ORIGINAL ARTICLE

Oral Health and Linear Growth in Primary School Children: a Five-Year Longitudinal Study

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Abstract

Background: Young children are in the fundamentally important physical and cognitive growth phases of their life. Undermining the health issues of this critical segment of the population may seriously affect communities' health and development. Linear growth among children is a fundamental health index, which is affected by so many different factors. This study was carried out to evaluate the growth status of school-age children to identify some demographic and clinical factors that can predict linear growth among schoolchildren in the fourth largest Iranian city.

Methods: The present retrospective cohort study was carried out on a large sample (n=2488) of female and male schoolchildren from the first (7-year-old) to the last year (12-year-old) of primary school in Shiraz, the capital of Fars province.

Results: Adjusted for the other study variables, negative and significant associations were found between children's height Z-score and family size (P<0.001); and the number of decayed teeth (P=0.03). However, a direct and significant association was found between father's education and children's height Z-score (P=0.01). Concerning their weight, paternal literacy was inversely associated with the children's weight Z-score (P=0.002). A positive and significant association was also found between the birth order and children's weight (P=0.04).

Conclusion: Oral health is an important parameter in children's growth and possibly development. Oral health services should be provided to children before school age.

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Introduction

Children, especially those in school age, are among groups with special needs. This is because young children are in the fundamentally important physical and cognitive growth phases of their life. Children are facing remarkable health hazards, which may put them at higher risk of many problems such as under or overweight, metabolic diseases, growth retardation, and cognitive impairments. Undermining the health issues of this important segment of the population may seriously affect communities' health and development.[1, 2] Among different health indexes in children and adolescents, physical growth from birth to puberty is of particular importance because many psycho-physical changes occur along with or affected by growth indexes.[3] Indeed, the easiest and most common method of monitoring children's health is to measure the indicators of physical growth.[2] That is why children's growth is of any nation's significant concerns.[4, 5] Measuring and monitoring growth is done via completing growth charts for each child. The charts are easily accessible and applicable to monitor children's growth and to screen children for growth or health problems.[6] Growth charts are used by general practitioners, health professionals in the primary sectors, and pediatricians in medical centers.[7] According to global reports, a large number of children are suffering from growth impairments, which again raises the urgent need for on-time diagnosis and understanding the causal path of growth impairment as well as its serious adverse

effects.[4] Growth impairment happens possibly due to some modifiable and non-modifiable factors including environmental, or genetic, nutritional and socio-economic factors during childhood and adolescent ages.[2, 8-10]

The fastest, cheapest and easiest indexes to assess children's health are weight and height.[11] These indexes during childhood reflect the involvement of different health affecting factors including[12] birth weight and height, genetic, nutrition, general health, number of siblings, parental functioning, socio-economic status of the parents, nutrition, and many other issues.[13-15] As a result, weight and height are regarded as the key components of a community health status, especially for young children.[11] Indeed, if growth monitoring is done timely and correctly, it will be the most effective method of on-time recognition of health issues in a community.[11] There are several growth charts introduced to monitor an individual's growth, among which those recommended by the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) are more discussed. These organizations have provided standardized growth chars based on healthy individuals.[16, 17] In that regard, the WHO's international growth standard charts and CDC growth charts are now being vastly used as a reliable instrument to define the status of growth measures of an individual in any relevant age.[11]

Despite several studies on the contributing factors of children's growth in Iran, the results of studies are not universally consistent.[14, 15] For example, in an Iranian study, children with less-educated mothers, compared to those with more educated mothers had significantly worse growth indixes.[14] On the other hand, according to the results from a study conducted by Esfarjan, high-educated mothers were at higher risk of having stunted child.[15]

To sum up, linear growth among children is essential health index which is affected by so many different factors. The present study was carried out to evaluate the growth status of school-age children to identify some demographic and clinical factors that can predict linear growth among school children in the fourth largest Iranian city.

Methods

The present retrospective cohort study was carried out through five years following up a large sample (n=2488) of female and male school children from the first year (7 years of age) to the last year (12 years of age) of primary school in Shiraz the capital of Fars province. All measurements were conducted at the registration of each academic year.

Data Collection

The students' registry database via a systematic sampling approach was used to select the required sample. The selected participants were included in the study if no pathologic growth retardation was reported in their school files. Data on the student's demographic and health status was obtained from students' school and health files from the first year of school (at the age of 7 of the study participants). The study variables included both quantitative (age, birth order number of the filled decayed and lost teeth, family size, weight, height, and BMI) and qualitative (education of father, education of mother, insurance, anemia, goiter, vision and hearing disorders) measures. Anthropometric measures were measured by a trained nurse at the first and last year of the study. Every school was visited by a physician and a dentist who carried out a physical exam for any health or dental problem respectively and the results of the exams were recorded in the health files of the children based on the Iranian routine student's health monitoring program by the ministry of health.

Growth Status

To define the growth status of the participants, WHO's growth charts were used. Accordingly, z-scores of weight for age and height for age were calculated using EPI-info 7 software.

Statistical Analysis

A post hoc calculation suggested that the sample size was large enough to detect a significant association between parent's education and height as small as 0.15 cm, with an alpha value of 0.05 and a power of 80%.

Chi-square was used to measure the associations between categorical variables. Simple linear regression was used as a primary analysis strategy to determine unadjusted associations between the study variables and weight and height z-scores separately. Multiple linear regression was applied to measure the adjusted associations between the study variables (listed above) with weight and height z-scores separately. Forward stepwise selection strategy was used to include variables in the model. Birth order was removed from the model due to strong collinearity with family size, which had a stronger and dose-response association with the children's height. A sex-stratified analysis was also conducted to understand better the associations of the study variables and growth with respect to sex using the final model. R statistical software (version 4.2) was used for the above analysis.

Results

The demographic and anthropometric measures of the participants are presented in Table 1. Accordingly, Fathers predominantly had a primary or secondary school education. Besides, participants were mainly in the second or third order of birth. Children (both

Table 1: Baseline characteristics of the study population

Variable		N (%)
Sex	Male	1428 (57.40)
	Female	1059 (42.60)
Father education	Illiterate	136 (5.80)
	Primary	1529 (65.2)
	Diploma	533 (22.70)
	University	146 (6.20)
Mother education	Illiterate	228 (9.70)
	Primary	1523 (65.10)
	Diploma	524 (22.40)
	University	66 (2.80)
Anemia	No	1819 (94.20)
	Yes	113 (5.80)
Goiter	No	1819 (99.60)
	Yes	8 (0.40)
Hearing disorder	No	2323 (94.80)
	Yes	128 (5.20)
Vision disorder	No	2106 (85.90)
	Yes	345 (14.10)
No of missed teeth	With no filed teeth	1862 (80.30)
	1-2	384 (16.60)
	More than 3	73 (3.10)
No of filled teeth	With no filed teeth	1906 (83.70)
	1-2	294 (11.80)
	More than 3	78 (3.10)
No of decayed teeth	With no decayed teeth	798 (33.10)
	1-2	805 (33.40)
	3-5	660 (27.40)
	More than 5	150 (6.20)
Family size	3	387 (16.80)
	4-5	1432 (62.30)
	>5	479 (20.80)
Birth order	1st	815 (35.50)
	2nd -3rd	1129 (49.20)
	>3	353 (15.40)
		X ± SD
Height at age 7		118.33±5.73
Weight at age 7		20.87±3.55

genders) predominantly did not have any insurance coverage (52.35% among boys compared to 50.25% among girls, P=0.80). On average, girls and boys at age 7 had no significant differences in the number of filled teeth (15.02% greater than one filled teeth among girl compared to 11.44% among boy participants, P=0.30), vision impairment (15.25% among girl compared to 13.22 among boy participants, P=0.70) and hearing disorder (5.86% among boy compared to 4.36% among girl participants, P=0.60). At age 7, boy participants were more massive (20.87±3.55kg among boy compared to 20.03±3.50 among girl participants, P<0.001). However, no significant difference was found between boy and girl participants concerning height (P>0.05).

Results for Total Sample

The results of unadjusted associations between the study variables and weight and height of the participants are presented in tables 2 and 3. Based on the results from multiple linear regression, negative and significant associations were found between child's height for age z-score and family size ($B_{\text{more than 5 members /3 members=}}$-0.29, CI: -0.47 to -0.11, P<0.001) and the number of decade teeth (B=-0.04, CI: -0.08 to -0.004, P=0.03). On the other hand, direct and significant associations were found between birth order (B=0.10, CI: 0.003 to 0.20, P=0.04) and the child's height for age z-score (Table 4). Neither of the study variables was found to be associated with the weight z-scores of the participants concerning weight (Table 5).

Results of Sex-Stratified Analysis

About girls, mother's education ($B_{\text{diploma/illiterate=}}$0.74, CI: 0.22 to 1.26, P=0.004) had a direct association with the height z-score of female students. On the other hand, an inverse association was found between the participants' family size and height z-scores among girl participants ($B_{\text{diploma/illiterate=}}$-0.42, CI:-0.73 to -0.11, P=0.006 (Table 4). With regard to

Table 2: unadjusted associations of the study variables with height at age 11 (z scores)

Variable		Male			Female			Total		
		B	CI	P value	B	CI	P value	B	CI	P value
Anemia	No	-	-	-	-	-	-	-	-	-
	Yes	-0.02	-0.29 to 0.25	0.87	0.07	-0.28 to 0.43	0.69	0.01	-0.20 to 0.23	0.89
Goiter	No	-	-	-	-	-	-	-	-	-
	Yes	-0.83	-1.86 to 0.19	0.11	0.67	-0.88 to 2.22	0.39	-0.33	-1.19 to 0.52	0.44
Hearing disorder	No	-	-	-	-	-	-	-	-	-
	Yes	-0.16	-0.40 to 0.07	0.17	-0.13	-0.47 to 0.19	0.42	-0.15	-0.35 to 0.04	0.12
Vision disorder	No	-	-	-	-	-	-	-	-	-
	Yes	-0.10	-0.06 to 0.27	0.23	-0.07	-0.27 to 0.12	0.47	0.02	-0.10 to 0.15	0.49
Father's education	Illiterate	-	-	-	-	-	-	-	-	-
	Primary	0.37	0.12 to 0.61	0.002	0.03	-0.28 to 0.35	0.84	0.24	0.05 to 0.43	0.01
	Diploma	0.42	0.16 to 0.69	0.001	0.06	-0.28 to 0.40	0.72	0.29	0.08 to 0.50	0.006
	Higher	0.38	0.05 to 0.71	0.02	0.10	-0.31 to 0.52	0.62	0.28	0.02 to 0.53	0.03
Mother's education	Illiterate	-	-	-	-	-	-	-	-	-
	Primary	0.30	0.11 to 0.49	0.001	0.04	-0.20 to 0.30	0.71	0.21	0.06 to 0.36	0.005
	Diploma	0.33	0.11 to 0.54	0.002	0.11	-0.17 to 0.40	0.42	0.25	0.08 to 0.42	0.003
	Higher	0.26	-0.12 to 0.65	0.18	0.67	0.10 to 1.23	0.01	0.39	0.07 to 0.71	0.01
Insurance coverage	No	-	-	-	-	-	-	-	-	-
	Yes	0.003	-0.11 to 0.11	0.94	-0.05	-0.19 to 0.09	0.48	-0.01	-0.01 to 0.07	0.69
Family size	3	-	-	-	-	-	-	-	-	-
	4-5	-0.002	-0.16 to 0.16	0.98	-0.01	-0.21 to 0.17	0.84	-0.01	-0.13 to 0.11	0.89
	>5	-0.08	-0.27,0.10	0.38	-0.20	-0.43,0.03	0.09	-0.12	-0.27 to 0.01	0.08
Number of decayed or filled teeth		-0.11	-0.17 to -0.06	<0.001	-0.01	-0.08 to 0.06	0.75	-0.07	-0.12 to -0.03	<0.001
Height at first visit?		0.66	0.62 to 0.71	<0.001	0.65	0.59 to 0.72	<0.001	0.65	0.61 to 0.69	<0.001

Table 3: unadjusted associations of the study variables with Weight z scoresa

Variable		Male			Female			Total		
		B	CI	P value	B	CI	P value	B	CI	P value
Anemia	No	-	-	-	-	-	-	-	-	-
	Yes	-2.72	-33.38 to 27.94	0.86	21.04	-22.00 to 64.07	0.33	6.72	-18.29 to 31.73	0.59
Goiter	No	-	-	-	-		-	-	-	-
	Yes	14.78	-103.69 to 133.26	0.80	20.40	-140.14 to 180.95	0.80	16.79	-78.49 to 112.07	0.73
Hearing disorder	No	-	-	-	-	-	-	-	-	-
	Yes	17.37	-10.77 to 45.51	0.22	-1.01	-1.38 to 3.14	0.85	8.38	-13.79 to 30.55	0.45
Vision disorder	No	-	-	-	-	-	-	-	-	-
	Yes	-6.20	-25.74 to 12.50	0.49	1.16	-20.21 to 22.54	0.91	2.28	-2.14 to 6.72	0.31
Father's education	Illiterate	-	-	-	-	-	-	-	-	-
	Primary	-10.31	-38.75 to 18.13	0.47	-15.71	-52.67 to 21.24	0.40	-12.14	-34.66 to 10.37	0.29
	Diploma	5.31	-25.37 to 36.01	0.73	-21.35	-61.19 to 18.50	0.29	-4.59	-28.88 to 19.70	0.71
	Bachelor &higher	11.77	-27.03 to 50.57	0.55	-18.52	-67.51 to 30.46	0.45	0.11	-30.27 to 30.49	0.99
Mothers 'education	Illiterate	-	-	-	-	-	-	-	-	-
	Primary	2.41	-19.81 to 24.64	0.83	-6.59	-36.71 to 23.53	0.66	-0.73	-18.59 to 17.12	0.93
	Diploma	6.30	-19.03 to 31.65	0.62	8.06	-25.10 to 41.22	0.63	7.56	-12.51 to 27.63	0.46
	Bachelor &higher	20.15	-24.60 to 64.90	0.37	-39.63	-103.15 to 23.87	0.22	0.76	-35.76 to 37.29	0.96
Insurance	No	-	-	-	-	-	-	-	-	-
	Yes	8.58	-4.79 to 21.96	0.20	13.15	-2.96 to 29.26	0.11	10.35	0.06 to 20.64	0.04
Birth order	First	-	-	-	-	-	-	-	-	-
	Second/Third	-6.73	-21.54 to 8.07	0.37	6.01	-12.86 to 24.88	0.53	-1.59	-13.22 to 10.03	0.78
	Others	-12.31	-32.59 to 7.96	0.23	14.10	-11.63 to 39.84	0.28	-1.90	-17.82 to 14.00	0.81
Family size	3	-	-	-	-	-	-	-	-	-
	4-5	0.74	-19.81 to 18.32	0.93	9.18	-13.46 to 31.83	0.42	9.18	-13.46 to 31.83	0.42
	Others	-5.49	-27.73 to 16.73	0.62	13.35	-14.05 to 40.76	0.33	13.35	-14.05 to 40.76	0.33
Number of decade or filled teeth		1.85	-4.87 to 8.58	0.58	-5.66	-13.88 to 2.55	0.17	-1.04	-6.25 to 4.16	0.69
Weight at first visit?		2.97	-3.39 to 9.34	0.36	0.71	-7.13 to 8.56	0.85	2.11	-2.82 to 7.05	0.40

Table 4: Adjusted association of study variables with height at age (z scores)

Variable		Male			Female			Total		
		B	CI	P value	B	CI	P value	B	CI	P value
Height at first visit		0.67	0.63 to 0.72	<0.001	0.68	0.60 to 0.75	<0.001	0.66	0.62 to 0.70	<0.001
Father's education	Illiterate	-	-	-	-	-	-	-	-	-
	Primary	0.44	0.21 to 0.67	<0.001	0.11	-0.22 to 0.46	0.49	0.32	0.13 to 0.51	<0.001
	Diploma	0.50	0.25 to 0.75	<0.001	0.19	-0.18 to 0.57	0.30	0.39	0.18 to 0.60	0.0002
	University	0.45	0.12 to 0.78	0.006	0.07	-0.36 to 0.51	0.72	0.29	0.03 to 0.55	0.02
Mothers 'education	Illiterate	-	-	-	-	-	-	-	-	-
	Primary	0.18	0.009 to 0.75	0.03	0.005	-0.26 to 0.27	0.96	0.11	-0.02 to 0.26	0.11
	Diploma	0.05	-0.15 to 0.26	0.58	0.10	-0.19 to 0.41	0.49	0.07	-0.09 to 0.24	0.39
	University	0.09	-0.32 to 0.51	0.67	0.74	0.22 to 1.26	0.004	0.39	0.06 to 0.72	0.01
Hearing disorders	No	-	-	-	-	-	-	-	-	-
	Yes	-0.10	-0.32 to 0.11	0.33	-0.11	-0.45 to 0.22	0.49	-0.09	-0.28 to 0.08	0.29
Family size	3	-	-	-	-	-	-	-	-	-
	4-5	-0.06	-0.22 to 0.10	0.47	-0.11	-0.32 to 0.09	0.27	0.05	-0.18 to 0.07	0.36
	> 5	-0.24	-0.47 to -0.02	0.03	-0.42	-0.73 to -0.11	0.006	-0.29	-0.47 to -0.11	0.001
Birth order	First	-	-	-	-	-	-	-	-	-
	Second/Third	0.11	-0.01 to 0.24	0.07	0.11	-0.05 to 0.28	0.19	0.10	0.003 to 0.20	0.04
	>3	0.31	0.09 to 0.52	0.004	0.44	0.13 to 0.74	0.004	0.34	0.17 to 0.52	<0.001
Number of decade or filled teeth		-0.06	-0.10 to -0.01	0.01	0.0006	-0.06 to 0.06	0.98	-0.04	-0.08 to –0.004	0.03

weight, neither of the study variables was found to be associated with the weight z-scores of the female participants (Table 5).

With regard to boys, the fathers' education ($B_{university/illiterate=}$0.45, CI: 0.12 to 0.78, P=0.006) and mothers' education ($B_{primary/illiterate=}$0.18, CI: 0.009 to 0.75, P=0.03) found to be associated with the linear growth of the male participants. On the other hand, family size ($B_{>5/3=}$-0.24, CI:-0.47 to -0.02, P=0.03) and number of lost teeth (B=-0.06, CI:-0.10 to -0.01, P=0.01) were inversely associated with height z-scores. With regard to weight, neither of the study variables was found to be associated with the weight z-scores of the male participants (Table 5).

Discussion

This 5-year retrospective study was conducted on 2488 of primary school children (started at age 7) in Shiraz city, the capital of Fars province. The data suggested a significant and negative association between the child's height and family size, birth order, and the number of filled and missed teeth. Accordingly, children with larger family sizes achieved less linear growth compared to those with small family sizes. Besides, the observed association between family size and height seems to be dose-response, more substantial evidence for the existence of the association. The same result was observed in another study in Iran in which family size raised the risk of stunting among children with larger family size.[10] However, the result of the present study is in contrast with the results of Hajian's study (2013), which suggested no significant association between family size and height.[13] It is believed that in larger families, the parent's attention and care of their children are less effective. Also, larger family sizes may represent the lower quality of life, including nutrition and health care.

Concerning weight, no significant association was found between the weight and family size of the participants, whatever was the gender of the participants. This finding may also represent the fact that the quality of food mainly affects the height of children, whereas low-quality foods provide children with the required energy but not other needed nutrients.

The results of the sex-stratified analysis also suggested that education of mother positively affect height among girls who are following Hajian's study (2013) who suggested that children with higher educated parents have better liner growth.[13] This may directly or indirectly affect a child's growth.

The other result of the current study is that father's education is directly associated with the child's height. More educated fathers may provide better living conditions, including better food and health care. This finding is in line with the previously

Table 5: Adjusted association of study variables with weight z scores

Variable		Male			Female			Total		
		B	CI	P value	B	CI	P value	B	CI	P value
weight at first visit		3.03	-3.83 to 9.90	0.38	1.17	-8.10 to 10.45	0.80	2.12	-3.36 to 7.62	0.44
Father's education	Illiterate	-	-	-	-	-	-	-	-	-
	Primary	-12.36	-50.62 to 25.89	0.52	-24.93	-78.29 to 28.43	0.35	-14.62	-45.59 to 16.33	0.35
	Diploma	3.91	-38.09 to 45.92	0.85	-40.18	-98.54 to 18.16	0.17	-11.76	-45.74 to 22.21	0.49
	University	7.91	-47.35 to 63.19	0.77	-34.09	-102.79 to 34.60	0.33	-5.08	-47.51 to 37.34	0.81
Mothers 'education	Illiterate	-	-	-	-	-	-	-	-	-
	Primary	6.19	-23.54 to 35.93	0.68	7.20	-34.95 to 49..36	0.73	6.03	-18.13 to 30.200	0.62
	Diploma	6.98	-28.22 to 42.20	0.69	31.18	-16.85 to 79.23	0.20	16.29	-11.88 to 44.46	0.25
	University	13.70	-52.59 to 80.00	0.68	-15.64	-94.60 to 61.31	0.69	-0.14	-50.35 to 50.05	0.99
Hearing disorders	No	-	-	-	-	-	-	-	-	-
	Yes	22.27	-15.09 to 59.64	0.24	-15.38	-65.34 to 34.56	0.54	8.21	-21.57 to 38.01	0.58
Family size	Three	-	-	-	-	-	-	-	-	-
	4-5	13.30	-14.57 to 41.18	0.34	3.34	-28.80 to 35.48	0.83	8.89	-12.03 to 29.81	0.40
	More than 5	15.08	-23.92 to 54.09	0.44	0.90	-47.32 to 49.42	0.97	8.74	-21.41 to 38.90	0.57
Birth order	First	-	-	-	-	-	-	-	-	-
	Second/Third	-16.95	-38.11 to 4.21	0.11	4.04	-22.63 to 30.72	0.76	-7.96	-24.47 to 8.54	0.34
	Others	-16.32	-52.82 to 20.18	0.38	19.02	-28.88 to 66.92	0.43	-2.04	-30.94 to 26.85	0.89
Number of decade or filled teeth		1.86	-6.23 to 9.96	0.65	-4.89	-15.31 to 5.51	0.35	-0.95	-7.30 to 5.39	0.76

published studies on the same subject.[18, 19] More educated parents may provide their families with better quality food and better quality of life, which may cause better physical growth.

The present study could not find any significant association between vision and hearing impairments and physical growth having adjusted for other study variables. Besides, although few other studies suggested it, the results of the present study could not find any significant association between anemia and child's growth.

Regarding the importance of birth order in children's growth, the results of the present study suggested a significant yet negative association between the child's birth order and height. Again child's birth order is a factor correlated with family size, which was discussed before.

According to a study conducted by Asfaw (2015), a negative association was found between birth order and children's weight.[20] In this regard, compared to height, malnutrition affects children's weight rapidly. As a result, children born of mothers who gave birth to more than three children are more prone to become underweight. This is expected because families with more children are at higher risk of economic restraint since they cannot afford to provide quality food, which in turn may cause growth retardation. Possibly, the most critical finding of the present study is the observed inverse association between the number of decade teeth and linear growth of both male and female participants. The relationship may exist due to the adverse effects of decade teeth and poor oral hygiene on the health of children or due to the children's rich in sugar diet. Whatever the reason, the results highlight the importance of oral health services in preventing DMFT and the recognition of children with a higher risk of growth retardation.

Strengths and limitations: our study used a population-based sampling, which makes the results representative of the source population. Health and anthropometric data were obtained from the health files of the students as a result, measurement error is possible in the recorded values.

Conclusion

Social and economic factors affect the most basic indexes of health namely, height and weight. However, these factors are hardly under the control of parents or even the government. Oral health, on the other hand, is an easily modifiable effective factor in children's growth and possibly development. Oral health services should be provided to children before school age. And parents should be advised to supervise their children's oral health. Further studies on the pathologic pathways of the reported associations are needed to understand

the potential reasons for the observed associations.

Conflict of Interest: None declared.

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