculum.

A second design feature of the program was parental involvement as it is generally recognized that the family plays an important role in shaping the eating and exercising habits of children, particularly young children [*13*]. Following baseline examinations, meetings were organized at which parents in the intervention group were given a file containing their child's medical screening results. They were also given booklets, produced by the Preventive Medicine and Nutrition Clinic, which provided nutritional guidelines and information on physical activity. The booklets also included sections on cholesterol level, hypertension, and obesity management. During these meetings there were presentations on topics relevant to the dietary and exercising habits of the children. Furthermore, parents were encouraged to modify their own dietary habits, where appropriate, in addition to those of their children. They were also advised to support their offspring in their physical activity rather than to encourage sedentary behavior. The meetings were held annually and at every school, in order to facilitate parental participation. The meetings provided parents with the opportunity to voice any queries regarding their children's health. Control group parents did not attend any such educational sessions and received medical screening results and brief comments by mail.

Data Collection

Data collection took place during morning school visits during the periods September to November 1992 and September to November 1995. A maximum of 30 pupils and their parents were screened each day by either one large or two small teams of trained personnel. The data collected from the children (in both intervention and control groups) were health knowledge scores, anthropometric measurements, physical fitness indices, and biochemical examinations.

Parents provided feedback during the study in three main ways:

(a) by completing coded questionnaires regarding personal characteristics (age, occupation, years of education, etc.) and issues related to both their own health habits and knowledge; (b) by completing a questionnaire regarding the weekly frequency of consumption of various foods and, in a random sample of 30% of the baseline cohort, by providing a record of the weights of all foods consumed by their child over a 3-day period; and (c) by completing forms relating to their child's physical activity levels.

Pupils' Health Knowledge Assessment

A multiple-choice questionnaire with color illustrations was used to assess students' knowledge at the beginning and at the end of the 3-year intervention period. The questionnaire focused on diet, food products, and physical activity, in a similar style to those of previous studies [*20,21*]. It was completed in the presence of a member of the research team. The test–retest reliability of the questionnaire was assessed by administering the questionnaire to a subsample of 35 first-grade and 35 fourth-grade pupils with a 2-week interval. With the use of the paired *t* test, no significant difference was found between the first assessment and the reexamination results ($P = 0.073$ and $P = 0.23$ for first and fourth graders, respectively).

Dietary Assessment

The parents randomly selected to complete the 3-day weighed food record were given oral and written instructions for correct completion, forms, and a food scale with 5-g divisions and a maximum weight of 1 kg. Scale accuracy was checked with a standard 100-g weight. Implementation of the procedure was closely monitored by dietitians. The foods were coded and analyzed using the USDA food database extensively amended to include chemically analyzed Greek foods. Fat analysis was based on the chemical analyses of 120 Greek foods providing 95% of the fat in the Greek diet. The foods used for this Greek database were collected and prepared at the Preventive Medicine and Nutrition Clinic of the University of Crete while chemical analysis was undertaken by the Wageningen Agricultural University and TNO Nutrition Institute in the Netherlands [*25*].

Physical Activity Measurement

Children's physical activity out of school was assessed using a standardized activity interview based on a questionnaire completed by parent or guardian. Respondents reported the time spent by children on various physical activities on 2 consecutive weekdays and 1 day during the weekend. Further details on the method used and its validation and reliability are given elsewhere [*26*].

Fitness Assessment

Pre- and postintervention evaluations of physical fitness were based on the EUROFIT Tests Protocol designed by the Committee of Experts on Sports Research [*27*] that has been used in several European countries in order to assess fitness in primary school children [*28*]. The battery of tests included:

1. Sit and reach test (SAR): reaching as far as possible from a sitting position. This test measures the flexibility of the hamstrings, buttocks, and lower back.
2. Sit ups (SUP): Maximum number of sit-ups achieved in 30 s. This test measures the endurance of the abdominal muscles.
3. Handgrip test (HGR): Squeezing a calibrated hand dynamometer as forcefully as possible with the dominant hand.
4. Standing broad jump test (SBJ): Jumping for a distance from a standing start. Tests 3 and 4 measure the strength of the muscle groups involved in these tasks.
5. Endurance 20-m shuttle run test (20mSRT): This is a standard test of cardiovascular fitness in school children. Subjects start running at a speed of 8.5 km/h and the speed is increased gradually. The subjects move between two lines, a distance of 20 m apart reversing direction and continuing backward and forward

in accordance with a pace dictated by a sound signal on an audio tape, which gets progressively faster (0.5 km/h every minute). Each stage of the test is made up by several shuttle runs. The actual score of the subject is the last stage fully completed before he/she drops out.

Anthropometric Measurements

Body weight was measured by a digital scale (Seca) with an accuracy of ±100 g. Subjects were weighed without shoes, in their underwear. Standing height was measured without shoes to the nearest 0.5 cm with the use of a commercial stadiometer with the shoulders in relaxed position and arms hanging freely. Body mass index (BMI) was calculated by dividing weight (kg) by height squared (m^2). Left triceps, biceps, subscapular, and suprailiac skinfold thickness were measured with a Lange skinfold caliper, ensuring that the subject was standing with the upper extremities relaxed at the sides of the body [*29*].

Biochemical Measures

Early morning venous blood samples were taken from each child for biochemical screening tests, following a 12-h overnight fast. Venipuncture was performed by professional staff using vacutainers to obtain 10 ml of whole blood. The blood samples were transferred to the Nutritional Research Laboratory of the University of Crete in tanks containing ice packs which maintained the temperature at 3–4°C. Blood was centrifuged and 1.5-ml aliquots were pipetted into plastic Eppendorf tubes. One aliquot was used for blood analysis of triglycerides (TG), total cholesterol (TC), and high-density lipoprotein cholesterol (HDL-C) measurements on the same day of collection, while the other was stored (at −80°C).[3] TG was determined using Fossati's method [*30*]. TC was determined by Allain's method [*31*]. HDL-C was measured by the heparin–manganese precipitation method [*32*] while low-density lipoprotein cholesterol (LDL-C) was calculated as follows: LDL-C = TC − (HDL-C + TG / 5) [*33*]. The ratio of LDL-C to HDL-C was calculated.

Subjects

The 6-year health education program was initiated in March 1992 with detailed parental consent forms being signed prior to the participation of each child. The experimental population consisted of 541 primary schools in three of the four counties of Crete: Heraklio, Rethymno, and Hania, a total of 5716 pupils. The intervention took place in Heraklio and Rethymno while the schools in Hania formed the control group. A random sample of 40 schools was taken and allocated to control or intervention group, according to the county in which they lay, resulting in 24 intervention schools and 16 control schools. Eligible subjects were all pupils in the first grade of the selected schools in 1992. Of the 1,281 eligible pupils, 1,046 (81.7%) participated in the baseline assessments; 844 parents (65.9%) also completed questionnaires. Following completion of the first 3 years of intervention, a random subsample of 21 of the schools initially examined was drawn (12 intervention, 9 control); 579 pupils. Of the baseline participants in the schools sampled at follow-up, 471 (81.3%) were available for rescreening. The major reasons for lack of rescreening were transferal to another school, 46 pupils (7.9%), and absence on the examination day, 43 pupils (7.4%), while 19 (3.3%) did not have parental permission.

These percentages did not differ between control and intervention groups. At reexamination, parents who had been given the 3-day weighed food record to complete at baseline were asked to complete a similar record; records were obtained both at baseline and at reexamination from 76 intervention group parents and 63 control group parents.

Statistical Analysis

Comparisons of baseline biochemical, fitness, health knowledge scores, and anthropometric measurements were made between groups using *t*-tests and nonparametric Mann–Whitney tests. In order to investigate whether a bias had resulted from selecting a subsample at follow-up, despite the fact that the selection process was random, baseline levels of key variables were compared for those not followed-up with those followed-up after 3 years.

The midterm effects of the program were analyzed by mixed model analyses estimating the changes in the measured variables in the two groups over the 3-year period, taking account of possible interschool variation by including the random school effect in the model. Adjustments were made for baseline values, sex, parental education levels, increase in height, and initial BMI (having checked the lack of interaction assumption). The assumption of equality of the error variances in the main-effects model was tested in each case by applying Levene's test.

RESULTS

Table 1 shows that the mean values of key measurements at baseline of the children included in the reevaluation did not differ in the main from those not examined at midterm. The only clearly significant difference

[3] The research laboratory of the University of Crete is a participant in the quality control protocol of the Murex Clinical Chemistry Quality Assessment Program and the WHO Collaborating Lipid Reference Centre at the Institute for Clinical and Experimental Medicine, Prague.

TABLE 1

Comparison of Baseline Measurements between Participants both at Baseline and Follow-Up and Subjects not Measured at Follow-Up

Selected variables	Subjects who were not measured at follow-up mean (SE)	*N*	Subjects who participated at baseline and follow-up mean (SE)	*N*	*P* value for *t* test[a] Mann–Whitney[b]
Serum lipids (mg/dl)					
TC	184.0 (1.3)	498	183.6 (1.5)	438	n.s.[a] n.s.[b]
LDL	113.6 (1.2)	498	113.0 (1.4)	438	n.s.[a] n.s.[b]
HDL	58.6 (0.6)	498	59.9 (0.7)	438	n.s.[a] n.s.[b]
TG	58.8 (1.2)	498	53.3 (1.1)	438	0.001[a] 0.02[b]
Anthropometric indices					
BMI (kg/m^2)	16.4 (0.1)	470	16.3 (0.1)	419	n.s.[a] n.s.[b]
Sum of skinfolds (mm)	32.4 (0.8)	470	30.1 (0.8)	418	0.04[a] n.s.[b]
20mSRT (stages)	1.7 (0.05)	418	1.7 (0.05)	403	n.s.[a] n.s.[b]
Health knowledge score (%)					
Parental score	61.7 (0.7)	448	61.7 (0.8)	413	n.s.[a] n.s.[b]
Children's score	68.4 (0.5)	526	68.4 (0.5)	453	n.s.[a] n.s.[b]

($P < 0.05$ in both tests) occurs in the serum triglyceride level with mean levels being 53.3 mg/dl (SE 1.1) for those reexamined and 58.8 mg/dl (SE 1.2) for those only measured at baseline.

At baseline, the intervention group had significantly higher average values of TC and LDL than the controls, the measurements being displayed in Table 2 (mean TC levels 187.4 mg/dl, SE 1.8, and 177.3 mg/dl, SE 2.3, $P = 0.001$; and mean LDL levels 117.4 mg/dl, SE 1.8, and 106.2 mg/dl, SE 2.2, $P < 0.0005$, for interventions and controls, respectively). The mean 20mSRT measurement at baseline in the intervention group (Table 3) was significantly lower than that in the control group (1.6 vs 1.9 stages with SE 0.05 and 0.08, respectively,

TABLE 2

Comparisons of Serum Lipid Levels for Intervention and Control Groups

Serum lipids	Group[a]	Baseline mean (SE)	Follow-up mean (SE)	Change[b] mean (SE)	*P* value
Total serum cholesterol (mg/dl)	I	187.4 (1.8)	173.7 (1.8)	−14.0 (1.6)	0.001
	C	177.3 (2.3)	190.6 (2.4)	10.5 (2.1)	
LDL-C (mg/dl)	I	117.4 (1.8)	111.6 (1.6)	−5.0 (1.4)	0.001
	C	106.2 (2.2)	124.6 (2.2)	16.5 (1.8)	
HDL-C (mg/dl)	I	59.6 (0.9)	53.6 (0.9)	−6.6 (0.8)	n.s.
	C	14.6 (1.1)	57.3 (1.0)	−5.0 (1.1)	
TC/HDL ratio	I	3.3 (0.1)	3.5 (0.1)	0.2 (0.1)	n.s.
	C	3.1 (0.1)	3.5 (0.1)	0.5 (0.1)	
LDL/HDL ratio	I	2.1 (0.05)	2.3 (0.1)	0.3 (0.1)	n.s.
	C	1.9 (0.1)	2.3 (0.1)	0.5 (0.1)	
Triglycerides (mg/dl)	I	52.4 (1.3)	42.9 (1.5)	−12.3 (1.8)	n.s.
	C	52.6 (1.4)	43.8 (1.8)	−3.9 (2.3)	

[a] Restricted to pupils with repeated measurements. I, intervention (248 pupils); and C, control (177 pupils). Data for baseline and follow-up are unadjusted means and standard errors.

[b] The estimated (GLM) change has been adjusted for baseline values, sex, initial BMI, change in height, and parental education. The *P* value compares I with C.

TABLE 3

Comparisons of Anthropometric Variables for Intervention and Control Groups

Anthropometric variables	Group[a]	Baseline mean (SE)	Follow-up mean (SE)	Change[b] mean (SE)	*P* value
Height (cm)	I	118.3 (0.3)	134.2 (0.4)	15.5 (0.2)	0.009
	C	122.1 (0.4)	134.2 (0.4)	11.8 (0.2)	
Weight (cm)	I	22.8 (0.3)	30.9 (0.4)	7.4 (0.2)	n.s.
	C	24.4 (0.3)	32.8 (0.5)	9.1 (0.3)	
BMI (kg/m^2)	I	16.2 (0.1)	17.0 (0.2)	0.7 (0.1)	0.001
	C	16.3 (0.2)	18.1 (0.2)	1.8 (0.1)	
Biceps skinfold (mm)	I	4.8 (0.1)	6.0 (0.2)	0.6 (0.1)	n.s.
	C	5.5 (0.2)	6.4 (0.2)	1.1 (0.2)	
Triceps skinfold (mm)	I	10.2 (0.3)	10.9 (0.3)	−0.3 (0.3)	n.s.
	C	11.9 (0.4)	11.5 (0.3)	−0.04 (0.3)	
Suprailiac skinfold (mm)	I	6.7 (0.4)	8.3 (0.3)	0.8 (0.2)	0.04
	C	7.0 (0.4)	9.6 (0.4)	2.9 (0.3)	
Subscapular skinfold (mm)	I	6.8 (0.2)	8.1 (0.3)	0.6 (0.2)	n.s.
	C	7.4 (0.4)	8.4 (0.3)	1.1 (0.3)	

[a] Restricted to cohort substudy pupils with paired data. I, intervention (248 pupils); and C, control (177 pupils).
[b] Data for baseline and follow-up are unadjusted means and standard errors. The estimated (GLM) change has been adjusted for baseline values, sex, initial BMI, change in height, and parental education. The *P* value compares I with C.

$P = 0.001$). There was also strong evidence ($P < 0.005$) that the control group pupils had higher health knowledge scores at baseline (mean values presented in Table 7). There were also differences of the same direction in the parental health knowledge scores ($P < 0.05$). None of the other baseline measurements differed significantly between the groups

In Table 2 are presented the baseline and 3-year serum lipid measurements. Following 3 years of intervention, the total serum cholesterol levels had displayed a decrease in the intervention group while they had increased in the control group ($P = 0.001$) with follow-up mean values of 173.7 mg/dl (SE 1.8) in the intervention group and 190.6 mg/dl (SE 2.4) in the controls. There was a similar effect displayed in LDL levels, which decreased on average in the intervention group while in the controls the average LDL levels exhibited an increase ($P = 0.001$), the mean levels at follow-up being 111.6 mg/dl (SE 1.6) for the intervention group pupils and 124.6 mg/dl (SE 2.2) in the control group pupils.

The anthropometric measurements are displayed in Table 3. Children from the intervention group were found to have had a significantly higher average gain in height over 3-year period, compared to the control group pupils (adjusted mean gains were 15.5 cm, SE 0.16, for the intervention group and 11.8 cm, SE 0.19, for the controls, $P = 0.009$). Control group pupils had a significantly higher change in mean BMI than intervention group pupils (adjusted mean gain 1.8 kg/m^2 cf, 0.7 kg/m^2, $P = 0.001$) and suprailiac skinfold (2.9 vs 0.8 mm, $P < 0.05$) when adjusting for the change in height, sex, parental educational group, and baseline values.

With reference to the dietary data, there were no significant differences between the intervention and the control group in the weekly food consumption levels at follow-up when controlling for baseline levels, sex, BMI, and parental education. The nutrient intakes as estimated by the 3-day weighed food record are presented in Table 4.

Table 5 depicts the results concerning time spent in MVPA out of school. Intervention group pupils displayed a significantly greater increase in time spent in MVPA over the 3-year period, compared to the control group (adjusted increases of 2.0 vs 0.4 h/week, $P < 0.0005$).

Table 6 presents the fitness indices. There were significantly greater mean increases in both the SBJ and the SUP measurements over the 3-year period in the intervention group, when controlling for initial values, sex, change in height, parental educational group, and initial BMI (mean adjusted increases of 27.0 cm, SE 0.9, and 26.1 cm, SE 1.3, in the SBJ test and 7.8 repetitions, SE 0.3, and 5.3 repetitions, SE 0.4, for intervention and control groups, respectively).

In Table 7 it can be seen that increases in the children's mean health knowledge scores by midterm were significantly higher in the intervention group (with adjusted mean increases of 12.5 and 10.3% for interventions and controls, respectively). There were no significant differences in the increase in the parents' health knowledge scores between the two groups.

DISCUSSION

The positive 3-year outcomes of the present study regarding obesity indices and serum lipids are clearly of value in light of the frequent lack of significant short-term improvements in the particular indices [*34–36*] or

TABLE 4

Comparison of Daily Nutrient Intake for Intervention and Control Groups

	Group[a]	Baseline mean (SE)	Follow-up mean (SE)	Change[b] mean (SE)	*P* value
Energy (kcal)	I	1,872.8 (91.7)	2,169.2 (50.7)	269.7 (99.1)	n.s.
	C	1,867.5 (55.5)	2,180.5 (53.0)	296.8 (69.6)	
Total fat (g)	I	99.2 (3.9)	109.2 (3.3)	8.3 (6.3)	n.s.
	C	96.8 (3.8)	110.6 (3.1)	9.0 (4.4)	
Monounsaturated fatty acids (g)	I	43.3 (1.9)	47.2 (1.7)	3.3 (3.6)	n.s.
	C	41.3 (2.0)	47.2 (1.7)	2.9 (2.5)	
Polyunsaturated fatty acids (g)	I	11.3 (0.5)	13.2 (0.6)	1.0 (1.1)	n.s.
	C	11.4 (0.5)	12.7 (0.5)	1.6 (0.8)	
Saturated fatty acids (g)	I	34.4 (1.6)	35.9 (1.2)	2.7 (2.4)	n.s.
	C	32.9 (1.3)	37.7 (1.1)	2.7 (1.7)	
Trans fatty acids (g)	I	1.5 (0.1)	1.6 (0.1)	0.0 (0.2)	n.s.
	C	1.6 (0.1)	1.7 (0.1)	0.1 (0.2)	
Cholesterol (mg)	I	304.9 (18.3)	378.5 (19.6)	71.5 (35.3)	n.s.
	C	322.4 (18.6)	351.8 (15.0)	22.5 (24.9)	
Protein (g)	I	63.8 (2.7)	74.1 (2.1)	6.4 (4.3)	n.s.
	C	65.6 (2.4)	72.3 (2.1)	7.8 (3.0)	
Carbohydrate (g)	I	202.7 (13.3)	237.6 (6.4)	38.4 (12.4)	n.s.
	C	202.8 (6.7)	238.6 (6.9)	36.3 (8.7)	
Fiber (g)	I	3.5 (0.2)	4.1 (0.9)	0.05 (0.4)	n.s.
	C	3.8 (0.2)	4.2 (0.2)	0.5 (0.3)	

[a] Restricted to pupils with repeated measurements. I, intervention (76 pupils); and C, control (63 pupils). Data for baseline and follow-up are unadjusted means and standard errors.
[b] The estimated (GLM) change has been adjusted for baseline values, sex, initial BMI, change in height, and parental education. The *P* value compares I with C.

restricted significant improvements [*37,38*] in primary school health education interventions worldwide. To our knowledge, there are six published studies regarding primary school interventions, four with programs similar to ours [*39–42*] and two with nutrition intervention alone [*43,44*], in which findings like ours were observed. Similar findings to the present study have also been observed in certain school-based health education studies that applied similar interventions in schools with students from low and middle socioeconomic backgrounds [*23*] and school children with baseline TC values greater than 170 mg/dl [*45*]. It is likely that the difficulty in lowering lipoprotein levels in children is due to the reported age-dependent increase in total cholesterol levels during childhood [*46,47*].

The positive findings of the present study can be attributed both to the effectiveness of the school-based intervention and to the seminars organized for parents with the high parental participation rate. The range of materials provided for teachers was designed to minimize any effects of possible teacher-delivery variability between the intervention schools. The teacher seminars were also designed to provide standardized preparatory materials, and the research team was available to provide support [*48*]. Periodic monitoring of teacher delivery of the program by the research team indicated good compliance with the program in terms of hours taught and the materials utilized. This was reinforced by reports of compliance from the school inspectors. The PE instructors in particular viewed the project with enthusiasm as it is the first time in Greece that PE instructors have been asked to teach first to third grade pupils, and they viewed it as a challenge. It was also the first

TABLE 5

Comparison of Leisure Time Physical Activity for Intervention and Control Groups

	Group[a]	Baseline mean (SE)	Follow-up mean (SE)	Change[b] mean (SE)	*P* value
Leisure-time MVPA	I	0.9 (0.1)	2.8 (0.2)	2.0 (0.3)	<0.0005
(h/week)	C	1.4 (0.1)	2.0 (0.2)	0.4 (0.3)	

[a] Restricted to pupils with repeated measurements. I, intervention (199 pupils); and C, control (149 pupils). Data for baseline and follow-up are unadjusted means and standard errors.
[b] The estimated (GLM) change has been adjusted for baseline values, sex, initial BMI, change in height, and parental education. The *P* value compares I with C.

TABLE 6

Comparison of Fitness Indices for Intervention and Control Groups

Fitness tests	Group[a]	Baseline mean (SE)	Follow-up mean (SE)	Change[b] mean (SE)	*P* value
Standing broad jump (cm)	I	84.7 (0.9)	113.2 (1.0)	27.0 (0.9)	0.023
	C	85.5 (1.1)	107.8 (1.2)	26.1 (1.3)	
Sit-ups (repetitions)	I	7.2 (0.3)	15.1 (0.3)	7.8 (0.3)	<0.0005
	C	7.8 (0.5)	12.7 (0.4)	5.3 (0.4)	
Sit and reach (cm)	I	15.4 (0.3)	15.1 (0.4)	−0.2 (0.3)	n.s.
	C	15.8 (0.4)	14.6 (0.5)	−1.3 (0.4)	
Handgrip (kg)	I	6.7 (0.2)	12.3 (0.2)	5.5 (0.2)	n.s.
	C	7.0 (0.2)	13.2 (0.2)	6.3 (0.2)	
Endurance run (stages)	I	1.6 (0.05)	3.2 (0.1)	1.7 (0.1)	n.s.
	C	1.9 (0.1)	3.0 (0.1)	1.4 (0.1)	

[a] Restricted to pupils with repeated measurements. I, intervention (248 pupils); and C, (177 pupils). Data for baseline and follow-up are unadjusted means and standard errors.

[b] The estimated (GLM) change has been adjusted for baseline values, sex, initial BMI, change in height, and parental education. The *P* value compares I with C.

time that the PE classes were accompanied by a workbook for pupils and a teacher's instruction manual explaining, in addition to teaching strategies, the importance of their input into the program.

Since it is generally recognized that the family plays an important role in shaping children's eating and exercising habits [*13*], parental involvement has become an integral part of the majority of school-based health education programs [*21,34,39,43,45*]. However, contrary to previous reports [*49*], there was an adequate level of parental involvement in the present program. A factor that may have contributed to parental participation at the scheduled meetings was the fact that the medical and biochemical findings pertinent to the children were not mailed to the parents but were handed to them during these meetings. Furthermore, the increase in parental health knowledge issues following the 3-year period is indicative of the impact of the program on the parents. However, the parental seminars and school-based intervention applied in the present study did not indicate any significant dietary changes. This may be due to difficulties in gaining changes in dietary habits in interventions, such as the present one, where school meals are not provided (as meals are not available in Greek schools). Significant changes in diet are more likely to be obtained from interventions involving school restaurants with control home interventions [*50*] or school restaurants alone [*22,50*]. On the other hand, the lack of significant dietary changes may be the result of the small proportion of subjects providing dietary records.

As no dietary changes were observed, the positive outcomes of the intervention regarding serum lipids and the obesity indices could be explained by the increased physical activity both out of school and during school hours. In previous controlled studies, exercise conditioning in apparently healthy young children either in the form of exercise training trials [*51–53*] or in the form of extended PE classes [*54*] was not found to have an effect on TC and LDL-C levels. However, a meta-analysis combining 95 studies on exercise training found the serum lipid levels to be affected most when the intervention was accompanied by decreases in weight [*55*]. Furthermore, non-school-based interventions applying dietary counseling [*56,57*], exercise interventions alone [*58*], or a combination of both [*59–*

TABLE 7

Comparisons of Health Knowledge Scores for Intervention and Control Groups

Total scores (% correct responses)	Group[a]	Baseline mean (SE)	Follow-up mean (SE)	Change[b] mean (SE)	*P* value
Pupils	I	66.5 (0.6)	80.7 (0.3)	12.5 (0.5)	<0.0005
	C	71.0 (0.7)	79.2 (0.3)	10.3 (0.4)	
Parents	I	60.2 (1.0)	66.4 (1.0)	7.5 (1.2)	n.s.
	C	63.4 (1.0)	66.4 (1.1)	3.7 (1.1)	

[a] Restricted to pupils and parents with repeated measurements. I, intervention (248 pupils and 185 parents); and C, control (177 pupils and 132 parents). Data for baseline and follow up are unadjusted means and standard errors.

[b] The estimated (GLM) change has been adjusted for baseline values, sex, initial BMI, change in height, and parental education. The *P* value compares I with C.

62] on hypercholesterolemic or obese children are consistent with ours in showing significant improvements in obesity indices and/or serum lipid levels. These results have been attributed to the increased energy expenditure resulting from significantly increased physical activity while the calorie consumption remained stable or even decreased [63]. This could also be applied to the present study where the baseline data indicate high levels of hypercholesterolemia and obesity in the children. According to the baseline data, 33% of the children were classified as obese according to the WHO/FAO weight for height cutoff point [64] and 38% had TC values above 170 mg/dl, with 29% having TC values above 200 mg/dl. These indicators are on the whole in agreement with the findings of recent studies on Greek children [11] and adolescents [10] and have been attributed to poor dietary knowledge and habits along with the sedentary lifestyle of contemporary Greeks [7,12].

Finally, the significant increase in the intervention group children's health knowledge can be attributed mainly to the classroom-based health education curriculum. These findings are in agreement with the findings of other primary school nutritional education studies with [23,44] or without [65–67] parental involvement, as well as with studies that combined nutritional education with promotion of physical activity and fitness [21,34,35,41,42,65]. In addition, the total number of school hours devoted annually to the intervention in the present study exceeded the 40- to 50-h cutoff proposed by Contento et al. [66] for effectiveness in improving both health knowledge and behaviors. It has been similarly observed by Bush et al. [41] and Resnicow et al. [42] that the effectiveness of this type of intervention is related to the intensiveness of the program [42] but also to teachers' ability and enthusiasm [41].

A statistical consideration to be borne in mind in the interpretation of the findings is that the sampling procedure used to allocate the schools was not a completely randomized procedure. Having been chosen at random, schools were allocated to intervention and control according to the county in which they lay. There was no prior reason to believe that this could lead to biased results as the three counties are very similar with regard to population distribution, socioeconomic status of residents, etc., but the rigorous statistical analysis required becomes extremely difficult to perform. Mixed effect linear model analyses, fitted by generalized least squares, were used with the random effect school incorporated into the model. Only the interschool variation (and not the theoretically possible interclass variation) was accounted for because there were relatively few schools with more than one class for each year (3 of 21 at follow-up) and the classes in the same year in the latter schools shared the same physical activity lessons. The school, therefore, was chosen as the unit of analysis. During the 3-year period some pupils in these three schools changed from one class to another although they remained within the same school. It was not possible to apply multilevel modeling (hierarchical linear modeling) or generalized estimating equations to take account of any within-school clustering because of lack of available software [69].

To summarize, the significant changes observed in the intervention group compared to the control group can be attributed to the high parental participation in the program, the baseline data of the overall population (health knowledge, obesity, serum lipids, and dietary and exercising habits) which had room for significant improvements and the organized and expanded PE classes. Combining the health education program with the PE classes optimized the physical activity and fitness as well as the nutritional component of the program thus allowing more hours of intervention with the least possible interference for the remainder of the curriculum. Such interventions provide an important model for school-based health promotion programs for primary prevention of CVD, without requiring substantial school time or new resources [34].

ACKNOWLEDGMENTS

This study was funded by the EU, the Europe Against Cancer program and the Mediterranean Integrated Program of Crete, General Secretary of the Periphery of Crete. We would also like to acknowledge the help of our colleagues Caroline Codrington, Ioanna Apostolaki, Fotini Chiladaki, Eleni Kantidaki and George Mamalakis. We would also like to thank the Directors of the Boards of Education in the counties of Heraklio, Rethymno and Hania during the 1992 to 1995 time period for their cooperation: Manolis Gondikakis, Grigoris Smirnakis, Kostas Flouris, Theoharis Doukakis, Yiannis Fotakis, Manolis Voludakis and Spiros Aligizakis. Our thanks also go to Evaggelia Balomenaki, Director of the Pediatric Clinic in Chania and the pediatricians Hara Galanaki and Dimitris Athanasopoulos for their valuable contribution in the Chania field assessments. Finally, we would like to thank the Archbishop Ireneos of Chania for the hospitality and accommodation provided to our research team in Hania.

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