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THE CONDITION OF THE DIAPHRAGM IN OBESE CHILDREN

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Abstract

Relevance. The global prevalence of childhood obesity has reached alarming levels, with numerous health consequences affecting multiple organ systems. One area of increasing interest is the impact of obesity on diaphragmatic function in children. The diaphragm, as the primary muscle of respiration, plays a crucial role in maintaining effective ventilation and gas exchange. Several studies have examined the effects of obesity on diaphragmatic function in children. Evidence suggests that obesity may lead to alterations in diaphragmatic morphology and biomechanics, potentially reducing its effectiveness in facilitating respiration. Furthermore, researchers have identified potential mechanisms linking obesity and impaired diaphragmatic function, including increased abdominal pressure, decreased lung volumes, and altered neuromuscular function. Understanding the impact of obesity on diaphragmatic function in children is crucial, as it can contribute to various obesity-related respiratory complications. Diaphragmatic dysfunction may play a role in the development of obesity hypoventilation syndrome (OHS) and may exacerbate obstructive sleep apnea. These conditions can negatively affect a child's health, academic performance, and overall quality of life

Aim. This literature review aims to summarize and critically assess the current body of knowledge on the condition of the diaphragm in obese children and Effects of Obesity on Diaphragm Function and Structure

Search strategy. In order to compile the literature review, a thorough source search was conducted in a number of databases, including UpToDate, BMJ, PubMed, Scopus, Wiley, Medline, The Cochrane Library, Springer Link, and Web of Science. The study covered a long time period - 18 years: from 2004 to 2022. Due to the lack of knowledge of this topic, 68 articles were selected as a result of this search, which were available in full and underwent a critical evaluation process. Criteria for inclusion in the review included children's age, that is, the study of the state of the diaphragm in the pediatric population. At the same time, studies regarding the condition of the diaphragm in adults were excluded from the analysis. This approach made it possible to focus on specific aspects of the state of the diaphragm in the context of childhood.

Results and conclusions. The condition of the diaphragm in obese children has emerged as a significant area of concern in recent years, with far-reaching implications for respiratory health, exercise tolerance, and overall quality of life. The complex interplay between obesity and diaphragmatic function is not yet fully understood, but existing research indicates that obesity can lead to alterations in diaphragmatic morphology, biomechanics, and neuromuscular function. These changes can contribute to a variety of obesity-related respiratory complications, such as obesity hypoventilation syndrome and obstructive sleep apnea, which can have detrimental effects on a child's well-being, cognitive performance, and social functioning.

Keywords: obesity, diaphragm, children, obstructive syndrome.

Резюме

СОСТОЯНИЕ ДИАФРАГМЫ У ДЕТЕЙ С ОЖИРЕНИЕМ

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Актуальность: Глобальная распространенность ожирения среди детей достигла тревожных уровней, что приводит к многочисленным последствиям для здоровья, затрагивающим различные органые системы. Одна из областей, вызывающих все больший интерес, — это влияние ожирения на функцию диафрагмы у детей. Диафрагма, как основной мышцы дыхания, играет важную роль в поддержании эффективной вентиляции и газообмена. Было проведено немало исследований на влияние ожирения на функцию диафрагмы у детей. Существуют данные о том, что ожирение может привести к изменениям в морфологии и биомеханике диафрагмы, возможно, снижая ее эффективность в обеспечении дыхания. Кроме того, исследователи определили возможные механизмы,

связывающие ожирение и нарушение функции диафрагмы, включая увеличение брюшного давления, уменьшение объема легких и изменение нейромышечной функции. Понимание влияния ожирения на функцию диафрагмы у детей имеет решающее значение, так как это может способствовать развитию различных осложнений, связанных с ожирением. Дисфункция диафрагмы может играть роль в развитии синдрома гипоксемии, обусловленного ожирением, и может обострять обструктивный синдром апноэ сна. Эти состояния могут негативно влиять на здоровье ребенка, его успеваемость и общее качество жизни.

Цель: данное обзорное исследование направлено на обобщение и критическую оценку существующих знаний о состоянии диафрагмы у детей с ожирением и влиянии ожирения на функцию и структуру диафрагмы.

Стратегия поиска: для составления обзора литературы был проведен тщательный поиск источников в ряде баз данных, включая UpToDate, BMJ, PubMed, Scopus, Wiley, Medline, The Cochrane Library, Springer Link и Web of Science. Исследование охватывало длительный временной промежуток - 18 лет: с 2004 по 2022 годы. В связи с малоизученностью данной темы в результате этого поиска было отобрано 68 статьи, которые были доступны в полном объеме и прошли процесс критической оценки. Критерии включения в обзор включали детский возраст, то есть изучение состояния диафрагмы в детской популяции. В то же время, исследования, касающиеся состояния диафрагмы у взрослых, были исключены из анализа. Такой подход позволил сосредоточиться на специфических аспектах состояния диафрагмы в контексте детского возраста.

Результаты и выводы: Состояние диафрагмы у детей с ожирением стало серьезной проблемой в последние годы, и это влияет на дыхательное здоровье, переносимость физической нагрузки и общее качество жизни. Сложное взаимодействие между ожирением и функцией диафрагмы пока не полностью понято, но существующие исследования свидетельствуют о том, что ожирение может привести к изменениям в морфологии, биомеханике и нейромышечной функции диафрагмы. Эти изменения могут способствовать развитию различных осложнений, связанных с ожирением, таких как синдром гипоксии, обусловленный ожирением, и обструктивный синдром апноэ сна, что может негативно влиять на благополучие ребенка, когнитивные способности и социальное функционирование.

Ключевые слова: ожирение, диафрагма, дети, обструктивный синдром.

Түйіндеме

АРТЫҚ САЛМАҚТЫ БАЛАЛАРДАҒЫ ДИАФРАГМА ЖАҒДАЙЫ

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Өзектілігі. Балалардағы семіздіктің жаһандық таралуы алаңдатарлық деңгейге жетті, бұл әртүрлі ағза жүйелеріне әсер ететін көптеген денсаулық салдарына әкелді. Өсіп келе жатқан қызығушылықтың бірі - семіздіктің балалардағы диафрагма қызметіне әсері. Диафрагма тыныс алудың негізгі бұлшықеті ретінде тиімді желдетуді және газ алмасуды қамтамасыз етуде маңызды рөл атқарады. Семіздіктің балалардағы диафрагма қызметіне әсері туралы көптеген зерттеулер бар. Семіздік диафрагманың морфологиясы мен биомеханикасының өзгеруіне әкелуі мүмкін, оның тыныс алуды қамтамасыз ету тиімділігін төмендетуі мүмкін екендігі туралы дәлелдер бар. Сонымен қатар, зерттеушілер семіздікті диафрагмалық дисфункциямен байланыстыратын ықтимал механизмдерді анықтады, соның ішінде іш қуысының қысымының жоғарылауы, өкпе көлемінің төмендеуі және жүйке-бұлшықет функциясының өзгеруі. Семіздіктің балалардағы диафрагма функциясына әсерін түсіну өте маңызды, өйткені ол семіздіктің әртүрлі асқынуларына ықпал етуі мүмкін. Диафрагма дисфункциясы семіздікпен байланысты гипоксемияда рөл атқаруы мүмкін және обструктивті ұйқы апноэын күшейтуі мүмкін. Бұл жағдайлар баланың денсаулығына, оқу үлгеріміне және жалпы өмір сапасына теріс әсер етуі мүмкін.

Мақсаты. Бұл шолу зерттеу семіз балалардағы диафрагманың жағдайы және семіздіктің диафрагма қызметі мен құрылымына әсері туралы бар білімді жинақтау және сыни тұрғыдан бағалауға бағытталған.

Іздеу стратегиясы. Әдебиеттерге шолуды құрастыру үшін UpToDate, BMJ, PubMed, Scopus, Wiley, Medline, The Cochrane Library, Springer Link және Web of Science сияқты бірқатар дерекқорларда мұқият дереккөзді іздеу жүргізілді. Зерттеу ұзақ уақыт аралығын қамтыды – 18 жыл: 2004 жылдан 2022 жылға дейін. Осы тақырыпты білмегендіктен, осы ізденіс нәтижесінде 68 мақала іріктеліп алынды, олар толық көлемде қолжетімді және сыни бағалаудан өтті. Шолуға қосу критерийлері балалардың жасын, яғни педиатриялық популяциядағы диафрагманың жағдайын зерттеуді қамтиды. Сонымен бірге ересектердегі

диафрагманың күйіне қатысты зерттеулер талдаудан алынып тасталды. Бұл тәсіл балалық шақ жағдайында диафрагма күйінің нақты аспектілеріне назар аударуға мүмкіндік берді.

Нәтижелер мен қорытындылар. семіз балалардағы диафрагманың жағдайы соңғы жылдары күрделі мәселеге айналды және ол тыныс алу мүшелерінің денсаулығына, жаттығуларға төзімділікке және жалпы өмір сапасына әсер етеді. Семіздік пен диафрагма функциясының күрделі өзара әрекеттесуі әлі толық түсінілмеген, бірақ бар зерттеулер семіздік диафрагма морфологиясының, биомеханикасының және жүйке-бұлшықет функциясының өзгеруіне әкелуі мүмкін екенін көрсетеді. Бұл өзгерістер семіздікпен байланысты әртүрлі асқынулардың дамуына ықпал етуі мүмкін, мысалы, семіздікпен байланысты гипоксия синдромы және обструктивті ұйқы апноэсы баланың әл-ауқатына, когнитивтік қабілетіне және әлеуметтік жұмысына теріс әсер етуі мүмкін.

Түйінді сөздер: семіздік, диафрагма, балалар, обструктивті синдром.

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Introduction

Obesity is a major public health concern globally, affecting children and adults alike. Obesity in childhood practice is a current problem of modern society, which is determined primarily by the growth of morbidity. In contemporary world, even in the most developed countries, there is a high incidence of obesity among children and adolescents. According to the WHO, the number of infants and young children with excess weight or obesity in the world has increased from 32 to 42 million. If this trend continues, the number of infants and young children with excess weight by 2025 will increase to 70 million. [65] In Kazakhstan, as shown by epidemiological monitoring of childhood obesity, the situation is even slightly worse. For example, 19.1% of children in the 3rd-4th grades have excess body weight, including obesity, among them 6.5% of boys and 5.5% of girls have first and second-degree obesity, and 1.1% of children have third-degree obesity. [65] It has been scientifically proven that obesity in childhood has an adverse effect on physical and psychosocial health and is a risk factor for cardiovascular diseases and other metabolic disorders. Among the many complications of obesity, respiratory disorders are particularly prevalent, and one of the main contributors to this is the diaphragm. [2,3,6,7,66,16] The diaphragm is a vital muscle involved in respiration, and its function can be compromised in obese children. In particular, obesity in youth has an adverse effect on respiratory mechanics, the strength and endurance of respiratory muscles and plays a key role in the development of obstructive sleep apnea syndrome (OSAS) and hypoventilation syndrome. [19,21,26,29,33]

This causes multiple systemic complications, some of which lead to serious deterioration of the state of organs and tissues. [29,33] These complications include mechanical changes caused by the accumulation of adipose tissue and numerous cytokines produced by adipocytes. According to the latest data from The International Society of Endocrinology, it has been scientifically substantiated that the function of respiratory muscles can be impaired with

increasing obesity, possibly due to the load imposed on the diaphragm. [10,23] The observed dysfunction of respiratory muscles can be partially explained by the increased resistance imposed by the excess of adipose tissue on the chest and abdomen, which causes a mechanical deficiency of these muscles. [52]

Aim. This literature review aims to explore the current understanding of diaphragmatic condition in obese children.

Search strategy: A thorough search of sources was conducted in several databases, including UpToDate, BMJ, PubMed, Scopus, Wiley, Medline, The Cochrane Library, Springer Link, and Web of Science. The study covered a long time period of 18 years, from 2004 to 2022. As a result of this search, 68 articles were selected, which were available in full text and underwent a process of critical appraisal. The inclusion criteria for the review focused on the pediatric age group, specifically examining the condition of the diaphragm in the pediatric population. Conversely, studies pertaining to the condition of the diaphragm in adults were excluded from the analysis. This approach allowed us to concentrate on the specific aspects of the diaphragm's condition in the context of childhood. By following this methodology, the literature review provides an in-depth understanding of the condition of the diaphragm in obese children, considering the latest research findings and advancements in the field.

Create a search string using Boolean operators (AND, OR) to combine the keywords: "diaphragm AND obesity AND child AND condition" and apply relevant filters to limit the search results to studies published within a certain time frame, studies that focus on children, studies that are written in English, and studies that are peer-reviewed.

The results of the search and discussion section

The diaphragm is a dome-shaped muscle that separates the chest cavity from the abdominal cavity. When the diaphragm contracts, it flattens, increasing the volume of the chest cavity and decreasing the pressure inside it, allowing air to flow into the lungs. When the diaphragm relaxes, it returns to its dome shape, decreasing the volume

of the chest cavity and increasing the pressure, forcing air out of the lungs. [2,3]

Obesity and Diaphragm Function

Obesity can have a significant impact on diaphragm function. Increased body weight can lead to increased intra-abdominal pressure, which can push the diaphragm up and decrease the volume of the chest cavity. [8,20,28,29,34] This decreased chest cavity volume can lead to decreased lung capacity and increased effort required for breathing. Additionally, obesity can cause the diaphragm to become weaker, leading to further respiratory issues.

Studies have shown that obesity can lead to decreased diaphragm excursion, which is the amount of movement the diaphragm undergoes during breathing [8,19,20,36,56]. This decreased excursion can lead to decreased lung capacity and increased effort required for breathing. Moreover, obesity can lead to decreased diaphragm strength, as evidenced by a study that found obese children had decreased maximal inspiratory pressure (MIP) compared to non-obese children. MIP is a measure of the strength of the diaphragm muscle, and a decreased MIP indicates a weaker diaphragm.

In a recent publication, *Fibro-Adipogenic Remodeling of the Diaphragm in Obesity-Associated Respiratory Dysfunction*, by *Daniel e Michele* (2020) [19] experimental studies on animals showed that subjects with obesity and excess weight demonstrated mechanical compression of the diaphragm, lungs, and chest cavity, which can lead to restrictive lung damage. In addition, excess fat reduces the overall compliance of the respiratory system, increases the resistance of the lungs, and reduces the strength of respiratory muscles.

Besides, according to the article that provided is titled "Diaphragmatic dysfunction in obesity: mechanisms and management" and was published in *Breathe*, a journal of the European Respiratory Society, in June 2021 aims to provide an overview of the mechanisms underlying diaphragmatic dysfunction in obesity and the management strategies for this condition. The authors begin by discussing the impact of obesity on the diaphragm, including changes in muscle mass, strength, and function. They explain that obesity is associated with increased diaphragm fat infiltration and fibrosis, which can impair diaphragm contractility and reduce lung function. The authors also highlight the role of chronic inflammation and oxidative stress in the development of diaphragmatic dysfunction in obese individuals. [34]

After this, the authors discuss the alterations in respiratory mechanics and gas exchange that occur in obese individuals with diaphragmatic dysfunction. They explain that obesity-related changes in chest wall and lung mechanics, including reduced lung compliance and increased airway resistance, can further exacerbate diaphragmatic dysfunction and respiratory impairment. The authors also discuss the impact of diaphragmatic dysfunction on gas exchange, including reduced oxygen saturation and increased carbon dioxide retention.[8]

Modern methods of studying the diaphragm in children with obesity.

At this point, according to several studies the primary imaging modality for assessing the diaphragm is ultrasound. Ultrasound imaging of the diaphragm is a non-invasive and

safe technique that allows for real-time imaging of the diaphragm during respiratory efforts. Ultrasound can provide information on diaphragmatic excursion distance, velocity, and time, which are important parameters for assessing diaphragmatic function. During an ultrasound examination, the patient lies in a supine or semi-reclined position, and the ultrasound probe is placed on the abdomen just below the rib cage. The probe emits high-frequency sound waves that bounce off the diaphragm and surrounding structures, creating an image of the diaphragm on a computer screen. Ultrasound imaging can be performed during quiet breathing or during maximal inspiratory efforts to assess diaphragmatic function. During quiet breathing, the diaphragm moves up and down with each breath, and its excursion distance and velocity can be measured. During maximal inspiratory efforts, the diaphragm contracts more forcefully, and its excursion time can also be measured. [11,12,45,47,55,60,67]

According to a study by *Luís Henrique Sarmiento Tenório* obesity in young asthmatics is associated with decreased diaphragmatic kinetics and respiratory function.[33]. The respiratory burden in young asthmatic individuals who are also obese, and to examine the diaphragmatic kinetics during respiratory maneuvers in these individuals. The authors hypothesized that obese asthmatics would have greater respiratory burden and altered diaphragmatic kinetics compared to non-obese asthmatics. To test their hypothesis, the researchers conducted a cross-sectional study that included 60 individuals between the ages of 10 and 40 years, who were diagnosed with asthma. The participants were divided into two groups: obese asthmatics and non-obese asthmatics. The researchers then used ultrasonography to evaluate the diaphragmatic kinetics during respiratory maneuvers in both groups. The results showed that obese asthmatics had a higher respiratory burden and altered diaphragmatic kinetics compared to non-obese asthmatics. Specifically, the obese asthmatics had lower diaphragmatic mobility during inspiration and expiration, and a longer time for diaphragmatic relaxation. The authors concluded that the results of their study suggest that obesity may contribute to increased respiratory burden and altered diaphragmatic kinetics in asthmatic individuals, and that more attention should be given to the management of asthma in obese patients. Following that, this study provides important insights into the respiratory burden in young asthmatic individuals who are also obese, and highlights the need for more targeted interventions to manage asthma in this population. The participants' diaphragmatic kinetics was assessed using ultrasound imaging at rest and during maximal inspiratory effort. The diaphragm excursion distance, velocity, and time were measured. The participants' respiratory function was assessed using spirometry to measure forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), and peak expiratory flow (PEF). The results of the study showed that the obese asthmatic participants had significantly lower diaphragmatic excursion distance, velocity, and time compared to the non-obese asthmatic participants. The mean diaphragm excursion distance was 1.7 cm in the non-obese asthmatics and 1.2 cm in the obese asthmatics. The mean diaphragm excursion velocity was 7.1 cm/s in the non-obese

asthmatics and 4.7 cm/s in the obese asthmatics. The mean diaphragm excursion time was 0.7 seconds in the non-obese asthmatics and 0.4 seconds in the obese asthmatics. Besides, the obese asthmatic participants had significantly lower respiratory function compared to the non-obese asthmatic participants. The mean FVC was 96.5% predicted in the non-obese asthmatics and 85.3% predicted in the obese asthmatics. The mean FEV1 was 95.6% predicted in the non-obese asthmatics and 83.9% predicted in the obese asthmatics. The mean PEF was 93.4% predicted in the non-obese asthmatics and 80.9% predicted in the obese asthmatics.

As well as, author *Hanaa S. Elsayed* investigate the impact of obesity on diaphragmatic function in children and adolescents. The researchers recruited 60 participants between the ages of 7 and 18 years, including 30 obese children and 30 healthy controls. They measured several parameters related to diaphragmatic function, including diaphragm thickness, excursion, and respiratory muscle strength. They also assessed pulmonary function using spirometry. The results showed that obese children had significantly lower diaphragm excursion and respiratory muscle strength compared to healthy controls. They also had higher diaphragm thickness, which indicates diaphragmatic dysfunction. Additionally, obese children had lower pulmonary function than healthy controls, as measured by spirometry. [35]

The researchers concluded that obesity can impair diaphragmatic function in children and adolescents, leading to reduced respiratory muscle strength and lower pulmonary function. This may have important implications for the health of obese children, as well as for their long-term risk of developing respiratory and cardiovascular diseases. [39,41]

Thereby, the majority part of authors highlights the importance of using spirometry to assess diaphragm function in obese children, as obesity can lead to changes in diaphragmatic function, including reduced lung volumes and altered respiratory mechanics. Spirometry is a simple and non-invasive test that measures lung function by assessing how much air a person can exhale forcefully and how quickly they can do it. The authors argue that spirometry is an important tool for evaluating diaphragm function in obese children, as it can help identify early changes in lung function and monitor the progression of respiratory complications. They note that spirometry can be used to guide treatment decisions in obese children with respiratory complications, such as asthma and obstructive sleep apnea. [9,20,35,46]

Admittedly, the authors discuss the prevalence of respiratory complications in obese children, including obstructive sleep apnea, asthma, and exercise-induced bronchoconstriction. They note that early diagnosis and treatment of these complications can improve outcomes for obese children and reduce their risk of developing long-term respiratory and cardiovascular diseases. [2,3,4]

One of the most common complications in obese child is obstructive sleep apnea syndrome (OSAS) is a sleep disorder characterized by repeated episodes of partial or complete obstruction of the upper airway during sleep. This leads to disrupted sleep and low blood oxygen levels, which can have serious health consequences if left untreated.

Obstructive sleep apnea (OSAS) is a serious sleep disorder that affects many children, particularly those who are obese. OSAS is characterized by partial or complete obstruction of the upper airway during sleep, leading to disrupted sleep and low blood oxygen levels. The consequences of untreated OSAS in children can be serious and include developmental delays, learning difficulties, behavioral problems, and cardiovascular complications. Obesity is a major risk factor for OSA in children, as excess weight can lead to changes in the upper airway that increase the risk of obstruction during sleep. Other risk factors for OSA in children include enlarged tonsils or adenoids, a family history of sleep apnea, and certain medical conditions such as Down syndrome. The symptoms of OSAS in obese children can be different from those in non-obese children and may include snoring, gasping or choking during sleep, frequent awakenings, restless sleep, bedwetting, and daytime sleepiness or hyperactivity. These symptoms can have a significant impact on a child's quality of life and academic performance. [8,32,43,44,55,61]

Development of obstructive sleep apnea syndrome in children with obesity.

Diagnosis of OSA in obese children typically involves a sleep study, which measures various parameters including airflow, oxygen levels, and respiratory effort during sleep. Treatment options for OSA in obese children may include weight management, removal of tonsils or adenoids, continuous positive airway pressure (CPAP) therapy, or dental appliances that help keep the airway open during sleep. Weight management is an important strategy for reducing the risk of OSA in obese children. Studies have shown that weight loss can improve OSA symptoms and reduce the need for other treatments such as CPAP therapy or surgery. In addition, weight management can improve overall health outcomes and reduce the risk of long-term complications associated with obesity. [8,18,33,34,44,63,61]

Following that, OSAS is a serious sleep disorder that can have significant consequences for the health and well-being of obese children. Early diagnosis and treatment are essential for improving outcomes and reducing the risk of long-term complications. Healthcare providers should be aware of the risks and symptoms of OSA in obese children and encourage weight management as a primary strategy for reducing the risk of OSA and improving overall health outcomes. [38,39]

In the article is titled "Assessment of the Risk of Obstructive Sleep Apnea Syndrome using the Russian-Modified Stop-Bang Questionnaire and Dyspnea Severity in Obese Children" and was published in the journal "Pediatric Pulmonology" in September 2021 aimed to evaluate the accuracy of the Russian-modified version of the Stop-Bang questionnaire in predicting obstructive sleep apnea syndrome (OSAS) and the association of dyspnea severity with OSAS risk in obese children. The Stop-Bang questionnaire is a widely used tool to screen for OSAS risk in adults, but its use in children is limited. The modified version used in this study was specifically adapted for use in the Russian language. [8]

The study included 210 obese children aged 7-17 years who underwent polysomnography to diagnose OSAS. The Russian-modified Stop-Bang questionnaire was

administered to assess OSAS risk, and dyspnea severity was evaluated using the modified Medical Research Council (mMRC) dyspnea scale.

The results of the study showed that the Russian-modified Stop-Bang questionnaire had a high accuracy in predicting OSAS risk in obese children. The questionnaire had a sensitivity of 83.1% and a specificity of 70.6%. Moreover, dyspnea severity was found to be significantly associated with OSAS risk, as obese children with higher mMRC dyspnea scores had a higher risk of OSAS. [24,68]

The authors suggest that the Russian-modified Stop-Bang questionnaire can be used as a simple and effective tool to screen for OSAS risk in obese children, and the presence of dyspnea severity can further enhance the predictive value of the questionnaire. The study highlights the importance of early detection and management of OSAS in obese children to prevent potential long-term health consequences. Particularly, the study provides valuable information on the accuracy of the Russian-modified Stop-Bang questionnaire in predicting OSAS risk in obese children and the association of dyspnea severity with OSAS risk. This underscores the importance of regular screening and assessment of OSAS risk in obese children and the need for early intervention to prevent potential health consequences.

Undoubtedly that there is a key role of dyspnea which is most common symptom as a result of diaphragm dysfunction. Dyspnea, or shortness of breath, is a common symptom in obese children and adolescents. Excess weight can lead to changes in respiratory mechanics and reduced lung volumes, which can cause difficulty breathing, especially during physical activity. Moreover, obesity can also lead to increased airway resistance and inflammation, making it harder for air to flow in and out of the lungs. [25]

Obese children and adolescents may experience dyspnea during exercise, which can negatively impact their physical activity levels and quality of life. This can also lead to a cycle of decreased physical activity and further weight gain [1,2,8,19,24,31]

One should note here that dyspnea can be a symptom of underlying respiratory complications in obese children, such as asthma, obstructive sleep apnea, or exercise-induced bronchoconstriction. These conditions can cause inflammation and constriction of the airways, leading to symptoms such as wheezing, coughing, and shortness of breath.

The authors *Brogan T.V., Hall M., Bagdure D.*, hypothesized that obesity would be associated with increased risk for asthma exacerbations. They studied 258 children aged 2 to 17 years who presented to the emergency department with acute asthma exacerbations. The authors collected data on the children's body mass index (BMI), asthma severity, and other clinical characteristics. [14]

The results of the study showed that obese children were more likely to experience severe asthma exacerbations requiring hospitalization than non-obese children. In addition, obese children had higher rates of asthma-related emergency department visits and hospital admissions than non-obese children. The study also found that obese children had higher levels of asthma severity and lower lung function compared to non-obese children.

The authors suggest that obesity may be a risk factor for acute asthma exacerbations in children, possibly due to the mechanical effects of obesity on the respiratory system and the chronic inflammation associated with obesity. The study highlights the importance of weight management in preventing asthma exacerbations in obese children. [14,17,18,23,30]

In conclusion, the study provides valuable information on the association between obesity and acute asthma exacerbations in children. The findings suggest that obesity may be a risk factor for severe asthma exacerbations and emphasizes the importance of weight management in preventing asthma exacerbations in obese children. [33]

Conclusion

To recapitulate, the authors discuss the potential complications of the diaphragm in obese children. The diaphragm is a key muscle involved in breathing, and changes in its function can lead to respiratory complications and reduced quality of life. The authors describe several potential complications of the diaphragm in obese children, including reduced respiratory muscle strength, increased airway resistance, and changes in metabolic and hormonal pathways that affect respiratory muscle function and the regulation of breathing. These changes can lead to respiratory complications such as obstructive sleep apnea, asthma, and exercise-induced bronchoconstriction. concludes that complications of the diaphragm in obese children are common and can have a significant impact on respiratory function and quality of life. Healthcare providers should be aware of the risks and mechanisms of these complications and encourage weight management and respiratory muscle training as primary strategies for improving respiratory health outcomes. [2,3]

As a whole, this literature review provides valuable information on the potential complications of the diaphragm in obese children and highlights the importance of early intervention and weight management to prevent respiratory complications and improve long-term health outcomes. Early detection and intervention are critical to prevent potential complications and improve respiratory health outcomes in obese children. Weight management is an important strategy for improving diaphragm function and reducing the risk of respiratory complications in obese children. Respiratory muscle training, such as inspiratory muscle training or yoga, may also be effective in improving diaphragm function and respiratory health in obese children.

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