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Health and nutrition education in primary schools in Crete: 10 years' follow-up of serum lipids, physical activity and macronutrient intake

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The current study is a 4-year follow-up after the 6-year-long health and nutrition intervention programme applied in the primary schools of Crete. The aim of the current work was to identify whether the benefits obtained in certain health indices at the end of the intervention period were also present 4 years later. From a representative population of 441 pupils (250 from the intervention schools and 191 from the control schools), biochemical, dietary and physical activity data were obtained at baseline, at the end of the intervention period and after intervention (academic years 1992–1993, 1997–1998 and 2001–2002, respectively). The findings of the current study revealed that the favourable changes in serum lipids observed at the end of the intervention period were maintained from baseline to after intervention for total cholesterol (−24·3 (SE 1·65) *v.* −9·70 (SE 2·03) mg/dl; $P=0·001$), LDL-cholesterol (−18·6 (SE 1·41) *v.* −2·49 (SE 1·75) mg/dl; $P<0·001$), HDL-cholesterol (−8·34 (SE 0·75) *v.* −9·60 (SE 1·10) mg/dl; $P=0·014$) and total cholesterol : HDL-cholestrol ratio (0·31 (SE 0·06) *v.* 0·04 (SE 0·05); $P=0·001$). Similar favourable changes for the intervention group were observed in leisure-time physical activities (38·3 (SE 11·7) *v.* −13·2 (SE 10·9) min/week; $P=0·038$) and BMI (6·05 (SE 0·18) *v.* 6·67 (SE 0·21) kg/m^2; $P=0·014$), whereas no changes were observed in the fitness and dietary indices examined. The findings of the current study are encouraging, indicating maintenance of the favourable changes observed in serum lipids, BMI and physical activity 4 years after the programme had ended.

Nutrition education: Children: Diet and physical activity: Serum lipids: Obesity

Over the past 30 years, increased mortality rates from CVD have been observed in the Greek adult population (Kafatos, 1998; Pitsavos *et al.* 2003). This upward trend is attributed mainly to the dietary and smoking habits, sedentary lifestyle and limited health awareness of contemporary Greeks (Kafatos, 1998; Kafatos *et al.* 1999). However, both the physiological precursors of CVD, as well as the behavioural patterns related to the development of the disease, have their roots in childhood (Cohen, 2004). Recent data have reaffirmed the link between risk factor exposure in childhood and adolescence, and preclinical atherosclerosis in adulthood (Li *et al.* 2003; Raitakari *et al.* 2003). In addition, several longitudinal studies have demonstrated the tracking of certain behaviours related to an increased risk of CVD from childhood to young adulthood (Janz *et al.* 2000; Boreham *et al.* 2004; Mikkila *et al.* 2004).

The beneficial effect of physical activity and diet on cardiovascular health is well recognized. In particular, the risk of CVD mortality or morbidity is inversely related to the level of physical activity (Wei *et al.* 1999; Lee *et al.* 2000; Sesso *et al.* 2000), whereas the adoption of a diet low in saturated fat and rich in olive oil, fruits and vegetables favourably affects certain health indices and reduces the odds of CVD risk (Law, 2000; Pitsavos *et al.* 2002). These studies raise the importance of an early promotion of healthy dietary patterns and a physically active lifestyle as a potential protective tool for preventing adverse health outcomes in adulthood.

Based on this approach, several school-based health and nutrition education programmes have been implemented worldwide. Although the short-term benefits of the preventive potential of such programmes (Luepker *et al.* 1996; Harrell *et al.* 1998; Manios *et al.* 2002; Hayman *et al.* 2004) are encouraging, it should not be forgotten that the success of such interventions is best judged in the long term, several years after intervention, in adolescence or adulthood.

To our knowledge, the only school-based study that has conducted a post-intervention follow-up is the Child and Adolescent Trial for Cardiovascular Health (CATCH) study. The intervention applied by the CATCH study was multicomponent, targeting both pupils' behaviour and school environment (i.e. food services and physical education classes). The findings of the follow-up examination 3 years after the programme's cessation revealed a maintenance of the favourable behavioural changes observed during the intervention period, but no changes were observed for the biochemical indices examined (Nader *et al.* 1999). Regarding the school environment, the favourable changes achieved in the food services and physical education classes during

Abbreviations: CATCH, Child and Adolescent Trial for Cardiovascular Health; CG, control group; ERT, endurance run test; HDL-C, HDL-cholesterol; IG, intervention group; LDL-C, LDL-cholesterol; MVPA, moderate-to-vigorous physical activity; TC, total cholesterol; TG, triacylglycerol.

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the intervention period were also present 4 years after the end of the programme, indicating a long-term effect on institutionalizing these changes into school operation (Kelder *et al.* 2003; McKenzie *et al.* 2003; Osganian *et al.* 2003).

The limited post-intervention data from school-based programmes, as well as the importance of such indices in assessing their long-term effectiveness, has led the Preventive Medicine and Nutrition Clinic to undertake a 10-year follow-up of the Cretan Health and Nutrition Education Programme. In this context, the current study aimed to assess whether the benefits obtained in certain health indices over the 6-year intervention period (Manios *et al.* 1998*a*, 1999; Manios & Kafatos, 1999) were also present 4 years after intervention.

Methods

The Cretan Health and Nutrition Education programme was initiated in September 1992 with the approval of the Greek Ministry of Education (Manios *et al.* 1998*a*, 1999; Manios & Kafatos, 1999). The population of the intervention group (IG) comprised 4171 children registered in the first grade of primary schools throughout the counties of Iraklio and Rethimno in September 1992, while the 1510 children registered in the county of Hania served as the control group (CG). The total duration of the programme was 6 years, following the same children from the first grade to the sixth grade. The applied intervention programme was based on the health profile component of the 'Know Your Body' school health-promotion programme of the American Health Foundation (Williams *et al.* 1977; Walter & Wynder, 1989), which was adapted, modified and supplemented to suit the population studied. A complete and detailed description of the theoretical framework on which the design and implementation of the intervention were based has been provided by Manios *et al.* (1999) at an interim evaluation of the programme.

A random sample of 24 schools in the intervention counties of Iraklio and Rethimno were selected in order to assess the effectiveness of the programme. Similarly, 16 schools randomly selected in the county of Hania, at which no intervention was delivered, were used as a control group for comparative evaluation purposes. Reflecting the geographical distribution of the population, 49·8 % of these pupils came from urban areas (towns with a population above 40 000) and 50·2 % came from rural areas (villages with a population less than 4000). Both intervention and control pupils, and their parents, were examined at baseline (academic year 1992–1993) and at the end of the 6-year intervention period (academic year 1997–1998). The final re-examination of both groups took place 4 years after the end of the programme (academic year 2001–2002) and when pupils were in the tenth grade.

The findings presented in the current paper have been based on those pupils participating in all three examinations (i.e. baseline, end of intervention and post-intervention). Parental socio-economic data were obtained at baseline, whereas pupils' anthropometrical, biochemical and behavioural (dietary and physical activity) indices were obtained in all three examinations following the same procedures (Manios *et al.* 1998*a*, 1999, 2002).

More specifically, BMI was calculated by dividing weight (kg) by height squared (m^2). Biochemical indices were assessed using venous blood samples obtained from children early in the morning, after 12 h overnight fasting. One aliquot of serum was used for the blood analysis of triacylglycerols (TG), total cholesterol (TC) and HDL-cholesterol (HDL-C) measurements on the same day of collection. LDL-cholesterol (LDL-C) was calculated as follows: $LDL-C = TC + HDL-C - (TG/5)$ (Friedewald *et al.* 1972).

Children's dietary intake was obtained from a random sample of 30 % of the baseline cohort by the provision of a weighed record of all foods consumed over a 3 d period. Thus, complete dietary intake data from all three examinations were obtained for 136 pupils. Furthermore, children's leisure-time physical activity was assessed using a standardized activity questionnaire completed by the parents at baseline and by the pupils themselves at the follow-up examinations. In all cases, the questionnaire was completed in the presence and with the assistance of a member of the research team, assessing any kind of moderate-to-vigorous physical activity (MVPA) of intensity higher than four metabolic equivalents and duration longer than 30 min. More information on the validity and reliability of the questionnaire used are provided elsewhere (Manios *et al.* 1998*b*). Cardiorespiratory fitness was assessed with the use of the 20 m endurance run test (ERT) as described by the EUROFIT Tests Protocol (Committee of Experts on Sports Research, 1988).

Data were reported as means and their standard errors or as medians (25–75th percentiles). The unpaired Student's *t* test and the non-parametric Mann–Whitney test were used to evaluate any possible differences in baseline measurements for normally and non-normally distributed variables, respectively, between those subjects participating in all three examinations and those who dropped out. General linear mixed model analysis was further used to evaluate the differences between the IG and CG regarding the changes observed in serum lipids, nutrient intake, ERT score and MVPA over the 6-year intervention period and the 10-year follow-up and after controlling for gender, parental educational level, BMI and baseline values. Interschool variation was taken into account by including the random school effect in the model. Furthermore, two stepwise multiple linear regression analyses were carried out in order to assess the parameters related to the changes observed for serum lipids over the 10-year follow-up. The first analysis (model 1) was conducted for 432 subjects, including participation in the intervention programme and the changes observed in BMI and MVPA as independent variables. The second analysis (model 2) was conducted for 132 subjects, including the same independent variables as in model 1 as well as changes in fitness and dietary indices (energy and macronutrient intake). Both analyses were corrected for parental educational level. SPSS 11.0 (SPSS Inc., Texas, USA) software was used to carry out all analyses. The level of statistical significance was set at $P \leq 0{\cdot}05$.

Results

Prior to the baseline examination at 1992, parental signed consent forms were obtained for 1046 children. From this cohort, complete baseline anthropometrical, biochemical and parental socio-economic data were, however, finally obtained from 716 children and their parents. Based on the biochemical data available at the end of the intervention and at the post-intervention examination, the participation rates were 84 % and 61 %, respectively. The primary reason explaining drop-outs and losses-to-follow-up was the transition from primary to high school. As the current programme was a school-based one, those children who moved to different locations could not be tracked.

Table 1 indicates that the average baseline values for most of the variables assessed did not differ significantly between those pupils available after intervention and those who dropped out. The only exception was baseline serum TG concentration, which was significantly higher in those pupils not re-examined at follow-up, compared with those participating in all three examinations (mean 58·7 (SE 2·03) *v*. mean 52·9 (SE 0·99) mg/dl; $P=0·004$).

Table 2 presents the changes in serum lipid levels in the IG and the CG, over the intervention period and at the post-intervention follow-up examination. The differences between the two groups regarding the changes in LDL-C and TC : HDL-C ratio during the 6-year intervention period were in line with those presented in a previous publication (Manios *et al.* 2002), favouring the IG pupils. Over the 10-year period from baseline to post-intervention follow-up examination, the current study revealed a significantly higher decrease in serum TC and LDL-C concentrations for the IG than the CG pupils (−24·3 (SE 1·65) *v*. −9·70 (SE 2·03) mg/dl, $P=0·001$; −18·6 (SE 1·41) *v*. −2·49 (SE 1·75) mg/dl, $P<0·001$). Furthermore, the decrease observed in serum HDL-C concentration was significantly lower for the IG than the CG subjects (−8·34 (SE 0·75) *v*. −9·60 (SE 1·10) mg/dl; $P=0·014$), whereas the increase in TC : HDL-C ratio was significantly higher for the CG than the IG (0·31 (SE 0·06) *v*. 0·04 (SE 0·05); $P=0·001$).

The results of the stepwise multiple linear regression analysis are summarised in Table 3. As indicated by both regression models (models 1 and 2), participation in the intervention programme significantly accounted for the favourable changes observed in TC, LDL-C and TC : HDL-C ratio. Furthermore, the initial analysis (model 1) revealed that the change observed for BMI was positively associated with the changes in LDL-C, TC : HDL-C ratio and TG, whereas an inverse relationship was found between the change in leisure-time MVPA and the changes observed for TC, TC : HDL-C ratio and TG. When, however, fitness and dietary indices were included in the analysis (model 2), some of these associations between changes in leisure-time MVPA and BMI with TC, LDL and TG lost their significance. Finally, and as indicated by the second regression model, the change in ERT score was found to be inversely associated with the changes observed in the concentrations of TC and TG. No other significant correlations were observed.

Changes in certain anthropometrical, physical activity and fitness indices are summarised in Table 4. In accordance with previously presented data (Manios *et al.* 2002), the changes over the 6-year intervention period in BMI, leisure-time MVPA and ERT score were in favour of the IG subjects. Regarding the changes observed over the 10-year period, from baseline to the post-intervention follow-up examination, the increase in BMI was significantly lower for the IG than the CG pupils (6·05 (SE 0·18) *v*. 6·67 (SE 0·21) kg/m^2; $P=0·014$), although BMI increased in both groups. Furthermore, the IG pupils significantly increased the time they devoted to MVPA compared with the CG children, in whom a decrease was observed (38·3 (SE 11·7) *v*. −13·2 (SE 10·9) min/week; $P=0·038$). The changes in ERT score over the same period did not, however, differentiate significantly between the two groups.

As indicated in Table 5, and consistent with previously presented data (Manios *et al.* 2002), there were notable differences in the extent to which the nutrient intake changed in the two groups during the 6-year intervention period. More specifically, the increases over this period in the average total fat, saturated fat, monounsaturated fat and protein intake were significantly higher in the CG than in the IG ($P<0·05$). Nonetheless, there

Table 1. Baseline measurements obtained from pupils who dropped out or were lost to follow-up and those with complete participation in all three examinations

	Pupils who dropped-out or were lost to follow-up		Pupils participating in all three examinations		
	Mean	SE	Mean	SE	*P*
Anthropometric indices		(*n* 298)		(*n* 483)	
Weight (kg)	23·8	4·97	23·5	4·50	0·398
Height (cm)	119·9	5·29	120	5·85	0·931
BMI (kg/m^2)	16·5	2·67	16·2	2·17	0·209
Biochemical indices		(*n* 275)		(*n* 441)	
Total cholesterol (mg/dl)	183·8	2·12	182·2	1·44	0·458
HDL-cholesterol (mg/dl)	58·6	0·91	60·1	0·66	0·166
LDL-cholesterol (mg/dl)	113·8	2·03	111·2	1·39	0·285
Triacylglycerols (mg/dl)	58·7	2·03	52·9	0·99	0·004
Fitness		(*n* 358)		(*n* 323)	
Endurance run test (number of stages)	1·73	0·04	1·8	0·05	0·053
Dietary indices		(*n* 76)		(*n* 136)	
Energy intake (kJ/d)	7502·7	226·6	7724·6	151·9	0·408
Total fat intake (g/d)	84·1	2·82	87·1	2·05	0·393
Saturated fat intake (g/d)	30·5	1·21	30·8	0·74	0·814
Monounsaturated fat intake (g/d)	34·6	1·23	36·8	1·04	0·226
Polyunsaturated fat intake (g/d)	9·72	0·55	9·58	0·26	0·804
Protein intake (g/d)	62·4	2·19	62·9	1·55	0·864
Carbohydrate intake (g/d)	195·2	6·88	202·8	4·55	0·360
Physical activity*	Median	25–75th percentile (*n* 254)	Median	25–75th percentile (*n* 425)	
Moderate-to-vigorous physical activity (min/week)	0·0	0·0–120·0	0·0	0·0–60·0	0·264

* In the case of physical activity, the level of significance was assessed with the non-parametric Mann–Whitney test.

Table 2. Changes in BMI and serum lipids for the intervention (n 250) and control (n 191) group following the 6-year intervention and at the 4-year post-intervention follow-up (10 years from baseline)*

	Baseline (1992)		End of intervention (1998)		6-year change			Follow-up (2002)		10-year change		
Serum lipids	Mean	SE	Mean	SE	Mean	SE	P	Mean	SE	Mean	SE	P
Total cholesterol (mg/dl)												
Control group	174·5	2·19	173·4	2·05	−1·02	1·88	0·013	164·8	1·96	−9·70	2·03	0·001
Intervention group	187·8	1·96	174·3	1·94	−13·6	1·50		163·5	1·92	−24·3	1·65	
LDL-cholesterol (mg/dl)												
Control group	104·2	2·10	103·3	1·73	−0·87	1·65	<0·001	101·7	1·60	−2·49	1·75	<0·001
Intervention group	117.0	1·84	103·5	1·82	−13·5	1·40		98·3	1·64	−18·6	1·41	
HDL-cholesterol (mg/dl)												
Control group	59·6	1·11	56·4	1·09	−3·21	1·09	0·132	50.0	0·83	−9·60	1·10	0·014
Intervention group	60·3	0·79	57·5	0·98	−2·82	0·97		52·0	0·77	−8·34	0·75	
Total cholesterol : HDL-cholesterol												
Control group	3·10	0·07	3·24	0·06	0·14	0·06	0·049	3·41	0·05	0·31	0·06	0·001
Intervention group	3·23	0·05	3·18	0·07	−0·05	0·07		3·27	0·05	0·04	0·05	
Triacylglycerols (mg/dl)												
Control group	53·3	1·59	68·6	1·69	15·3	1·96	0·575	65·1	2.00	11·8	2·19	0·474
Intervention group	52·9	1·33	66·8	1·77	13·9	1·79		65·6	1·80	12·7	1·83	

* The differences between the two groups were evaluated using linear mixed models analysis. Adjustments were made for baseline values, gender and parental education. School was taken as a random effect. Values presented are for those pupils with complete biochemical data in 1992, 1998 and 2002.

were no significant differences between the IG and CG pupils regarding the changes in energy and nutrients intake during the 10-year period from baseline to the post-intervention follow-up examination.

Table 3. Results from stepwise multiple linear regression analysis with the 10-year change in serum lipids concentration as the dependent variables

	Model 1*		Model 2†	
Dependent variable	β_1	P	β_2	P
Δ Total cholesterol (mg/dl)	Adjusted R^2: 0·09		Adjusted R^2: 0·18	
Intervention v.control group	−0·28	<0·001	−0·32	0·010
Δ Moderate-to-vigorous physical activity	−0·12	0·027	−0·12	0·304
Δ Endurance run test score			−0·26	0·032
Δ LDL-cholesterol (mg/dl)	Adjusted R^2: 0·15		Adjusted R^2: 0·49	
Intervention v. control group	−0·37	<0·001	−0·49	<0·001
Δ BMI	1·82	0·048	0·09	0·397
Δ Total cholesterol : HDL-cholesterol	Adjusted R^2: 0·10		Adjusted R^2: 0·27	
Intervention v. control group	−0·16	0·004	−0·27	0·025
Δ BMI	0·27	<0·001	0·35	0·004
Δ Moderate-to-vigorous physical activity	−0·28	0·038	−0·24	0·047
Δ Triacylglycerols (mg/dl)	Adjusted R^2: 0·06		Adjusted R^2: 0·07	
Δ Moderate-to-vigorous physical activity	−0·15	0·005	−0·09	0·473
Δ BMI	0·23	<0·001	0·09	0·474
Δ Endurance run test score			−0·27	0·038

β, standardized beta coefficient; Δ, the change observed for the specific variable over the 10-year period of follow-up re-examination.

* Model 1 was conducted for 425 subjects. Independent variables in the model: 0, control/1, intervention (dummy variable), parental educational level and 10-year change in BMI and moderate-to-vigorous physical activity.

† Model 2 was conducted for 132 subjects. Independent variables in the model: 0, control/1, intervention (dummy variable), parental educational level and 10-year change in BMI, endurance run test, moderate-to-vigorous physical activity, saturated fat intake, monounsaturated fat intake, polyunsaturated fat intake, carbohydrate intake and protein intake.

Discussion

The 10-year follow-up of the Cretan Health and Nutrition Education Programme revealed that the favourable changes observed for serum lipids in the IG compared with the CG, at the end of the intervention period, were also present 4 years after the programme's cessation. The maintenance of favourable changes in serum lipid concentrations for the IG subjects could be mainly attributed to their higher physical activity levels and their lower BMI values, compared with the CG pupils, over the follow-up examination period. This observation is supported by the results derived from model 1 of the multiple linear regression analysis (Table 3), indicating a significant positive effect of participation in the intervention on the changes observed in TC, LDL-C and TC : HDL-C ratio, as well as a negative correlation of these changes with the respective changes observed for leisure-time MVPA and a positive one with the changes in BMI. When the analysis was repeated including fitness and dietary indices in the regression (model 2 in Table 3), many of the aforementioned associations lost their statistical significance, although participation in the intervention remained significant for all variables excluding TG.

The different findings observed with model 2 could be due to the smaller number of subjects which we approximately one third of those included in model 1. Additionally, the significant changes observed for TC and LDL-C over the 10-year follow-up could also be attributed to the unfavourably high levels of these indices obtained for both groups at baseline, leaving space for significant improvement (Lytle *et al.* 2002; Manios *et al.* 2002). This was even more pronounced for the IG, although the sampling procedures followed at baseline aimed to ensure the representativeness and homogeneity of the two groups. Both the unfavourably high levels of the biochemical indices at baseline as well as the differences observed between the two groups for these indices should be kept in mind when interpreting the effectiveness of the current intervention programme, as discussed extensively in previous publications (Manios *et al.* 1999, 2002; Lytle *et al.* 2002).

The existing body of scientific evidence presented in the recent literature highlights the undeniable role of physical activity as an important determinant of certain lipid metabolic adaptations (Hardman, 1999; Durstine *et al.* 2001; Bouziotas *et al.* 2004). The activities of the lipid metabolism enzymes lipoprotein lipase, lecithin cholesterol acyltransferase and hepatic lipase seem to increase in parallel with increases in physical activity level (Superko, 1991; Durstine *et al.* 2001), providing some possible explanations for the findings of the current study. In addition, the positive effect of regular exercise on controlling the concentration of blood lipids could be through weight management as several weight-reduction trials have consistently reported better results when physical activity is included in the treatment protocol (Williams *et al.* 2002).

Indeed, the favourable changes observed in leisure-time MVPA and BMI for the IG pupils at the end of the 6-year intervention period (Manios *et al.* 1998*a*, 2002; Manios & Kafatos, 1999) were partially sustained at the post-intervention examination (Table 4). The data from the current study showed that IG pupils were motivated to continue engaging in MVPA, whereas the MVPA levels of the CG pupils were decreased by 13·2 min/week from baseline to the post-intervention follow-up. However, both IG and CG pupils showed a decline in the mean time devoted to MVPA from age 12 to age 16.

This decline in leisure-time MVPA during this life stage is a common finding in many developed countries (Caspersen *et al.* 2000). Physical activity during adolescence diminishes for a variety of reasons. Adolescents tend to walk or bicycle less and increasingly rely on cars for transportation. Furthermore, a trend away from an active lifestyle and any kind of recreational physical activity is evident, and the reliance on sedentary entertainment, including television, video games and computers, has increased. Although this is true for both sexes, it seems to be more pronounced among girls (Kimm *et al.* 2000). This observation seems to lie in social and cultural beliefs regarding the types of activity appropriate for boys and girls. According to recent evidence, family and society appear to influence the level and type of physical activity that girls are engaged in and may therefore determine their lifetime habits with respect to habitual physical activity (Vilhjalmsson & Kristjansdottir, 2003).

The current finding regarding the smaller decline in leisure-time MVPA by the IG pupils suggests that the effects of intervention were generalized outside the supervised exercise setting and raises the encouraging possibility that the project's effects last beyond the end of the intervention period. Indeed, one of the dominant goals of the programme was to increase the time devoted to MVPA during the physical education classes with activities that were pleasant, non-competitive and cooperative, fostering a greater enjoyment and a sense of mastery for the children (Manios *et al.* 1998*a*). Furthermore, this approach, combined with parental encouragement to support the children in increasing their physical activity out of school, was an essential parameter of the programme, contributing to maintaining some levels of leisure-time MVPA across this life stage (van Beurden *et al.* 2003).

Only a very few studies have so far included a post-intervention follow-up reassessment of physical activity maintenance. The longest follow-ups were 12, 7 and 3 years, respectively, for the Oslo Youth Study, Class of 89 and CATCH study (Kelder *et al.* 1993; Klepp *et al.* 1994; Nader *et al.* 1999). The findings of these previous studies, regardless of the method used to assess physical activity, are in line with those of the current study, showing respective declines during adolescence but still reporting significant increases in physical activity in IG *v*. CG subjects. More specifically, according to data from the CATCH study, the IG pupils had significantly higher levels of physical activity than CG pupils 3 years after the programme ended (Nader *et al.* 1999). Similar findings applied to the former IG subjects of the Class of 89 and Oslo Youth Study, who remained more active some years after the end of the intervention compared with the former CG (Kelder *et al.* 1993; Klepp *et al.* 1994).

Although the current study has indicated significant favourable changes in nutrient intake for the IG compared with the CG pupils at the end of the 6-year intervention period (Manios *et al.* 2002), no such differences were present at the 10-year follow-up (Table 5). The favourable changes observed for the IG at the end of the intervention could be attributed to the intervention approach used by the current school-based intervention programme. Emphasis was laid not only on the adoption of nutrition messages for different school grades, but also on encouraging

Table 4. Changes in BMI, leisure-time physical activity and fitness for the intervention and control group following the 6-year intervention and the 4-year post-intervention follow-up (10 years from baseline)*

	All subjects												
	Baseline (1992)		End of intervention (1998)		6-year change			Follow-up (2002)		10-year change		
	Mean	SE	Mean	SE	Mean	SE	*P*	Mean	SE	Mean	SE	*P*
BMI (kg/m^2)												
Control group (*n* 222)	16·3	0·15	20·3	0·26	4·03	0·17	0·043	23·0	0·29	6·67	0·21	0·014
Intervention group (*n* 261)	16·2	0·13	19·7	0·23	3·53	0·16		22·2	0·25	6·05	0·18	
Moderate-to-vigorous physical activity (min/week)												
Control group (*n* 187)	74·4	11·4	273·0	27·3	198·6	28·3	0·030	61·2	6·87	−13·2	10·9	0·038
Intervention group (*n* 238)	50·0	8·78	365·2	29·9	315·2	30·8		88·3	8·04	38·3	11·7	
Endurance run test (number of stages)												
Control group (*n* 167)	1·84	0·07	3·07	0·12	1·23	0·11	<0·001	3·88	0·17	2·04	0·16	0·169
Intervention group (*n* 156)	1·75	0·07	4·59	0·17	2·83	0·15		4·15	0·17	2·39	0·17	

* The differences between the two groups were evaluated using linear mixed models analysis. Adjustments were made for baseline values, gender and parental education. School was taken as a random effect. Values are presented for those pupils with complete BMI, physical activity and fitness data in 1992, 1998 and 2002.

Table 5. Changes in daily energy and nutrient intake for the intervention (n 70) and control group (n 66) following the 6-year intervention and the 4-year post-intervention follow-up (10 years from baseline)*

	Baseline (1992)		End of intervention (1998)		6-year change			Follow-up (2002)		10-year change		
	Mean	SE	Mean	SE	Mean	SE	P	Mean	SE	Mean	SE	P
Energy intake (kJ/d)												
Control group	7602·8	209·1	8866·0	280·3	1263·3	318·9	0·092	8848·9	412·7	1246·1	450·4	0·322
Intervention group	7728·4	239·7	8423·2	264·0	694·7	284·9		9700·3	467·6	1971·8	494·4	
Total fat intake (g/d)												
Control group	85·9	2·95	101·6	4·04	15·8	4·44	0·035	96·4	5·71	10·6	6·39	0·406
Intervention group	86·5	3·05	92·1	3·78	5·66	4·11		106·0	5·72	19·5	5·82	
Saturated fat intake (g/d)												
Control group	30·1	1·09	34·7	1·27	4·59	1·52	0·022	33·4	2·06	3·25	2·33	0·449
Intervention group	31·0	1·10	31·4	1·31	0·32	1·45		36·7	2·14	5·71	2·23	
Monounsaturated fatty acid intake (g/d)												
Control group	36·4	1·53	44·4	1·94	7·98	2·12	0·024	39·2	2·47	2·76	2·82	0·267
Intervention group	36·0	1·48	39·1	1·90	3·12	2·13		44·1	2·63	8·13	2·65	
Polyunsaturated fatty acid intake (g/d)												
Control group	9·32	0·37	11·3	0·57	2·01	0·61	0·322	11·9	1·04	2·63	1·07	0·788
Intervention group	9·75	0·42	10·9	0·50	1·20	0·54		12·1	0·92	2·31	0·92	
Protein intake (g/d)												
Control group	63·0	2·26	76·7	2·48	13·7	3·19	0·047	71·2	4·09	8·30	4·43	0·650
Intervention group	62·2	2·32	71·2	2·66	9·02	2·97		75·1	3·90	12·9	4·53	
Carbohydrate intake (g/d)												
Control group	196·1	5·77	233·1	7·14	36·9	8·45	0·311	242·3	11·5	45·9	12·4	0·272
Intervention group	206·7	7·77	229·4	7·81	22·7	8·97		269·1	14·1	62·5	15·6	

* Nutrient intakes were assessed in a 30 % subsample. The differences between the two groups were evaluated using linear mixed models analysis. Adjustments were made for baseline values, gender and parental education. School was taken as a random effect. Values are presented for those pupils with complete dietary intake data in 1992, 1998 and 2002.

total class participation and learning through experience. Most importantly, however, developing and promoting a supportive environment within schools and family, thus assisting children to adopt and maintain appropriate food choices, was central to the programme (Manios *et al.* 2002).

These two components, school and family environment, seem crucial in determining food intake during the pre-adolescent life span. At the follow-up examination, however, both the IG and the CG pupils were aged 16. It could be hypothesized that the parameters primarily determining their food preferences and dietary intake were probably different from those at the end of the intervention period, when they were 12. The time between the ages of 12 and 16 years is considered a transition period. Adolescents begin to experience a need for autonomy as well as peer approval. These seemingly conflicting urges tend to result in a shift from parental and teacher influence to peer and media influence upon behaviour. As image and social needs become more important in decision-making, cultural messages become more valued. The act of eating may shift in meaning from a nutritional event to a social event, while food choices may become signs of friendship or symbols of independence. Adolescents take increasing control of what, when and where they eat and typically consume a greater proportion of their total intake outside the home, usually in convenience stores and fast-food restaurants, where pupils of this age often socialize. These parameters could possibly explain the poor maintenance of beneficial dietary patterns of the IG after the end of the intervention programme (Copeland & Hess, 1995).

A limitation of the current study could be the participation rate at the follow-up examination, which was 61 % of the original cohort. The primary reason explaining the loss of subjects through the follow-up re-examination period was the transition phase from primary to high school. As the current programme was a school-based one, those children who moved to different locations could not be tracked. Nonetheless, those children re-examined at follow-up (10th grade) comprised a representative sample of those participating in the sixth-year examination (6th grade), as no significant differences in baseline serum lipids or other health indices were detected between those examined in all three examinations and those not re-examined at follow-up, with the sole exception of TG (Table 1).

Another shortcoming of the current study was the dissociation between the changes observed for leisure-time MVPA and ERT score, especially during the post-intervention period (Table 4). This could, however, probably be attributed to the smaller set of data available on the fitness test, making the changes observed in this index not directly comparable with those obtained for the MVPA. Another interpretation of this dissociation could be the discontinuation reported by recent studies for physical activity and fitness indices from childhood through adolescence. This has been attributed to the strong genetic and physiological component of cardiorespiratory fitness compared with the large behavioural component of physical activity (Janz *et al.* 2000; McMurray *et al.* 2003).

Although the effectiveness of any intervention programme can only be assessed in the long term, the maintenance of the favourable changes obtained in serum lipids during the intervention period 4 years after the end of the programme are encouraging and underline the potential of such initiatives. These positive findings should be attributed to the approach followed by the Cretan Health and Nutrition Education Programme and the cognitive and behavioural changes achieved among pupils and their families during the intervention period. More indicative of the favourable behavioural changes were those observed for leisure-time physical activity, as this was found to remain higher for the IG than the CG pupils 4 years after the programme had ceased. Future health and nutrition education programmes might need to consider involving neighbourhood and society, in addition to school and family, thus developing a social and physical environment that will assist behavioural changes that should be enduring rather than transitory.

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