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Stunting and its Determinants among Governmental Primary School Children in Egypt: A School-based Cross-sectional Study

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Abstract

BACKGROUND: In developing countries, stunting among children is a major public health concern. It affects all aspects of children's lives; its effects are not constrained to physical wellbeing but reach out to mental, social, and spiritual wellbeing.

AIM: The aim of this study is to determine the prevalence of stunting in some of the Egyptian governmental primary school children and its nutritional and socioeconomic determinants.

METHODS: A cross-sectional observational study was conducted on primary school children aged 6–12 years. General demographic, socioeconomic, and anthropometric data, as well as dietary pattern, were collected.

RESULTS: Out of 1740 children, 7.8% were stunted. Not eating eggs and dairy products had the most profound effect on stunting in children (p < 0.001). Not having meals on time, skipping breakfast, and having <3 meals per day were predictors of stunting (p = 0.003, p = 0.00, and p = 0.008, respectively). Mother's education (p = 0.005) followed by family income (p = 0.007) was the most affecting social factors.

CONCLUSION: There are many nutritional factors associated with stunting as skipping breakfast, not having meals on time, and having <3 meals per day. Scarcity in nutritive foods as eggs and dairy products and increased soft drink intake can lead to stunting. There are many enabling social factors for stunting as mother's education and family income. However, the effects of these factors can be modified by health awareness.

Introduction

The concern about undernutrition is due to a long series of devastating effects on early childhood growth and development, contributing not only to infant and child mortality but also to physical and cognitive developmental impairments among children. As child malnutrition leads to an infinite cycle of malnutrition throughout the life cycle of the child later on in his life, this might create considerable risks for future mothers. This is especially true, looking at stunting, wasting, and micronutrient deficiencies [1].

Overcoming undernutrition in all its forms is linked to sustainable development goals (SDG) 1 (no poverty) and (SDG) 2 (zero hunger) [2]. Children are the hope of the future and resemble seeds that, if well taken care of, will flourish and open unlimited possibilities for a better society in terms of health, lifestyle, and building capacities.

Child stunting can be due to many factors, including socioeconomic status, dietary intake, infections, maternal nutritional status, infectious diseases, micronutrient deficiencies, and the environment [3]. In 2016, there were 87 million stunted children in Asia versus 59 million lived in Africa and 6 million lived in Latin American and the Caribbean regions [4].

School children are the most important segment of Egyptian society. They represent 40.1% of the total population. In 2018, their number reached 38.9 million [5]. The physical growth and nutritional status of school-aged children are considered to be of utmost significance as it presents the general health status of the whole community. Good nutrition is also a determinant of healthy growth of mind and body in all stages of life, especially in the early stages of life [6], [7], [8], [9], [10], [11].

Since the degree of stunting is likely to increase with the advancement of the school-age years [12],

it was important to focus on studying the nutritional status of children of ages 6–12 years, especially with the limited literature about studying this group. In addition, it is well-known that both girls and boys of this age group have the potential of experiencing catch-up growth to be brought to the normal ranges of height for age. That is why the problem of child stunting in Egypt has to be sufficiently identified among the school-age group (6–12 years) as well as the reasons behind it.

The aim of the study is to determine the prevalence of stunted children among Egyptian governmental primary school-aged children and its nutritional determinants as taking breakfast, the number of meals per day, the impact of daily and weekly intake of nutrient-rich food versus energy-dense food on stunting, and also the socioeconomic determinants as mother education and family income.

Methodology

Study design

The study was a cross-sectional conducted in three governorates representing different geographical regions in Egypt with different nutritional habits that were selected randomly, one representing lower Egypt (Behaira governorate), one representing the Coastal region (Damietta governorate), and one representing upper Egypt (Fayoum governorate).

Sampling frame and sampling unit

Three sampling frames were chosen. The first sampling frame used was based on stratification of the Egyptian governorates into three strata representing rural Lower Egypt, Coastal region, and upper Egypt governorates. The second sampling frame was based on a comprehensive list of the governorates as per regions. The third sampling frame was the stratification of listing the units to be sampled (governmental primary school children). For the third sampling frame, a logical order was used for schools and then a cluster of schools was chosen with probability proportion to size from that listing. This ensured that the units were evenly distributed within the listing and avoided the possibility that, due to chance, one type of school ends up being under-represented.

The selection along all the stages was random one; governorates that were randomly selected and matched the inclusion criteria were Behaira, Damietta, and Fayoum governorates representing lower Egypt, Coastal region, and upper Egypt governorates respectively.

Figure 1 presents the probability proportion to the size distribution of sample along the three governorates of Egypt.
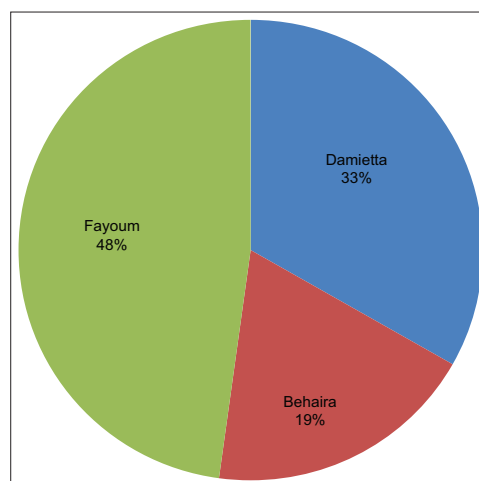

Figure 1: Sample distribution

Sample size

A sample size of 1710 produces a two-sided 98% confidence interval with a width equal to 0.030 as a margin of error when the sample proportion is 0.080 [13], [14]. The sample was rounded to be 1740 to ensure the number of clusters.

The proportion used for sample size calculation was according to the findings of an Egyptian study that was done to detect stunting and underweight among children in 4th-grade primary school children, which found that the percentage of stunted children was 7.6% and the under-weight children 1.1% among 903 sampled children representing a small percentage for both [6]. Accordingly, the calculated sample size was big enough to detect the burden of undernutrition among primary school children.

Sample size calculation was as follow

Sample Confidence Level	Size (N)	Target Width	Actual Width	Proportion (P)	Lower Limit	Upper Limit	Width if p = 0.5
0.975	1710	0.030	0.030	0.080	0.066	0.096	0.055

Study participants

The choice of subjects was random in the form of clusters (6 clusters/each school); each cluster was formed of 10 students from each grade with a total of 60 children/each primary school children. The actual total number of the randomly surveyed schools was 29 schools distributed along 16 districts within the three governorates with average 1–3 schools/ district and 8–10 schools/each of the selected governorates according to the number of schools per district.

Inclusion criteria

Apparently healthy prepubescent boys and girls in primary schools within six grades. The primary school children were aged 6–12 years.

Exclusion criteria

Students proved to have any endocrinal disorders or syndromes (recorded among the children's own school health files) were excluded from the study.

Methods

An assessment questionnaire

Was used which included: General demographic and socioeconomic data including order of child among his siblings, family size, family income, father's income, and mother's education. The socioeconomic level of the participants was calculated according to Egypt's Central Agency for Public Mobilization and Statistics [15].

Dietary pattern

A rapid ethnographic study was done in each community. It was conducted by senior nutritionists to obtain: Qualitative information about the different items of food and beverages consumed by children. The dietary pattern was used to assess cultural preferences, availability of different food items, dietary habits and behavior of children (skipping breakfast [whether taken or not], number of meals consumed per day [3–5 meals], eating meal at school through school day).

The frequency of food eaten per week which is called share of the stomach was determined.

Frequency of nutrient-rich foods (vegetables, fruits, nutrient-rich sources of protein, and dairy products) eaten per week compared to energy-dense foods (French fries, Chips, sugar-sweetened beverages (SSB), Biscuits, Chocolate, Pancakes/cakes, Ice cream, and Candies) was analyzed.

Pre-testing of the questionnaire was done for 100 students that were excluded from data analysis.

Nutritional status assessment

The assessment was carried out through anthropometric measurements of height. All measurements were made as per the techniques described in the anthropometric standardization reference manual [16]. Standardization was made during taking anthropometric measurements; for height, it was taken during morning hours on an empty stomach before having breakfast or any meal at their school, within a minimum 8 h after micturition and defecation and after their morning exercises at school. All scores were calculated based on the WHO growth standards with the help of Anthro-Program of PC [17].

- Height/age Z-score (HAZ): Children whose HAZ < - 2 are considered stunted.

Anthropometric indicators provide measures of nutritional status based on measures of body size relative to their distribution in a reference population. Anthropometric indicators measure achieved nutritional status rather than nutrition inputs, are less subject to measurement error than dietary intake data, and also are less expensive.

Growth assessment best defines the health and nutritional status of a child because disturbances in health and nutrition, regardless of their etiology, invariably affect child growth. WHO has been recommending that a single international reference population be used worldwide, with common indicators and cut-offs, and set standard methods to analyze child growth data [18]. Height-for-age is used to indicate past nutritional deficits as it reflects a child's nutritional history.

Ethical issues

The study was approved by the Ministry of Education. Moreover, the Medical Research Ethics Committee of the National Research Centre with ethical approval number of 19068. Consent from the children's guardians was taken and the conduct of the study complied with the International Ethical Guidelines for Biomedical Research Involving Human Subjects [19].

Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21.0 software. All data were represented by percentages and comparisons between groups were done using the odds ratio (ref, to study the association of the studied parameters with stunted). Probability values (P) of <0.05 were regarded as statistically significant. Logistic regression analysis and was done to assess the contribution of each independent variable in explaining the predictors of stunting [20], [21], [22].

Results

According to anthropometric measurements, the height of children was classified as being normal or stunted.

The prevalence of stunting in our study was 7.8%. Factors affecting physical growth were classified into nutritional factors and social factors.

When children did not have breakfast and their number of meals was <3 meals per day, the risk of stunting was 4 times more than those who had breakfast and their number of meals was more than

three per day (OR = 4.5). Skipping breakfast or morning snack, not having meals on time and number of meals <3 carried more than double risk of being stunted than having breakfast or morning snack, having more than 3 meals and having meals on time (OR = 2.75, 2.8, 2.06) respectively (Table 1).

Table 1: Effect of dietary behavior on stunting

Parameters	Stunted	Normal	Test of sig.
	(n=135) 7.8 %	(n=1605) 92.2 %	Odds ratio (CI)
Breakfast			
No (n=480)	61 (45.19)	419 (26.1)	OR=2.33
Yes (n=1260)	74 (54.81)	1186 (73.89)	(1.63–3.33)*
Number of meals			
<3 (n=210)	69 (51.11)	541(33.7)	OR=2.06
≥3 (n=1530)	66 (48.89)	1064 (66.29)	(1.45–2.93)*
Breakfast and/or morning snacks			
No (n=308)	47 (34.81)	261 (16.26)	OR=2.75
Yes (n=1432)	88 (65.19)	1344 (83.74)	(1.88–4.01*)
Breakfast + number of meal			
No breakfast + number of meals <3 (n=154)	45 (33.33)	109 (6.79)	OR=4.5 (2.89–7.02*)
Breakfast + number of meals ≥3 (n=655)	55 (66.67)	600 (93.21)	
Source of breakfast			
Other (n=1698)	133 (98.6)	1565 (97.5)	OR=1.7
Home (n=42)	2 (1.4)	40 (2.5)	(0.40–7.11)
Meals on time			
No (n=339)	52 (38.2)	287 (17.9)	OR=2.8
Yes (n=1401)	83 (61.8)	1318 (82.1)	(1.99–4.13)*
Mid-day snack			
No (n=179)	15 (10.8)	164(10.2)	OR=1.09
Yes (n=1561)	120 (89.2)	1441 (89.8)	(0.62–1.92)
Snacks/anything between meals			
No (n=321)	24 (17.9)	297 (18.5)	OR=0.95
Yes (n=1419)	111(82.1)	1308 (81.5)	(0.60–1.51)
Snacks before sleep sweets, chips…etc.)			
Yes (n=743)	63(46.3)	680 (42.4)	OR=1.19
No (n=997)	72 (53.7)	925 (57.8)	(0.83–1.69)
Having dinner			
No (n=347)	29 (21.5)	318 (19.8)	OR=1.1 (0.72–1.7)
Yes (n=1393)	106 (78.5)	1287 (80.2)	

HAZ: Height for age Z scores.

Intake of nutrient-rich foods (vegetables, fruits, nutrient-rich sources of protein, and dairy products) was more in normal children (50%) contrary to energy-dense food (French fries, Chips, SSB, Biscuits, Chocolate, Pancakes/cakes, Ice cream, and Candies) and carbohydrate in grains which were eaten more by stunted children (30% and 42%, respectively). Half of the food consumed by normal children was nutrient-rich due to the consumption of dairy and beans or meat versus 28% of stunted children. This is considered the weekly share of the stomach. Beverages and chocolate were consumed more than once every day in 81% and 66% of stunted children versus 68% and 64% of normal children, respectively (Table 2).

The majority of the social factors had a profound effect on stunting. Having illiterate mothers or mothers who could just read and write, low-income families, and large family size carried more than 3 times the risk of having stunted children than having highly educated mothers, middle-income families, and small-sized families (OR = 3.78, OR = 3.24, and OR = 3.13, respectively). Having illiterate fathers or fathers who could just read and write and is the third or more in order among siblings carried more than double risk of being stunted (OR = 2.64 and OR = 2.49, respectively) (Table 3).

Table 2: Comparison of the weekly and daily dietary intake of nutrient-rich foods versus energy-dense food between stunted and normal children

Parameters	Stunted	Normal	Odds ratio
	(n=135) 7.8 %	(n=1605) 92.2 %	
Diversity of nutrient-rich foods (vegetables, fruits, nutrient-rich sources of protein, and dairy products) eaten per week			
Nutrient rich foods (overall)	38 (28)	803 (50)	2.56 (1.74–3.77)*
Energy dense food	41 (30)	385 (24)	0.72 (0.49–1.06)
Carbohydrates/grains	56 (42)	417 (26)	0.49(0.34–0.71)*
Share of the stomach (frequency of nutrient-rich foods as per food groups eaten per week)			
Dairy	8 (6)	289 (18)	3.49 (1.69–7.20)*
Meat/beans/eggs	16 (12)	321 (20)	1.86 (1.09–3.18)*
Fruits	9 (7)	112 (7)	1.05 (0.52–2.12)
Vegetables	5 (3)	81 (5)	1.38 (0.55–3.47)
Proportion and types of the most weekly consumed unhealthy food among children			
Weekly consumption			Odds ratio
French fries	118 (87)	1396 (87)	1.03 (0.61–1.76)
Chips	113 (84)	1332 (83)	1.05 (0.65–1.69)
Sugar sweetened beverages	109 (81)	1091 (68)	1.97 (1.27–3.07)*
Biscuits	89 (66)	1075 (67)	0.95 (0.67–1.32)
Chocolate	89 (66)	1027 (64)	1.09 (0.75–1.58)
Pancakes/cakes	81 (60)	995 (62)	0.92 (0.64–1.32)
Ice cream	74 (55)	931 (58)	0.88 (0.62–1.25)
Candies	58 (43)	738 (46)	0.88 (0.62–1.26)

*=p < 0.05, significant, sugar-sweetened beverages (packed juice, homemade juice, and carbonated soft drinks).

The important factors having a significant effect on the height of children were having meals on time (p < 0.001), having breakfast in addition to having a morning snack (p = 0.002), or having breakfast alone (p = 0.003). The number of meals eaten by the child (p = 0.008) and eating eggs and dairy products had a profound effect (p < 0.001), drinking soft drinks p = 0.007, concerning social factors mother education followed by family income then father education was the priority index for having stunted children (OR = 0.005, OR = 0.007, and OR = 0.009), respectively (Table 4).

Table 3: Effect of social factors on stunting

Parameters	Stunted	Normal	Test of sig.
	(n=135) 7.8 %	(n=1605) 92.2 %	Odds ratio (CI)
Child order			
Child order (≥3) (n=715)	89 (65.93)	626 (39)	OR=2.49
Child order (1–2) (n=1035)	56 (34.07)	979 (61)	(1.75–3.52)*
Family size*			
Large family (n=866)	100 (74.07)	766 (47.73)	OR=3.13
Small family (n=874)	35 (25.93)	839 (52.27)	(2.10–4.66)*
Family income**			
Low-income family (n=836)	99 (73.33)	737(45.91)	OR=3.24
Middle-income Family(n=904)	36 (26.67)	868(54.08)	(2.18–4.80)*
Mother education***			
Illiterate or read and write (n=829)	105 (77.78)	724 (45.12)	OR=3.78
High education (n=911)	30 (22.22)	781(54.89)	(2.49–5.74)*
Father education***			
Illiterate or read and write (n=995)	101 (74.81)	894 (55.7)	OR=2.64
High education (n=708)	29 (25.19)	679 (44.3)	(1.73–4.04)

*Large family=Family size ≥6, Small family=Family size 1–5, **Low-income family: Father and mother are unemployed, day by day workers, farmers, or laborers, Middle-income family: Father and mother are employees, professionals, employers, or dealers, ***High education=High school and university.

Negative means: For continuous data with the increase, there is a decrease in the risk of stunting, and for dichotomous data, it means that with its absence, the risk of stunting increases.

Discussion

Nutritional status is a strong determinant of health, neurocognitive performance, and school achievement of school-aged children [6], [7], [8], [9], [10], [11]. In

addition to this, childhood undernutrition can impact adults' salaries and families' incomes [23].

Table 4: Logistic regression of factors affecting height for age Z scores

Parameter	B	Sig.
Breakfast	0.840	0.003
School meal	−0.522	0.134
Number of meals	0.890	0.008
Child order	1.007	0.051
Family size	1.155	0.023
Breakfast and/or morning snacks	1.150	0.002
Mid-day snack	−0.552	0.238
BREAKFAST+ NUMBER OF MEAL	1.349	0.008
Snack before sleep	0.104	0.661
Meals on time	1.098	0.000
Snacks between meals	−0.005	0.987
Egg No/Yes	1.279	0.000
Dairy No/Yes	1.556	0.000
Vegetable No/Yes	−1.149	0.073
Fruit No/Yes	0.228	0.599
Soft drink No/Yes	−0.779	0.007
Chips No/Yes	0.024	0.943
Candy No/Yes	0.026	0.914
Father education cat	−1.136	0.009
Mother education cat	−1.007	0.005
Family income	1.382	0.007
Mother job cat	0.165	0.387
Constant	0.831	0.730

The WHO estimates that malnutrition accounts for 45% of child mortality worldwide [24]. In developing countries, 52% of school-aged children are stunted [25].

The Egypt Demographic and Health Survey 2008 (EDHS 2008) revealed that the prevalence of stunting among children under 5 years was 28.9%, while in the EDHS 2014, it was found to be 21% [5]. Height-for-age used to indicate past nutritional deficits as it reflects a child's nutritional history. Stunting is a long-term process beginning from early life, so children who were under five in 2014 are today's school-aged children. Detecting prevalence of stunting in these age groups, detecting the associated factors, and whether applying school feeding programs, promoting awareness, and improving social factors can have a beneficial effect on the catch-up of those children, are important factors to investigate to reach our targets of SDGs.

In our study, the prevalence of stunting was 7.8% which is less than many previous Egyptian studies. A school-based cross-sectional survey was conducted on children aged 6–17 years in an Egyptian village revealed that stunting among children was 34.2%. Father employment, which reflects family income, and dietary habits, were from the high priority factors in this study [26]. A study that was done in Egypt revealed varied prevalence of stunted ranging 9.8% of urban and 12.8% of rural primary school-aged children [27]. They attributed this to bad feeding practices and a lack of awareness among children and parents. Another study in Egypt estimated that the prevalence of stunting and severely stunted growths was 11.3% and 1.15%, respectively. This was significantly associated with rural location, poorly educated mothers, and birth order ≥4 [28]. In the current study, there were many dietary behaviors associated with stunting. Skipping breakfast and having <3 meals per day carried more than 4 times the risk of being stunted than those who had breakfast and their number of meals were more than three per day. There are many Egyptian studies supporting

these findings and at the same time suggesting that school feeding programs and breakfast resulted in improvements in children's health and nutrition when provided for a long period [6], [7], [8], [9], [10], [11].

Egypt is on course to meet the global targets of under-five stunting which is less than that of developing countries by 25% [29]. Such a target could not be achieved without educating mothers about the role of breastfeeding during the first 2 years of life in improving the health and development of infants [8], [9], [10], [11]. Meanwhile, to achieve SDG for decreasing stunting in Egypt, community-based programs for empowering women is indicated as it proved to be successful for rural communities in Egypt for controlling both communicable and non-communicable diseases and for enhancing progress toward a better quality of life [30], [31], [32], [33].

FAO statistics in the year 2018 revealed that there is a reduction in the overall percentage of the undernourished population from 5.1% to 4.5% along the years 2001 to 2017. This was in consistent with the increase of the availability of fruits and vegetables per gram was 930 in 2008 and 812 in 2013 [34]. Tomorrow's generation grows up healthier is an initiative falling under the Egyptian President's "100 Million Health" campaign. The initiative will provide free healthcare to anyone suffering from conditions associated with a bad or unbalanced diet such as anemia, obesity, or stunted growth as well as raising awareness on how to avoid such problems in the future [35].

The school feeding program in Egypt is an initiative from the Egyptian government that can lower stunting percentage in the long run [7]. Preventing stunting is from the targets included in Egypt's national plan that requires general improvements in maternal and child nutrition. Decreasing the percentage of stunted children is also one of the Egyptian indicators for SDG 2 (zero hunger) [36]. Meanwhile, the role of primary health care in educating women about healthy food is considered a woman and child right and is mandatory, especially in rural communities [37], [38].

The social enabling factors that were found to affect physical growth included family size and income, mother's education, and the order of the child among his siblings. In this study, it was found that large family size was a significant factor for stunting where the majority of stunted children (74.07%) belonged to large-sized families. This can be interpreted by that large family size leads to decreased child's share of family income as well as diminished child's share of daily food. Family income is related mainly to father income as in most families, the father is the money earner. It was found that the majority of stunted children were from low-income families (73.33%) compared to normal children where 54.08% were from middle-income families.

Another reason may be that large families depend on school meals for feeding their children and direct resources formerly used to feed their children

toward other household needs, which could ultimately improve the welfare of the family as a whole. Poverty negatively affected a child's growth, both in utero and in early childhood.

Among the underlying causes of malnutrition in Egypt is food insecurity besides poor access to a balanced diet among the poor, poor dietary habits, as well as lifestyle and lack of nutritional awareness across the population [39].

Parental characteristics are considered one of the non-economic factors that may result in variability in children's diets and their nutritional status. There are many factors that were proved to be significantly associated with increased child height including higher maternal education levels, higher maternal height, higher family income, and a higher percentage of energy intake from protein [40], [41]. The results of the present study indicate that mother's education is an important social factor affecting physical growth where it was found that children of illiterate mothers were more affected by stunting (77.78%). The influence of maternal education – the years of schooling achieved by the mother in the local school system – proved to be profound and dominated upon different aspects of diet and the nutritional status of children. The fact that higher levels of education for women in developing countries translate into better nutrition for offspring may be due to that more schooling leads to greater exposure to nutrition principles. It was also hypothesized that more educated women in developing countries are more receptive or have a higher ability to understand information about child care and nutrition [8], [42], [43], [44] and are more able to maximize utilization of existing family and community resources for available governmental primary health care services [45], [46]. Moreover, the linkage between exclusive breastfeeding with higher levels of maternal education was documented among studies targeted infants and preschool children from developing countries [8], [9], [10], [11], [43]. Meanwhile, higher levels of maternal intelligence promote better offspring health as it influences increased usage of adaptive behavior strategies. Results of a previous study done in Egypt indicated that toddlers whose mothers had higher levels of education had higher-quality diets, even after controlling socioeconomic status factors [11].

Conclusion

Nutrition is a fundamental aspect for health and development in school-age children. There are many dietary behaviors associated with short stature as skipping breakfast, having <3 meals per day, not having meals on time, and taking non-nutritive food as soft drinks. Enabling social factors included family size and income and mother's education. Improvement of those factors can lead to a decreasing prevalence of short stature.

It is recommended to disseminate knowledge about healthy eating and good health practices and how to make use of the available resources through massive campaigns, especially in rural and poor areas.

Strengths of the study

Our study is characterized by being a facility-based one on representing three different geographical areas with a very large sample size (1740 child), with a high confidence level of 98% and low two-sided margin of error (0.03). As the role of the paternal and maternal parameters on child development is well evident in many Egyptian studies, the influence of these parameters was studied in the current manuscript.

Limitation of the study

This study was limited to investigate the dietary behavior and social factors on stunting. Another limitation is that the cognitive capabilities and behavior of school-aged children were not studied.

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