Cardiovascular Risk Associated with Sleep Respiratory Disorders

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Exposure to risk factors in youth can exacerbate the development of future cardiovascular disease (CVD). Obstructive sleep apnea (OSA), characterized by repetitive episodes of airway obstructions, could trigger said CVD acting as a modifiable risk factor. Measurements from echocardiography have shown impairments in the anatomy and function of the heart related to the severity of OSA.

Keywords: cardiovascular ; echocardiography ; sleep apnea ; adenotonsillectomy ; children

1. Cardiovascular Disease in the Pediatric Population

Cardiovascular disease (CVD) is the main cause of death globally [1]. Although these adverse events are infrequent in children, the basis of these CVDs, atherosclerosis, may begin in childhood [2][3][4]. The exposure to risk factors and behaviors in youth can exacerbate its development. Hence, both addressing the social, economic, and environmental determinants of health to prevent the onset of risk factors (primordial prevention) and intervening to prevent risk factors from progressing into clinical diseases in adulthood (primary prevention) should be contemplated [2][5].

Focusing on primary prevention, some of these factors are related to life habits, while others are hereditary or the result of diseases [6]. The most common factors are excess body mass, high blood pressure (HBP), tobacco, low physical activity, and alterations in glucose and lipid metabolism [3][4][5][7]. Controlling said morbidities could decrease the atherosclerotic process and delay future cardiometabolic disease [8][9][10]. However, the importance of sleep as a possible trigger of CVD is often not considered despite the recent evidence highlighting its association [11][12]. It is imperative to consider the diagnosis and treatment of sleep disorders, even in the absence of clinically manifested CVD, as these may serve as potential contributors to them.

2. Sleep Disordered Breathing in the Pediatric Population

Sleep disturbances, and more concisely, sleep disordered breathing (SDB), are prevalent conditions in the pediatric population. SDB ranges from primary snoring (PS) to obstructive sleep apnea (OSA), being the prevalence of SDB of 10–17% and between 1 and 4% in OSA [13][14][15]. OSA is characterized by repetitive episodes of partial (hypopnea) or total (apnea) airway obstructions, driving immediate consequences that include changes in intrathoracic pressure, intermittent hypoxia, and sleep fragmentation [16]. The gold standard test to diagnose OSA is polysomnography (PSG), an objective sleep study that collects neurophysiological and cardiorespiratory variables, which is performed in-laboratory during the night. OSA in children is considered when the apnea–hypopnea index (AHI), a parameter obtained from the sleep study that collects the number of respiratory events per hour of sleep, is greater than 1–3 events per hour. Adenotonsillectomy (AT) is the first line and effective treatment in moderate-to-severe OSA patients (AHI ≥ 5) when adenotonsillar hypertrophy, the most-frequent cause in children, is also present [16][17].

3. Obstructive Sleep Apnea Treatment as a Modifiable Cardiovascular Risk Factor

OSA has particularly been related to adverse cardiovascular (CV) responses due to its associated immediate consequences [18], which result in the activation of the sympathetic nervous system, increased oxidative stress, and a proinflammatory and hypercoagulable state [19]. All these processes taking place in children with OSA have an impact on their CV sphere: alterations in hemodynamic and cardiac structure and function, increase in blood pressure (BP) levels with special impact during night, activation of the inflammatory cascade, and dysfunction of endothelium [20]. Therefore,

treating OSA could reduce these intermediate mechanisms acting as a modifiable risk factor in the development of future CVD.

In the present research, CV risk (CVR) was evaluated through the alteration of both the anatomy and function of the heart, assessed using the ultrasound-based imaging technique (echocardiography). On the other hand, OSA was considered for the narrative review when AHI ≥ 1/h was identified from PSG performed in-laboratory. Performing an echocardiography as a complementary test to the PSG could help to identify children who have OSA and concomitant increased CVR. Therefore, the main aim of this research was to propose a new clinical management of CVR in children based on treating OSA as a potential modulator of this risk.

4. Management Proposal for Children with Cardiovascular Risk and Obstructive Sleep Apnea

Historically, the AHI has served as a primary marker guiding surgical indications for values ≥ 5 events per hour of sleep. Recent studies, however, have illuminated structural and functional cardiac abnormalities in children with AHI values below this threshold. Notably, these alterations appear to be potentially reversible with appropriate treatment. In this discourse, researchers advocate for a paradigm shift in the assessment of treatment indications, favoring a focus on preventing future comorbidities rather than relying solely on parameters that may not encapsulate the entire spectrum of the disease.

Furthermore, emerging data introduce novel parameters within the realm of OSA, which exhibit stronger associations with CV consequences more than the traditional AHI. Consequently, researchers propose that future clinical guidelines for the OSA definition in children and severity levels should be based on associated comorbidities and their potential ramifications. However, research exploring the genetic basis of OSA and its relationship with CV outcomes has uncovered candidate genes and pathways that may play crucial roles in both conditions. These genetic factors could influence not only the severity and susceptibility to OSA but also contribute to the development and progression of CV comorbidities associated with the disorder [21].

A transformative approach to diagnostic methods is suggested, directing efforts towards parameters more intricately linked to comorbidity. This would not only simplify diagnostic processes but also enhance their relevance in clinical decision-making. Researchers posit that the diagnostic algorithm should incorporate assessments for organic damage, particularly CV impact. Compared to adults, the management of OSA in children faces two relevant problems: (1) the scientific knowledge in OSA and CVR association is less explored and slower in the child population; (2) the incorporation of the results into clinical practice is delayed. In order to mitigate these problems, strategic actions are relevant, including the following: developing research to transfer the knowledge to the pediatric population and the periodic updating of clinical guidelines based on scientific evidence.

Although guidelines published by ATS and AHA recommend performing preoperative echocardiography only on children with severe OSA [22], the reviewed studies have reported that children with SDB from PS to OSA may have cardiac abnormalities. Accordingly, children referred to the sleep unit for suspected SDB should undergo echocardiography in addition to the PSG, to adapt the treatment to the complete resolution of OSA and reduce their CVR. Additionally, a reevaluation of children after treatment may decide future readjustment when necessary, although it is not clear what the ideal follow-up period should be.

Beyond its role in diagnosis, echocardiography serves as a valuable tool for indicating the necessity of treatment and mitigating CVR. By employing echocardiographic parameters that intimately link to comorbidities, such as cardiac structure and function, clinicians can enhance their understanding of the diverse CV manifestations associated. This approach not only aids in treatment decision-making but also in more tailored and patient-centered care strategies. Furthermore, the integration of follow-up echocardiography post treatment, when necessary, provides an additional insight into the effectiveness of interventions, allowing for the continuous refinement of management strategies.

Implementing these modifications would fundamentally alter the current treatment management algorithm, allowing for the identification of patient cohorts deriving clear treatment benefits. This risk-based approach, departing from arbitrary measures, offers a more personalized framework for the management of pediatric OSA. The delay produced in the application of these advances involves the development and implementation of tailored educational programs for healthcare professionals. These programs could focus on disseminating the latest research findings to clinicians to make them well-informed about advancements in the field. Furthermore, fostering collaboration between researchers and healthcare practitioners (specialist and primary care practitioners) through interdisciplinary forums and conferences may

enhance mutual understanding and facilitate the translation of research findings into clinical practice also in primary care levels.

As always, in the health management of children, promoting a supportive relationship, addressing parental concerns, promoting understanding, and obtaining informed consent are integral components of the diagnostic and treatment processes. By prioritizing these aspects, healthcare providers can enhance the quality of care and outcomes for pediatric patients.

Finally, the strengths and limitations of this research need to be commented on. The strengths of the study include a summarized broad spectrum of literature that provides a comprehensive overview of echocardiographic parameters in pediatric OSA. The inclusion of rigorous selection criteria, such as the strict age limit (under 18 years), standardized diagnostic criteria (PSG) for diagnosis and classification, and the temporal proximity between both methods, enhances the internal validity of researchers' findings. Moreover, this population is of special interest as it offers insights into a critical developmental stage.

Within the limitations of the study, there is some controversy on the reported results, which may be due to the heterogeneity of the populations, composition of the control group that was predominantly PS children, different follow-up periods for reevaluation, and differences in echocardiographic performance. Additionally, the inclusion criteria for papers may have introduced selection bias, as only studies published in English were included, and those with participants presenting comorbidities or specific disorders were excluded. Additionally, there may be an underrepresentation of certain populations or recent advancements. These limitations should be considered when interpreting the results, and future research could address these constraints to understand the interplay between pediatric OSA and CV health.

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