

## Research Article

# Preventing Obesity and Promoting Oral Health in School-Aged Children by the use of Multi-Targeted Programs: A 3 Year Cohort Study

Fasoulas A<sup>1</sup>, Pavlidou E<sup>1\*</sup>, Kiortsis D<sup>2</sup>, Petridis D<sup>2</sup>, Mantzorou M<sup>1</sup>, Seroglou K<sup>3</sup> and Giaginis C<sup>4</sup>

<sup>1</sup>Department of Food Science and Nutrition, School of Environment, University of the Aegean, Myrina, Lemnos, Greece

<sup>2</sup>Department of Medicine, University of Ioannina, Greece

<sup>3</sup>Department of Food Science and Technology, International Hellenic University, Thessaloniki, Greece

<sup>4</sup>Department of Statistics and Insurance Science, University of Piraeus, Greece

\*Corresponding author: Pavlidou E, Department of Food Science and Nutrition, University of the Aegean Mitropolitou Ioakim 2, Greece

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## Abstract

Purpose of this study was the assessment of three-year programs to promote oral health and adopt healthy eating habits in schoolchildren by a multidisciplinary primary health care team. Participants: 588 children. Programs: Three-year oral health education program and one-year for healthy eating. Results of the study suggest that (1) Dental Caries (DC) prevalence over the three-year period showed a significant improvement of 8%, (2) prevalence of overweight in the second year decreased by 4%, while in the third year with discontinuation of preventive programs the percentage of pre-obesity increased by 10%, (3) the lowest socio-economic level and normal weight were associated with the presence of severe DC, (4) underweighted children were at higher risk of periodontal disease, (5) no significant interactions of obesity and socio-economic status with periodontal disease, nor between obesity and DC, were recorded. In conclusion, our study demonstrates (a) the effectiveness of ongoing systematic programs to prevent and promote oral health and the short-term effectiveness of discontinued programs to promote healthy body weight, (b) the relationship between DC, socio-economic status and Body Mass Index and (c) the highest incidence of periodontal disease in underweighted schoolchildren. Our study highlights the need for ongoing prevention programs in schools.

**Keywords:** Oral Health; Obesity; Dental caries; Schoolchildren; Prevention programs

## Introduction

Health education programs aim to encourage and support children and young people to stay healthy, preventing illness and reducing health-damaging behaviours. Childhood and adolescence are the most appropriate ages for implementing such programs, as behaviours that have a significant impact throughout the lifespan are adopted and consolidated at that time. In addition, schools provide the best possible access to the schoolchildren population [1] and the implementation of these programs is more effective, so the role of school is in prevention is considered particularly important [2] and can play an important role in the implementation of such programs. Modern health education programs include experiential and active learning methods, encourage active student engagement and enhance skills such as decision-making and assessment of the consequences of adopting specific behaviours [3].

The epidemic of obesity constitutes a major public health problem. Because it is a modifiable factor that is related to biological and atomic factors, as well as changing socio-economic and environmental factors, obesity is reversible [4]. Increased values of Body Mass Index (BMI) during childhood and adolescence are important risk factors for the presence of adult overweight or obesity, which can lead to increased morbidity and mortality [5]. Therefore, is needed a “wake-up call”, [6] that involves early identification, [7] reduction and prevention of obesity [5]. Bahia et al., (2018) suggest that interventions taking place in schools and families have positive

results for both obesity and cardiovascular profiles.<sup>8</sup> Obesity, apart from other health effects, also affects oral health and there seems to be an interrelated relationship<sup>9</sup> that makes it necessary to carry out combinational prevention programs.

One of the most common diseases of the oral cavity is Dental Caries (DC), which could also be described as an epidemic, as it is the most prevalent non-communicable disease, as defined by the World Health Organization [10]. Its increased prevalence [11] surpasses in some cases that of obesity and is largely influenced by eating habits (consumption of fermentable carbohydrates) [12]. Also, unlike the body’s mucosal surfaces, which have continuous regeneration of cells, the teeth are not reconfigured [13]. Damage caused by the destruction of hard dental tissues is restorable, but also irreversible.

Another prevalent disease of the oral cavity is periodontal disease, which is a group of inflammatory pathologies that include mainly gingivitis and periodontitis and depends on the level of biofilm accumulation, humoral bacteria, their infectivity and cellular immune responses to microbiome biofilm [14]. Among the factors involved in the periodontal diseases, studies suggest a positive association between obesity and periodontal changes in children [15].

In view of the above, the ultimate aim of this study is to evaluate the effectiveness of prevention programs focusing on maintaining and/or improving oral and dental health, maintaining and pursuing healthy body weight and assimilating healthy attitudes in relation to eating habits.

## Material and Methods

### Population

The program included 588 of the 711 children and adolescents (293 girls and 295 boys) from public schools of northern Greece. The study did not include children a) with special health care needs, [16] b) without parents' signed consent forms, c) who refused to participate and d) who were absent on the day of the visit. The program was held in five pre-primary schools, five primary schools, three middle schools and one high school, in 58 class-divisions and 40 visits per year with an average of 15 participants per visit. The duration of the program per module and per class ranged from 2 to 3 hours and was implemented for primary schools within the flexible zone and for secondary schools in the framework of the implementation of the social school program.

### Prevention programs

The educational program to promote healthy eating was implemented for one year. The oral health promotion program was implemented for three consecutive years. The educational material, themes and educational processes were differentiated according to age group and were developed in a variety of ways (e.g. lectures, experiential education presentations, etc.). Thus, in the pre-primary schools, preventive programs related to the "Consequences of poor nutrition" and "Strong teeth, happy children" were implemented using fairy tales, puppet theatre, energetic play, small theatrical performances, painting, oral hygiene training and creation of the school's menu. In the primary schools, educational programs related to "Promoting healthy eating" took place. The training was conducted through various methodologies such as painting, creative play and development of free thinking and exchange of experiences. Additionally, oral hygiene training (such as proper brushing and flossing techniques, etc.) was implemented. Furthermore an approved training material on "Oral Health" was presented.

In the secondary schools, the actions had as a thematic axis the "Mediterranean-style eating pattern" and the "Oral health promotion". The education of children was supported by experiential learning, role-playing and active participation in the preparation of healthy meals.

### Ethics and morality

Ethical approval for the study was obtained from the Ministry of Education. Head teachers were briefed by government authorities and they were asked to cooperate with the healthcare professionals. The interdisciplinary primary health care team contacted the heads of schools (by phone and electronically) to determine the dates of the sessions in each school. Parents/guardians were informed in writing and asked to submit a signed consent form. During both the exams and the training sessions, the teachers of each class were discreetly present.

### Data collection

Data were collected over the same period in each year of the three years of the study. Individual and demographic data, such as date of birth, gender, class, residence and nationality, were recorded. Different nationalities were considered as a factor of low socio-economic status, as some children were from families of economic migrants employed in agricultural work. The remaining schoolchildren were

considered to have originated in the middle socio-economic category, as the survey was conducted in a rural region without individuals of high socio-economic status.

### Assessment of anthropometric characteristics

Anthropometric measurements were collected using standardized examination procedures and calibrated equipment. BMI was calculated for each subject (as weight in kilograms divided by the square of height in meters) and compared to percentile BMI growth charts for children and adolescents of the same sex and age.

### Assessment of oral and dental health

The assessment of oral health was performed with a complete intraoral and extraoral examination to determine caries, periodontal status and any disorders of the stomatognathic system. The risk of caries was determined by the international DMFT index used in epidemiological studies [17]. This index refers to the number of D: decayed teeth, M: missing teeth due to caries and F: filled teeth due to caries. For statistical convenience, the DMFT was divided into 3 categories: a) DMFT = 0 (no caries disease), b) DMFT = 1-5 (moderate caries disease) and c) DMFT = 6-10 (severe caries disease).

Periodontal condition was divided into two categories based on the presence (yes) or absence (no) of periodontal disease, as determined by the occurrence of bleeding from the gums during the detection, without further categorization.

### Statistical analysis

The statistical analysis relied heavily on the change of percentage over time. Although chi-square tests were used to analyse the significance of the "changes" and other characteristics of the participants, this test did not account for the effects of demographic details (e.g., a wide age range of the participants 4-18 year old), and the effect sizes and the confidence intervals of the effects were not reported.

The DMFT index and periodontal disorder were cross-tabulated with BMI classes and student nationality to detect any particular associations. Overall Pearson's chi-square test and Likelihood ratio of independence were used to detect any cross-tab interactions ( $p \leq 0.05$ ) and cell chi-square values greater than 3.841, referring to a 0.05 probability level of significance, were highlighted. JMP 13.2 (SAS Institute Inc.) software was used for the statistical analysis.

## Results

The percentage of overweight (pre-obesity and obesity) in the 3-year follow-up varied by about 7%. In the first year (2015 to 2016), overweight was recorded at 40%. By the second year of the prevention programs, overweight decreased by 4% (36%). The third year, following the discontinuation of the prevention programs, showed a vertical increase in the percentage of pre-obesity from 20% to 30% and a small reduction in the percentage of obese children from 20% to 15% (Figure 1).

The prevalence of DC during the 3-year period showed a significant improvement of 8% due to the continued implementation of the prevention programs. More specifically, the absence of dental caries improved from 36% to 44% (Figure 1) and the presence of severe caries disease (DMFT 6-10) halved (from 13% to 6%).

**Table 1:** Crosstabulation between DMFT index and BMI classes and overall test of significance. The layers in each cell correspond to count, deviation (observed minus expected) and cell  $\chi^2$  statistic. The highlighted chis-square value is statistically significant at 0.087 probability level.

Count Deviation Cell $\chi^2$	Under weight	Normal weight	Preobesity	Obesity	Total
<b>None caries disease</b>	8	129	79	43	259
	-4.7738	-9.3095	7.20238	6.88095	
	1.7841	0.6266	0.7225	1.3109	
	20	157	77	37	291
<b>Moderate caries disease</b>	5.64796	1.60204	-3.6684	-3.5816	
	2.222	0.0165	0.1668	0.3161	
	1	28	7	2	38
<b>Severe caries disease</b>	-0.8741	7.70748	-3.534	-3.2993	
	0.4077	2.927	1.1856	2.0541	
<b>Total</b>	29	314	163	82	588
<b>Test</b>		$\chi^2$		<b>P-value</b>	
Likelihood Ratio		14.279		0.0267	
Pearson		13.741		0.0327	

An indication of interaction between dental caries and BMI classes was observed (Table 1). Normal-weight schoolchildren more frequently showed a higher DMFT condition (6-10) than did other classes ( $p=0.087$ ).

Foreign students with a low socio-economic level showed a lower probability to have absence of caries (DMFT=0, Table 2) and a higher probability of serious caries disease (DMFT 6-10).

Periodontal disease appeared more often in students belonging to the underweight class (Table 3), while no significant interactions were observed with student nationality ( $p=0.776$ ).

## Discussion

This study showed a short-term improvement in the prevalence of obesity recorded after implementing an annual healthy eating program and the reversal of this improvement after discontinuing the program. The short-term reduction of BMI has been highlighted by other studies, which also support the need for long-term follow-up and further research [18,19]. In the literature, certain studies have indicated that programs designed to prevent childhood obesity may exert beneficial effects [20,21], especially on children aged 6-12 years [22]. In these age groups, the positive effects of prevention programs increased as they extended to parents and caregivers [21]. On the other hand, there are some studies showing that there was no significant effect of school interventions on body weight among overweight and obese children [23]. Further research is needed to assure that the benefits of interventions can be maintained in the long term.

**Table 2:** Crosstabulation between DMFT index and student's socioeconomic status and test of significance.

Count Deviation Cell $\chi^2$	Middle	Low	Total
<b>None caries disease</b>	244	15	259
	10.5476	-10.548	
	0.477	4.354	
	258	33	291
<b>Moderate caries disease</b>	-4.2959	4.29592	
	0.0704	0.6429	
	28	10	38
<b>Severe caries disease</b>	-6.2517	6.2517	
	1.147	10.427	
	530	58	588
<b>Test</b>	$\chi^2$		<b>P-value</b>
Likelihood Ratio	14.614		0.0007*
Pearson	17.113		0.0002*

**Table 3:** Crosstabulation between periodontal disease and BMI classes and overall test of significance. The layers in each cell correspond to count, deviation (observed minus expected) and cell  $\chi^2$  statistic. The highlighted chis-square value is statistically significant at 0.007 probability level.

Count Count Deviation Cell $\chi^2$	Under weight	Normal weight	Preobesity	Obesity	Total
<b>No</b>	17	96	49	20	182
	8.0238	-1.1905	-1.4524	-5.381	
	7.172	0.015	0.042	1.141	
			114	62	406
<b>Yes</b>	-8.0238	1.19048	1.4524	5.3809	
	3.215	0.006	0.019	0.511	
<b>Total</b>	29	314	163	82	588
<b>Test</b>		$\chi^2$			<b>P-value</b>
Likelihood Ratio		11.235			0.0105
Pearson		12.122			0.007

The present study also highlights a significant improvement in the percentage of DC after implementing ongoing related programs. In the literature, there are several studies supporting the effectiveness [24,25] of both experiential [26] and traditional educational methods [27]. Nevertheless a systematic review and meta-analysis of the effectiveness of oral hygiene education from 1995 to 2015, indicates insufficient evidence of the effectiveness of interventions to reduce caries [28]. However, it should be emphasized that the school-based oral health programs may play an important role in improving access to health care and reducing socio-economic inequalities [29].

The findings of this study support the occurrence of severe DC in normal-weight school children, reinforcing the findings of previous studies that show a lower risk of DC in children with higher BMI30 and a non-statistically significant relationship between obesity and DC [31-36]. However, there are studies, systematic reviews and meta-analysis that supported the association between caries and obesity in children [37,38] and others showing contradictory results [39].

Further studies on the confounding factors that may affect BMI and caries (such as BMI classification for childhood obesity, or dietary habits) are recommended.

This study also showed the presence of higher percentages of periodontal disease in underweight children. This association has either not been investigated or statistically significant correlations have not been found in previous studies. In contrast, published research has suggested that overweight /obesity [15,40,41], weight gain, and increased waist circumference [41] may contribute to periodontal complications regardless of other risk factors such as gender, age, ethnicity or smoking [15,40]. However, a complete medical history should be obtained and other predisposing factors of periodontal disease such as genetic factors, systemic diseases, [42] hereditary trend [42,43], socioeconomic status etc [44]. Should be sought. Whatever the causes of the disease, it should be noted that early diagnosis and information may provide the greatest chance of prevention [45].

Furthermore, this study supports the higher probability of serious DC in children from families with low socio-economic status and confirms previous studies that have reported a link between DC and low socio-economic backgrounds.46 Studies that have investigated socioeconomic inequalities in oral health [47] indicate that low of parental educational or occupational background or income [48] and maternal education level in particular, as well as, living in more disadvantaged districts [49] may be important factors of the socio-economic status in relation with DC. These results, in relation to DC and its association with existing social inequalities, should raise concerns and encourage the development of prevention programs.

Finally, it should be noted that the present study was designed strictly and was conducted by a trained multidisciplinary team consisting of a dentist, a dietician-nutritionist and nurses. The three-year duration of the program and its evaluation, as well as the large sample size, enabled the authors to examine the interactions between body weight, oral health and demographics, as well as the effectiveness of prevention programs in school environment.

### Implications for practice

One of the practical contributions of this research is that it provides data on two different educational programs of different durations for school-aged children. Another important implication stems from the finding that socio-economic indicators and obesity are not related to risk factors for caries. This information is important for finding other causal relationships between these categories and caries. Finally, our study creates a range of opportunities for future research, both in terms of the validation of findings and expansion them.

### Conclusions

The findings of this study strongly point to the effectiveness of repeated programs to prevent and promote oral health. Short-term nutrition education programs led to a short-term reduction in obesity. However, in order to better consolidate the knowledge and make radical changes in dietary behavior, continuous preventive programs are required.

The results of this study suggest that low weight can be considered as an indicative risk factor for periodontal disease. Similarly, low

socioeconomic status can be considered as indicative risk factor for high grade caries. The study's findings also show that obesity is not a risk factor for tooth decay, nor socioeconomic status affects the periodontal status. More cohort studies are needed to generalize the results.

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### Conflict of Interest

The authors have no competing interests.

### Orcid

Eleni PavlidouQ <https://orcid.org/0000-0002-7764-3544>.

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