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Childhood Obesity and the Risk of Hypertension in the Caribbean Region: A Narrative Review

Feimatta Immah Sowa, Md, Mph, Pg. Dip.

ABSTRACT: Introduction: Childhood obesity is a rising epidemic affecting both developed and developing countries worldwide. In the Caribbean, estimates of obesity in children are noted to be above the predicted global values, and evidence suggests that the rise in obesity levels is due to environmental influences in dietary practices and physical inactivity.

Methods: This review aims to determine the effects of childhood obesity and the associated risks of developing hypertension in the Caribbean population. Research articles were identified using computer-based search engines such as Google Scholar, PubMed, ScienceDirect, World Health Organization (WHO), and Caribbean Public Health Agency (CARPHA) databases. Researched articles with various study designs were then thoroughly analyzed to extract detailed information about obesity in childhood and the risks for hypertension in later years.

Results: Rapid weight gain in infancy and high (body mass index) BMI levels in childhood are associated with higher blood pressure values and increased cardiovascular risk. Additionally, direct baseline elevation of blood pressure (B.P.) measurements, noted in obese/overweight children compared to their nonobese counterparts, confirm the hypothesis that childhood obesity is positively associated with hypertension.

Conclusion: This review article provides detailed facts about childhood obesity, the risk for hypertension, and improvement recommendations and calls attention to the health implications of obesity-related hypertension in children if left untreated.

KEYWORDS: childhood obesity, childhood hypertension, obesity in Caribbean youths.

INTRODUCTION

Childhood obesity is a global epidemic of increasing public health concern, and studies in the Caribbean have reported a rise in childhood obesity levels more extraordinarily than the global average of 5% (Henry, 2016). [(1)] Records from 2016 global estimates reveal that approximately 340 million children and adolescents between 5-19 years of age were obese/overweight, and a substantial rise in the prevalence of obesity from 4% in 1975 to approximately 18% in 2016 was noted (World Health Organization, WHO, 2020a). [(2)]

Higher trends in obesity levels of Caribbean children have been attributed to culturally and economically motivated changes in dietary practices, such as the overconsumption of energy-dense foods and shifts toward lower levels of physical activity (Henry, 2016). [(1)]

Once obesity develops, it has been noted that children are more likely to stay obese or overweight into adulthood, increasing their susceptibility to the early development of cardiovascular comorbidities and early death (Rees et al., 2009; Shrivastava et al., 2014). [(3,4)]

Hypertension, a condition previously classified as rare among children, is now considered a significant health concern, especially in obese/overweight children and adolescents where the prevalence of childhood hypertension is noted to rise (Shrivastava et al., 2014, Song et al., 2019). [(4,5)]

One primary explanation for the elevations in blood pressure (B.P.) levels in overweight or obese children is that the accumulation of fat cells (adipocytes) in the body eventually leads to activation of the neurohormonal sympathetic system, especially in the renal (kidney) vascular beds, which increases secretion of renin and other renal system substances that indirectly raise B.P. levels (Brady, 2017). [(6)]

This review aims to determine whether there is an association between childhood obesity and how adiposity influences hypertension in youths and early adulthood in the Caribbean region.

METHODOLOGY

For this review, a narrative approach was used to analyze various electronic databases, such as PubMed, Google Scholar, New England Journal, University of the West Indies, and corporate websites, such as the World Health Organization (WHO), Caribbean Public Health Agency (CARPHA), the Healthy Caribbean Coalition (HCC), and the Pan American Health Organization (PAHO). Articles were selected for analysis if they:

- Contained descriptive data on childhood exposure to obesity/overweight, the outcomes on health and adulthood.
- Have published data in journals, public and controlled search engines with free or unrestricted access to materials.
- Studies were published within the last two decades (2003-2023).
- Articles were written in the English language.

This review was conducted to appraise previously conducted research, with the aim of increasing awareness of childhood obesity and its effects on health and prevention mechanisms in the Caribbean region, as well as promoting future research into country-specific analytic studies on obesity-related hypertension.

LITERATURE REVIEW

The predominance of global obesity in most low- and middle-income countries over the past decades has led to epidemiologic transitions from a period of infectious diseases and dietary deficits to a period of noncommunicable diseases with a resultant increase in chronic conditions such as heart diseases, cancers, and diabetes (Arisaka et al., 2020; Bridger, 2009; Scribner et al., 2018). [7–9])

Obesity and Standard Measurement/Reference Calculations

Overweight and obesity are described as medical conditions where there is an excessive amount of body fat accumulation into cells called adipocytes (World Health Organization (WHO), 2020a; National Institute of Health (NIH), 2021). [2,10]

Since childhood obesity most likely progresses into adulthood, appropriate measuring parameters and reference cutoff ranges must be available and standardized to define and classify the stages of obesity. Body mass index (BMI) calculation {using the weight in kilograms (kg) divided by height in meters squared (m^2)} was proposed as a standard reference used to define childhood obesity. However, differences in calculated reference ranges affected uniformity in the prevalence estimates of obesity, given that BMI substantially changes with age and height in children, as opposed to adults (Wang and Lim, 2012). [11] The need for a more refined consensus on reference methods that would be adequate for international comparisons was therefore acknowledged. As a result, sex-age-specific measurements were considered, and organizations such as the International Obesity Task Force (IOTF) and the World Health Organization (WHO) developed global reference ranges that are useful. However, the WHO's growth standard references for children worldwide are globally used based on local preferences for either previously used BMI percentile charts or the more recent z score BMI values.

Therefore, obesity as defined using BMI percentiles is when BMI ≥ 95th percentile for age-and-sex, and overweight is BMI ≥ 85th percentile but < 95th percentile for age-and-sex, whereas BMI z scores ≥1 define overweight, and BMI z score ≥ 2 defines obesity in children and adolescents (Brady, 2017; Wang and Lim, 2012; De Onis et al, 2012). [6,11,12]

DEFINITION OF HYPERTENSION

Hypertension in children is defined as elevated B.P. levels ≥ 90th percentile for children 0-12 years of age and ≥ 120/80 mmHg for children 13 years and older, where the values 120/80 represent systolic blood pressure (SBP) and diastolic blood pressure (DBP), respectively, and the determination of elevated B.P. is based on a standard distribution of B.P. in healthy normal-weight children (Riley et al., 2018; Mahbuba et al, 2021). [13,14] However, reviews from other articles define childhood hypertension as SBP ≥ 130 mmHg and DBP ≥ 80 mmHg taken on 3 or more outpatient visits for all children under 18 years of age (Pike et al, 2021). [15]

Global Status of Childhood Obesity and Hypertension

It has been proposed by many that rapid weight gain in infancy and early childhood has a significant impact on the appearance of obesity in children (Arisaka et al., 2020; Bridger, 2009). [7,8] There is evidence that children evaluated to be obese/overweight in infancy had higher probabilities of staying obese through adolescence and that even though at a slower rate, the body mass index (BMI) became progressively higher from infancy into adolescence (Brady, 2017; CARPHA, 2021; Geserick et al., 2018; HCC, 2019). [6,16-18] A report on adolescents from the article by Geserick et al., 2018, stated that the period of excessive weight gain (measured by rapid BMI acceleration) most likely started between 2 and 6 years of age, and once initiated, the BMI continues to increase through adolescence, magnifying the symptoms of obesity in affected adolescents. Moreover, higher BMI levels were associated with elevated blood pressures and increased cardiovascular risk (Brady, 2017; Friedemann et al., 2012; Kelly et al., 2015). [6,19,20] Furthermore, the rate of overweight or obesity in youths was increased in those who were large for gestational age (LGA)

compared with those who were average or small for gestational age (SGA), potentially raising their BMI levels and risk for hypertension (Geserick et al., 2018). [17] Direct B.P. measurements in obese/overweight children and adolescents also revealed higher B.P. levels when equated to their nonobese counterparts, confirming the hypothesis that childhood obesity is positively associated with hypertension (CARPHA, 2014; Puri et al., 2008; Schwiebbe et al., 2012; Umer et al., 2017). [21–24]

Current Situation on the Prevalence of Childhood Obesity in the Caribbean Region

Although there are available data from major Caribbean organizations about obesity-related hypertension, only a handful of analytic studies from individual nations about current obesity-related hypertension issues have been conducted, raising questions about the validity of prevalence estimates. There is, however, sufficient recorded data on the rise in unhealthy weights among young people in the Caribbean. Reports from various Caribbean nations show that the prevalence of overweight and obesity in children lies between 28% and 35% {CARPHA, 2021; Health Caribbean Coalition (HCC), 2019}. [16,18] Between 2001 and 2010, the prevalence of overweight in Caribbean children less than five years old increased from 6% to 14%; the prevalence for both overweight and obesity in boys 11-13 years of age was 27% and 33% for girls between the same age range, (Henry, 2016; HCC, 2019). [1,18] Moreover, girls, especially adolescent females, are noted to have increased risks for overweight and obesity in the Caribbean and Latin American regions (Traboulay & Hoyte, 2015). [41]

Country-specific Global School-based Student Health Surveys (GSHS) conducted by the World Health Organization (WHO) prove unsatisfactory effects of overweight and obesity among young Caribbean people. For example, in Dominica (2009), the rates of overweight and obesity in children between 13 and 15 years old were 24.8% and 9.1%, respectively; Guyana (2010) recorded rates of 15.3% for overweight children of the same age range and 4.1% for obese children; and in Barbados (2011), rates were 31.9% and 14,2%, respectively (HCC, 2019 [18]

Presently, 1 in every 3 Caribbean children is overweight or obese, and the major causes are unhealthy diets, powered by increased intakes of ultra-processed, energy-dense but nutrient-poor foods, excess consumption of sugary and carbonated soft drinks, and increased sedentarism (HCC,2019). [18]

There is evidence that risk factors for hypertension, cardiovascular diseases, and diabetes, such as increased blood pressure (B. P), excess abdominal and waist circumferences due to adiposity, and insulin resistance have already risen in obese Caribbean children (CARPHA, 2021). [16] In effect, reports prove that diseases such as hypertension and other cardiovascular illnesses, diabetes, and stroke have thus far started to manifest in the Caribbean youth population (CARPHA,2021). [16]

Additionally, the movement from locally grown foods (fruits, legumes, vegetables, and less processed animal products) to a more highly processed, energy-dense diet and more animal-sourced products, accompanied by environmental lifestyle influences, has extensively promoted the obesity epidemic in many Caribbean populations over the last 30 years (CARPHA, 2014; PAHO, 2015, Traboulay & Hoyte, 2015). [21,25 41]

RISK FACTORS AND HEALTH EFFECTS OF OVERWEIGHT/OBESITY

In general, BMI rises in the first year of life and then slows down until the age of 5-6 years. The second rise in BMI after the first year of life is known as adiposity rebound (Kang, 2018). [26] It seems evident that the earlier the stage of adiposity rebound in childhood, the greater the risk of developing obesity in later years (Bridger, 2009; Rolland-Cachera, 2006). [8,27]

There are a handful of instrumental factors believed to be responsible for developing overweight and obesity in Caribbean children. These risk factors include insufficient/lack of exclusive breastfeeding in infancy, birth weight, eating habits, childhood lifestyle, physical activity, environmental and socioeconomic factors, and genetic predisposition (Henry, 2016; CARPHA, 2014). [1,21]

Birth weight

Some studies report that children born large for gestational age (LGA) are more likely to have higher BMI levels during infancy and adolescence and become obese when compared to those who had an average weight or were small for gestational age (Geserick, 2018). [17] However, others refute this claim by proving that lower birth weights are associated with more significant risks for obesity and chronic diseases later in life (Taylor-Bryan et al., 2018). [28] Poor maternal nutrition, prenatal infections, smoking, or alcohol abuse during pregnancy could result in intrauterine growth restriction and the birth of children small for gestational age (SGA) or low birth weight (Arisaka et al., 2020). [7]

A follow-up of SGA/low birth weight babies reveals that they tend to have rapid weight recovery (catch-up growth) by suppressing the sympathetic nervous system to reduce energy spending and conserve more energy. Moreover, rapid weight regain can cause high-speed fat accumulation, promoting resistance to insulin and leptin hormones, which will result in increased lipogenesis (increased fat cell formation and accumulation) from insulin resistance and increased hunger with decreased energy expenditures from leptin resistance (Arisaka et al., 2020; Bridger, 2009). [7,8] Thus, these babies are more prone to develop obesity and likely

cardiovascular adverse outcomes if not halted sooner. Stimulating mothers of SGA babies to engage in exclusive breastfeeding and encouraging adequate prenatal care would promote healthy growth in the postpartum period and infancy.

Insufficiency or lack of exclusive breastfeeding in infancy

There is evidence that breast-fed infants for at least the first 6 months of life are less likely to suffer from obesity, given that breastfeeding is a known protective factor against obesogenic agents (HCC, 2019; CARPHA, 2014; Rito et al., 2019). [18,21,29] In addition, there are sufficient explanations that breastfeeding stimulates a hormonal response such as formula feeding but causes a decreased insulin response in the body compared to formula-fed infants (Rito et al., 2019). [29] Thus, breastmilk provides sufficient nutrients for adequate growth compared to formula feeds that promote rapid growth by a more significant induction of insulin and its actions on tissues, leading to fat accumulation, an increase in unhealthy weight, and the likelihood of hypertension in later years (Arisaka et al., 2020, Rito et al., 2019). [7,29] Furthermore, human breast milk contains abundant Bifidobacteria, which are helpful microorganisms and function as probiotics that protect the gut lining against harmful substances aiding in digestion (Rito et al., 2019). [29] However, obese children have been noted to have fewer of these bacteria in their digestive tract, which could be explained by the lack of/reduced breastfeeding.

Although the importance of breastfeeding is vastly promoted and encouraged in the Caribbean and exclusive breastfeeding at birth is initiated by many mothers, most women do not continue breastfeeding past three months. For example, a study in Jamaican women showed that after six months, the number of breastfeeding mothers dropped to 15%, and between 6 and 11 months when additional feeds were introduced, 85% of mothers did not follow the needed feeding guidelines, which meant that fewer children received adequate and proper nutrition (Henry, 2016). [1] Similar reports within this region show that an average of 88% of mothers start breastfeeding, but this value depreciates as the amount of exclusive breastfeeding varies within the first six months of life (average is 39%), reaching as low as 5% in some nations (CARPHA, 2014). [21] Encouraging exclusive breastfeeding for at least six months could prevent obesity in infancy and thus help reduce future risk for hypertension.

Eating habits and childhood lifestyles

Inappropriate dietary practices and physical inactivity, especially in infancy and adolescence, are significant challenges leading to overweight/obesity, and inadequacies in policies for food supply, processing, marketing, and transport, as well as environmental lifestyle changes, have all been identified as reasons for obesogenic conduct in many Caribbean nations (Henry, 2016). [1] Over the last 30 years, feeding habits have drastically changed from locally and culturally produced healthy foods to more energy-dense foods that are highly processed, containing increased quantities of salt, sugar, fat, and other unhealthy substances (CARPHA, 2020a; Singh et al, 2017). [16,30] This fact, along with less physical activity due to increased advances in transportation modalities, reduced educational promotion of exercises within schools, increased urbanizations, and increased sedentarism secondary to changes from outdoor games to increased screen-time games, has also influenced modifications in the lifestyles of Caribbean children (Henry, 2016; HCC, 2019; WHO,2021). [1,18,31] Additionally, it is worth noting that most parents are part of the problem rather than being part of the solution. For instance, parents/guardians who adopt unhealthy diets and physically inactive lifestyles are more likely to expose their children to similar unhealthy habits (Henry, 2016). [1]

Environmental influences

Relevant environmental behaviors proven to increase unhealthy weights include lack of healthy food choices in educational centers, commercial food advertisements, and the inexistence of community recreational or physical activity centers. Surveys have shown that school-going children consume enormous quantities of snacks and sugary foods (high in saturated fats, sugars, and less vital nutrients) than vegetables or fruits while also engaging in activities requiring minimal exercise in schools. Additionally, children are more likely to recall food advertisements when compared to other advertisements on-screen media, which increases cravings for such foods (CARPHA, 2014). [21] Substantial evidence likewise shows that increased weight, high BMI levels in childhood, and a positive family history of high blood pressure were significantly positively associated with increased B.P. in adolescence (Nichols and Cadogan, 2006). [32] Thus, there is an increasing correlation between obesity and higher B.P. levels in adolescents, which should motivate national stakeholders to implement action plans to help prevent hypertension among Caribbean youths (Henry, 2016; Schwiebbe et al., 2012). [1,23]

THE ROLE OF OBESITY IN HYPERTENSION AND CONSEQUENCES OF CHILDHOOD HYPERTENSION

A vast amount of evidence indicates that elevated body weight is associated with higher B.P. values in children. Overweight or obese children typically present with high BMI and high B.P. levels at baseline, increasing the odds of developing hypertension later in life compared to children with normal weight or lower BMI levels (Brady, 2017; Kelly et al., 2015; Puri et al., 2008). [6,20,22]

In addition, some studies provide further proof that excluding B.P. values of overweight or obese children from a pool of recorded data with normal-weight children, B.P. levels were notably lower across the board (Brady, 2017). [6]

A study performed in 9–10-year-old Barbadian children in 2015 showed that one-third of these children were overweight/obese, and 12% had an associated high blood pressure (Gaskin et al, 2015). [42]

Many pathways have been proposed to explain how obesity is related to B.P. elevations and hypertension.

Nevertheless, a dominant consensus is that adiposity increases the size and quantity of fat cells, which increases secretory substances/hormones called adipokines from adipose/fat cells {leptin, interleukin 6 (Il-6) and resistin}, thus incapacitating the body's regulation of fat metabolism (Brady, 2017; Schwiebbe et al., 2012). [6,23] As a result of high circulating levels of adipokines, the sympathetic nervous system (SNS) becomes excessively activated, which in turn affects most vital organs. In overweight or obese states, SNS activation preferentially influences the renal vascular bed, directly causing vasoconstriction and increasing B.P. levels and stimulating renin production. Renin then activates the renin-angiotensin-aldosterone system (RAAS), which indirectly elevates B.P. levels by increasing renal tubular reabsorption of sodium and water into the vasculature. Direct increases in B.P. levels also occur due to elevated angiotensin II effect, a potent vasoconstrictor, further elevating B.P. levels (Brady, 2017; Vecchiola et al., 2016). [6,33] Additionally, extra weight gains will promote supplementary rises in adiposity, potentiating more SNS activation and secretion of the RAAS stimulating factors, contributing to further rises in B.P. levels (Brady, 2017). [6]

Dyslipidemia is another issue that overweight and obese children face, as it predisposes them to have abnormal lipid profiles, with elevated levels of triglycerides, free fatty acids, and low-density lipoproteins (LDL-cholesterol). However, individuals with increased adiposity levels present with further disruptions in lipid metabolism by having low values of the 'good cholesterol,' high-density lipoproteins (HDL-cholesterol), believed to help lower heart diseases and stroke risks (Brady, 2017; Bridger, 2009). [6,8] In addition, the increased influx of macrophages into adipose tissue due to distortions in the lipid/cholesterol profile in overweight or obese children causes a build-up of fat plaques and inflammatory products in arterial vessels (atherosclerosis), leading to chronic inflammation of adipose tissue and vasculature (Brady et al., 2017; Dorresteijn et al., 2012). [6,34]

Another noteworthy instrumental factor in obesity-related hypertension is the accumulative effects of oxidative stress (build-up of oxygen free radicals), caused by obesogenic products, among others, which stimulates activation of SNS that eventually promotes poor vascular function and impaired excretion of sodium, clinically manifesting as hypertension (Brady, 2017). [6]

Elevations in body fat accumulation in obese individuals also promote fat deposition in and around many internal (visceral) organs, particularly the kidneys. For example, in fatty kidneys, there are increased adipose tissue deposits in the renal sinus, which will increase compression of vessels exiting or entering the kidneys, thereby raising renal interstitial pressure, and leading to elevated sodium and water reabsorption and higher B.P. levels (Brady, 2017; Foster et al., 2011). [6,35]

Hypertension is a known risk factor influencing the appearance of other cardiovascular diseases, including heart failure, cardiomyopathies, coronary artery disease, and arrhythmias (Wulh, 2018). [36] Moreover, obesity-related hypertension contributes to stroke, chronic kidney disease, disabilities, and even death (Song et al., 2019). [5]

RECOMMENDED STRATEGIES FOR THE PREVENTION AND MANAGENMENT OF OVERWEIGHT AND OBESITY

Heart diseases are the leading causes of death worldwide, followed closely by stroke, and hypertension significantly elevates the risks for both conditions (WHO, 2020b). Therefore, more attention must be directed to factors likely to increase the burden of cardiovascular diseases in younger populations and establish/implement ways to prevent them (WHO, 2020b). [37] Strategies to improve dietary habits, encourage and participate in physical activity, and modify environmental influences in favor of healthier lifestyles will positively reduce overweight or obesity, thereby decreasing the prevalence of obesity-related hypertension in childhood. Essential stakeholders, including parents and guardians, educational sectors, community members, and governmental departments, should take responsibility and engage in the fight against the rising epidemic of unhealthy weight in children and adolescents (Genovesi et al., 2019). [38]

Some recommended measures based on the WHO Commission on ending childhood obesity include interventions to promote healthy diets; to encourage physical activity; action plans for adequate preconception, antenatal and pregnancy care; to motivate early healthy childhood dietary choices, physical activity, and weight management; and to provide healthy food options and physical activity for school-age children (CARPHA, 2014; WHO, 2016). [21,39]

National leaders must consider fiscal policies and regulations for food production, marketing, and labeling to promote healthy diets among community members. Measures to promote local farmer production by establishing food fairs and the marketing of more natural home-grown products at affordable prices could motivate changes to dietary habits.

Influences such as media advertising (television, internet, and other social media commercial breaks) and celebrity endorsements should be tailored to project more healthy food choices to limit the persuasive power of food marketing notifications on childhood

vulnerability (PAHO,2015). [25] Furthermore, increased taxations on highly processed, poor-nutrient, and unhealthy foods should be discussed and considered for implementation by policy levers.

Suggestive evidence that extended periods of breastfeeding may reduce childhood overweight and obesity by approximately 10% and that mothers who exclusively breastfeed their babies lose post pregnancy weight faster are stimulating findings that could positively encourage and modify breastfeeding practices during the postpartum period (PAHO, 2015). [25] Monitoring established breastfeeding measures through adequate primary health care and hospital programs could motivate mothers to participate.

Individual healthy eating behaviors, physical activity, and weight management are paramount in the fight to reduce unhealthy weights in children and adolescents. Healthy food choices in parents or guardians undoubtedly impact eating patterns in children. In addition, engaging in a type of exercise (such as physically active sports, gym practices, walking, swimming) can inspire children to adopt similar practices. Additionally, encouraging family-based or group-based physical activities, reducing time spent on screen devices, and stimulating outdoor playtime (at home, parks, recreational centers, beach visits) can help decrease sedentarism and promote healthy weight management.

Poverty, ignorance, inadequate living conditions, and lack of accessibility or affordability of healthcare facilities, especially in low- and middle-income countries, could prevent or reduce adherence and compliance to set obesity-related programs (Ford et al., 2017). [41] Therefore, supplementing deficits in these areas can influence favorable lifestyle modification, which is beneficial for all.

There is substantial evidence that implementing school-based interventions to provide nutrient-rich healthy food options that meet children's dietary demands effectively changes eating habits and stimulates healthy weights (PAHO, 2015). [25] Therefore, initiatives to establish/improve and implement food programs according to nutrition and food safety norms while integrating daily physical activity into school curricula would suffice to stimulate and strengthen childhood overweight and obesity reductions successfully.

Furthermore, health awareness and risk assessment checks in schools, such as B. P records of children within a classroom, at the start of the term and at least one (1) repeat check at the end of the term will assist with the early detection and intervention of at-risk children for hypertension.

Finally, policymakers could ensure that surveillance strategies to effectively monitor and assess progress, evaluative schemes on available facilities, emerging deficits, and challenges in management capability, and research into improvement modalities are well operational for subsequent re-evaluations and improvements to equally profit all persons concerned.

CONCLUSION

In closing, this review provides a comprehensive evaluation of how childhood obesity is associated with the risk for hypertension. Recorded results that Caribbean nations have already noted a rise in hypertension among the overweight and obese young population is a growing concern, and recommended strategies must be initiated and monitored to control unhealthy weight progression. There is also a current need for additional well-designed research at country-specific levels to determine the extent of obesity-associated hypertension, affiliated risk factors, and possible improvements in screening methods, prevention, and management of overweight and obese children.

Acronyms and Abbreviations

AR: Adiposity Rebound
BMI: Body Mass Index
B.P.: Blood Pressure
CARPHA: Caribbean Public Health Agency
HCC: Healthy Caribbean Coalition
HDL: High-density Lipoproteins
LDL: Low-density Lipoproteins
LGA: Large for Gestational Age
NEJM: New England Journal of Medicine
NIH: National Institute of Health
PAHO: Pan American Health Organization
RAAS: Renin-angiotensin-aldosterone-system
SES: Socioeconomic status
SGA: Small for Gestational Age
SNS: Sympathetic Nervous System
WHO: World Health Organization

DECLARATIONS

Ethical Approval and Consent to Participate

There was no need for ethical approval or consent to participate in this review.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing/Conflicting interests

The author declares no conflict of interest in authorship, financial relations or issues pertaining to publication.

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Authors' contributions

FIS is the sole contributor to the conception, design, acquisition, and interpretation of the data for this review. FIS is responsibility for the drafting and final approval of the version to be published; and agrees to be accountable for all aspects of the work ensuring integrity and accuracy.

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