

## Prevalence of pectus carinatum and pectus excavatum in students in the city of Manaus, Brazil\*

Prevalência de pectus carinatum e pectus excavatum em escolares de Manaus

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### Abstract

**Objective:** To determine the prevalence of congenital anterior chest wall deformities in 11- to 14-year-old students. **Methods:** Students participating in the study were recruited from public schools in the city of Manaus, Brazil. The statistically significant sample (precision, 1%; 95% CI) comprised 1,332 students. Pectus deformities were identified by physical examination of the chest, and the individuals with one of these deformities completed a questionnaire regarding heredity and symptoms resulting from the chest abnormality. **Results:** The mean age of the participants was 11.7 years. The prevalence of pectus abnormalities was 1.95% (pectus excavatum: 1.275%; pectus carinatum: 0.675%). Of the 26 students with a pectus deformity, 17 (65.4%) had pectus excavatum, and 18 (69.2%) were male. Concomitant scoliosis was observed in 3 cases (11.5%). A family history of pectus was reported by 17 students (65.4%), and 17 (65.4%) reported chest pain, dyspnea or palpitations. **Conclusions:** In this study, the prevalence of pectus deformities (1.95%) was lower than that reported in other studies conducted in Brazil (3.6-4.9%) but was higher than that reported in the literature (mean, 1%).

**Keywords:** Musculoskeletal abnormalities; Prevalence; Funnel chest.

### Resumo

**Objetivo:** Determinar a prevalência das deformidades congênicas da parede torácica anterior em escolares de 11 a 14 anos. **Métodos:** Participaram do estudo escolares da rede estadual de ensino da cidade de Manaus (AM). Para a composição de uma amostra estatisticamente significativa, com precisão de 1% e IC95%, foram incluídos 1.332 escolares. A deformidade pectus foi identificada através de exame físico do tórax, e os indivíduos com esta deformidade responderam a um questionário com questões sobre hereditariedade e sintomatologia decorrente da anomalia torácica. **Resultados:** A idade média dos participantes foi de 11,7 anos. A prevalência da deformidade pectus foi de 1,95% (pectus excavatum: 1,275%; pectus carinatum: 0,675%). Dos 26 escolares com deformidades pectus, 17 (65,4%) tinham pectus excavatum, e 18 (69,2%) eram do sexo masculino. Houve associação com a escoliose em 3 casos (11,5%). História familiar de pectus foi relatada por 17 escolares (65,4%), e 17 (65,4%) relataram dor torácica, dispnéia ou palpitações. **Conclusões:** A prevalência das deformidades pectus encontrada neste estudo (1,95%) foi inferior àquela de trabalhos em outras regiões do país (3,6-4,9%), porém, superior àquela relatada na literatura (média, 1%).

**Descritores:** Anormalidades musculoesqueléticas; Prevalência; Tórax em funil.

### Introduction

Congenital deformities of the anterior chest wall affect approximately 1 in 300 people. Such deformities are caused by genetic disorders that have yet to be clarified and are characterized by abnormal development of the costal cartilages. The sternum can be displaced posteriorly or anteriorly, conditions known as pectus excavatum and pectus carinatum, respectively.<sup>(1)</sup>

Pectus excavatum, also known as funnel chest, is the most common chest wall deformity, accounting for approximately 85% of the cases. The excessive or unbalanced growth of the costal cartilages leads to a depression of the sternum. The anomalies can range from a slight antero-posterior deviation to a severe sternal depression that can come close to the spinal column. Some

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patients also present significant asymmetry between the right and the left hemithorax, which results in rotation of the sternum.<sup>(2)</sup>

Pectus carinatum, also known as pigeon breast, is characterized by protrusion of the sternum and costal cartilages. This anomaly predominantly affects males, at a ratio of 4:1, and is less common than is pectus excavatum (accounting for only approximately 15% of congenital chest wall deformities).<sup>(1)</sup>

There continues to be a lack of information regarding the prevalence of congenital chest wall deformities and their clinical characteristics; therefore, studies aimed at disseminating knowledge regarding pectus deformities, especially regarding the possibility of their correction, are needed.<sup>(3)</sup> The objective of the present study was to determine the prevalence of congenital anterior chest wall deformities in 11- to 14-year-old students in the city of Manaus, Brazil.

## Methods

The city of Manaus is located in the northern region of Brazil. According to technical studies

carried out by the Municipal Institute for Urban Planning and Information Technology, the city is divided into 126 neighborhoods that are distributed in six urban areas: southern; eastern; western; central-western; and an area designated the Urban Expansion area, which is considered rural. In 2003, according to the Amazonas State Department of Education, enrollment at state and municipal public schools reached 299,263 and 102,917 students in junior high and high school, respectively.<sup>(4)</sup>

Students participating in the study were recruited from public schools, being proportionally distributed by the number of students enrolled in the various geographic areas of the city. Based on the prevalence of pectus carinatum and pectus excavatum in the city of Brasilia, Brazil, reported in a study (3.6%), the statistically significant sample size required to estimate the prevalence of anterior chest wall deformities in 11- to 14-year-old students from public schools (precision, 1%; 95% CI) was determined to be 1,332 students.<sup>(5)</sup>

### Chart 1 - Study protocol.

<p>Part 1 - Questionnaire</p> <p>1. Identification</p> <p>Name: _____ Age: _____</p> <p>2. What was your level of knowledge about the existence of your chest defect?</p> <p>None <input type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/></p> <p>3. Do you have any relatives with a similar defect, or a crooked spine, or heart problems?</p> <p>No <input type="checkbox"/> Yes <input type="checkbox"/></p> <p>If so, which defect?</p> <p>Spinal deviation <input type="checkbox"/> Heart problems <input type="checkbox"/></p> <p>Chest deformity <input type="checkbox"/> Other <input type="checkbox"/> Which? _____</p> <p>4. Do you feel any physical discomfort during physical activities?</p> <p>No <input type="checkbox"/> Yes <input type="checkbox"/></p> <p>Which one(s)?</p> <p>Fatigue <input type="checkbox"/> Shortness of breath <input type="checkbox"/> Palpitations <input type="checkbox"/> Chest pain <input type="checkbox"/></p> <p>5. Do you face any problems at school or at home due to your different physical appearance? Do you feel excluded, worried? If you would like to, tell us about it.</p> <p>R= _____</p> <p>Part 2 - Physical examination protocol</p> <p>Name: _____ Gender: _____</p> <p>Weight: _____ Height: _____ Race: _____</p> <p>Pectus:</p> <p>Excavatum <input type="checkbox"/> Topographic distribution: _____</p> <p>Carinatum <input type="checkbox"/> Topographic distribution: _____</p> <p>Other <input type="checkbox"/> Topographic distribution: _____</p> <p>Degree of deformity: Mild <input type="checkbox"/> Moderate <input type="checkbox"/> Severe <input type="checkbox"/></p>
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By random drawing, a number of schools were selected for study, after which the visit for the physical examination of the students was scheduled. Physical examinations were conducted between February and November of 2005 by medical students who had been previously trained for the project. The present study was approved by the Ethics in Research Committee of the Adriano Jorge General Hospital.

The physical profiles of students with a pectus deformity and of students without such deformity were established based on the anthropometric variables weight and height, determined using a scale with a stadiometer (Filizola S.A., São Paulo, Brazil). The physical examination of each student was directed at detecting chest wall deformities by inspection of the chest.

The students with a confirmed chest abnormality completed a questionnaire regarding heredity and symptoms (Chart 1).

The type and degree of chest abnormality were analyzed according to the classification system previously recommended<sup>(3,6)</sup>: invasive pectus excavatum; localized pectus excavatum; superior pectus carinatum; inferior pectus carinatum; and lateral pectus carinatum. The degree of deformity was classified as mild, moderate and severe.<sup>(3,6)</sup>

## Results

A total of 1,332 11- to 14-year-old students were examined. The mean age was 12.03 ± 0.95 years, and there was a predominance of females (712/1,332; 53.5%). The anthropometric evaluation revealed a mean weight of 38.85 ± 6.14 kg (range, 24-105 kg) and a mean height of 144.55 ± 5.95 cm (range, 1.29-1.62 m). Of the 1,332 students evaluated, 1,110 (83.3%) were mulatto, 157 (11.8%) were white, and 65 (4.9%) were black.

The prevalence of chest abnormalities in 11- to 14-year-old students in the city of Manaus was 1.95% (26 cases; 95% CI: 1.30-2.89). The preva-

lence of pectus excavatum was 1.275%, and the prevalence of pectus carinatum was 0.675%. The mean age in the group with chest abnormalities was 11.7 ± 0.68 years, compared with 12.0 ± 0.95 years in the group without ( $p = 0.054$ ). The proportion of males among the patients with a chest abnormality was 69.2% (18/26), compared with 45.2% (602/1,306) among those without ( $p = 0.057$ ). The mean weight was 38.6 ± 4.8 kg in the patients with a chest deformity and 38.8 ± 6.2 kg in those without ( $p = 0.639$ ). The mean height in the groups with and without chest abnormalities was 151.4 ± 3.8 cm and 144.4 ± 5.9 cm, respectively ( $p < 0.001$ ).

Of the 26 patients with a pectus deformity, 13 (50%), 12 (46.2%) and 1 (3.8%) were mulatto, white and black, respectively.

Of the 1,306 students without a pectus deformity, 5 (0.38%) presented scoliosis and 1 (0.076%) presented kyphosis. Of the 26 students with a pectus deformity, 3 (11.5%) presented scoliosis.

Pectus excavatum was more common than was pectus carinatum—17 cases (65.4%) vs. 9 cases (34.6%).

The subtypes of the two chest deformities and their respective degree of severity were listed, revealing that deformities considered mild predominated, as did localized pectus excavatum and inferior pectus carinatum (Table 1).

When the individuals in the group with pectus deformities were asked if these deformities had occurred in other members of their family, 17 (65%) responded affirmatively and 9 (35%) responded negatively. Family history was considered positive in 13 (59.1%) of the 22 patients with a mild pectus deformity and in all 4 of the patients with a moderate pectus deformity. In terms of the types of pectus deformities, 2 patients (22.2%) with pectus carinatum and 15 (88.2%) with pectus excavatum had a positive family history.

**Table 1** - Distribution of the pectus deformities by subtype.

Deformity	Mild (n = 22)	Moderate (n = 4)	Severe (n = 0)	Total (n = 26)
Invasive pectus excavatum	-	-	-	-
Localized pectus excavatum	14 (63.6%)	3 (75%)	-	17 (65.4%)
Superior pectus carinatum	1 (4.6%)	-	-	1 (3.9%)
Inferior pectus carinatum	5 (22.7%)	-	-	5 (19.2%)
Lateral pectus carinatum	2 (9.1%)	1 (25%)	-	3 (11.5%)

**Table 2** – Distribution of symptoms in individuals with a pectus deformity.

Symptom	Pectus excavatum, n (%)	Pectus carinatum, n (%)
Chest pain	8 (47.0)	1 (11.2)
Dyspnea	5 (29.4)	2 (22.2)
Palpitation	4 (23.5)	1 (11.1)

Cardiorespiratory symptoms were reported by 17 students (65.4%) with a chest deformity. Of the 17 individuals with pectus excavatum, 8 (47%) presented chest pain, 5 (29.4%) presented dyspnea, and 4 (23.5%) presented palpitations. Of the 4 individuals identified as having pectus carinatum, 1 (11.1%) presented chest pain, 2 (22.2%) presented dyspnea, and 1 (11.1%) presented palpitations (Table 2).

## Discussion

The prevalence of chest deformities in the general population is variable, some authors reporting it to be approximately 1%.<sup>(2)</sup> In post-mortem studies, 0.12% of cases were identified as pectus excavatum.<sup>(7)</sup> In Brazil, there have been few studies on the prevalence of anterior chest wall deformities in the general population. In the southeastern region, the prevalence of these deformities in preschool children was found to be 4.9%,<sup>(8)</sup> whereas, in the central-west region, the prevalence reported was 3.6%.<sup>(5)</sup> In the present study, conducted in the northern region, the prevalence found (1.95%) was lower than that reported in previous studies conducted in Brazil.

The prevalence of chest deformities is considered to be higher in whites than in non-whites. In a study conducted in Brazil, whites accounted for 80% of the total number of cases identified.<sup>(8)</sup> The analysis of these data in our study revealed that the prevalence of mulattos and whites, in absolute numbers, was 50% and 46.2% (13/26 and 12/26 individuals with a chest deformity), respectively, which is to be expected, since there is a predominance of mulattos in our region.<sup>(9)</sup> However, when the relative prevalence was calculated, the prevalence of chest deformities was found to be higher in whites (12/157 individuals) than in mulattos (13/1,110 individuals).

Regarding gender, a study of students conducted in the central-west region of Brazil revealed that the prevalence of pectus deformities in males was 63.4%.<sup>(5)</sup> In a study of preschool children conducted in the southeastern region, the prevalence of pectus deformities in males (approximately 57%) was lower than that reported in previous studies.<sup>(8)</sup> In studies conducted in the United States and in Europe, the analysis of patients referred for surgical treatment of chest wall deformities revealed a predominance of males (78% and 76%, respectively).<sup>(10,11)</sup> In the present study, stratification by gender revealed a predominance of males (69.2%), corroborating findings in the literature.

When the deformities were analyzed separately, there was a divergence between the types of pectus deformities in terms of frequency. Pectus excavatum is more common than is pectus carinatum, although their prevalence is different in the populations studied, ranging from 2.2:1 to 5:1.<sup>(1,5,10,11)</sup> The present study revealed a predominance of pectus excavatum over pectus carinatum in the students (ratio, 1.8:1). However, a study of students conducted in the Federal District of Brasília, Brazil,<sup>(5)</sup> revealed that the prevalence of pectus carinatum was 0.9% and the prevalence of pectus excavatum was 0.04%.

In surgical studies, there is a marked predominance of pectus excavatum, although ratios vary among studies (5:1, 2.2:1 and 12.3:1).<sup>(10-12)</sup> At facilities where the treatment for pectus carinatum is preferably performed using orthoses, there is a predominance of this type.<sup>(5)</sup>

Pectus deformities can be classified subjectively, by clinical examination, or objectively, by clinical or radiological measurements. The Haller index, which is calculated by dividing the transverse diameter of the rib cage by the anteroposterior diameter at the level of the greatest depression on the computed axial tomography scan, is one of the most widely used radiological methods to quantify pectus excavatum severity. In a study carried out at the University of São Paulo, in São Paulo, Brazil, the researchers developed an anthropometric index for the quantitative classification of pectus excavatum that can be easily calculated during outpatient treatment using simple instruments (a square, a ruler with a level, a screw pin with a limiting nut and a conventional ruler) and presents an 86%

correlation with the Haller index.<sup>(13)</sup> However, in our study, we used the classification system recommended by other authors,<sup>(3,6)</sup> since it is more appropriate for use in a large number of patients.

In a study based on the same classification system, conducted in the central-west region of Brazil, pectus deformities were classified as pectus carinatum (superior, inferior and lateral) and pectus excavatum (localized and invasive)—pectus carinatum was found in 95% of the patients (inferior pectus carinatum was seen in 61% of the cases) and mild deformities predominated (in 72% of the patients).<sup>(5)</sup> In the present study, localized pectus excavatum was found in 65% of the patients and mild deformities occurred in 82% of the cases. The second most common subtype was inferior pectus carinatum, found in 19% of the patients, all of whom presented mild deformities.

Although a genetic predisposition has not been confirmed, a family history of pectus was found in approximately 30% of the cases.<sup>(2)</sup> In a study conducted in the city of Brasília, Brazil, the prevalence of heredity related to pectus deformities was 44%.<sup>(5)</sup> In the present study, the proportion of patients presenting a family history of pectus deformities (65%) was much higher than that found in the literature.

A study involving children<sup>(14)</sup> demonstrated that the association with heredity varies according to the degree of severity and is stronger among patients with moderate/severe pectus, corroborating the findings of the present study, in which all patients with a moderate pectus deformity had a positive family history.

Concomitant scoliosis and pectus deformities are seen in approximately 15% of the patients.<sup>(1)</sup> The concomitance of pectus deformities and scoliosis is well established in the literature. Although some theories have been proposed to explain this concomitance, the causes remain undefined.<sup>(15)</sup> In surgical studies, the prevalence varies widely, ranging from 16% to 45%.<sup>(10,11)</sup> In a study of students conducted in central-west Brazil, the prevalence of scoliosis (approximately 51%) was much higher than the mean found in the literature.<sup>(5)</sup> The authors identified 3 patients presenting this concomitance, corresponding to 11.5%. These data are in agreement with those presented in certain studies.<sup>(1,15)</sup> As in the present study, a study conducted in the

United States<sup>(15)</sup> revealed no association between the degree of pectus deformity severity and the prevalence of scoliosis.

The presence of symptoms is also controversial in the literature, although we found studies reporting few patients with symptoms of hypotension and syncope,<sup>(14)</sup> even among those presenting a significant degree of severity. The analysis of various surgical studies in the literature revealed a wide diversity in terms of the presence of symptoms, with descriptions of chest pain, tachycardia, tachypnea and limited exercise tolerance in 26.8% to 67.0% of the cases.<sup>(10,11,16)</sup> Other authors allege that the symptoms reported by the patients result from accompanying diseases or from psychological disorders.<sup>(17)</sup> In the present study, 17 (65%) of the 26 patients with a pectus deformity reported having a symptom (chest pain, 34.6%; dyspnea, 27.0%; palpitations, 23.0%).

Recent studies evaluating pulmonary and cardiovascular function in patients with pectus excavatum prior to and after surgery have shown that such patients present improved cardiovascular function after the surgical procedure, which might explain the reduction in the symptoms presented by such patients in most surgical studies.<sup>(18-21)</sup>

In conclusion, the present study is unique in the literature in that it determined the prevalence of congenital anterior chest wall deformities among students in the city of Manaus, Brazil. This prevalence was found to be 1.95%. Despite the fact that mulattos were predominant in the sample studied, the incidence of deformities was proportionally greater in whites than in the other races. Regarding gender, type of deformity and clinical characteristics, the findings of the present study were similar to those reported in the literature.

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