THE INFLUENCE OF NUTRITIONAL STATUS ON SCHOOL PERFORMANCE

A influência do estado nutricional no desempenho escolar

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ABSTRACT

Purpose: to analyze the relationship between nutritional status and school performance of children in the 4th year of elementary school of one public school in Belo Horizonte assisted by the School Health Program. **Methods:** it is cross-sectional descriptive study accomplished with 59 students rated as to the school performance and nutritional status through the School Performance Test and the Body Mass Index by age - BMI / A, respectively. The analysis of the data were performed using the Statistical Package for the Social Sciences, version 14.0 and for the anthropometric analysis the software Who Anthro Plus, version 1.0.4. **Results:** from the researched children, the average age was 9.4 years (±0,85), which 34 (57,6%) male gender. The anthropometric rating revealed that 45 children (76.3%) are eutrophic, one (1.7%) is undernourished and 13 (22%) are weighing more than expected, according to WHO standards. The Student performance in the written test TDE was rated as lower (74.6%), medium (15.3%) andsuperior (10.2%). In the reading test 79.7% achieved lower results, 16.9% medium and 3.4% superior and in the arithmetic test 78.0% were classified as having underperformed, 16.9% medium and 5.1% superior, respectively. It was observed a statistically significance between poorer performance on tasks of writing and arithmetic and overweight (p< 0,05). **Conclusion:** the study revealed low school performance in most children, and the children that were overweight had a worse outcome at writing and arithmetic.

KEYWORDS: Speech, Language and Hearing Sciences; Nutritional Status; Obesity; Malnutrition; Reading; Underachievement

INTRODUCTION

Reading and writing are regarded as key skills for the acquisition of knowledge from the very beginning of this process. The evolution of knowledge has resulted in increased demands placed on reading, text comprehension, and clear and correct writing[1]. These activities involve, beyond drawing letters representing sounds and words, the extraction and comprehension of graphic information, and the reconstruction of its meaning[2].

Despite the strong emphasis given to the written language, many children struggle with learning difficulties in school, which are related to poor reading and writing performance in varying degrees of duration and severity[2,3]. In this context, practitioners in various fields have conducted studies on school achievement to examine the children's ability to learn the content[2,4,5]. Some skills are more prominent and indispensable for the learning processes to develop adequately[2].

Among the factors that could be related to inadequate development of reading and writing skills and, consequently, to underachievement in school, are genetic, hereditary, and neurobiological

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Conflict of interest: non-existent

factors; prematurity and low birthweight; alterations in phonological, visual, language and hearing processing; psychological-emotional aspects; attention deficit and hyperactivity disorder[6]. Other contributing factors are a poorly stimulating home environment[7], socioeconomic factors[7,8], and nutritional disorders[9].

Balanced nutritional intake is required for adequate biological functioning, and any deficit or excess could lead to alterations that, in turn, affect such complex brain functions as the cognitive processes related to the learning of reading and writing[10].

Nutritional disorders are generally caused by an inadequate diet, and the affected children may be below or above the optimal weight for their age group. These disorders lead to greater susceptibility to disease as a result of deficits in specific nutrients—iron, for instance—and often result in school absenteeism and delayed development compared with peers[11]. Other characteristics observed in these children are marked irritability, attentional deficits, and decreased energy[9]. Obesity is considered a nutritional disorder linked to psychosocial issues, behavioral problems and difficulties in social, family and school relationships, all of which give rise to a condition of depression, anxiety and poor school performance[9]. Similarly, undernutrition has been associated with underachievement in school, and could, over the long term, impair or prevent the full development of an individual's abilities, especially when it occurs during the period of brain development[12,13].

The aim of the present study was to analyze the relationship between the nutritional status and school performance of children in the fourth year of elementary school at a public school in the city of Belo Horizonte, who are assisted by the *Programa Saúde na Escola* (PSE, School Health Program).

■ METHODS

The present study was approved by the Research Ethics Committee of the institution under protocol 686/2011.

This descriptive and cross-sectional study was conducted with children aged between 9 and 11 years regularly enrolled in the fourth year of elementary school at a municipal public school, assisted by the PSE of the Ministry of Health and the Ministry of Education[11].

Initially, the children's parents were informed as to the objectives and implications of the study, and provided signed informed consent authorizing the participation of their son or daughter in the study.

All the children regularly enrolled in the fourth year of elementary school were eligible to participate in the study. However, students with hearing loss, history of impaired neurological development, and those with irregular school attendance were excluded from the study.

The school performance of the study participants was evaluated with regard to reading, spelling and arithmetics skills, and in relation to their nutritional status.

School performance was evaluated using the reading, spelling and arithmetics subtests of the *Teste de Desempenho Escolar* (TDE, School Achievement Test)[14]. The spelling test assesses the ability of children to write their own name and single words in the form of a dictation; the reading test evaluates the recognition of words without context cues, and the arithmetics test evaluates simple mathematical operations[14]. The TDE was partly administered in the classroom (the spelling and arithmetics tests), and partly individually (the reading test). On average, the administration of the TDE required 40 minutes in the classroom for the collective part, and five minutes individually. The results were compared with the standard test score for third-grade (fourth school year) students, based on the TDE reference scores, which are shown in Figure 1.

Classification\Raw score	Spelling	Arithmetics	Reading
Superior	≥ 30	≥ 18	≥ 69
Average	24-29	15-17	66-68
Inferior	≤ 23	≤ 14	≤ 65

Source: Teste de Desempenho Escolar. Stein, 1994.

Figure 1 - Classification in the spelling, arithmetics and reading subtests based on the TDE raw scores–3rd grade

The nutritional status assessment comprised weight and height measurements. The collected data were combined with the information on child gender and age to generate the body mass index for age (BMI-for-age), an index applied throughout the life stages and recommended internationally for the individual and community-based diagnosis of nutritional disorders. Values were expressed as z-scores according to Ministry of Health criteria[15], which are in keeping with World Health Organization (WHO) guidelines[16].

Weight and height were measured by the dietitian who co-authored the present study according to techniques recommended by Jellife[17]. Weight was measured using a digital scale with 150-kg capacity and accurate to 0.1 kg (Plenna®). The children were weighed wearing minimal clothing. All the children were measured barefoot, using a stadiometer (*AlturaExata* model). The term "overweight" was used to group the children with overweight and obesity. In order to classify the nutritional status of the children, the reference values shown in Figure 2 were adopted.

Cut-off points	Nutritional status
< z-score -3	Severethinness
≥ z-score -3 and < z-score -2	Thinness
≥ z-score -2 and ≤ z-score +1	Eutrophy
≥ z-score + 1 and ≤ z-score +2	Overweight
≥ z-score +2 and ≤ z-score +3	Obesity
> z-score +3	Severeobesity

Source: WHO, 2007

Figure 2 - Norms for the classification of the nutritional status of children aged 5–10 years and adolescents aged 10–19 years

The SSPS software version 14.0 was used for data entry, processing and quantitative analysis, while the anthropometric analysis was performed using theWHO AnthroPlus software version 1.0.4. Performance in the TDE was compared with the results of the nutritional assessment. The frequency distribution of the categorical variables involved in the evaluation of the language in study was calculated for descriptive analysis, and the measures of central tendency and dispersion of the continuous variables were also analyzed. Pearson's chi-square test was used for inferential analysis with the significance level set at 5%.

■ RESULTS

A total of 66 male and female students in the fourth year of elementary school at a Belo Horizonte public school participated in this study. Of these, one student was excluded because of a neurological impairment; two were excluded for hearing loss, and four other students, due to irregular school attendance during the assessment period. Thus, the final sample of the present study comprised 59 children.

The mean age of the schoolchildren was 9.4 years (±0.85), and 34 (57.6%) of them were male. The anthropometric assessment showed that 45 children (76.3%) were eutrophic, only one (1.7 %) was underweight, and 13 (22%) weighed above the norm, with 10 and 3 students in the range of overweight and obesity, respectively, according to the WHO standards.

The performance in the TDE spelling test was ranked as inferior for 74.6% of the students, average for 15.3%, and superior for 10.2% of the children. In the TDE reading test, 79.7% of the students had inferior outcomes, 16.9% performed within the average range, and only 3.4% had a superior performance. In the arithmetics test, 78.0% were ranked as having inferior performance, 16.9% were average, and 5.1% scored higher than the expected average.

The analysis of the data revealed a statistically significant association between poorer performance in the spelling and arithmetics tasks and overweight ($p < 0.05$), as shown in Table 1.

Table 1 - Relationship between the results of the TDE spelling, reading, and arithmetics assessments and the nutritional status of 59 elementary school children

Assessment results		Nutritional status						Test	p-value
		Thinness		Eutrophy		Overweight			
		n	%	n	%	n	%		
TDE spelling	Inferior	0	0%	33	73.3%	11	84.6%	9.84	0.04*
	Average	0	0%	8	17.8%	1	7.7%		
	Superior	1	100%	4	8.9%	1	7.7%		
TDE Reading	Inferior	1	100%	35	77.8%	11	84.6%	0.94	0.91
	Average	0	0%	8	17.8%	2	15.4%		
	Superior	0	0%	2	4.4%	0	0%		
TDE arithmetics	Inferior	0	0%	36	80.0%	10	76.9%	19.6	0.001*
	Average	0	0%	8	17.8%	2	15.4%		
	Superior	1	100%	1	2.2%	1	7.7		

*Test: Pearson's Chi-Square

DISCUSSION

The present study was intended to relate the nutritional status to the school performance of children attending the fourth year of the elementary school at a Belo Horizonte public school who are assisted by the PSE of the Ministry of Health. The TDE[14] was selected for the present study because it is a standardized and validated test, easy to administer, and adequate for children in the age group under study. However, the standardization of this instrument was performed with children of the southern Brazilian region, while the setting of the students investigated in the present study is the southeastern region.

In the present study, most students were found to be eutrophic (76.3%), which is in accordance with other studies conducted with schoolchildren in the same age group[18-20]. Adequate nutritional intake is known to potentiate the development of children in their daily activities, whereas food intake that fails to supply, or exceeds, individual nutrient requirements impairs biological functioning[9].

A high prevalence of children with overweight or obesity was found in the present study, which is a reflection of the nutrition transition that Brazil has undergone[18-21]. This phenomenon is characterized by a reduction in the prevalence of nutritional deficits and a significant increase in overweight and obesity (Ministry of Health, 2009). In addition, malnutrition, micronutrient deficiency, and overweight may coexist in the same communities or households[18]. Only one undernourished child was identified in the present study sample; this could be due to the good quality of school meals, since most students attend full-time school, where they have five meals.

Among the contributing factors to the shift in the nutritional profile of the population is the change in the eating patterns of the Brazilian society, promoted by easy access to high-calorie foods and/or by reduced physical activity[11,19]. In the Brazilian population, it is possible to observe an elevated consumption of saturated fatty acids, sugars, industrialized foods, fat-rich foods, and goodies to the detriment of the intake of vegetables, fruits, and complex carbohydrates[11,22].

Likely explanations for the high rates of overweight/obesity are a low level of physical activity, inadequate nutrition, and the sexual maturation period[19].Although the mean age of the children in the study was under 10 years, typically a time when sexual maturation has not yet begun, this hypothesis should be taken into consideration, as precocious sexual maturation contributes to double the likelihood of overweight[19,23]. Additionally, at this stage fat is accumulated prior to the pubertal growth spurt, and adolescents start to rapidly gain weight and height, which accounts for approximately 50% of their adult weight and 20% of their full height[24]. In girls, menarche represents the beginning of the growth deceleration occurring by the end of the pubertal growth spurt, as well as greater accumulation of adipose tissue[25].

The poor performance observed in the TDE is in line with the findings of another study with elementary school children in Belo Horizonte[26]. However, the outcomes differ considerably from those obtained with students of Porto Alegre, the city where the TDE was standardized. This discrepancy is not justified by regional or local characteristics[14], since the realities of the two cities are analogous, as

illustrated by the human development indices (HDI) of Porto Alegre (0.865) and Belo Horizonte (0.839)[27].

When relating the nutritional status to school performance, a statistically significant relationship was noted between writing skills and overweight; however, no other studies directly addressing these variables were found. A relationship between performance in the arithmetics test and nutritional status was also identified, with overweight students showing inferior performance. This finding diverges from that of a study conducted in private school students in the age group of 6–9 years, which found no relationship between nutritional status and school performance[9].

The explanation for the poorer performance of the overweight students in the previously mentioned tasks could be that obese or overweight individuals engage in less physical activity and feel less motivated for the daily activities, with equally relevant emotional issues involved[9]. It is believed that persistent demands regarding physical appearance and the "worship of beauty" can affect negatively the progress of those who do not meet the "ideal" standards of physical beauty. In children, this could lead to self-consciousness and withdrawal. In the school setting, this situation can also give rise to difficulties when performing some tasks because these children might feel embarrassed[9]. However, these explanations are hypothetical, since no scientific evidence of such linkages has been found to date.

In the present study, no statistical difference was found between eutrophic, undernourished, and overweight students with respect to their performance in the reading tasks. However, the literature provides evidence that nutritional disorders adversely affect cognitive and language tasks[28,29], both of which precede the acquisition of reading skills.

The present study reiterates the need for government policies promoting the health of students, such as the PSE, instituted by Presidential Decree 6286 of December 5th, 2007. The PSE was the result of concerted work by the Ministry of Health and the Ministry of Education, the purpose of which was to extend the targeted health interventions to public school system students. One of the actions included in the PSE is aimed at monitoring the nutritional status of the school community[11].

Early detection of overweight and obesity can foster public health strategies intended to improve the quality of life of the population[19]. Regarding academic performance, government policies such as the PSE enable interventions to reduce, or even eliminate, underachievement; this is of paramount importance given that children with these difficulties may develop emotional problems with ensuing repercussions in their individual, family, school and social life[6].

The results of the present study warrant further studies in order to confirm the association between overweight and school performance. The cross-sectional study design of this study made it impossible to establish a relation of causality between the analyzed variables. A longitudinal study, however, would enable closer monitoring of the children's schoolwork and nutritional status, and the identification of other factors, such as a home environment providing little cognitive stimulation and an unfavorable socioeconomic-cultural setting, both of which could impact school performance. So far, it has not been possible to observe the children in their daily lives at home and the relationship with their parents, essential aspects of the investigation of the causes of student underachievement[30].

■ CONCLUSION

Greater prevalence of overweight over malnutrition was found among the third-grade students of the elementary school. A statistically significant relationship was found between poorer performance in spelling and arithmetics tasks and overweight, which suggests an adverse impact of inadequate nutritional status on school performance.

RESUMO

Objetivo: analisar a relação entre o estado nutricional e desempenho escolar de crianças do 4º ano do Ensino Fundamental de uma escola pública de Belo Horizonte assistidas pelo Programa Saúde na Escola. **Métodos:** trata-se de estudo transversal descritivo realizado com 59 estudantes avaliados quanto ao desempenho escolar e estado nutricional por meio do Teste de Desempenho Escolar e do Índice de Massa Corporal por idade - IMC/I, respectivamente. Para entrada, processamento e análise quantitativa dos dados, foi utilizado o SSPS versão 14.0 e para análise antropométrica, o software Who Anthro Plus, versão 1.0.4. **Resultados:** das crianças investigadas, a idade média foi 9,4 anos (±0,85), sendo 34 (57,6%) do gênero masculino. A avaliação antropométrica mostrou que 45 crian-ças (76,3%) estão eutróficas, uma (1,7%) desnutrida e 13 (22%) com peso acima do esperado, de acordo com os padrões da OMS. O desempenho dos estudantes no TDE prova de escrita foi classi-ficado como inferior (74,6%), médio (15,3%) e superior (10,2%). Na prova de leitura 79,7% obtiveram resultado inferior, 16,9% médio e 3,4% superior e na prova de aritmética 78,0% foram classificados como possuindo desempenho inferior, 16,9% médio e 5,1% superior, respectivamente. Observou-se relação estatisticamente significante entre pior desempenho nas tarefas de escrita e aritmética e o excesso de peso (p< 0,05). **Conclusão:** o estudo revelou baixo desempenho escolar na maior parte das crianças, sendo que, as crianças acima do peso apresentaram pior resultado nas tarefas de escrita e aritmética.

DESCRITORES: Fonoaudiologia; Estado Nutricional; Obesidade; Desnutrição; Leitura; Baixo Rendimento Escolar

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