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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Nutritional Assessment of Macronutrients in Primary School Children and its Association with Anthropometric Indices and Oral Health

Sayed Jalal Pourhashemi[1], Mehdi Ghandehari Motlagh[1],
Gholam Reza Jahed Khaniki[2] and Banafsheh Golestan[3]
[1]Department of Pediatric, School of Dentistry
[2]Department of Environmental Health Engineering,
[3]Department of Epidemiology and Biostatistics, School of Public Health,
Medical Sciences University of Tehran, I.R. Iran

Abstract: Childhood nutrition is known to have a considerable impact on children's health. Protein and fat are the two most important macronutrients with high impact on children's growth and energy provision. The aim of the present study is the assessment of children's nutrition based on energy, protein and fat intake with respect to their anthropometric and oral health. A total of 788 7-years-old primary school children selected via a cluster sampling in Tehran City, Iran. The general information about children has been asked from their mothers. Anthropometric measurements including weight and height measurements are also taken for each child. Finally the routine standard tooth check up was performed to get the dmft index. The chi-square test, Mann-Whitney U-test and Kruskal-Wallis were used for detecting statistical associations. Results showed that there is not a significant association between macronutrient intakes and anthropometric indices; however it was found that children who get saturated fat less than 75% recommended have higher dmft. The same results were found for energy, protein and total fat, but none of which were statistically significant. This study highlights the important role of saturated fatty acids in prevention of dental carries.

Key words: Nutrition, macronutrients, anthropometric indices, oral health, primary school children

Introduction

Nutrition has a strong impact on oral health and there is no question about the importance of childhood nutrition on children's health (Hornick, 2002; Alvarez, 1995). A healthy, correctly fed child is more expected to have healthy teeth. Vitamin D, proteins and minerals, especially calcium and phosphorus, are essential for the development of teeth (Pindborg, 1982; Alvarez *et al*., 1993). The fast growth and evolution of children permits the necessity for considering their nutritional status both qualitatively and quantitatively. This is the safest way to keep them from any deviation from normality (Whitney *et al*., 1998). Both the lack and the excess of these nutrients might be harmful. The excess need for food and the great change in the life style and nutritional habits especially in the primary school children has put them at higher risk of malnutrition (Ralf *et al*., 2000). Malnutrition and other childhood diseases during the growth period can result in moderate to severe stunting (height for age<2Sd) (Gallo, 1996). Among the food groups protein and fats play an important role not only in providing required energy, but also in the normally growth process (Emma *et al*., 1999; Mahan and Escott-Stump, 2004). These two macronutrients are the main sources of energy provision as well as having impact on oral health. Protein as well as energy malnutrition may cause dental defects or hypoplasias (Pindborg, 1982; May *et al*., 1993). Alternatively they play a local protection role within the oral cavity (Nizel, 1981). In turn, malformations of teeth expose them to caries (Li *et al*., 1996). Poor oral health is a problem in primary school children (Pourhashemi *et al*., 2007). Dental developmental defects are common in urban areas (Salmenkivi, 1997). On the other hand in cities 6-year old children have an average of 6 carious teeth. Change from a traditional milk-meat based diet to a western-type diet might be one of the reasons for the high incidence of caries in cities. The most important factors affecting the development of caries are the eating frequency of fermentable sugars and the use of fluorides (Geddes, 1994; Ismail, 1998). Eating frequency has a strong impact on oral health. When food containing fermentable sugar is eaten, the pH of the mouth decreases and the dental enamel starts to dissolve. In early childhood, caries can quickly become a serious health problem because the newly erupted teeth are very sensitive to caries. Nutritional assessment is only possible through knowing the nutritional habits of a group of people or a society, discovering the insufficiencies and then to be able to propose the best solutions to get the best results (Davis and Stegman, 1998). This area consists of anthropometric, clinical, laboratory and nutritional indices. None of the nutritional studies conducted in Iran has targeted the 7-year-old children which is the beginning of the school age. Moreover these studies did not aim to find the relationship between anthropometric

indices and oral health. This objective has not even been explored in many other countries. The main aim of this cross-sectional study was to investigate a possible relation between macronutrients (protein and fat) consumption and anthropometric indices and oral heath.

Materials and Methods

A total of 788 7-year-old school children (boys and girls) selected via a two-stage sampling from the second grade primary schools in Tehran, Iran. In the first stage, six districts of Tehran City were randomly selected from among the 22 districts of Tehran City. Within each district, it implemented WHO agenda for cluster sampling to get the required sample. The districts were chosen in such a way to be as representative as possible: two districts from the north, two districts from the center and two districts from the South of Tehran City. It was set a meeting with the parents for explaining the objectives of the study and getting some informed consent. Then it was asked from mothers to complete a general questionnaire including questions about their education and occupation status. They were trained about nutrition's children by nutrition interviewers. Then the mothers were interviewed and they completed the 24-hour-recall as well as the FFQ (Food Frequency Questionnaire). After that, each child's length and weight was measured by the nutritionist. Weight of children less than 20 kg was measured to the nearest 50 grams with mechanical scale for children (SECA, Vogel and Falke GmpH and Co, Germany). Children weighing over 20 kg were measured to the nearest 100 grams with electronic scale. Children were weighed with light underclothes or naked. The function of both scales was confirmed three times during the research period.

The weight-for-age growth chart was used to monitor the malnutrition, because the high prevalence of rickets reduces the reliability of height-for-age or weight-for-height charts (Kachondham *et al*., 1993). Weight of the children was compared to the weight-for-age growth chart of the WHO (World Health Organization) (WHO, 1986). Child's oral health was examined by the dentist, the trained dental hygienists and the nutritionist collected the dental examination data on the Oral Health Assessment form of the World Health Organization (WHO, 1987). The trained dental hygienists did the oral examination by using of forehead lamp, explorer and dental mirror to record the dmft index. After the examination, the team members gave the necessary oral health education and they referred those with any dental problem to the faculty of dentistry for care and management. Dmft-index (the number of decayed, missing and filled teeth) was calculated for each child. Nearly all of the teeth calculated on dmft-index were carious without fillings. The information of 24-hour recall was then analyzed by two nutritionists to derive the data on food intake and comparing of them to RDA (Recommended Dietary Allowance). Anthropometric indices using z-score criteria were obtained using EPI 2000. The three anthropometric indices namely: underweight (weight for age), stunting (height for age) and wasting (weight for height) are divided into three categories moderate and severe, normal and over. The moderate and severe status, normal and over were considered below-2 Sd (z-score), between-2 and 2 Sd (z-score) and above 2 Sd (z-score), respectively. Two broad categories for each macronutrient were defined in comparison to RDA. According this, Children who receive more than 75% of RDA are normal in macronutrient intake and children who receive less than 75% of RDA have macronutrient deficiency. Chi-square test (and Fisher exact probability where necessary) was used for detecting associations between the anthropometric indices and macronutrient intake. Since the dmft index is highly skewed to the right, it used as non parametric tests such as Mann-Whitney and Kruskal-Wallis for relationships of this variable with others. The statistical analyses were done by SPSS statistical software package version 11.5 (SPSS Inc., Chicago, IL, USA).

Results

Macronutrient deficiency and recommended daily allowance: This study showed that nearly 30 percent of children have received energy less than 75% by RDA, while 10.8 percent of children have gotten protein less than 75% (Table 1). None of the children had a problem with fat intake at this study, but 1.6 percent of children have received saturated fat less than 75% recommended dietary allowance.

Most people consumed more than 75% of the RDA for the most important nutrients. 29.9 and 10.8 percent of people consumed less than the RDA of energy and protein, respectively.

Table 1: Macronutrient deficiency in comparison with RDA

Macronutrient	≤ 75% RDA	95% CI
Energy	29.9	(26.8, 33.3)
Protein	10.8	(8.7, 13.2)
Fat:		
Saturated	1.6	(0.88, 2.8)
Un saturated	0.0	(0, 0.46)

Macronutrient deficiency and stunting: Table 2 shows the relationship of macronutrients and stunting (height for age). There is not a significant difference between macronutrient intake (according to RDA) and anthropometric indices namely stunting ($p>0.05$). 85.4 percent of children have a normal stunting and they intake energy with <75% RDA and 86 percent of these children intake energy with ≥75% RDA. Also, 84.3 and 86 percent received protein with <75% RDA and ≥75% RDA, respectively. Children has classified into <75% and

Table 2: Frequency distribution between macronutrients and stunting (height for age)

		Stunting : N (%)			
Macronutrient	RDA	Mild	Normal	Over	2-tailed significance
Energy:					P=0.886
	<75%	5 (2.1)	199 (85.4)	29 (12.4)	
	≥75%	9 (1.6)	472 (86.0)	68 (12.4)	
Protein:					P=0.772
	<75%	1 (1.2)	70 (84.3)	12 (14.5)	
	≥75%	13 (1.9)	601 (86.0)	85 (12.2)	
Fat:					
Saturated Fat	< 75%	0 (0.0)	11 (84.6)	2 (15.4)	P=0.743
	≥75%	14 (1.8)	660 (85.8)	95 (12.4)	(Fisher exact probability)
Un saturated Fat	< 75%	0 (0.0)	0 (0.0)	0 (0.0)	No cases
	≥75%	14 (1.8)	671 (85.8)	97 (12.4)	

Table 3: Frequency distribution between macronutrients and underweight (weight for age)

		Underweight : N (%)			
Macronutrient	RDA	Mild	Normal	Over	2-tailed significance
Energy:					P=0.233
	<75%	6 (2.4)	204 (87.6)	23 (9.9)	
	≥75%	6 (1.1)	497 (95.5)	46 (8.4)	
Protein:				P=0.12	
	<75%	2 (2.4)	69 (83.1)	12 (14.5)	
	≥75%	10 (1.4)	632 (90.4)	57 (8.2)	
Fat:					
Saturated Fat	< 75%	0 (0.0)	13 (100.0)	0 (0.0)	P=0.682
	75%	12 (1.6)	688 (89.5)	69 (9.0)	(Fisher exact probability)
Un saturated Fat	< 75%	0 (0.0)	0 (0.0)	0 (0.0)	No cases
	≥75%	12 (1.5)	701 (89.6)	69 (8.8)	

Table 4: Frequency distribution between macronutrients and wasting (weight for height)

		Wasting: N (%)			
Macronutrient	RDA	Mild	Normal	Over	2-tailed significance
Energy:					P=0.746
	<75%	14 (6.1)	201 (87.8)	14 (6.1)	
	75%	27 (5.0)	497 (88.1)	38 (7.0)	
Protein:					P=0.731
	<75%	5 (6.1)	70 (85.4)	7 (8.5)	
	75%	36 (5.2)	610 (88.3)	45 (6.5)	
Fat:					
Saturated Fat	< 75%	0 (0.0)	13 (100.0)	0 (0.0)	P=0.811
	75%	41 (5.4)	667 (87.8)	52 (6.8)	(Fisher exact probability)
Un saturated Fat	< 75%	0 (0.0)	0 (0.0)	0 (0.0)	No cases
	75%	41 (5.3)	680 (88.0)	52 (6.7)	

≥75% RDA of energy intake from saturated and unsaturated fat and compared nutrient intakes with mild, normal and over stunting. The people who consume less than 70 percent of an RDA are at risk for developing nutritional deficiency. 84.6 percent of children who has received less than 75 percent RDA saturated fat, they have a normal stunting, However, 15.4 percent of children who has received less than 75 percent RDA saturated fat, they have a over stunting.

Macronutrient deficiency and underweight: Table 3 shows that the most of the children have a normal weight. The most of macronutrient amount and underweight for children with ≥75% RDA is normal. There is not a significant variation between macronutrients and underweight.

Macronutrients and wasting: Further analysis revealed no statistically significant association between, macronutrient intake (according to RDA) and anthropometric indices namely stunting, underweight and wasting; however, children who receive energy less than what has been recommended, are at higher risk of mild to severe stunting and underweight, Table 2 to 4.

Nutritional status and Oral health: Caries was a common problem, which increased by the age. The

Table 5: Relationship of macronutrients and *dmft* for permanent and deciduous teeth

			dmft	
Macronutrient	RDA	No.	Permanent Teeth Mean (SD)	Deciduous Teeth Mean (SD)
Energy:				
	<75%	236	0.30 (0.78)	4.6 (3.29)
	≥75%	552	0.19 (0.57)	4.4 (3.22)
			*P=0.296	*P=0.41
Protein:				
	<75%	85	0.38 (0.9)	4.91 (3.18)
	≥75%	703	0.21 (0.6)	4.4 (3.25)
			P=0.11	P=0.107
Fat:				
Saturated Fat	< 75%	13	0.69 (0.95)	5.6 (3.16)
	≥75%	775	0.22 (0.63)	4.4 (3.24)
			P=0.006	P=0.088
Un saturated Fat	< 75%	0 (0.0)	No cases	No cases
	≥75%	788	0.22 (0.64)	4.44 (3.24)

2-tailed significance: p<0.05, *2-tailed significance of Mann-Whitney signed rank test

dmft-index of the study children presents the actual number of decayed, non-filled teeth, since children seldom had any teeth missing for reasons other than caries and hardly any cavities had been filled. It was also wanted to look for possible relation between getting less macronutrient than recommended and *dmft* index for permanent and deciduous teeth. The results indicated that for most macronutrients, the dmft index is slightly higher for macronutrient deficient 7-year-old children; however only with saturated fat deficiency did we find a statistically significant difference for permanent teeth (p=0.006) and a tendency toward statistical significance with deciduous teeth (p=0.088). It may be related to stress the high dmft in protein-deficient children, based on present findings and it seems to be a tendency toward statistical significance in this regard, Table 5.

Discussion

Dental caries is one of the most common chronic diseases of childhood. Despite improvements in oral health in the Islamic Republic of Iran, by late adolescence approximately 80% of children have a history of caries. Oral health is related to diet in many ways. Dental diseases impact considerably on self-esteem and quality of life and are expensive to treat. Nutrition affects the teeth during development and malnutrition may exacerbate periodontal and oral infectious diseases. However, the most significant effect of nutrition on teeth is the local action of diet in the mouth on the development of dental caries and enamel erosion (Moynihan and Petersen, 2004; Okolo *et al*., 2006).

This cross-sectional study showed that there is not a significant association between macronutrient intakes and anthropometric indices; however it was found that children who get saturated fat less than 75% recommended have higher dmft. The same results were found for energy, protein and total fat, but none of which were statistically significant. This study highlights the important role of saturated fatty acids in prevention of dental carries.

The RDA represents the establishment of a nutritional norm for planning and assessing dietary intake and are the levels of intake of essential nutrients considered to be adequate to meet the known needs of practically all healthy people. However requirements differ with age and body size; among individuals of the same body size owning to differences in genetic makeup; with the physiologic state of individuals-growth rate, pregnancy, lactation; and with sex. In present study, nearly 30 percent of children have received energy less than 75% by RDA, while 10.8 percent of children have gotten protein less than 75%. Although there is a great deal of evidence that suggests the RDAs are often far too low for optimal health, the argument over whether to raise these levels is intense. As these statistics bear out, the point may be moot since many people do not receive even today's lower allowances. Nutrition scientists generally agree, however, that people who consume less than 70 percent of an RDA are at risk for developing nutritional deficiency and these disturbing figures suggest that nutrient deficiencies may be common. At this study, none of the children had a problem with fat intake, but 1.6 percent of children have received saturated fat less than 75% recommended dietary allowance. The rapid changes in children's nutritional habits, confirms the importance of a complete and precise nutritional assessment. The most outstanding result of the present study is the significant association between dental caries and saturated fat intake. Although it has been believed that a saturated diet can prevent dental caries (Popllach, 1985), researchers were less interested in proving it. So, the present study can be considered unique in this regard. Saturated fatty acids can control the growth process of carrying microorganism and it can

change the physiology of carbohydrates. According the results of this research, it did not reveal any statistically significant association between anthropometric indices and macronutrient intakes. The findings are consistent with the study by Tuyet *et al*. (2003). They conducted a similar study on Vietnamese boys and girls of primary school age and did not find any significant relation between anthropometric indices and energy intake. Guilloume *et al*. (1998) also conducted a similar study in city of Luxembourg. They too, used the 24-hour-recall and measured anthropometric indices. Their results showed that a considerable percentage of the children receive macronutrient intake according to RDA which is the sign of a better economic and welfare situation in Belgium comparing to Iran. In a study, Agrabar-Murugkar (2005) found that the average energy intake is significantly lower in children with mild and severe stunting than in normal children. In other study, Macek and Mitola (2006) has examined the relationship between age-specific body mass index (BMI-for-age) and dental caries among US children from the 1999-2002 National Health and Nutrition Examination Survey. They reported that approximately 36% of overweight children 2 to 6 years old and 39% of overweight children 6 to 17 years old had dental caries. Geometric mean dental caries scores for overweight children were dmft=3.3 and DMFT=2.5 for primary and permanent dentitions, respectively.

Conclusion: Energy and protein deficiency seems to be a more serious problem among our study sample. Although saturated fat deficiency did not seem be as serious a problem as those two macronutrients, its important role in dental caries should not be underestimated. In conclusion, the present study showed that dental developmental defects and tooth decay are serious health problems among children in Tehran. Deficient intakes of energy and protein might be associated with dental developmental defects. For better oral health the growth of the children, their nutrition and the use macronutrients as well as the eating frequency need to be monitored. Nutrition education and counseling for the purposes of reducing caries in children is aimed at teaching parents the importance of reducing high frequency exposures to obvious and hidden sugars. Along with nutritional factors, a comprehensive approach to preventing dental caries in preschool children must include improved general dietary habits, good oral hygiene, appropriate use of fluorides and access to preventive and restorative dental care.

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