Global Journal of Medicine & Public Health

Sleep Disorders as a contributor to Cardiovascular Risk: A short review focused on Africa

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ABSTRACT

Background

There is a bidirectional association between cardiovascular disease and sleep disorders involving neurohormonal, inflammatory, metabolic, and autonomic dysfunction mechanisms. Sleep disorders are primarily associated with cardiovascular and metabolic complications, and it is crucial to carry out more research and introduce targeted interventions. Purpose of the review: This review addresses sleep disorders in children, pathophysiological pathways linking sleep disturbances to cardiovascular risk, challenges, and potential intervention strategies which can be implemented within the African context.

Key Findings

Several key sleep disorders associated with cardiovascular health have been identified in Africa, including Obstructive Sleep Apnea, Insomnia, Restless Legs Syndrome, and Sleep-Disordered Breathing. The impact of sleep disorders on children's cardiovascular risk is still identified as an issue yet to be exhaustively studied in Africa. Sleep health was reported to be an overlooked component in terms of the prevention of CVD in children, particularly in Africa, where the prevalence of non-communicable diseases is rising.

Conclusion

Some of the challenges identified regarding this overlook include poor awareness, inadequate health infrastructure, beliefs, and an absence of region-specific data.

Keywords: Africa; cardiovascular disease; children; sleep disorders

GJMEDPH 2025; Vol. 14, issue 3 | OPEN ACCESS

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Conflict of Interest—noneFunding—none

INTRODUCTION

Cardiovascular diseases (CVDs) are a global concern as they are among the leading causes of death, with over three-quarters of them occurring in low and middle-income countries [1]. Cardiovascular diseases have traditionally been perceived as diseases of adulthood, considering that most develop over time, related to personal lifestyle factors such as diet [2-4]. Recently, risk factors for cardiovascular diseases have been observed to be present even in childhood, where it was associated with factors such as poor feeding practices [2]. Sleep disorders in childhood have been identified as possible reasons for the premature onset of CVD [3]. Urbanisation, changes in dietary patterns, and increased exposure to screens have led to sleep disorders among children [4]. Data from some industrialised countries in Europe and the United States linked inadequate sleep to increased lifetime cardiovascular disease risk in Children [5]. Reports from China and Japan also revealed the harmful effects of poor sleep on children's blood pressure and insulin sensitivity [5].Epidemiologic data indicate that sleep disorders are a global concern in paediatric patients [5,6]. Sleep disturbance in children has been estimated at 25–30% in the US [1,6], while Obstructive Sleep Apnea (OSA) is between 1–5% [4]. In Europe, poor sleep quality was reported in a study in about 40% of school children [7]. Similarly, in China, childhood sleep disorders have been reported to affect over 35% of children, leading to significant consequences for metabolic health [6]. Comparable trends have been observed in Latin America, where the prevalence of obesity among children strongly associated with inadequate sleep—has increased dramatically [1]Despite this mounting body of evidence of sleep disorders in childhood, there is a great paucity of studies associating sleep disorders with cardiovascular disease in Africa [8]. Africa is undergoing rapid urbanisation, which has been accompanied by lifestyle changes and obesity [9], thus highlighting the need to determine more precisely how sleep disorders may contribute to cardiovascular risk in African children. Literature on African childhood sleep disorders is scant, although initial reports indicate alarming patterns [10,11]. Insufficient night sleep has been reported in about 30% of South African children to be highly linked with obesity and hypertension [12]. Partial sleep deprivation in children has also been linked to elevated biomarkers of oxidative stress and cardiovascular damage [13]. Similarly, findings from Kenya and Ethiopia show that urbanisation and lifestyle changes have resulted in poor sleep quality with long-term cardiovascular effects [10,11].Besides, socioeconomic status, limitations to healthcare, and lack of adequate information on sleep health have created additional complexities in the identification and management of paediatric sleep disorders in Africa [9,14]. If left unchecked, the mounting burden of sleep disturbances in childhood is likely to further add to the rising trend of cardiometabolic diseases among African populations [10,11].This review addresses sleep disorders in children of African ancestry, the pathophysiology of sleep disturbances related to cardiovascular risk in children and potential intervention strategies that can be implemented in the African context.

Sleep Disorders and Prevalence

Sleep disorders in children vary in prevalence and type among different locations and populations. In South Africa, children with poor sleep quality recorded higher levels of vascular dysfunction markers, an early indicator of cardiovascular disease [15]. The most commonly reported disorders are:

Obstructive Sleep Apnea (OSA): It is a common sleep disorder characterised by recurrent events of upper airway obstruction during sleep, leading to periodic breathing cessation, oxygen desaturation, and disturbed sleep [16]. Inflammation and oxidative stress, which result from repeated episodes of low oxygen during sleep, contribute to atherosclerosis and other CVDs [16]. Individuals with OSA are at higher risk of stroke due to the combination of hypertension, atrial fibrillation, and other cardiovascular risk factors that are exacerbated by the condition (Table 1) [13,17]. The intermittent hypoxia caused by OSA can cause elevated blood pressure since it leads to increased sympathetic nervous system activity.

ISSN# 2277-9604

Table 1: Cardiovascular Risk Factors and Associated Sleep Disorders [13,31-33]

Cardiovascular Risk Factor	Associated Sleep Disorders
Hypertension	Increased blood pressure is due to OSA's short sleep duration and poor sleep quality.
Obesity	Disrupted metabolism and increased appetite-regulating hormones contribute to weight gain.
Diabetes	Poor sleep alters glucose metabolism, increasing insulin resistance.
Inflammation	Sleep disorders are linked to higher levels of inflammatory markers (e.g., CRP, IL-6).
Dyslipidemia	Changes in lipid metabolism increase LDL cholesterol and decrease HDL cholesterol.
Sympathetic Nervous System Overactivity	Sleep deprivation leads to chronic stress, contributing to high heart rate and vasoconstriction.

In some African regions, the prevalence of OSA recorded among stroke patients is as high as 60% [17]. In Africa, studies have shown that hypertensive patients have a higher prevalence of OSA, with some estimates suggesting that up to 40% of hypertensive individuals may have OSA [18]. Studies in Tanzania have shown that hypertensive patients recorded a higher prevalence of OSA compared to normotensive individuals [19]. Studies in Tunisia have reported a high prevalence of OSA among patients with atrial fibrillation, with rates as high as 77% and 90% [20]. The pooled prevalence of OSA risk is estimated to be around 41.13% among patients with type 2 diabetes mellitus [21].

Insomnia: Though less commonly reported in children in Africa, insomnia and decreased sleep quality have been linked to increased sympathetic activity and hormonal deregulation, which has been implicated in increased cardiovascular risk [22]. Sleep deprivation affects glucose metabolism and increases inflammatory markers, which are known risk factors for metabolic syndrome and future hypertension [22,23]. Some research findings and reports have suggested that chronic childhood insomnia could have cardiovascular consequences in the long term. Therefore, further studies and awareness need to be generated in the African setting [5,6]. A meta-analysis study reported that individuals with insomnia had a 45% risk of developing or dying from cardiovascular diseases (coronary artery disease, hypertension, and heart failure) [24]. Chronic sleep deprivation can lead to physiological changes such as neuroendocrine, metabolic and immune disturbances, which in turn could increase the risk of cardiovascular disease [25]. In Africa, the impact of insomnia on cardiovascular health is compounded by other factors, such as limited access to healthcare, socioeconomic challenges and the high prevalence of hypertension and diabetes [26].

Restless Legs Syndrome (RLS): Parasomnias and RLS, including sleepwalking and night terrors, have been documented in African children [27]. However, there is a paucity of data regarding the cardiovascular outcomes associated with these conditions [10]. While specific data on RLS and cardiovascular diseases in Africa is limited, the magnitude of the association and direction of causation have not been adequately reported [10]. Individuals with RLS have also been reported to having a higher risk of cardiovascular diseases development [28]. The mechanisms linking RLS to cardiovascular diseases include increased sympathetic nervous system activity, periodic limb movements during sleep, and elevated blood pressure (Table 1) [13]. While specific data on RLS and cardiovascular diseases in Africa is limited, the general association between RLS and CVD is relevant [10]. Restless Legs Syndrome has been shown to be common and prevalent in women and older adults [29].

Sleep-disordered breathing (SDB): It is linked to various forms of CVD, including coronary artery disease and heart failure [5]. For instance, a study in Nigeria found a significant prevalence of SDB among patients with heart failure [30]. Intermittent hypoxia caused by SDB leads to sympathetic overactivation, which causes elevated blood pressure and contributes to the development of hypertension [26]. Individuals with SDB are at risk of developing stroke because of their association with hypertension, atrial fibrillation, and other cardiovascular risk factors [26].

Pathophysiological Mechanisms Linking Sleep Disorders to Cardiovascular Risk

There is a bidirectional association between cardiovascular disease and sleep disorders, with these disorders contributing to cardiovascular pathology through several mechanisms [13]. Some of these mechanisms include sympathetic nervous system activation, neurohormonal, endothelial dysfunction, inflammatory, metabolic dysregulations, oxidative stress, and autonomic dysfunction (Figure 1).

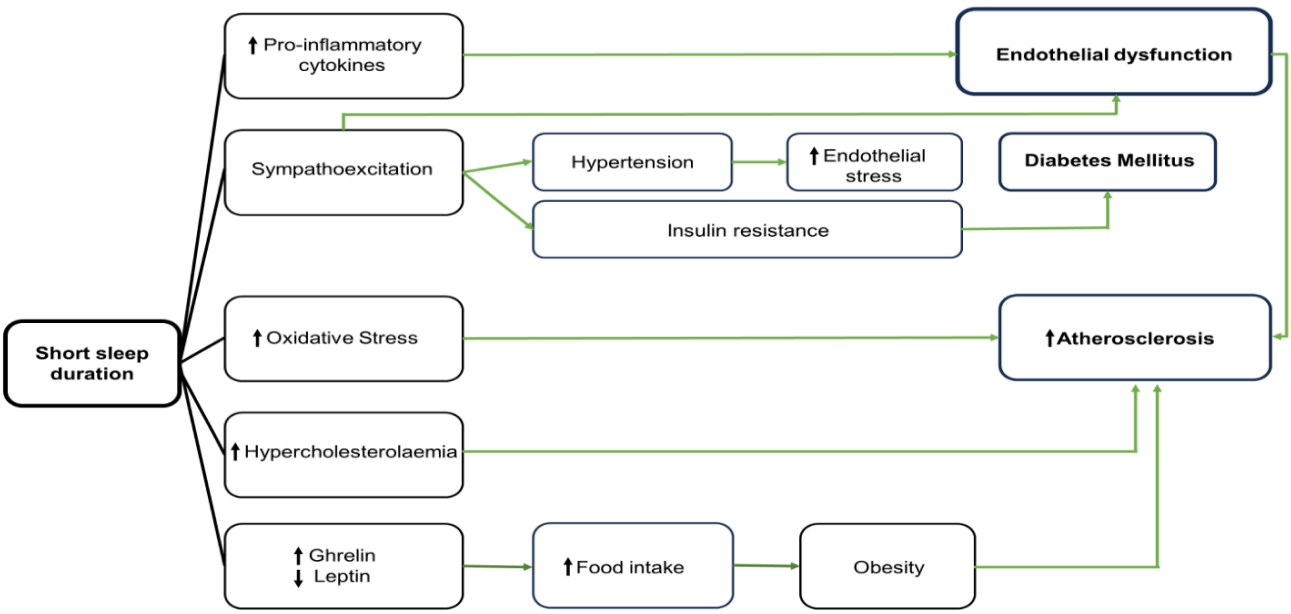

Figure 1: Mechanisms Linking Sleep Disorders to Cardiovascular Risk [13]

Dysregulation of the Autonomic Nervous System (ANS): Blood Pressure, Heart Rate and Respiratory rhythm are some of the vital functions regulated by ANS [13]. Cardiovascular recovery and Metabolic balance are promoted during healthy sleep since the body shifts towards parasympathetic dominance [13]. Sleep deprivation and sleep disorders such as OSA lead to sympathetic overactivation, resulting in high blood pressure and heart rate variability, and are preclinical predictors of cardiovascular risk [13,33]. It is known that children with OSA have increased nocturnal blood pressure, a preclinical predictor of future hypertension [31]. Oxidative Stress and Inflammation: Repeated episodes of hypoxia (low oxygen levels) in conditions like OSA lead to oxidative stress [13]. This oxidative stress damages the inner lining of blood vessels (endothelium), contributing to the development of cardiovascular diseases. Sleep disruptions enable chronic low-grade inflammation, with a high prevalence of biomarkers such as interleukin-6 (IL-6) and C-reactive protein (CRP) [13]. This Chronic low-grade inflammation can lead to destruction of blood vessels and promote atherosclerosis (Figure 1) [13]. Metabolic Dysregulation: Insulin resistance, dyslipidemia, and obesity are the fundamental components of metabolic syndrome, and sleep deprivation has been linked with them (Table 1) [32]. Sleep disturbance is known to impair glucose metabolism and reduce insulin sensitivity since it increases the sympathetic nervous system and elevates cortisol levels [32,33]. Sleep deprivation also decreases the appetite-suppressing hormone leptin and increases the appetite-stimulating

ISSN# 2277-9604

hormone ghrelin [32,33]. This will lead to increased hunger for food and, eventually, weight gain and visceral fat accumulation [33]. Children who were found to have poor-quality sleep had increased fasting glucose levels and dyslipidemia, making them susceptible to cardiovascular disease in adulthood (Figure 2) [33].

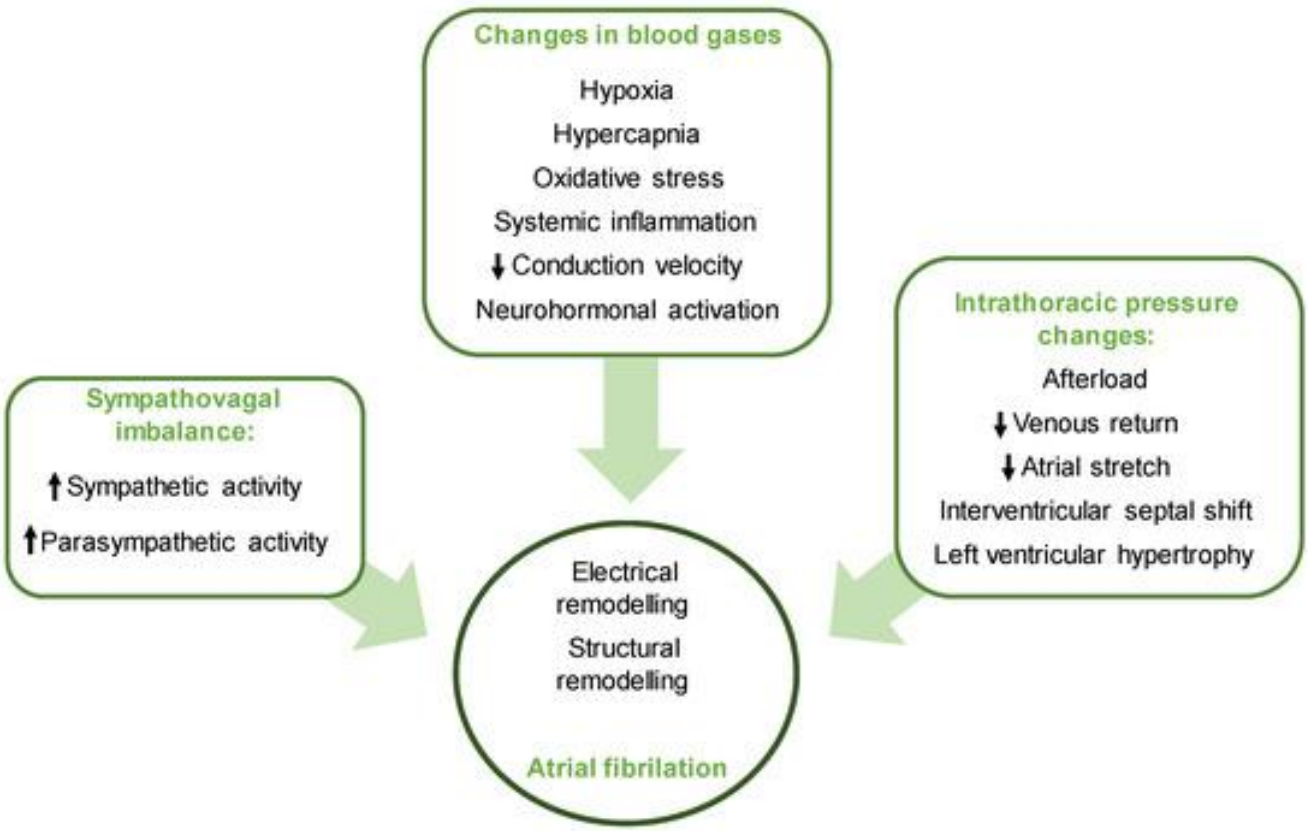

Figure 2: Various possible pathways linking Sleep disturbances/disorders to Cardiovascular disorders [13]

Endothelial Dysfunction: The thin layer of cells lining the blood vessels (endothelium), plays a vital role in vascular health by regulating blood flow, clotting and inflammation [33]. Sleep disturbances such as insomnia have been reported to cause endothelial dysfunction by impairing endothelial function [33]. Chronic sleep disturbance also promotes atherosclerosis by triggering systemic inflammation and oxidative stress, damaging the vascular endothelium [33]. Nitric oxide (NO) is known to help relax blood vessels and maintain proper blood flow. Sleep disorders are known to reduce nitric oxide production, thereby heightening arterial stiffness, resulting in hypertension and atherosclerosis (Figure 1) [33].

Association between predictive sleep dimensions and Cardiovascular Health

Sleep is a crucial component of worldwide health, and more recent research has identified its multidimensionality encompassing not just time, but quality, timing, regularity, and efficiency as well [34]. In recent studies, some of the dimensions of sleep related to cardiovascular health included:

Sleep Duration: Short sleep (<6-7 hours/night) and long sleep (>9 hours/night) have been linked to an increased risk of hypertension, coronary heart disease (CHD), and stroke [34]. In Africa, a cross-sectional study among Sudanese adolescents (10–15 years) reported that 55% of the participants who were short sleepers had significantly higher rates of MetS, especially low HDL-C in boys and high triglycerides in girls [35].

Sleep Quality and efficiency: The proportion of time spent asleep while in bed without obstructions, such as frequent awakenings, has been correlated with

higher cardiovascular risk [34]. Though data on sleep quality is limited in Africa, studies elsewhere have shown that poor sleep quality (low efficiency, fragmentation) in children/adolescents is associated with higher BMI, raised blood pressure, and dyslipidemia [8]. Adolescents with short duration and low efficiency have also been reported to have a greater odd of prehypertension [36].

Sleep Timing and Irregularity: Going to bed and waking up at biologically appropriate times, such as not too late, supports heart health [34]. Consistent bed and wake times have been associated with better cardiovascular outcomes [34]. Irregular sleep timing may disrupt circadian rhythms and pose a risk [34]. Studies outside Africa, such as in Macao-China, reported that irregular bedtimes (weekday-weekend differences >2h) increased the risk of overweight/obesity, independent of sleep length/quality [37]. Though not yet studied quantitatively in Africa, a scoping review highlighted the importance of circadian regularity and timing variables (bedtime, wake time variability) in adolescent cardiometabolic health [8]

Prevention and Management of Sleep Disorders to Improve Cardiovascular Health

The traditional approach of predicting the link between CVD has been to measure single factors such as sleep duration or sleep quality [38]. Emerging evidence has suggested that a more comprehensive measurement with multiple dimensions of sleep is a better predictor of cardiovascular risk [38].

The RU-SATED model (Regularity, Satisfaction, Alertness, Timing, Efficiency, and Duration) has been used extensively to measure overall sleep health [38]. Composite scores of both objective and subjective sleep health measures have been found in recent research to have very strong correlations with the prevalence of cardiovascular disease [38].

To prevent and manage sleep disorders in children, there needs to be some interventions:

Sleep Hygiene: One key foundational and vital factor essential in early life to prevent sleep disorders in children is healthy sleep practice [39]. This includes encouraging regular sleeping hours, no screen time before bed, and a proper sleeping environment, which can significantly improve the sleeping quality in children [39].

Physical Exercise and Weight Control: Since one of the most significant risk factors for sleep disorders is overweight, encouraging exercise and healthy eating can lower OSA incidence and the cardiovascular effects of sleep deprivation [2]. Physical exercise not only minimises this CVD risk, such as weight gain or obesity, but also enhances sleep quality [1,2]. It is recommended then for children to be involved with the appropriate age-related exercises regularly to help with weight management since obesity is an established risk factor for OSA and early CVD [1,2].

Medication Therapies: Although behavioural interventions are preferred, pharmacological interventions may be necessary for some disorders, such as RLS and severe Insomnia. Based on potential medication side effects, they should be used cautiously and under supervision. Continuous positive airway pressure therapy (CRAP) could be done in cases of surgery falls regarding OSA. Also, cognitive behavioural therapy for insomnia and iron supplementation for RLS have improved sleep quality and reduced cardiovascular risk [40].

Public Health Awareness: Awareness about the importance of sleep among parents, educators, and health practitioners is essential, particularly in African settings where sleep disorders are still underdiagnosed [8,40]. Public health campaigns should carry culturally sensitive messages, emphasising the role of sleep in developing and preventing CVD diseases [1].

Screening and Early Detection: Routine screening for sleep disorders in pediatric healthcare centres can lead to early detection and intervention, reducing long-term cardiovascular consequences [1,2]. Community-based screening has been recommended in resource-limited settings since it could be very effective and scalable [1].

Challenges in the African Context Regarding Sleep Disorders and Cardiovascular Disease in Children

Limited awareness and inadequate Healthcare Infrastructure: Sleep health is not widely reported as a public health issue in the majority of African countries [1,8]. There is scarce knowledge about sleep disorders and their impact on cardiovascular disease among healthcare workers and the general public [8]. This could lead to underdiagnosis and undertreatment of such conditions as sleep apnea,

insomnia, and circadian rhythm disturbance [41]. Extensive healthcare infrastructure issues affect most African regions, such as limited access to specialised care for the disorder. The unavailability of specialist diagnostic machinery, such as polysomnography for sleep disorders and advanced cardiovascular diagnostic machinery, may discourage early diagnosis and treatment [8,9]. There is a shortage of trained practitioners in sleep medicine and pediatric cardiology, especially in rural areas. Inadequate expertise can lead to misdiagnosis or improper treatment of sleep disorders and CVD in children [41].

Socioeconomic, environmental, cultural beliefs and practices: Poverty, poor education, and limited healthcare budgets are some of the issues in managing sleep disorders and CVDs. Healthcare may be sacrificed for basic survival, with resulting delays in diagnosis and treatment [9]. African children are exposed early to stressors such as overcrowded houses, irregular school schedules, noise pollution, and early responsibilities such as chores or work [1]. These stressors negatively impact their health, may affect their sleep hygiene, and lead to sleep deprivation [1]. Cultural practices and beliefs also influence the management and understanding of sleep disorders. For example, co-sleeping and late-night social activities are common in most African cultures, and thus, it becomes challenging to diagnose and manage sleep disorders [42]. Also, increased stigmatisation, which is common in most of these communities regarding health issues, may prevent families from seeking help.

Comorbidities and Health Priorities: The high prevalence of malaria, TB and HIV, among other diseases in Africa, could complicate the treatment of sleep disorders and CVDs. Comorbidities have the potential to aggravate both the symptoms and consequences of both cardiovascular diseases and sleep disorders [11]. Sleep health often falls low on the list of public health issues in some regions due to the high burden of some diseases, such as infectious diseases. There is limited knowledge of the prevalence and burden of CVDs and sleep disorders in African children. This makes it difficult to develop precise interventions and policies to best handle these conditions [10].

Conclusion and Recommendations

The impact of sleep disorders on children's cardiovascular risk is an issue yet to be exhaustively studied in Africa. Sleep health has been reported to be an overlooked component in terms of the prevention of CVD in children, particularly in Africa, where the prevalence of non-communicable diseases is rising. Some challenges identified regarding this overlook include poor awareness, inadequate health infrastructure, beliefs, and a lack of region-specific data. Insomnia, OSA, RLS, and SDB were some common sleep disturbances reported in Africa. These sleep disorders are a contributing factor to some of the CVD risks, such as obesity, hypertension and metabolic abnormalities at an early age. Poor nutrition, overcrowding, and a high burden of infectious diseases are some of the risk factors for sleep disorders common in Africa that could contribute to CVD. Identifying sleep disorders as modifiable risk factors represents a window of opportunity for early prevention and intervention and, by extension, reduction of the future burden of CVD. Also, encouraging and promoting sleep hygiene, physical activity, weight control, and public health awareness is key in managing these disorders. There is sparse evidence of sleep disorders and cardiovascular disease (CVD) in African children, and gaps, especially in epidemiologic data, longitudinal data, and culturally specific diagnostic tools. Some international studies underrepresent African children; sleep measures are rarely included in national child health initiatives. There is also sparse evidence of efficacious interventions and limited exploration of comorbidities such as obesity and mental disorders. Pediatric sleep disorders are not reported to be regularly diagnosed and treated by healthcare systems in the continent, which points out an urgent need for context-relevant studies and scalable solutions to inform policy and improve child health outcomes. Larger-scale epidemiologic studies are needed to determine the burden and contribution of sleep disorders to cardiovascular morbidity among African children. Furthermore, incorporating sleep screening into routine pediatric practice, increasing public awareness, and structuring healthcare systems to respond to sleep-related health risks should be the priority. Closing the gaps will facilitate a better understanding of pediatric cardiovascular health and guide tailored

interventions to improve outcomes in African populations.

Acknowledgements

We are thankful to all the authors whose articles were used to generate this review. We thank the Institute of Medical Research and Medicinal Plants Studies (IMPM) and Walter Sisulu University for providing us with scientific resources and endless support.

ISSN# 2277-9604

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