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ORIGINAL

# Overweight, Obesity and High Blood Pressure: Early Atherogenic Signs in Children Aged 3 to 7 Years

## Sobrepeso, Obesidad e Hipertensión Arterial señales aterogénicas tempranas en niños de 3 a 7 años

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**ABSTRACT**

**Introduction:** human atherosclerosis has been considered for centuries as one of the greatest predators of health, its distribution on the planet is so wide that it overwhelmingly surpasses any other pathological process and reaches epidemic proportions, both in economically developed populations and in the process of becoming so.
**Objective:** to identify the presence of overweight, obesity and arterial hypertension as early signs of atherosclerosis in children aged 3-7 years.
**Method:** a descriptive-analytical cross-sectional epidemiological study was carried out in 5 clinics of the "19 de abril" University Polyclinic, in the Plaza de la Revolución municipality, Havana City, during the period 2022-2023. The sample consisted of 152 children aged 3 to 7 years who met the inclusion criteria. The data were collected using the new model (AtecomR) and stored in an automated database in Microsoft Access. Statistical processing was performed using the SPSS statistical package, through a Toshiba Intel (R) Pentium IV microprocessor.
**Conclusions:** this study constitutes a preamble for other investigations that address the problem of cardiovascular disease from the perspective of intrauterine life. The results have provided certain evidence, which, together with a review of the literature, has allowed us to propose the following conclusions. A high frequency of obesity, overweight and high blood pressure levels was identified in the study population. It was observed that in the obese and overweight group they had a tendency to increase with age, being higher their frequency between five and six years respectively. It was shown that overweight and obesity in children were factors for the presence of alterations in blood pressure.

**Keywords:** Obesity; Overweight; High Blood Pressure in Children; Early Atherogenic Signs; Atherosclerosis.

**RESUMEN**

**Introducción:** la ateroesclerosis humana ha sido considerada desde hace siglos como uno de los más grandes depredadores de la salud, su distribución en el planeta es tan amplia, que supera abrumadoramente cualquier otro proceso patológico y alcanza proporciones epidémicas, tanto en poblaciones económicamente desarrolladas como en vías de serlo.
**Objetivo:** identificar la presencia de sobrepeso, obesidad e Hipertensión Arterial como señales tempranas de aterosclerosis en niños de 3-7 años de edad.
**Método:** se realizó un estudio epidemiológico descriptivo-analítico de corte transversal, en 5 consultorios del policlínico Universitario "19 de abril", del municipio Plaza de la Revolución, ciudad de la Habana en el período comprendido 2022- 2023. La muestra quedó conformada por 152 niños de 3 a 7 años quienes cumplieron los criterios de inclusión. Los datos fueron recolectados aplicando el nuevo modelo (AtecomR) y almacenados en una base de datos automatizada en Microsoft Access, el procesamiento estadístico se realizó utilizando el paquete estadístico SPSS, a

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través de un microprocesador Toshiba Intel (R) Pentium IV.

**Conclusiones:** este estudio constituye un preámbulo para otras investigaciones que afronten el problema de la enfermedad cardiovascular desde la perspectiva de la vida intrauterina, los resultados han dado cierta evidencia, que sumado a revisión de la literatura, ha permitido plantear las siguientes conclusiones. Se identificó una alta frecuencia de obesidad, sobrepeso y cifras tensionales elevadas en la población de estudio. Se pudo observar que en el grupo con obeso y sobrepeso tuvieron una tendencia a aumentar con la edad, siendo mayor su frecuencia entre los cinco y seis años respectivamente. Se evidenció que el sobrepeso y la obesidad en los niños fueron factores para la presencia de alteraciones de la tensión arterial.

**Palabras clave:** Obesidad; Sobrepeso; Hipertensión Arterial en Niños; Señales Aterogénicas Tempranas; Aterosclerosis.

## INTRODUCTION

Human atherosclerosis has been considered for centuries as one of the greatest predators of health. Its distribution on the planet is so widespread that it exceeds any other pathological process and reaches epidemic proportions in economically developed populations and those on the road to development. Several decades ago, experimental studies established the critical role played by lipids or fats in the body in the origin of atherosclerosis. The clinical consequences of atherosclerosis have also been known since ancient times.[1] The World Health Organization (WHO) has recognized that atherosclerosis constitutes the world's biggest epidemic;[2] also a problem for global public health.[3,4]

The study of atherosclerosis has been reinforced over many centuries by different studies and scientific investigations that reveal its importance. Cardiovascular diseases are currently the leading cause of death, accounting for 12 million deaths worldwide each year and representing the main cause of death in the United States and Western Europe. Atherosclerosis is the common underlying cause of these diseases.[5,6,7] Although there are diseases with a very close cause-effect relationship with atherosclerosis that act directly on the rate of its progression and severity, these are known as atherosclerotic risk factors. Among these risk factors, the following are internationally known and accepted as the main ones. The above statements are supported by much of the literature consulted, where cardiovascular diseases have consistently occupied the top places in the statistics, and their expected consequences constitute a major health problem for the individual and society. A longitudinal study by the Bogalusa Heart Study showed that the initial manifestations of arteriosclerosis can be observed in children as young as 8 years old, underscoring the importance of early intervention.

In Cuba, atherosclerosis, with its most frequent and harmful organic consequences, is the first (myocardial infarction, ischemic heart disease, sudden death) and third cause of death (cerebrovascular disease). In addition to obstructive peripheral arterial disease and atherosclerotic aneurysms, which are also frequently observed.[8] It is also a cause of disability and invalidity and a loss of quality of life for Cubans.[9,10] In 2004, a report was presented on a study of 5,000 children aged between 12 and 16, some of whom showed up to 7 signs of atherosclerosis.[11] The Framingham studies initially described Atherosclerotic or atherogenic risk factors.[12] Research aimed at identifying atherogenic risk factors in children and adolescents shows that the precursory events of diseases resulting from atherosclerosis in adults are established from an early age.[2]

Nowadays, scientific and technical development has allowed us to go even deeper into the pathogenesis of this predatory disease. Early study is becoming increasingly important and is the subject of research by different countries and international organizations.[13,14] Among the early-age atherosclerotic risk factors studied are Low birth weight, dyslipidemia, high blood pressure, smoking, obesity, the gen Sparc, hyperglycemia, homocysteinemia, infectious agents, family history, and others.[15]

In Cuba, in recent years, several investigations have been carried out aimed at identifying atherogenic risk factors at an early age, recognizing obesity, arterial hypertension, and insufficient physical activity as the most frequent.[16,17] For all the above reasons, early detection of early atherogenic signals (EAS) is essential, and it is clear that there is still insufficient knowledge of atherogenic risk factors in the pediatric population since new risk factors are identified every day, which are related to the etiopathogenesis, progression, and development of the disease; and their study is a social necessity.

## METHOD

A cross-sectional descriptive-analytical epidemiological study was carried out, directed by the Atherosclerosis Research and Reference Center of Havana, in 5 offices of the "19 de Abril" University Polyclinic, in the Plaza de la Revolución municipality, Havana City, in the period 2022-2023. Information gathering techniques: The new primary data collection model (AtecomR) for residents, developed by the Atherosclerosis Research and Reference Center of Havana (CIRAH), was applied. It is included in the sections (I) General Data, (II) Birth-Related Data, (IV) Physical and Anthropometric Examination (weight, height, abdominal circumference, hip circumference, BMI, blood pressure), and data related to birth (XIII).

Study universe: 152 children aged between 3 and 7 years were studied respectively from 5 clinics of the "19 de Abril" University Polyclinic where the presence of possible early signs of atherosclerosis was sought. Inclusion criteria: Children aged between 3 and 7 years old, belonging to 5 clinics of the "19 de Abril" University Polyclinic, voluntary acceptance by the children's parents and/or guardians. Exclusion criteria: children absent during data collection for any reason during the study.

Variables studied and their procedures. The staff, made up of collaborators (Comprehensive General Medicine Residents),

recorded the variables under investigation in the new ATECOM primary data collection model for residents created by CIRAH:

Demographic: Variable: Age. Continuous quantitative. Variable: Sex. Qualitative nominal dichotomous. Indicator: Absolute frequency and percentage. Male and Female according to biological gender.

Anthropometric: Weight, height, hip circumference, waist circumference, Body Mass Index (BMI), blood pressure.

Nutritional status (BMI): Normal or typical between the 10th and 90th percentiles, thin between the 3rd percentile and below the 10th percentile, malnourished below the 3rd percentile, overweight above the 90th percentile and up to the 97th percentile, and obese above the 97th percentile.

Information processing techniques: All the data collected was stored in an automated database created in Microsoft Access. A data extraction model was also developed to facilitate data analysis. The summarized information was presented in tables and graphs; statistical processing was done using the SPSS statistical package through a Toshiba Intel (R) Pentium IV microprocessor for better analysis and understanding. Conclusions were reached based on the study and discussion of the results obtained.

## RESULTS

A total of 152 children aged between 3 and 7 years were studied in 5 family medical centers at the 19 de Abril Polyclinic. There were 53 males, 28 %, and 46,71 % females. The predominant skin color was white (57,89 %), followed by black (21,05 %), then mestizo (16,44 %) and finally yellow (4,60 %), as described in table 1.

**Table 1.** Characteristics of the sample studied according to sex and skin color

| **Sex** | **No.** | **%** |
|---|---|---|
| Masculine | 81 | 53,28 |
| Feminine | 71 | 46,71 |
| Skin color | N | % |
| White | 88 | 57,89 |
| Black | 32 | 21,05 |
| Mixed race | 25 | 16,44 |
| Yellow | 7 | 4,60 |

When analyzing nutritional status by age, it was observed that in the group with obesity and overweight, there was a tendency to increase with age, being higher in frequency between five and six years of age (46,5 %) and (30,7) respectively, except for seven-year-olds, where the increase above was not observed. This is contrary to what happened with thin children, where their frequency was higher in younger children (40 %), as can be seen in table 2.

**Table 2.** Distribution of nutritional status according to age

| **Nutritional Assessment** | **Age** | | | | | |
|---|---|---|---|---|---|---|
| | **3 years n (%)** | **4 years n (%)** | **5 years n (%)** | **6 years n (%)** | **7 years n (%)** | **Total n (%)** |
| Malnourished | 1(100) | 0 | 0 | 0 | 0 | 1(100) |
| Thin | 2(40) | 2(40) | 1 (20) | 0 | 0 | 5(100) |
| Normal weight | 3(5,8) | 25(49) | 20(39,2) | 2(3,9) | 1(1,9) | 51(100) |
| Overweight | 1(2,3) | 9(20,9) | 20(46,5) | 10(23,2) | 3(6,9) | 43(100) |
| Obese | 1(1,9) | 10(19,2) | 14(26,9) | 16(30,7) | 11(21,2) | 52(100) |

In table 3, blood pressure was analyzed. The highest percentage of the children studied had regular blood pressure figures, with 76,3 % and 3 %. However, it should be noted that even though these children were still young, 35 had impaired blood pressure (23 % prehypertensive and 0,7 % hypertensive).

**Table 3.** Classification of Blood Pressure

| **Classification of blood pressure** | **Frequency** | **Percentage** |
|---|---|---|
| Normal blood pressure | 116 | 76,3 |
| Pre-hypertensive | 35 | 23 |
| Hypertensive | 1 | 0,7 |
| Total | 152 | 100,0 |

Table 4 shows the relationship between blood pressure classification and age. The frequency of pre-hypertension and hypertension increased with age, with a high frequency of hypertension at three years of age 2 (5,7 %).

Table 5 shows the influence of birth weight on evaluating nutritional status. Taking into account the atherogenic signals related to this variable, the results indicate that children with a history of macrosomia contributed 8 cases of overweight (47,1 %), followed by 6 (35,6 %) obese children. In comparison, those who were underweight at birth contributed to 2 cases of obesity (33,3 %).

**Table 4.** Classification of blood pressure according to age

| Classification of blood pressure | Age | | | | | |
|---|---|---|---|---|---|---|
| | 3 years | 4 years | 5 years | 6 years | 7 years | Total |
| Normal | 6(5,2) | 35(30,2) | 42(36,2) | 19(16,4) | 14(12,1) | 116(100) |
| Pre-hypertensive | 2(5,7) | 10(28,6) | 13(37,1) | 8 (22,9) | 1 (2,9) | 35(100) |
| Hypertensive | 0 | 0 | 0 | 1(100) | 0 | 1(100) |

**Table 5.** Relationship between nutritional status and birth weight

| Weight at birth (WB) | Nutritional Status | | | | | |
|---|---|---|---|---|---|---|
| | Malnourished | Underweight | Normal weight | Overweight | Obese | Total |
| | 0 | 0 | 3(17,6) | 8(47,1) | 6(35,6) | 17(100) |
| Macrosomic | 1(0,8) | 5(3,9) | 45(34,9) | 34(26,4) | 44(34,1) | 129(100) |
| Normal weight | 0 | 0 | 3(50) | 1(16,7) | 2(33,3) | 6(100) |

In table 6, we can see the children who already have tangible evidence of being affected by three critical atherogenic signs: overweight, obesity, and hypertension. It should also be noted that of 36 (100 %) children with blood pressure abnormalities, 23 (44,2 %) are obese, followed by 6 (13,9 %) who are overweight.

**Table 6.** Three Early Atherogenic Signs dependent on body weight and blood pressure

| Body Weight | Alterations in blood pressure | | |
|---|---|---|---|
| | yes N=36 | No N=116 | Total N=152 |
| | 7(13,7) | 44(86,3) | 51(100) |
| Normal Weight | 6(13,9) | 38(88,2) | 44(100) |
| Overweight | 23(44,2) | 29(55,8) | 52(100) |

## DISCUSSION

Atherosclerosis begins with fertilization and evolves asymptomatically, affecting men when they are most useful to their families families, society, and themselves.[18,19,20] This makes it considered a true scourge of humanity, which is why it is considered a true epidemic, "the silent killer", responsible for the highest incidence of acute cardiovascular episodes and years of life potentially lost. The issue of atherosclerosis at increasingly younger ages is evident, and it has aroused the growing interest of various researchers worldwide. Cuba is not exempt from this; this research studied 152 children aged 3-7 years, a stage of life in which this issue has been insufficiently addressed. Obesity is a major public health problem worldwide due to its frequency and its health repercussions. It is estimated that in the last two decades, obesity and overweight have increased exponentially, and currently, excess weight affects 40 % of the population between 2 and 24 years of age. The United States is known to have the highest prevalence of obesity and overweight in childhood, but other countries, such as England, have seen a marked increase over the last 10 years. It has also been shown that an increase in the body mass index (BMI) in childhood correlates with arterial stiffness and end arterial dysfunction, key markers of future cardiovascular risk.[21,22]

In Cuba, even though malnutrition and underweight do not constitute a health problem, obesity and overweight are on the increase, a phenomenon that is occurring in both developed and developing countries.[23] The interconnection between obesity, hypertension, and arteriosclerosis in childhood highlights the need for a preventive approach and early intervention involving multiple disciplines. The results obtained by the nutritional food surveillance system of the Institute of Nutrition and Food Hygiene (INHA) reported 13,5 % of overweight and obese children under 5 years of age, confirming the presence of alterations in body weight at an early age.[24] Another investigation carried out by researchers from the CIRAH on schoolchildren aged between 5 and 12 detected prevalences of 17 % for overweight and 12,5 % for obesity.[25] In Havana City, studies have been carried out on the prevalence of overweight and obesity in primary school children, which report 14 % overweight and 9,3 % obese.[26] In the municipality of Arroyo Naranjo, with similar results, overweight and obese (19 and 9,50 % respectively). The above research is in line with our study, even though a significant number of obese children were identified (34,21 %), followed by normal weight (33,55 %), while (28,28 %) were in the overweight category.

When analyzing nutritional status by age, it was observed that in the obese and overweight group, there was a tendency for this to increase with age, being higher in frequency between five and six years of age (46,5 %) and (30,7 %), respectively, coinciding with the age at which rebound adiposity occurs at 5 or 6 years of age, a stage within the critical periods of development and its presence before this age is related to the persistence of overweight and metabolic complications in later stages of life.[27] Contrary to what happened in thin children, its frequency was higher in younger children (40 %), as seen in table 3.

Many current publications point in the same direction regarding the importance of blood pressure in children.[28,29] When analyzing this variable, it was found that the highest percentage of the children studied had regular blood pressure figures, with 76,3 % and 3 %. However, it should be noted that even though these children were still young, 35 had abnormal blood pressure readings: 23 % pre-hypertensive and 0,7 % hypertensive.

When relating blood pressure classification to age, it can be seen that the frequency of pre-hypertension increased with age, with the frequency of this condition at three years of age being 2 (5,7 %). Blood pressure figures rise with age.[30,31] In a study carried out by Ferrer et al. on school children in the Plaza de la Revolución municipality, the figures reported were higher, confirming the trend of blood pressure alterations to increase with age.[25] However, there is evidence of preschool children with high blood pressure without proven cause.[31] examined serial data from the Fels Longitudinal Study, showing that high BP figures at five predicted hypertension in adults.[32] The risk of obesity persisting into adulthood increases in direct relation to the age at which the obesity appears (greater risk in adolescence in correspondence with breastfeeding) and to the severity of the obesity (the risk of suffering from obesity in adulthood is 100 % if the child'schild's weight exceeds 18 % of their ideal body weight).[33]

The influence of birth weight on the evaluation of nutritional status. Taking into account the atherogenic signals related to this variable, the results indicate that children with a history of macrosomia contributed 8 cases of overweight (47,1 %), followed by 6 (35,6 %) obese children, while those who were underweight at birth contributed 2 cases of obesity (33,3 %). This is one of the outstanding aspects of the present study. When observing the results related to birth weight, it was detected that macrosomic children with a weight (over 4000 g) currently presented a higher body mass index. This finding allows us to alert this group to monitor their weight and nutrition curve.

The levels of risk factors remain within a specific range over time. This phenomenon, known as tracking, means that cardiovascular risk can be predicted from observations made at an early age.[34] Childhood obesity and hypertension are strong predictors of the onset of these diseases. The relationship between high blood pressure (HBP) and so-called exogenous obesity in children and adolescents is well known. Blood pressure levels are said to return to normal when excess weight is lost.[35,36] High blood pressure is part of metabolic syndrome and is closely associated with obesity and insulin resistance. According to our results, 36 (100 %) children with blood pressure alterations, 23 (44,2 %) are obese, followed by 6 (13,9 %) overweight, the percentage of which was higher than that found by other authors such as Cabal and Álvarez Gómez.[37,38]

There is objective evidence that they are affected by three critical atherogenic signs: overweight, obesity, and hypertension. It is suggested that when two risk factors are associated, the cardiovascular risk is multiplied by four, and when three factors appear, it is multiplied by eight. The Bogalusa study[39] concluded that as cardiovascular risk factors increase, so does the severity of atherosclerosis in the young population. All of the above reinforces the need for early identification of risk factors such as SAT, which should constitute a strategy for the prevention of this disease as well as its most harmful complications. This becomes particularly important when some of these risk factors are associated with childhood. At this point, it is essential to develop interventions with a positive impact on the population's health status.

## CONCLUSIONS

This study constitutes a preamble for other research projects that address the problem of cardiovascular disease from the perspective of intrauterine life. The results have provided some evidence, which, together with a review of the literature, has allowed the following conclusions to be drawn:

The study population was identified with a high frequency of obesity, overweight, and high blood pressure. The group with obesity and overweight tended to increase with age, being higher in frequency between five and six years of age, respectively. It was evident that overweight and obesity in children were factors for the presence of blood pressure alterations.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## AUTHORSHIP CONTRIBUTION

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