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Does Obesity Affect Respiratory Function In Children? A Systematic Review

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Abstract:
Background: *This review seeks to determine whether childhood obesity, as a pandemic and a public health problem, interferes with pulmonary strength and function variables in children without associated comorbidities, since it is known that in adults these variables will be reduced if affected by obesity. Therefore, this systematic review aims to elucidate whether there are differences in the respiratory muscle strength and pulmonary function of obese and non-obese children without associated comorbidities.*
Materials and Methods: *This is a systematic review carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines and registered with PROSPERO CRD42023406834. The systematic review was carried out in the Scielo, Scopus and PubMed databases between January and March 2023, updated September 2024.*
Results: *Of the five studies found that met the criteria, all had spirometry (100%), while only one (20%) had an assessment of respiratory muscle strength (RMS). Most of the studies classified the groups of children as obese or non-obese according to their body mass index (BMI). The number of children ranged from 12 to 1294, and the age range was 6 to 17 years. Regarding RMS, there was no significant difference between them. In terms of lung function, the obese group showed a reduction in peak expiratory flow (PFE) and forced expiratory flow (FEF25-75%) and in the forced expiratory volume in the first second and forced vital capacity ration (FEV1/FVC). The non-obese group showed a reduction when the following parameters were analyzed: PFE; VEF1; CVF; FEF 25-75%.*
Conclusions: *Only one study has evaluated RMS and the pulmonary function studies were inconclusive. However, there is a need to develop more studies that assess MPR and pulmonary function and that include markers such as WC, waist-to-height ratio and (WHtR), which are markers strictly related to the pediatric public.*
Keywords*: Pediatric Obesity; Spirometry; Respiratory Muscles.*

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I. Introduction

Obesity is a pandemic and a public health problem that influences the development of cardiovascular and cardiometabolic diseases. In the last five years, there are more than 340 million children obese worldwide,[1] with 12 out of every 100 children suffering from such comorbidity in Brazil.[2] In the United States, childhood obesity increased by 19.7% between 2017 and 2020.[3] In China, the estimated prevalence between 2015 and 2019 was 11.1% for overweight and 7.9% for obesity in this population.[4] As for European countries, between 2007 and 2013, in Greece and Spain, childhood obesity increased by 4.8% and 4.0% respectively.[5]

From another point of view, food consumption and daily activities of children with obesity are organized by their parents, who face increasingly stressful and long work routines, which do not allow them to prioritize a good diet and physical activity for their children. This situation consequently affects children's health.[6] As a result, damage caused by childhood obesity can have an impact on adulthood, with deficits in productivity and emotional health. In addition, it specifically affects cardiovascular health and the respiratory system, with a reduction in tissue oxygenation and respiratory muscle strength.[7]

In the transition to teenage years, children undergo major biological changes, such as an increase in the production and secretion of hormones related to puberty, which is related to physical growth and functional development of the body systems, including the respiratory system. In addition to the physiological changes, the child is faced with relationships in society also undergoes emotional changes.[7] Obesity is therefore a multi-systemic disease that needs to be studied in lieu of the consequences it has on children. Various anthropometric parameters are used to assess excess weight in children, such as body mass index (BMI),[8] followed by waist-to-height ratio (WHtR) and waist circumference (WC), the latter being the most specific measure of abdominal obesity.[9]

Parameters to assess obesity in children, because although BMI is widely used in scientific studies, there are anthropometric measures, such as the waist-to-height ratio (WHtR) mentioned above, which takes into account the child's body surface area and total body measurement, as well as WC, which is more specialized in data related to abdominal obesity, but these are not found as sample stratification measures in most studies that classify children as obese or non-obese. It is important to note that when it comes to this subject, the gold standard method used is Dual Energy X-Ray Absorptiometry (DEXA), as it can comprehensively assess bone mass, lean mass and body fat in a quantified manner[10].

In adults, overweight and obesity lead to lower compliance, reduced residual capacity and increased resistance of the respiratory system to flow generation.[6] In the case of children, the increase in abdominal obesity can lead to different outcomes from adults, either due to their adaptive profile or partial respiratory muscle development, as well as physiological effects such as dyspareunia, which is the disproportion between the growth of the bronchial tree, where the cross-sectional area does not follow the growth in length of the bronchial tree, thus affecting lung volumes.[11,12] This is still unknown when lung function is analyzed, as there are studies that show worse results in obese children[9] and studies that show the opposite,[13] as well as those that show no significant difference between the groups.[14] As for respiratory muscle strength (RMF), it is a subject that has been little explored in current studies.[18]

It is suggested that RMS and volumes and capacities may be altered in children with obesity, but the studies in the literature are inconclusive and, in order to devise forms of intervention, it is necessary to know whether obesity will generate a difference in the markers of the respiratory system in children. This review seeks to determine whether childhood obesity interferes with pulmonary strength and function variables in children without associated comorbidities, since it is known that in adults these variables will be reduced if affected by obesity. In children, there may be differences due to their ability to adapt, and few studies have investigated this issue. Therefore, this work will highlight the need for studies in the area, show the quality of existing studies and clarify whether the parameter used to classify obesity is the most appropriate or whether it needs to be associated with others. Therefore, this systematic review aims to elucidate whether there are differences in the RMS and pulmonary function of obese and non-obese children without associated comorbidities.

II. Material And Methods

This systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO, Registration ID: CRD42023406834) and was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines[25].

Study Design: The question to be investigated was developed through meetings between two members of the Cardiorespiratory and Metabolic Health Studies Laboratory (LESaC), who carry out research into pulmonary health, cardiorespiratory fitness and pediatric quality of life. The main questions guiding the research were: a) what are the anthropometric parameters most commonly used to assess childhood obesity? b) is there a difference in respiratory muscle strength and pulmonary function in maximal effort maneuvers in obese and non-obese children?

Eligibility: The eligibility criteria for the studies were determined by the PECO strategy and were: P) children aged 4-11 years; E) obesity classified by BMI, waist circumference and/or fat percentage; C) children without obesity; O) studies that used spirometry and/or manovacuometry to analyze lung function and respiratory muscle strength, respectively.

Inclusion criteria: Regarding the research, articles were included between 2019 and March 2023, in English, French, Spanish, Portuguese and research carried out on humans.

Exclusion criteria: Papers that did not qualify as original were excluded, as were researches that presented a respiratory system disease such as asthma or cystic fibrosis, papers that did not have a group without obesity, duplicated papers, and papers that did not meet the quality threshold.

Procedure methodology

The systematic review was conducted with the Scielo, Scopus and PubMed databases, and used title/abstract to detect papers related to the subject. The same combination of descriptors was used, with scielo and pubmed using the title and abstract as the basis and scopus using the title, abstract and keywords. The searches were carried out between January and March 2023. An update of the searches was proposed using the filter for the year 2023 and 2024. The following descriptors were included in the search strategy for respiratory muscle strength (RMS): (children; childhood; child) AND (obesity; obese) AND (respiratory muscle strength; maximal respiratory pressure; maximal expiratory pressure (MEP); maximal inspiratory pressure (MIP)). The descriptors combined to find papers related to lung function were: (children; childhood; child) AND (obesity; obese) AND (spirometry; forced vital capacity; forced expiratory volume in first second). Three researchers (MM, VS and VM) independently reviewed the title and abstract in order to identify eligible researches and, if there was any doubt about the inclusion of the paper, this was solved in discussion by the authors until a consensus was reached.

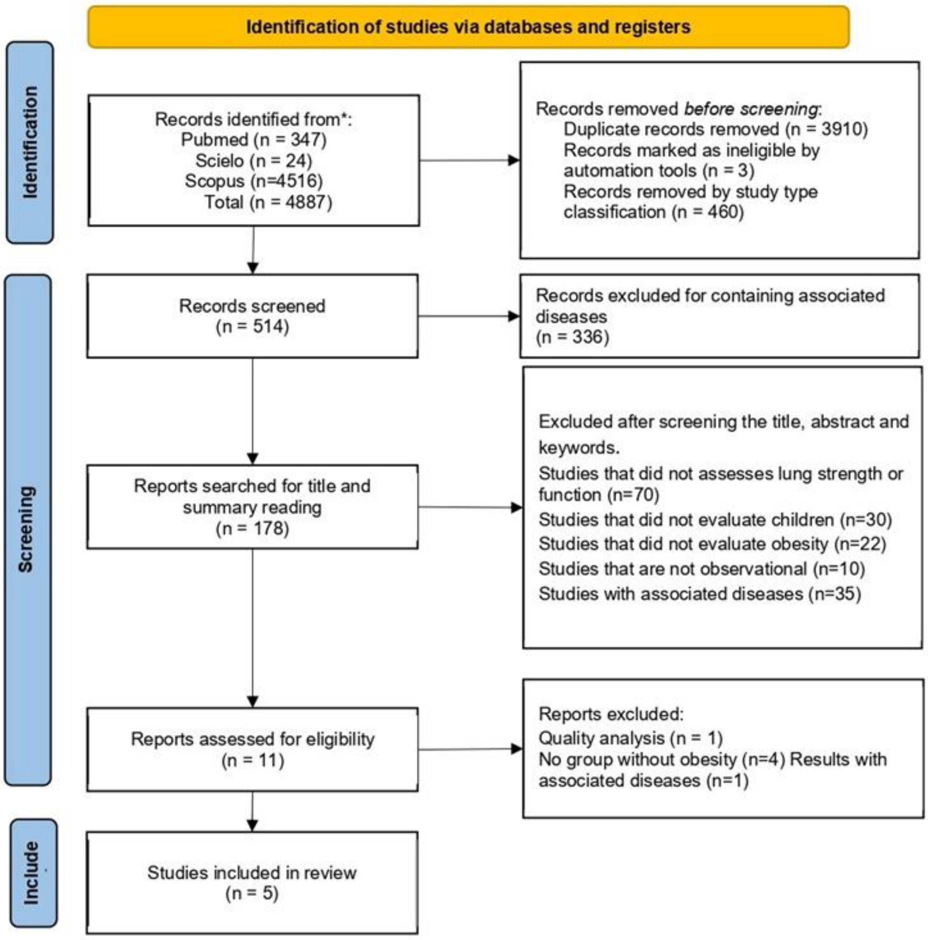
Outcomes

Respiratory muscle strength, maximum inspiratory pressure (MIP) and maximum inspiratory pressure (MEP) will be assessed as outcomes of the study. As for lung function, forced expiratory volume in the first second - FEV1, peak expiratory flow - PEF, forced expiratory flow - FEF 25%, FEF 50%, FEF 25-75%, forced vital capacity - FVC and the ratio of forced expiratory volume in the first second and total forced capacity - FEV1/FVC.

Data extraction

After applying the criteria, the studies were analyzed in full (Figure no 1). Data was extracted into a standardized spreadsheet containing: information on the author, year and place of publication, number of patients submitted, mean age, type of study and whether the study divided obese and non-obese children. The values for RMS (Pimax and Pemax) and pulmonary function (forced expiratory volume in the first second - FEV1, peak expiratory flow - PEF, forced expiratory flow - FEF 25%, FEF 50%, FEF 25-75%, forced vital capacity - FVC, FEV1/FVC) were extracted as means and standard deviations.

Figure no 1: Flowchart according to Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) – 2020



To verify the correlation or influence of obesity on lung strength and function, the Pearson and Spearman correlation coefficients were collected from the studies, as well as the Beta and confidence interval indicators that indicate the relationship between obesity and the other variables. The data was described in a table and then discussed.

Data extraction in three studies had to be adjusted to establish the values for obese and non-obese children. In the study by Li et al.,[16] the average was determined between the two study periods presented in the article. The units of measurement were in milliliters (mL) and were converted into liters (L). After transformation, the mean of boys and girl groups and the FVC/FVC1 ratio were calculated, but it was not possible to calculate them because the standard deviation was greater than the means presented. Strozza et al.[17] subdivided their group into those with and without flow limitation and, in the case of the present study, data from obese and non-obese children without flow limitations were used. The study by Udomittipong et al.[18] was the only one to present all the study variables, but the main aim of the study was to assess cardiorespiratory fitness using the 6-minute walk test, so all the results were extracted.

Quality of the studies

The quality of the studies was measured using the Dows and Black scale.[19] It is a scale recommended by the Cochrane Collaboration for experimental studies and has 27 questions that assess quality in the domains of reporting (information needed), external validity, selection and measurement bias and power of findings. Each question has a value of one point, and some have a value of two points (reporting domain). 13 questions were adapted and used (question numbers: 1,2,3,6,7,9,10,11,12,18,20,26 and 27). These scale questions are common to both observational and experimental studies. The studies were analyzed by two researchers (MM and VS) and those scoring ≥ 7 points were considered to be of good quality. Only one study did not reach this average and was excluded[26] (Table no 1).

Table no 1: Quality analysis of the studies: adapted Dows and black (1998) scale.

	Strozza et al. 2020	Li et al. 2021	Kaeotawee et al. 2022	Irandoust et al. 2020	Kochli et al. 2019	Pratanaphon et al. 2022	Satapathy et al. 2022	Udomittipong et al. 2021	Hochart et al. 2021	Endes et al. 2019	Corbelli et al. 2023
Hypothesis/objective clearly described	1	1	1	1	1	1	1	1	1	1	1
Outcomes described in the introduction or methods	1	1	1	1	1	1	1	1	1	1	1
Characterization of the sample	1	1	1	1	1	1	1	1	1	1	1
Main findings clearly described	1	1	1	1	1	1	1	1	1	0	1
Estimates of the variability of the data of the main findings	1	1	1	1	1	1	1	1	1	0	1
Characteristics of losses	1	1	1	1	1	1	1	1	0	0	1
95% confidence intervals and/or p-values	1	1	1	1	1	1	1	1	1	0	1
Sample representative of the population	0	0	0	0	1	0	0	0	0	0	0
Participants prepared to participate representative of the population	1	1	0	0	1	1	0	0	0	0	0
Appropriate statistical tests	1	1	1	1	1	1	1	1	1	0	1
Measures of main outcomes accurate (valid and reliable)	1	1	1	1	1	1	1	1	1	0	1
Patient losses taken into account	1	1	1	1	1	1	1	1	0	0	1
Sufficient power to detect a clinical effect	1	1	0	0	1	1	0	0	0	1	0
Score	12	12	10	10	13	12	10	10	8	4	10

Source: authors (2024)

III. Result

The results of the search showed a total of 4887 studies, 326 of which were on RMS and 4561 on pulmonary function. A total of 3910 duplicates were excluded, three for not presenting the complete study and 460 for not being cross-sectional observational studies. Of the remaining 514, 336 had associated diseases, 178 were selected for reading the title and abstract, during this stage studies were excluded that did not assess respiratory muscle strength and lung function (n=70), were not children (n=30) and without obesity (n=22); studies that were not observational (n=10) or had associated comorbidities, such as cystic fibrosis, asthma, bronchitis, diabetes, hypertension, down syndrome and muscular dystrophy (n=35). Finally, 9 studies remained to be read in their entirety, four of which were excluded because they did not have a group without obesity.

These results refer to the first search carried out. When the searches were updated with a filter for the years 2023 and 2024, the following were found 1 study related to pulmonary function that did not meet the eligibility criteria was found. 9 studies were found in relation to pulmonary function, of which 6 had associated diseases, 1 had adults as the population and 2 did not evaluate the group with and without obesity. Therefore, none of these new studies were added to the previous collection.

Of the 5 included studies that met the criteria, all had spirometry (100%),[14-18] while only 1 (20%) had an RMS assessment.[18] The groups of children were classified as obese and non-obese according to BMI. Other measures of obesity such as waist circumference, hip circumference (3 studies) or skinfolds (1 study) were also collected in the studies but were not parameters for stratifying the groups. The number of children ranged from 12 to 1294, and in only one study[15] was sample power demonstrated and this was not achieved. The age range varied between 6 and 17 years (table no 2).

Table no 2: Assessment of lung strength and function in obese and non-obese children.

Variable/ Author (year)	Coutry	Type of study Class. Obesity	n	Age group	NO	O	P	TDE	Outcome*
MIP (cmH_2O)									
Udomittipong *et al.* (2021)	Turkey	Cross-sectional BMI	O= 37 NO= 31	8-15	88.3±23.5	94.3±25.1	0,31	-0.12	
MEP (cmH_2O)									
Udomittipong *et al.* (2021)	Turkey	Cross-sectional BMI	O= 37 NO= 31	8-15	80.3±21.5	77.4±20.5	0,57	0.07	
PEF (L/s)									
Udomittipong *et al.* (2021)	Turkey	Cross-sectional BMI	O= 37 NO= 31	8-15	92.5±19.6%	81.2±15.0%	0,01	0.31	
Kochli *et al.* (2019)	Switzerland	Cross-sectional BMI	O= 43 NO= 1081	7.2±0.4	3.13 (3.9-3.17)	3.34 (3.15-3.54)	0,006	-	
FEV¹(L)									
Satapathy *et al.* (2022)	Índia	Cross-sectional BMI	O= 56 NO= 47	6-14	1.85±0.42	1.76±0.44	0,30	0.10	
Udomittipong *et al.* (2021)	Turkey	Cross-sectional BMI	O= 37 NO= 31	8-15	103.9±11.0%	103.4±15.25%	0,62	0.02	
Li *et al.* (2021)	China	Cross-sectional BMI	O= 95 NO= 1199	9.8±1.5	1.89±0.453	2.06±0.551	0,283	-0.17	
Kochli *et al.* (2019)	Switzerland	Cross-sectional BMI	O= 43 NO= 1081	7.2±0.4	1.38 (1.37-1.40)	1.57 (1.50-1.64)	<0,001	-	
Strozza *et al.* (2020)	United States	Cross-sectional BMI	O= 15 NO= 10	10.5±0.4	2.22±0.32	2.33±0.47	0,999	-0.14	
FVC (L)									
Satapathy *et al.* (2022)	Índia	Cross-sectional BMI	O= 56 NO= 47	6-14	2.01±0.51	1.91±0.48	0,29	0.10	
Udomittipong *et al.* (2021)	Turkey	Cross-sectional BMI	O= 37 NO= 31	8-15	102.8±12.0%	108.9±15.16%	0,07	-0.22	
Li *et al.* (2021)	China	Cross-sectional BMI	O= 95 NO= 1199	9.8±1.5	2.19±0.512	2.4±0.577	0,267	-0.19	
Kochli *et al.* (2019)	Switzerland	Cross-sectional BMI	O= 43 NO= 1081	7.2±0.4	1.53(1.51-1.54)	1.75(1.67-1.83)	<0,001	-	
Strozza *et al.* (2020)	United States	Cross-sectional BMI	O= 15 NO= 10	10.5±0.4	2.52±0.39	2.73±0.52	0,915	-0.22	
FEV¹/FVC (%)									
Satapathy *et al.* (2022)	Índia	Cross-sectional BMI	O= 56 NO= 47	6-14	92,33±7.99	92.65±8	0,84	-0.02	
Udomittipong *et al.* (2021)	Turkey	Cross-sectional BMI	O= 37 NO= 31	8-15	90.8±4.5%	85.3±6.7%	<0,001	0.43	
Kochli *et al.* (2019)	Switzerland	Cross-sectional BMI	O= 43 NO= 1081	7.2±0.4	0.91(0.90-0.91)	0.90(0.88-0.92)	0,050	-	
Strozza *et al.* (2020)	United States	Cross-sectional BMI	O= 15 NO= 10	10.5±0.4	89±5	87±4	0,683	0.22	
FEF 25-75% (L)									
Udomittipong *et al.* (2021)	Turkey	Cross-sectional BMI	O= 37 NO= 31	8-15	100.4±17.3%	89.8±23.1%	0,04	0.25	
Kochli *et al.* (2019)	Switzerland	Cross-sectional BMI	O= 43 NO= 1081	7.2±0.4	1.80(1.77-1.83)	1.96(1.82-2.10)	0,01	-	
Strozza *et al.* (2020)	United States	Cross-sectional BMI	O= 15 NO= 10	10.5±0.4	2.72±0.57	2.73±0.64	0,957	-0.01	

MIP = maximum inspiratory pressure; MEP = maximum expiratory pressure; PEF = peak expiratory flow; FEV1 = Forced expiratory volume in the first second; FVC = Forced vital capacity; FEF 25-75% = Forced expiratory flow 25-75%; O = Obese; NO = Non-obese; *Larger columns on the left = NO greater than O, Larger columns on the right = O greater than NO, Equal columns = No significant difference. The P value was reported by the studies.

With regard to respiratory muscle strength, the only study that compared obese and non-obese children showed no significant difference between them.[18] As for lung function, the obese group showed a reduction in PEF and FEF25-75% in only one study[18] and in the FEV1/FVC ratio in two studies[14;18] The non-obese group showed a reduction in only 1 study, when the following parameters were analyzed: PFE; VEF1; CVF; FEF 25-75%.[14]

Three studies used correlation analysis[15,16,18] and only one used linear regression,[14] which used BMI as an independent variable. BMI showed a correlation with pulmonary function markers, and the models using fat percentage also showed correlative results, as shown in Table 3. Two studies correlated with WHtR and one with WC, but the results were not significant. The study that used linear regression analysis presented three models that were in line with the present study: model 1 was adjusted for age and gender, model 4 was model 1 plus adjusted for systolic, diastolic blood pressure and shuttle run (stages) and model 5 was model 1 plus adjusted for body weight, body height, systolic, diastolic blood pressure and shuttle run (stages).

Table no 3: Correlation between lung strength and function and obesity markers in children.

Variable/ Author (year)	n	BMI		WHtR		WC	
Udomittipong *et al.* (2021)	O=37 NO=31	r	p	r	p	r	p
MIP		- 0,04	0,79	- 0,08	0,64	- 0,06	0,72
MEP		- 0,12	0,49	- 0,15	0,37	- 0,02	0,89
FEV_1/FVC		- 0,13	0,43	- 0,13	0,42	- 0,18	0,28
Satapathy *et al.* (2022)	O=56 NO=47						
FVC		- 0,029	0,77	- 0,56	0,57		
FEV_1		- 0,33	0,73	- 0,05	0,61		
FEV_1/FVC		- 0,01	0,01*	- 0,0359	0,71		
Li *et al.* (2021)	O=95 NO=1199						
FVC		0,402	<0,001*				
FEV_1		0,381	<0,001*				
Kochli et al. (2019)	O=43 NO=1081	**B (IC 95%)**		**B (IC 95%)**			
		Model 1		**Model 1 (% fat)**			
FVC		0,036 (0,030; 0,043)	<0,001*	0,005 (0,003; 0,008)	<0,001*		
FEV_1		0,028 (0,022; 0,034)	<0,001*	0,004 (0,002; 0,006)	<0,001*		
FEV_1/FVC		- 0,003 (- 0,005; - 0,001)	0,001*	- 0,001 (- 0,001; - 0,6E-3)	0,033*		
PEF		0,040 (0,024; 0,056)	<0,001*	0,005 (-0,7E4; 0,010)	0,054		
$FEF_{25-75\%}$		0,019 (0,007; 0,031)	0,002*	0,002 (-0,002; 0,005)	0,422		
		Model 4		**Model 5 (% fat)**			
FVC		0,038 (0,031; 0,045)	<0,001*	-0,012 (-0,016; -0,009)	<0,001*		
FEV_1		0,029 (0,023; 0,036)	<0,001*	-0,011 (-0,014; -0,007)	<0,001*		
FEV_1/FVC		-0,003 (- 0,005; - 0,001)	0,004*	0,2E-3 (- 0,001; 0,001)	0,725		
PEF		0,051 (0,033; 0,069)	<0,001*	-0,018 (-0,028; -0,008)	0,016*		
$FEF_{25-75\%}$		0,022 (0,009; 0,035)	0,001*	-0,012 (-0,020; -0,005)	0,001*		

MIP = Maximum inspiratory pressure; MEP = Maximum expiratory pressure; PEF = Peak expiratory flow; FEV1 = Forced expiratory volume in the first second; FVC = Forced vital capacity; FEF 25-75% = Forced expiratory flow 25-75%; BMI = Body mass index; WHtR = Waist-to-height ratio; WC = Waist circumference; *p<0.05

IV. Discussion

Five studies were found in this systematic review: 1) only 1 evaluated RMS and did not identify a significant difference;[18] 2) With regard to function, when PEF was analyzed, 2 studies were found, one in which the obese group was higher[14] and the other the opposite;[18] 3) Most studies indicated FVC and FEV1 with no difference[15-18] or higher in obese children;[14] 4) In the case of the FEV1/FVC ratio, half of the studies indicated no difference[15,17] and 50% were higher in the non-obese group;[14,18] 5) In the FEF 25-75% variable, there were only 3 studies that measured this parameter, each of which found a different result.[14,17,18] All the studies classified the children as obese or non-obese using BMI. When analyzing the correlation between obesity markers, RMS and lung function, it was possible to see that BMI and fat percentage are markers that correlate with children's lung function, especially with the variables FVC; FEV1 and FEV1/FVC. Fat percentage was another marker that correlated with these variables. As for RMS and the markers WHtR and WC, it was not possible to identify a correlation, and it was only found in 1 study.

Respiratory muscle strength

Regarding respiratory muscle strength, measured by Pimax PEmáx, only one study was found in the last 5 years[18] and indicated no difference between the groups of obese and non-obese children. The respiratory muscles in childhood have different aspects when compared to adults.[20] Most of the fibers present are still type II, resistant fatigues, and the development of type I fibers will occur during growth, with the exception of the diaphragm, which by the age of 2 is already made up of 51% type I fibers. Although its dome is not yet fully formed, it is more horizontal. As a result, its power of contraction is reduced, affecting the force of contraction and thoracic expansibility. The accessory muscles of breathing (external and internal intercostals) are still underdeveloped,[20] as they will accompany the bodily changes that will bring functionality to the rib cage. Thus, the rib cage has a more complacent profile, and muscles are the main stabilizers in childhood, which differs from the expansive pattern found in adults.

The respiratory rate in children is higher than in adults/teenagers,[21] and when it is high, it indicates greater muscle work.[20] As the study found[18] no significant difference between the obese and non-obese groups, it can be said that both groups were able to adequately supply ventilation for gas exchange and body oxygenation. If RMS were reduced, the diaphragm, ECOM, scalene and intercostal muscles would not be able to keep the respiratory pump working and effective tidal volume input. Therefore, the similar RMS is due to the adaptive capacity of the rib cage and the incompleteness of infant muscle maturation. One aspect that would allow this hypothesis to be confirmed would be a description of the number of children with RMS within or outside the predicted range. The lack of regression equations to estimate RMS according to age prevents a more specific data analysis. It is worth noting that there is a clear distinction between the behavior of RMS in adults and in children with obesity.

Pulmonary function

When pulmonary function was analyzed using forced expiratory maneuvers, two studies were found evaluating PEF, with the obese group having the highest results in one and the non-obese group having the best results in the other. Most of the studies indicated that FVC and FEV1 were no different or higher in obese children. In the case of the FEV1/FVC ratio, half of the studies indicated no difference and 50% were higher in the non-obese group. As for the FEF 25-75% variable, there were 3 studies, each with different results. In order to expand the area available for gas exchange, the process of alveolarization takes place in childhood, as body height grows, and can reach adolescence.[22] From childhood to adulthood, the alveoli grow around 10 times and the lung surface area 20 times.[23] Therefore, it can be said that age will play a fundamental role in determining lung volumes and capacities and how much obesity will interfere with these results.[11] For this reason, these studies identified greater results in the obese group, especially in the FVC and FEV1 variables.

Even with obesity, child development will occur, there will be an increase in tracheal branching and alveolarization, as well as an increase in the gas exchange area, but it may occur inadequately. There are studies that point to the phenomenon of dysanapsis in obesity.[11,12] It is known that age will affect the level of maturation of the organs and the volumes and capacities of the respiratory system. The older you get, the less the effects of adaptation will be and, consequently, obesity will affect lung function to a greater degree. This result has been shown in the literature, where the older the children, the worse the results for the obese group (PEF; FEV1/FVC; FEF 25-75%).[18] On the other hand, younger children have better respiratory system adaptations and better results when obesity is present (PEF; FEV1; FVC; FEF 25-75%).[14]

It is clear that obesity mainly affects lung function and when it becomes ectopic obesity (outside the adipose tissue, it reaches the organs) it reaches the alveoli, directly damaging dynamic and static lung volumes as well as "delaying" the transfer of oxygen across the blood-blood barrier.[24] These events occur in obese adults[11] and what is not clear is at what level of obesity the respiratory system is affected. In children, there is still no explanation or evidence of the damage obesity does to lung function (FEV1; FVC) since studies either show higher values[14] or no significant differences.[15-18]

It is worth noting that there are several ways of detecting obesity, so studies may differ between these methods. One of the focuses of this study was to evaluate the ways of classifying obesity, but the studies evaluated only used BMI as a marker, which works with mass and height parameters (it doesn't distinguish between body compartments) and wide numerical ranges, which makes its analysis non-specific and, commonly, it must be associated with fat percentage, for example. Other markers such as waist circumference (WC) and waist-to-height ratio (WHtR), which are also used as parameters, can be more specific. Studies with associated comorbidities were not included in this review. It is known that the presence of other comorbidities, such as diabetes and hypertension, can affect lung function, but there is still no conclusive data. Of the studies found, only one[15] described its sample size as 80% with 55 children in each group, but this number was not reached by the study. Although the number of children in the other studies seemed significant, the author was not concerned about the sample size of the studies.

In short, the child's metabolism is increased and this leads to greater oxygen consumption.[20] To date, the literature has not identified obesity as directly affecting the respiratory system. The overload of obesity on the ribcage until adolescence leads to compensatory activity and does not affect RMS and the parameters PEF, FVC, FEV1, FEF 25-75%; on the contrary, the obese child may show better results due to compensation and physiological patterns such as dysanapsis. In post-natal development up to adolescence, the pulmonary system has 10x more branched alveoli and airways with 20x more lung surface area.[22,23] In obese children, increased chest overload does not seem to interfere with lung function; on the contrary, studies[14,18] indicate that RMS is maintained and spirometric parameters increase during maximal expiratory maneuvers.

Limitations

The main limitations of this study were: 1) the standardization of the measurements, given that each study generated its data in a standard, with different units of measurement (transformation of Ml into liters, calculation of theVEF1/CVF ratio, some studies brought other stratifications in the classification of the groups, it was necessary to taper into obese and non-obese); 2) the studies did not present total parameter values, for example when they were stratified by gender, the calculation had to be carried out, one study presented two moments, it was necessary to calculate the mean between them; there was no indication of parametric and non-parametric variables; 3) the sample interval was wide, the lack of sampling power and effect size; in addition, when assessing the quality of the study, the vast majority did not score in items 11 and 12, which indicates carelessness when selecting the population and lack of maturity in data analysis; 4) Evaluate ways of classifying obesity, as all studies used BMI as a parameter to stratify obesity, but no studies were found using WHtR and WC, for example, which are more specific parameters; 5) none of the studies analyzed presented a diagnosis of the dysfunctions analyzed. 6) This study did not develop a meta-analysis.

Strengths

As far as the strengths of this review are concerned, it can be seen that: 1) no studies involving asthma or other associated comorbidities were added; 2) by reaching inconclusive data, this review shows that the maxim emphasized in the current literature, that obese children will show deficits in their breathing pattern, is inaccurate and mistaken; 3) the study highlighted the importance of increasing the production and improving the quality of studies involving pulmonary function parameters and, especially, RMS in children with and without obesity.

V. Conclusion

The results found for RMS are inconclusive and more studies are needed. When the PEF of the two studies found was analyzed, their results were different, making it impossible to conclude. Most of the studies indicated that FVC and FEV1 were no different or higher in obese children. In the case of the FEV1/FVC ratio, there is no conclusion since half of the studies indicated no difference and the other half were higher in the non-obese group. For FEF 25-75%, there is still a need for more results, since those presented were divergent. Therefore, there were few studies found, with a demonstration of sample power, stratified by age group and using different parameters to assess obesity. However, it is necessary to develop more studies that assess RMS and lung function and that include markers such as WC and WHtR, which are markers strictly related to the pediatrics concern.

References

[1]. SØRENSEN, Thorkild IA; MARTINEZ, Andrea Rodriguez; JØRGENSEN Tshøj. Epidemiology Of Obesity. From Obesity To Diabetes. 2022; 274:3–27.

[2]. Ferreira CM, Reis ND Dos, Castro A De O, Höfelmann DA, Kodaira K, Silva MT, Et Al. Prevalence Of Childhood Obesity In Brazil: Systematic Review And Meta-Analysis. J Pediatr (Rio J) [Internet]. 2021;97(5):490–9. Available From: Https://Doi.Org/10.1016/J.Jped.2020.12.003.

[3]. HU, Kathy; STAIANO, Amanda E. Trends In Obesity Prevalence Among Children And Adolescents Aged 2 To 19 Years In The US From 2011 To 2020. JAMA Pediatrics, V. 176, N. 10, P. 1037-1039, 2022.

[4]. PAN, Xiong-Fei; WANG, Limin; PAN, An. Epidemiology And Determinants Of Obesity In China. The Lancet Diabetes & Endocrinology, V. 9, N. 6, P. 373-392, 2021.

[5]. SPINELLI, Angela Et Al. Prevalence Of Severe Obesity Among Primary School Children In 21 European Countries. Obesity Facts, V. 12, N. 2, P. 244-258, 2019.

[6]. Warkentin S, Mais LA, Latorre M Do RDO, Carnell S, Taddei JAAC. Factors Associated With Parental Underestimation Of Child's Weight Status. J Pediatr (Rio J). 2018 Mar 1;94(2):162–9.

[7]. Kumar S, Kelly AS. Review Of Childhood Obesity: From Epidemiology, Etiology, And Comorbidities To Clinical Assessment And Treatment. Vol. 92, Mayo Clinic Proceedings. Elsevier Ltd; 2017. P. 251–65.

[8]. Onis M De, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development Of A WHO Growth Reference For School-Aged Children And Adolescents. Bulletin Of The World Health Organization. 2007; 85:660–7.

[9]. Reis Gaya A, Gaya A, Pedretti A, Mello J. PROJETO ESPORTE BRASIL Manual De Medidas, Testes E Avaliações Versão 2021.

[10]. Marra, M., Sammarco, R., De Lorenzo, A., Iellamo, F., Siervo, M., Pietrobelli, A., Donini, L. M., Et Al. Assessment Of Body Composition In Health And Disease Using Bioelectrical Impedance Analysis (Bia) And Dual Energy X-Ray Absorptiometry (Dxa): A Critical Overview. In Contrast Media And Molecular Imaging. 2019(1); 3548284.

[11]. Forno E, Han YY, Mullen J, Celedón JC. Overweight, Obesity, And Lung Function In Children And Adults—A Meta-Analysis. Journal Of Allergy And Clinical Immunology: In Practice. 2018 Mar 1;6(2):570-581.E10.

[12]. Forno E, Weiner DJ, Mullen J, Sawicki G, Kurland G, Han YY, Et Al. Obesity And Airway Dysanapsis In Children With And Without Asthma. Am J Respir Crit Care Med. 2017;195(3):314–23.

[13]. Ülger Z, Demir E, Tanaç R, Gökşen D, Gülen F, Darcan Ş, Et Al. The Effect Of Childhood Obesity On Respiratory Function Tests And Airway Hyperresponsiveness. Vol. 48, The Turkish Journal Of Pediatrics. 2006.

[14]. Köchli S, Endes K, Bartenstein T, Usemann J, Schmidt-Trucksäss A, Frey U, Et Al. Lung Function, Obesity And Physical Fitness In Young Children: The EXAMIN YOUTH Study. Respir Med. 2019 Nov 1;159.

[15]. Satapathy AK, Das RR, Mahapatro S, Panigrahi MK, Bandopadhaya D. Effect Of Body Mass Index (BMI) On Pulmonary Functions In Children Of 6-14 Years Of Age: A Cross-Sectional Study. J Family Med Prim Care. 2022 Jun;11(6):3156–60.

[16]. Li S, Cao S, Duan X, Zhang Y, Gong J, Xu X, Et Al. Children's Lung Function In Relation To Changes In Socioeconomic, Nutritional, And Household Factors Over 20 Years In Lanzhou. J Thorac Dis. 2021 Jul 1;13(7):4574–88.

[17]. Strozza D, Wilhite DP, Babb TG, Bhammar DM. Pitfalls In Expiratory Flow Limitation Assessment At Peak Exercise In Children: Role Of Thoracic Gas Compression. Med Sci Sports Exerc. 2020 Nov 1;52(11):2310–9.
[18]. Udomittipong K, Thabungkan T, Nimmannit A, Tovichien P, Charoensitisup P, Mahoran K. Obesity Indices For Predicting Functional Fitness In Children And Adolescents With Obesity. Front Pediatr. 2021 Dec 15;9.
[19]. Downs SH, Black N. The Feasibility Of Creating A Checklist For The Assessment Of The Methodological Quality Both Of Randomised And Non-Randomised Studies Of Health Care Interventions. Vol. 52, J Epidemiol Community Health. 1998.
[20]. Di Cicco M, Kantar A, Masini B, Nuzzi G, Ragazzo V, Peroni D. Structural And Functional Development In Airways Throughout Childhood: Children Are Not Small Adults. Pediatr Pulmonol. 2021 Jan 1;56(1):240–51.
[21]. Fleming S, Thompson M, Stevens R, Heneghan C, Plüddemann A, Maconochie I, Et Al. Normal Ranges Of Heart Rate And Respiratory Rate In Children From Birth To 18 Years Of Age: A Systematic Review Of Observational Studies. The Lancet. 2011;377(9770):1011–8.
[22]. Trachsel D, Erb TO, Hammer J, Von Ungern-Sternberg BS. Developmental Respiratory Physiology. Vol. 32, Paediatric Anaesthesia. John Wiley And Sons Inc; 2022. P. 108–17.
[23]. KARLBERG P. Respiratory Physiology During Infancy And Childhood. -; 1970.
[24]. Taytard J, Dubern B, Aubertin G. Obesity In Childhood: What Are The Respiratory Risks? Vol. 36, Revue Des Maladies Respiratoires. Elsevier Masson SAS; 2019. P. 1139–47.
[25]. Page, M. J., Mckenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Et Al. The PRISMA 2020 Statement: An Updated Guideline For Reporting Systematic Reviews. In The BMJ 2021; 372 (71).
[26]. Endes, K., Köchli, S., Zahner, L., & Hanssen, H. Exercise And Arterial Modulation In Children: The Examin Youth Study. Frontiers In Physiology. 2019; 10(43).