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Overweight and obesity related factors in schoolchildren in Santa Catarina State, Brazil

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SUMMARY. The purpose of this study is to determine the correlation of socioeconomic, dietary, and anthropometric-nutritional variables of parents and their children to overweight (including obesity) in schoolchildren in Santa Catarina State, Brazil. This is a transversal study conducted on 4,964, 6 to 10-year-old schoolchildren registered in 345 Santa Catarina elementary schools. The following data were acquired: the children's current weight and height, birth weight and length, duration of breastfeeding, age at which water, herbal tea and other foods were introduced to their diet; parental income, education level, age, weight and height were also obtained. The prevalence of overweight and obese children were estimated by point and by interval with a 95% confidence; prevalence rates were obtained based on the Poisson model. An hierarchical approach was used, in which variables were adjusted within blocks and included in the model when they presented p<0.05 at the outcome (overweight including obesity). The results indicate that 47.8% of the subjects were male. The prevalence of overweight and obese students was 15.4% (CI95%: 14.4%-16.5%) and 6.1% (CI95%: 5.4%-6.7%) respectively and were statistically similar among sexes and age ranges. BMI values were higher in males and among older children (p<0.05). After adjustment within and among blocks, the variables per capita household income and parents' BMI values remained associated with overweight (including obesity). Overweight (including obesity) in schoolchildren is associated with a higher per capita household income and parental overweight and obesity.
Key words: Nutritional status, childhood obesity, schoolchildren.

RESUMO. Fatores associados ao sobrepeso e a obesidade em escolares do Estado de Santa Catarina. Este estudo objetivou verificar a associação entre variáveis socioeconômicas, dietéticas, antropométrico-nutricionais dos pais e da criança e a presença de sobrepeso incluindo obesidade, em escolares do Estado de Santa Catarina. Trata-se de um estudo transversal com 4.964 escolares entre 6 a 10 anos matriculados em 345 escolas do ensino fundamental de Santa Catarina. Foram obtidos dados de peso e estatura dos escolares, peso e comprimento ao nascer, tempo de aleitamento materno, idade da introdução de água ou chá e de outros alimentos, renda, escolaridade e idade, peso e estatura dos pais. As prevalências de sobrepeso e obesidade foram estimadas por ponto e por intervalo com 95% de confiança e as razões de prevalência foram obtidas a partir do modelo de Poisson. Foi utilizada a abordagem hierárquica, onde as variáveis foram ajustadas dentro dos blocos e incluídas no modelo quando apresentaram p<0,05 com o desfecho (sobrepeso incluindo obesidade). Os resultados indicam que 47,8% dos participantes pertenciam ao sexo masculino. As prevalências de sobrepeso e obesidade foram, respectivamente, 15,4% (IC95%: 14,4%-16,5%) e 6,1% (IC95%: 5,4%-6,7%), sendo estatisticamente semelhantes entre sexos e categorias de idade. Os valores do IMC foram maiores no sexo masculino e entre as crianças mais velhas (p<0,05). Após ajuste dentro e entre os blocos permaneceram associadas com a presença de sobrepeso incluindo obesidade, as variáveis renda familiar *per capita e* IMC dos pais. O sobrepeso incluindo obesidade dos escolares está associado à renda familiar *per capita* mais elevada e ao fato dos pais apresentarem sobrepeso e obesidade.
Palavras chave: Estado nutricional, obesidade infantil, escolares.

INTRODUCTION

The prevalence of overweight and obesity has become a public health issue in developed but also in developing countries (1) in recent years. This has sparked increased interest in the development of interventions and policies to deal with this epidemic and its harmful consequences (2).

Childhood obesity is a complex disease influenced by environmental and genetic factors, and their interactions. Epidemiological studies have identified multiple risk factors leading to this condition, which results from the interplay of economic, social, environmental and biological factors (3,4).

The most influential determining factors include: high birth weight, early catch-up postnatal growth, a short breast-feeding period, overweight and obese parents, household income, reduced physical activity as well as unhealthy eating habits (5-9).

The findings generally support that the parents' excess weight is associated with increased probability of being overweight (7,8,10,11). According to Mondini et al. (10), the most

important risk factors for overweight in children, is the mother's or guardian's overweight (RP=1.6; CI95%=0.95-2.71) or obese (RP=3.54; IC95%= 2.16-5.80) status. These results may not only be due to genetic factors but also to the family's eating habits (10).

Regarding socioeconomic factors, most studies revealed a positive association between overweight and obesity, and socioeconomic indicators (12-14). Study performed in Mexico showed that pupils of medium (OR=1.9; CI95%=1.61-2.28) and high (OR=2.8; CI95%=2.33-3.34) socioeconomic levels were more likely to be obese, when compared with those of lower socioeconomic standing (8).

Although there is evidence that breastfeeding may help prevent childhood obesity (7,15), Ryan (2) points out that this should not be considered the only preventive measure. Other studies have indicated that a child's gender (4), age (12) and his or her mother´s level of education (9,16) are associated with overweight and obesity.

The purpose of this article is to investigate how socioeconomic, dietary and anthropometric-nutritional variables of parents and children are probably associated with overweight and obesity in 6 to 10-year-old schoolchildren in Santa Catarina, Brazil.

METHOD

The data analyzed in this article are part of a transversal study conducted from June 2007 to May 2008 on schoolchildren registered in both public and private elementary schools in eight municipalities in Santa Catarina. Santa Catarina is located in southern Brazil and has an area of 95.4 thousand km² and a population of 5,866,487 (17).

The design and methodological development of the study were described in previous articles (18,19). The sampling plan was comprised of two units of analysis: the school and the pupil.

The schools were located in eight municipalities regarded as those with the largest number of students registered in the early elementary school grades.

Other criteria were used to compose the sample including financial and operational factors, such as whether the school was public or private, and the number of registered pupils. The sample universe was comprised of 140,878 pupils registered in 569 public and private schools in the eight previously chosen municipalities.

The number of schools was calculated to ensure a maximum sampling error of ± 6 percentage points. The final sample had 347 schools located in both urban and rural areas, 266 of which were public and 81 private.

Pupils were sampled randomly and in proportion to the number of students in their grade, which was picked randomly in each school. It also depended on the return of the Informed Consent form by their parents' or guardians. A total of 5,686 subjects were authorized to participate in the study.

The data collection team included eight nutritionists who were trained to comply with a previously established protocol for the standardization of data collection procedures designed to minimize possible intra- and inter-evaluator errors. The technical error of measurement among the members of the data collection team was not determined, but 10% of the pupil samples were measured twice as a quality control of the anthropometric measurements.

Data regarding the region of each school and type of administration (public or private), as well as the subjects' age and gender were obtained from school offices and indicated on the record for each participating student.

Data concerning the parents' socioeconomic status (per capita household income and education level), maternal and paternal age, weight and height, the child's birth weight and length and dietary variables including duration of breastfeeding, age at which water, herbal tea and other foods (or other types of milk) were introduced in the infant´s diet (Table 1) were obtained from a questionnaire sent to the parents or guardians. The variables' were categorized in Table 2.

TABLE 1
Theoretical Model for performing multiple analyses designed to associate overweight and obesity with independent variables grouped per level.
Santa Catarina, 2008

Level (or block)	Variable
Socioeconomic status	Per capita household income Parents' level of education
Maternal and paternal characteristics	Age of parents Parents' BMI
Infant's characteristics at birth	Weight Length
Dietary variables	Duration of breastfeeding Age of introduction of water or herbal tea Age of introduction of other foods (or other types of milk)
Child's characteristics	Gender Age

TABLE 2
Distribution of schoolchildren (number and percentage or mean and standard deviation) according to socioeconomic, dietary and anthropometric-nutritional variables of parents and their children and nutritional status. Santa Catarina, 2008

Block	Variable	Overweight (n=766, 15.4%) N or mean (% or SD)	Obesity (n=300, 6.1%) N or mean (% or SD)	P value†
1	**Per capita household income (R$)**	500.6 (549.4)	451.7 (638.4)	< 0.001‡
	< R$ 200.00	147 (11.5)	63 (4.9)	< 0.001
	R$ 200.00 to R$ 399.99	229 (16.8)	99 (7.2)	
	≥ R$ 400.00	250 (17.6)	83 (5.8)	
	Mother's level of education			0.001
	Did not study	4 (7.6)	3 (5.6)	
	Primary (Complete or not)	256 (13.4)	129 (6.7)	
	Secondary (Complete or not)	247 (17.0)	86 (5.9)	
	University (Complete or not)	181 (19.0)	47 (5.0)	
	Father's level of education			0.001
	Did not study	5 (8.2)	3 (4.9)	
	Primary (Complete or not)	246 (13.8)	136 (7.7)	
	Secondary (Complete or not)	206 (16.7)	71 (5.8)	
	University (Complete or not)	169 (18.5)	41 (4.1)	
2	**Mother's age (years)**	35.1 (6.8)	35.7 (7.0)	0.014
	< 31	210 (15.0)	69 (4.9)	0.050
	31 to 36	211 (14.6)	88 (6.1)	
	≥ 37	302(16.7)	125 (6.9)	
	Father's age (years)	38.6 (7.3)	38.7 (8.1)	0.167
	< 35	189 (13.6)	92 (6.6)	0.028
	35 to40	231 (16.3)	74 (5.2)	
	≥ 41	244 (17.0)	100 (6.9)	
	Mother's BMI (kg/m²)	25.4 (4.3)	27.4 (5.3)	< 0.001
	< 18.5	6 (4.8)	2 (1.6)	< 0.001
	18.5 – 24.9	374 (13.9)	107 (4.0)	
	25.0 – 29.9	207 (17.9)	93 (8.1)	
	≥ 30.0	96 (20.7)	68 (14.7)	
	Father's BMI (kg/m²)	26.9 (3.6)	28.2 (4.1)	< 0.001
	< 18.5	1 (6.7)	- (-)	< 0.001
	18.5 – 24.9	205 (12.5)	57 (3.5)	
	25.0 – 29.9	294 (17.4)	113 (6.7)	
	30.0 – 34.9	88 (19.9)	59 (13.4)	
	≥ 35	16 (15.8)	17 (16.8)	
3	**Birth weight (g)**	3335.8 (542.2)	3395.6 (563.0)	< 0.001
	< 2500	39 (11.2)	15 (4.3)	0.044
	2500 – 4500	650 (15.8)	255 (6.2)	
	> 4500	12 (20.3)	5 (8.5)	
	Birth length ‡	48.9 (4.0)	49.3 (3.6)	0.010
	< 48 cm	180 (15.0)	58 (4.9)	0.027
	48 – 49.9 cm	209 (15.0)	79 (5.6)	
	≥ 50 cm	283 (16.4)	127 (7.4)	
4	**Age of foods introduction‡**	4.8 (3.3)	4,9 (3.6)	0.393
	< 3 months	153 (15.4)	77 (7.8)	0.003
	3 to 6 months	416 (16.0)	128 (4.9)	
	>6 months	109 (15.4)	57 (8.0)	

*SD – standard deviation † Anova or chi-square ‡ Logarithmic transformation for performing statistical test

Weight and height measurements were used to calculate Body Mass Index (BMI). The father's and mother's BMI classification was made according to the WHO criteria (1): BMI < 18.5kg/m^2 (underweight); between 18.5 and 24.9kg/m^2 (normal weight); between 25 and 29.9kg/m^2 (overweight or pre-obesity) and > 30.0kg/m^2 (obesity).

The pupils' weight and height data were collected according to pre-established procedures using the appropriate scientific equipment for this type of research (1,20). Weight was measured once with a 180 kg-capacity digital scale with precision of 100g (Marte, Model PP 180, Brazil). Height was measured once with a stadiometer with 1mm-precision (Altura Exata, Brazil).

The outcome variable is overweight (including obesity), classified according to BMI per gender and age, and cut-off points suggested by Cole et al. (21), recommended by the International Obesity Task Force (IOTF), based on outcome overweight values for adults (BMI>25kg/m² and <30kg/m²) and obesity (BMI > 30kg/m²).

Independent variables are shown in Table 1. The prevalence of overweight and obese children according to sex was estimated by point and by interval with 95% confidence. Mean values and standard deviations were obtained for quantitative variables and absolute and relative frequencies, according to the children's BMI values, were obtained for qualitative variables. The Anova variance analysis was used with Bonferroni correction, when applicable for analysis of the quantitative and qualitative data. The chi-square test was used to compare averages and frequencies. Quantitative variables that did not present normal distribution were logarithmically transformed. Tercile values were used for grouping variables such as per capita household income, parental ages and the infant birth length. The median value was used for beginning of water/tea intake and child's age.

Prevalence rates (gross and adjusted) were obtained from the Poisson model as recommended by Barros and Hirakata (22). We adopted the hierarchical approach proposed by Fuchs et al. (23) for the modeling process based on the theoretical model shown in Table 1. At this stage of the analysis we considered, as dependent variables, the presence or absence of overweight (including obesity). The variables were initially adjusted within the blocks and included in the "complete" model only when they showed a statistically significant association ($p<0.05$) with the outcome variable (overweight including obesity). The modeling process (complete model) was initiated from the "representative" variables of the first and second blocks; the latter remained in the model only if the respective p values were <0.05 in the presence of the variables of the first block. A similar criterion was adopted for the variables of the other blocks. The final model was comprised of the variables which, in the presence of those from previous blocks, remained statistically associated with the outcome.

Stata Statistical Software release 10 (College Station, TX Stata Corporation) was used in all stages.

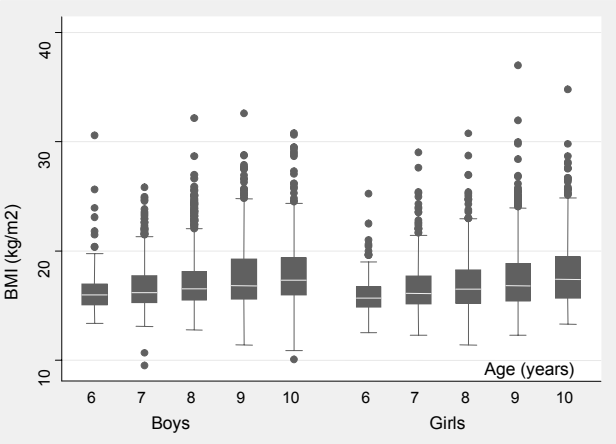
The research project was approved by the Research Ethics Committee of the Federal University at Santa Catarina (UFSC), in compliance with norms established by the Brazilian Health Council for research on human beings.

RESULTS

The number of schools participating in this study was 345 (269 public and 76 private), and a total of 4,964 schoolchildren. On the day of collection of anthropometric data, 275 subjects were absent from school and thus excluded from the study; 358 were eliminated because they were more than 10.9 years old; and 89 were excluded due to inconsistent data. Of the 4,964 students, 2,375 (47.8%) were male and 2,589 (52.2%) female.

The prevalence of overweight and obese children was 15.4% (CI95%: 14.4% - 16.5%) and 6.1% (CI95%: 5.4% - 6.7%) respectively, totaling 21.5% of overweight (including obesity), which was statistically similar between sexes and age ranges. BMI values were statistically higher in boys and among the oldest subjects ($p< 0.05$) (Figure 1).

FIGURE 1
Schoolchildren's BMI values broken down per gender and age. Santa Catarina, 2008



p<0.05

Table 2 illustrates the mean values (SD) and pupil frequencies, according the presence of overweight or obesity and variables of interest that presented a statistically significant association (according to the blocks).

In relation to socioeconomic variables (Block 1), statistically significant associations were observed among overweight

and obesity, per capita household income and parental level of education. As for maternal and paternal characteristics (Block 2), both parental age and BMI values had a significant association. Regarding birth weight and length (Block 3), these values indicate a statistically significant association with overweight and obesity. In regard to dietary variables (Block 4), only age of introduction of foods other than breast milk, had a significant difference between categories. Breastfeeding (p= 0.25) and age of herbal tea/water introduction (p= 0.77) had no significant correlations (data not shown). Also, no significant correlations were found between overweight and obesity and gender (p= 0.16) and age (p= 0.32) schoolchildren's (data not shown).

In Table 2, the average per capita household income of schoolchildren with normal BMI was statistically lower than that of overweight or obese pupils. These factors are also reflected when the percentage distribution is analyzed; the largest number of overweight and obese schoolchildren are found in the lower two thirds of income. In terms of parental education, it was found that the more educated the parents, the more overweight their children were likely to be. This proportion was not found for obesity.

Regarding parental age, the average age of mothers of schoolchildren with normal BMI was lower than those of overweight and obese pupils. In terms of the father's age, there was a larger concentration of overweight and obese children among those whose fathers were > 35 years old.

The average BMI values of parents of overweight and obese schoolchildren were higher than those of other pupils'. Birth weight and length variables were also higher in overweight and obese schoolchildren.

As for age at the introduction of foods other than mother´s milk, the lowest percentage of obese schoolchildren was found among those who were fed with other foods during the intermediate period from 3 to 6 months.

Table 3 shows adjusted prevalence rates for the presence of overweight or obesity among schoolchildren according to variables grouped in blocks (final model). After adjustment among blocks, only the variables per capita household income and parental BMI remained associated with overweight (including obesity).

TABLE 3
Adjusted prevalence rates to the presence of overweight or obesity among schoolchildren according to variables grouped in blocks (final model). Santa Catarina, 2008

Block	Variable	Adjusted prevance rates	95% confidence interval
1	**Per capita household income (R$)**		
	< R$ 200.00	1	
	R$ 200.00 to R$ 399.99	1.28	1.05-1.56
	≥ R$ 400.00	1.38	1.13-1.68
2	**Mother's BMI (kg/m^2)**		
	< 18.5 kg/m^2	0.38	0.16-0.91
	18.5 to 24.9 kg/m^2	1	
	25.0 to 29.9 kg/m^2	1.39	1.18-1.64
	≥ 30.0 kg/m^2	1.87	1.51-2.31
	Father's BMI (kg/m^2)		
	< 18.5 kg/m^2	0.52	0.07-3.72
	18.5 to 24.9 kg/m^2	1	
	25.0 to 29.9 kg/m^2	1.41	1.19-1.68
	≥ 30.0 kg/m^2	1.67	1.35-2.07

DISCUSSION

Our data concerning the prevalence of overweight (including obesity) in schoolchildren of Santa Catarina and its association with variables such as socioeconomic, dietary and parents' and children's characteristics, are different from other studies in this field conducted so far in the state. The latter were, however, carried out either partially or locally.

A possible constraint to this study was the use of self-referred data to assess the infant's birth weight and length, duration of breastfeeding, and other dietary characteristics of the child, as well as the nutritional status of the parents. In some situations, the use of these measurements may interfere with the reliability of the findings. However, some studies require that data be collected this way (24).

The prevalence of overweight (including obesity) in the studied schoolchildren was high (21.5%), similar to that found in the literature, regardless of the diagnostic criterion used,

which confirms the magnitude and severity of the problem. In Brazil, some studies have found a prevalence of overweight ranging from 10.8% to 21.3%, and prevalence of obesity in the 3.5%-8.3% range (4,10,12,19,25). These data are in accord with those from international studies (8,13,14), some of which have shown rates higher (7,26) than those ones in Brazil.

Of all socioeconomic variables (household income and parental level of education), only household income was associated with the finding, indicating that overweight (including obese) schoolchildren were more frequent in households with higher income.

Corroborating this finding, another study conducted of schoolchildren in Brazil revealed that obesity was more frequent in population groups with better socioeconomic standing, with the odds ratio (OR) for overweight being 3.8 (CI95%=1.82-7.71) for schoolchildren with higher per capita household income in relation to lower income households (4). Other studies observed that the high education level of the mothers was also conducive to a greater likelihood of overweight children (4,14).

However, the association of the mother's level of education did not persist in the final model of analysis of the Santa Catarina study, as in other studies. This can be explained by the fact that education level is a 'proxy' variable relative to income (7,10).

Different findings were reached in a systematic review of cross-sectional studies 1990–2005, where the association between socioeconomic status and adiposity in childhood from western developed countries was predominately inverse and very few positive associations were found. Children whose parents (particularly mothers) have a low level of education appear to be at higher than average risk 27. In the same way, one study conducted of schoolchildren in China revealed that a low level of education among mothers' (OR=1.9; CI95%=1.14-2.78) and fathers' (OR=1.6; CI95%=1.01-2.67) was associated with overweight[16].

The relationship between socioeconomic variables and the prevalence of overweight (including obesity), occurs because socioeconomic level can determine the availability of food, access to information, and be associated to different patterns of physical activity, thus shaping nutritional status (12).

Among the parental characteristics selected by this study, it should be highlighted that the average BMI values of the parents was higher in overweight (including obese) schoolchildren. These variables, and per capita household income, were associated with overweight (including obesity) in schoolchildren in the final hierarchical model. One study of Greek schoolchildren showed that boys whose fathers or mothers were obese, were 3.3 (CI95%=1.03-10.47) and 7.4 (CI95%=1.86-29.02) times more likely to become overweight or obese. On the other hand, girls were 5.4 (CI95%=1.19-7.61) and 4.2 (CI95%=1.37-12.74) times more likely to develop this nutritional status when either parent (or both) were obese (7).

The influence of maternal BMI values can be further illustrated by a study of Mexican schoolchildren, which found that children of overweight and obese mothers were 1.9 (CI95%=1.62-2.18) and 3.4 (CI95%=2.96-4.00) times more likely to be obese, when compared with children whose mothers had a normal BMI (8).

As for birth weight, this study revealed that, this variable was associated with overweight (including obesity) only when analyzed in isolation. A study conducted of 10 to 12-year-old schoolchildren showed that girls who weighed more than 3500g at birth were 1.9 times (CI95%=1.02-3.38) more likely to be overweight or obese at school age (7). However, a review of this issue (9) found that it is not possible to estimate, with a single measurement, how much birth weight contributes to later overweight or obesity.

The study presented here also did not find an association between birth length and overweight (including obesity) in schoolchildren.

No association was found between breastfeeding and the children's BMI values. However, this study found that boys and girls who were breastfed for more than three months had, respectively, a 72% (CI95%=0.09-0.84) and a 81% (CI95%=0.06-0.65) lower risk of becoming overweight or obese when compared with schoolchildren who had not been breast fed (7).

Even though there is evidence showing that breastfeeding can prevent childhood obesity (7,15,28), this should not be considered the only preventive measure. A review of 14 studies published between 2003 and 2006 identified that in three of them breastfeeding played a preventive role against childhood overweight or obesity; four studies showed it had a partial protective factor (evident in one subgroup only); six studies showed no protective factor, and one exhibited a protective factor for children, but not for adults (2). In the United States, where there is increasing prevalence of breastfeeding, it is known that childhood overweight and obesity rates have dramatically increased in recent years. These findings seem to corroborate the notion that there are multiple factors involved in maintaining healthy weight (2), and that wide-spectrum measures must be analyzed and developed to control childhood overweight and obesity.

Studies also suggest that the total time of breastfeeding may be associated with slower growth in the first year of life, which could be why breastfeeding may protect against childhood overweight or obesity (29).

The other dietary variables included in this study (age at which water or herbal tea, and other foods or other types of milk were introduced in the infant's diet) were not associated with overweight (including obesity).

In this study, overweight and obesity rates were similar for both sexes. While some studies have had similar findings (10,30), others (4,14) observed more overweight and obesity cases among girls. No association was found to the age of schoolchildren in the final model of this study, unlike the findings of Silva et al. (12). These authors found higher rates of overweight pre-school children (22.2%), and progressively lower rates among school-age children (12.9%), and adolescents (10.8%).

Our findings suggest that the prevalence of overweight (including obesity) is associated with socioeconomic level, determined by per capita household income, and parental BMI.

Parental BMI, and particularly the magnitude of the association with maternal BMI, demonstrate the important role played by the mother in shaping the relationship of the child with the environment, which, begins during gestation, including the sharing of socio-environmental conditions, lifestyles (eating habits and physical activity), which greatly influence the child's BMI (4,31).

The influence of parents' excess weight on their children calls for reflection and questioning, to identify issues and patterns related to genetic predisposition, the interference of poor family habits that are handed down from one generation to the next, and how much these factors may interfere in the genesis and maintenance of childhood overweight and obesity (11,31,32). This is a topic yet to be explored. Priority should be given to monitoring and intervention of children with obese parents, because their risk of developing this problem is higher (11).

These findings indicate that interventions must consider the child's family and socioeconomic context, and be supported by broader actions that also address behavioral issues.

Also, it should be highlighted that preventive and corrective strategies for feeding and nutrition must also ensure concrete and consistent action in the educational sphere. This includes effective measures by the healthcare sector to promote healthy eating habits, the monitoring of nutritional problems and effective accompaniment of schoolchildren known to have nutritional disorders. In this context, nutritionists, healthcare professionals and actors from other sectors play a crucial role in encouraging and implementing initiatives that promote healthy feeding in schools. Their contribution by informing and developing school food service policies designed to enhance the nutritional status of children is much desired and expected.

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