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Overweight status, abdominal circumference, physical activity, and functional constipation in children

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SUMMARY

OBJECTIVE: The aim of this study was to assess the prevalence of functional constipation and its relationship with the food intake, overweight status, and physical activity of children.

METHODS: This cross-sectional study included students from two public schools in the municipality of Osasco, which is located in the metropolitan area of São Paulo. Functional constipation was diagnosed if the clinical manifestations of the Rome IV criteria were present for more than 2 months. A 24-h recall survey was used to determine the daily food intake. Weight, height, abdominal circumference, and bioelectrical impedance were used to evaluate the weight status. Active commuting to school and physical activity scores were assessed using a questionnaire that has been validated in Brazil.

RESULTS: A total of 452 children, aged 6–12 years, were evaluated. Functional constipation was observed in 22.3% of participants. A greater abdominal circumference was associated with functional constipation in girls (p=0.036) in the bivariate analysis but not in the logistic regression model. Boys with functional constipation consumed higher quantities of fats (p=0.041). There was no statistically significant relationship between functional constipation and overweight status (44.6 and 34.5% of children with and without constipation, respectively; p=0.083) and active commuting to school (48.5 and 56.7% of children with and without constipation, respectively; p=0.179).

CONCLUSION: Functional constipation was associated with a greater abdominal circumference in girls in the bivariate analysis, however, without association in the logistic regression model. Boys with functional constipation consumed higher quantities of fat. No association was found between functional constipation, overweight status, and physical activity.

KEYWORDS: Child. Constipation. Eating. Pediatric obesity. Exercise. Sagittal abdominal diameter.

INTRODUCTION

Functional constipation is a functional gastrointestinal disorder that is a highly prevalent health issue in children[1-3]. Functional constipation is caused by the interaction of biopsychosocial factors such as genetic features, intestinal motility disturbance, low dietary fiber intake, low fluid intake, physical inactivity, and a vicious cycle of painful evacuation leading to fecal retention due to the inhibition of bowel movements[1-6].

In adolescents and adults, constipation is more frequent in females; however, in children, there is no consensus on the distribution of constipation between the sexes[1,4].

Increasing the intake of dietary fiber and water is recommended to treat and prevent functional constipation[6-8]. However, the effects of energy intake and different types of dietary nutrients as factors associated with functional constipation have not been completely explored[9,10].

Although few studies have indicated that overweight status is a risk factor for functional constipation[2-11], the scientific evidence is controversial[2,11]. An association between visceral body fat and irritable bowel syndrome in adult women was recently reported[12]. However, the relationship between abdominal circumference and functional constipation has not been evaluated in the pediatric age range. Furthermore, the effects of physical activity and its intensity on functional constipation in children and adolescents have not been widely investigated[13-15]. This study was conducted to assess the prevalence of functional constipation and its relationship with food intake, overweight status, and physical activity of children.

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METHODS

Study design

This cross-sectional study included students from two public schools in the municipality of Osasco, which is located in the metropolitan area of São Paulo. Functional constipation was diagnosed based on the clinical manifestations of the Rome IV criteria for more than 2 months. Food intake was evaluated using the 24-h dietary recall. Overweight status was evaluated using anthropometric and electrical bioimpedance measurements. Physical activity was evaluated based on the active commuting of the students to school and physical activity scores were obtained using a questionnaire validated in Brazil. The study was approved by the Research Ethics Committee of the Federal University of São Paulo (CEP 2.250.658).

Participants

Data were collected between November 2014 and 2015. The Department of Education selected the schools where greater collaboration and adherence of employees was expected to carry out the study. The only inclusion criterion was the enrollment in the schools included in the study by the Secretary of Education of the Municipality of Osasco. Therefore, all students were invited to participate in the study, regardless of their sex, nutritional status, race, or economic status. Patients with severe genetic, neurologic, cardiopulmonary, inflammatory, endocrine, or chronic kidney diseases were excluded from the data analysis.

A total of 1,770 students between 6 and 12 years of age attended the two designated schools. A presentation on the topic of the study was made to all parents and/or guardians. Authorization to participate in the study was requested from all parents or guardians. The parents of 480 (27.1%) children signed an informed consent form, while one student refused to participate in this study. The parents of 25 students could not be interviewed to provide information for the study. Two students were excluded because of severe disease (one with myelomeningocele and one with cerebral palsy). Finally, a total of 452 participants were included in this study.

Method

Functional constipation diagnosis

Functional constipation was diagnosed when the children had two or more of the following six clinical manifestations of the Rome IV criteria[3] for a minimum of 2 months[5]: two or fewer defecations per week in the toilet for a child of developmental age (at least 4 years of age); at least one episode of fecal incontinence per week; history of retentive posturing or excessive volitional stool retention; history of painful or hard bowel movements; and history of large-diameter stools that can obstruct the toilet[3,5].

Parents answered questions about the Rome IV criteria during the face-to-face interviews. The questions used in the interview were in Portuguese, and they had been tested for comprehension and were successfully used to identify functional constipation[16] in accordance with the Rome criteria[3,5].

Food intake analysis

The 24-h dietary recall survey, answered by parents/guardians, was used to obtain data for the quantitative analysis[17]. The nutrient calculations were performed using the Nut Win version 2.5 software developed by the Health Information Technology Department of the Federal University of São Paulo (São Paulo, Brazil).

Weight, height, and abdominal circumference measurements

Weight and height were measured as recommended[18]. Abdominal circumference was measured with an inelastic tape from the midpoint between the last rib and the upper border of the iliac crest (hip bone)[18]. The height-for-age z-scores and the relationship between the body mass index and age were calculated by the Anthro plus software version 1.0.4 (World Health Organization, Geneva, Switzerland).

Electrical bioimpedance analysis

The electrical bioimpedance test was performed using electrode placement (101 Quantum; RJL Systems, Miami, FL, USA) and BC software version 1.038 (RJL Systems, Miami, FL, USA) to estimate the body fat mass and lean mass.

Physical activity analysis

To evaluate physical activity, the children received illustrated questionnaires with drawings related to the activities they might have performed the previous day. The previous day's version improves measurements and reduces the child's need for recall by preventing craving behavior responses[19]. During the first part, they identified the means of transportation used to go to school (on foot, or by bicycle, public bus, car, or school bus). Then, the answer was rated as active or inactive commuting to school[19,20].

During the second part of the test, the participants were asked to choose the intensity level of each type of activity (low, medium, or high). The survey illustrated 11 possible types of

activities (dancing, walking/running, biking, performing chores, going up the stairs, playing soccer, jumping rope, swimming, gymnastics, skating, and playing with a dog). The score for each activity was determined by assigning 1 point for low intensity, 3 points for medium intensity, and 9 points for high intensity; the maximum score for all activities was 99[19,20].

Statistical analysis

Parametric and nonparametric statistical tests were performed according to the variable distribution to analyze the results along with the Sigma Plot version 11.2 software (Systat Software, San Jose, CA, USA). For all the tests, the significance level was set at 5% or 0.05.

RESULTS

The prevalence of functional constipation was 22.3% (101/452) for the total population, with a rate of 23.9% (65/273) for girls and 20.1% (36/179) for boys (p=0.419). The mean age was similar in children with (9.4 years±1.3) and without (9.2 years±1.5) constipation (p=0.257). Logistic regression showed a statistically significant effect (p=0.011) on the interaction between sex and age. Up to 9 years of age, the proportion of constipation was similar in both sexes; however, from 10 years onward, it was more frequent (p<0.05) in females.

Food intake was similar between children with and without functional constipation; however, fat intake was higher for boys with functional constipation (Table 1). The body mass index, height-for-age z-scores, lean mass, and fat mass did not differ between children with and without functional constipation (Table 2). The abdominal circumference was larger for girls with functional constipation than for boys.

Overweight status was more frequent in boys and girls with functional constipation (44.6%; 45/101) than in those without constipation (34.5%; 121/351). However, the difference was not statistically significant (p=0.083); a total of 46.2% (30/65) and 37.0% (77/208) of girls with and without functional constipation, respectively, were overweight (p=0.242). Furthermore, 41.7% (15/36) and 30.8% (44/143) of boys with and without functional constipation, respectively, were overweight (p=0.296). There was no difference in the frequency of active commuting to school or in the physical activity scores of the groups with and without functional constipation (Table 3).

The logistic regression model including sex, age, overweight, and functional constipation did not confirm the association between abdominal circumference and functional constipation (p=0.705) in female students as found in the bivariate analysis.

Table 1. Food intake of children according to sex and the presence of functional constipation.

	Functional constipation		p-value[a]
	Yes	No	
Energy (kcal)			
Girls	1960.7±906.7	1980.1±750.4	0.615
Boys	2199.2±631.5	2049.6±771.5	0.071
Total	2045.7±823.9	2008.4±758.7	0.571
Protein (g)			
Girls	89.2±45.0	93.7±44.7	0.258
Boys	101.8±37.2	101.4±57.0	0.416
Total	93.7±42.7	96.8±50.2	0.689
Lipid (g)			
Girls	54.0±40.2	56.3±29.8	0.255
Boys	62.8±24.2	55.6±26.7	**0.041**
Total	57.2±35.5	55.9±28.5	0.770
Carbohydrate (g)			
Girls	280.7±126.8	275.7±110.9	0.909
Boys	307.3±105.2	285.6±102.5	0.240
Total	290.2±119.7	279.7±107.5	0.474
Water (mL)			
Girls	1212.3±506.9	1216.6±453.8	0.579
Boys	1348.7±445.7	1286.2±488.9	0.618
Total	1260.9±488.2	1244.9±468.9	0.926
Dietary fiber (g)			
Girls	25.9±15.2	28.3±17.5	0.466
Boys	33.1±19.3	29.8±18.2	0.444
Total	28.5±17.1	28.9±17.8	0.828
Calcium (mg)			
Girls	597.7±323.2	611.7±337.7	0.612
Boys	639.4±300.7	673.8±395.0	0.825
Total	612.6±314.5	637.0±362.9	0.607
Iron (mg)			
Girls	9.7±5.3	9.9±4.5	0.362
Boys	11.5±4.3	10.8±5.1	0.176
Total	10.3±5.0	10.3±4.8	1.000
Vitamin A (IU)			
Girls	622.2±1140.0	509.9±480.2	0.832
Boys	550.7 ± 397.4	834.2±3057.4	0.993
Total	596.7 ± 942.5	641.9±1988.5	0.883
Vitamin C (mg)			
Girls	69.5±91.9	81.5±119.1	0.333
Boys	76.1±88.2	62.0±76.7	0.443
Total	71.9±90.2	73.6±104.2	0.738
Cholesterol (mg)			
Girls	217.1±112.5	265.3±185.3	0.141
Boys	263.2±125.0	262.6±206.1	0.272
Total	233.5±118.6	264.2±193.7	0.605

Number of children with constipation: 65 girls and 36 boys. Number of children without constipation: 208 girls and 143 boys. Mean±standard deviation. [a]Student's t-test was performed for independent samples. Bold indicates statistically significant p-values.

Table 2. Body mass index, height-for-age z-score, abdominal circumference, abdominal circumference for height, and body composition of children according to sex and the presence of functional constipation.

	Functional constipation		p-value[a]
	Yes	No	
Body mass index (kg/m^2)			
Girls	19.0±3.5	18.2±3.4	0.074
Boys	18.2±3.7	17.9±3.3	0.616
Total	18.7±3.6	18.1±3.4	0.079
Height for age (z-score)			
Girls	0.3±1.1	0.4±0.9	0.590
Boys	0.3±0.9	0.3±1.1	0.806
Total	0.3±1.0	0.3±1.0	0.578
Abdominal circumference (cm)			
Girls	64.5±9.2	61.9±8.8	**0.036**
Boys	62.9±9.4	62.5±8.9	0.693
Total	63.9±9.3	60.2±8.9	0.054
Abdominal circumference[a] / height (cm)			
Girls	0.47±0.1	0.46±0.1	0.274
Boys	0.47±0.1	0.46±0.0	0.524
Total	0.47±0.1	0.46±0.1	0.202
Lean mass (%)			
Girls	74.2±7.8	74.9±7.3	0.541
Boys	76.3±7.3	77.0±0.6	0.705
Total	74.9±7.7	75.7±7.1	0.283
Fat mass (%)			
Girls	25.8±7.8	25.0±7.1	0.470
Boys	23.7±7.3	22.9±6.7	0.701
Total	25.0±7.7	24.2±6.9	0.268

Number of children with constipation: 65 girls and 36 boys. Number of children without constipation: 208 girls and 143 boys. Mean±standard deviation. [a]Student's t-test was performed for independent samples. Bold indicates statistically significant p-values.

Table 3. Physical activity of children according to sex and the presence of functional constipation.

	Functional constipation		p-value
	Yes	No	
Physical activity score			
Girls	15.4±8.1	16.4±10.4	0.901[a]
Boys	20.7±16.3	18.7±10.1	0.792[a]
Total	17.3±11.9	17.3±10.3	0.601[a]
Active commuting to school			
Girls	44.6% (29/65)	52.9% (110/208)	0.307[b]
Boys	55.6% (20/36)	62.2% (89/143)	0.587[b]
Total	48.5% (49/101)	56.7% (199/351)	0.179[b]

Number of children with constipation: 65 girls and 36 boys, n=36. Number of children without constipation: 208 girls and 143 boys. Mean±standard deviation. [a]Student's t-test was performed for independent samples, [b]Pearson's chi-square test.

DISCUSSION

The prevalence of functional constipation in the present study was similar to that reported by other studies in Brazil[1] and other countries[4].

For boys, a higher fat intake was observed, which was in concordance with a study on Japanese children[9]. This finding suggests that there might be an abnormal gastrocolic reflex response with prolonged retrograde phasic contraction after eating a fat-rich meal[9]. This mechanism may be related to dysmotility in functional constipation. No additional differences were observed in the intake of other nutrients, including dietary fiber, between the groups with and without functional constipation. However, studies showed that children with functional constipation had a lower intake of total dietary fiber, insoluble dietary fiber, vegetables, fruits, and fluids[15,21]. The absence of relationships between functional constipation and other nutrients observed during this study may be related to the fact that the participants had mild functional constipation.

Our results are also in agreement with those of studies performed in Brazil[22] and Colombia[11] that did not demonstrate any association between functional constipation and overweight status; however, this result differed from those of studies performed in developed countries. Moreover, this discrepancy can be explained by hormonal, emotional, and genetic factors, as well as by eating habits, lifestyle, and financial status in different countries[11], in addition to the severity of functional constipation.

This study is the first to show the relationship between increased abdominal circumference and functional constipation in children, specifically in girls. This result agrees with the amount of visceral fat observed using abdominal tomography in adult women with irritable bowel syndrome[12]. The fact that fecal incontinence was not observed in patients with functional constipation suggests that there was insufficient fecal retention in the colon that could increase the abdominal circumference. Notably, the relationship between functional constipation and abdominal circumference observed during our study agrees with the results of another study in Brazil that demonstrated a higher correlation between metabolic syndrome and abdominal

circumference in relation to the ratio of the abdominal circumference to height[23].

The relationship between increased abdominal circumference and functional constipation dysmotility may be related to increased intra-abdominal pressure caused by excess visceral fat. Another possible mechanism is related to the amount of adipokines and cytokines secreted by the visceral adipose tissue, which cause low-grade tissue inflammation in the gut. Inflammation may result in abnormal epithelial secretion, visceral hypersensitivity, smooth muscle dysfunction syndrome, dysmotility, and pain perceived by the enteric nervous system[11,22]. However, further studies are required to explore and support this hypothesis.

In contrast to the literature[15,24,25], no connection between less physical activity and functional constipation was observed. Research involving children and teenagers in Iceland has shown a connection between these two factors for children older than 10 years[24]. However, the children and teenagers studied in Iceland were older than the children evaluated during our study.

A limitation of this study is its cross-sectional design that does not allow for establishing a cause–effect relationship. The study was performed in only one city and thus does not represent the entire Brazilian population. The results of the present study justify the development of future projects in not only public but also private schools. In addition, there is a need for further studies on the intensity of physical activity and constipation in children to elucidate whether there is a relationship.

CONCLUSION

The prevalence of functional constipation was similar to that observed in other epidemiological studies. Functional constipation was associated with a greater abdominal circumference in girls in the bivariate analysis; however, there was no association in the logistic regression model. Boys with functional constipation consumed higher quantities of fat. No association was found among functional constipation, overweight status, and physical activity.

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AUTHORS' CONTRIBUTIONS

FCD: Conceptualization, Data curation, Formal Analysis, Investigation, Resources, Writing – original draft, Writing – review & editing. **SNB:** Data curation, Visualization, Writing – review & editing. **ST:** Conceptualization, Formal Analysis, Supervision, Visualization, Writing – review & editing. **LM:** Conceptualization, Formal Analysis, Supervision, Visualization, Writing – review & editing. **MBM:** Conceptualization, Formal Analysis, Project administration, Supervision, Writing – original draft, Writing – review & editing.

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