STUDY OF CARDIOVASCULAR RISKS IN ADOLESCENTS (ERICA): MAIN RESULTS AND PERSPECTIVES

ESTUDO DE RISCOS CARDIOVASCULARES EM ADOLESCENTES (ERICA): RESULTADOS PRINCIPAIS E PERSPECTIVAS

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Received on 09/04/2018,
Accepted on 02/22/2019

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ABSTRACT

Cardiovascular disease is the leading cause of mortality in Brazil. Modifiable risk factors for this group of diseases can be observed since childhood, and their persistence is associated with the early diagnosis of morbidities. In this context, adolescence is considered a key period for prevention strategies. In order to evaluate the prevalence of cardiovascular risk factors and their associated factors, the Study of Cardiovascular Risks in Adolescents ("ERICA") was planned. This is a multicenter school-based nationwide survey involving more than 70,000 adolescents aged between 12 and 17 years from Brazilian cities with more than 100 thousand inhabitants. The main results of the study indicated concerning prevalence of overweight/obesity (25.5%, 95% CI: 24.4%-26.6%), high blood pressure (9.6%, 95% CI: 8.9%-10.3%) and low HDL-c (47.3%, 95% CI: 45.2%-49.3%). The prevalence of metabolic syndrome was 2.6% (95% CI: 2.3%-2.9%). In addition, more than half of adolescents reported a sedentary lifestyle. Regional estimates pointed to the south as the region with the highest prevalence of risk factors. ERICA was a pioneering study in Brazil and the adolescents who participated in the study in Rio de Janeiro, Porto Alegre, Brasília and Fortaleza will be followed in a new stage. The first results of ERICA can both serve as a reference for future research on cardiovascular risks among Brazilian adolescents and support public health policies.

Keywords: Adolescents; Risk Factors; Metabolic Syndrome; Pediatric Obesity; Sedentary Lifestyle.

RESUMO

As doenças cardiovasculares são a principal causa de morte no Brasil. Os fatores de risco modificáveis dessas doenças podem ser observados desde a infância e sua persistência está associada ao diagnóstico precoce de morbidades. Neste contexto, a adolescência é considerada um período chave para estratégias de prevenção. Com objetivo de avaliar a prevalência de fatores de risco cardiovascular e seus fatores associados foi planejado o Estudo de riscos cardiovasculares em adolescentes (ERICA), um inquérito multicêntrico de base escolar com abrangência nacional que envolveu mais de 70 mil adolescentes, entre 12 e 17 anos, de cidades brasileiras com mais de 100 mil habitantes. Os principais resultados do estudo apontaram prevalências preocupantes de sobrepeso/obesidade (25,5%, IC 95%: 24,4%-26,6%), pressão arterial elevada (9,6%, IC 95%: 8,9%-10,3%) e HDL-c baixo (47,3%, IC 95%: 45,2%-49,3%). A prevalência de síndrome metabólica foi de 2,6% (IC 95%: 2,3%-2,9%). Além disso, mais da metade dos adolescentes reportaram um estilo de vida sedentário. As estimativas regionais apontaram a região sul como a que tem maiores prevalências de fatores de risco. O ERICA foi um estudo pioneiro no Brasil e os adolescentes que participaram do estudo no Rio de Janeiro, Porto Alegre, Brasília e Fortaleza serão acompanhados em uma nova etapa. Os primeiros resultados do ERICA podem servir de referência para futuras pesquisas sobre riscos cardiovasculares entre adolescentes brasileiros, bem como subsidiar políticas públicas de saúde.

Descritores: *Adolescente; Fatores de Risco; Síndrome Metabólica; Obesidade Pediátrica; Estilo de Vida Sedentário.*

INTRODUCTION

Cardiovascular disease are the main cause of death in Brazil since the 1960s and, nowadays, accounts for almost 30% of the total mortality.[1] In recent years, there has been a decrease in the cardiovascular mortality rate in some segments of the population.[1] This age-adjusted decline was 24% between 2000 and 2011 in Brazil; however, primary prevention which focuses on confronting the main risk factors for CVD early remains a major challenge.[2,3] We may point to the increased prevalence of being overweight/obese, which increased from around 25% in the 1970s to over 50% today, as a crucial point in this context.[1]

We may observe lifestyle-related behaviors and modifiable risk factors for CVD since childhood and their persistence is associated with early diagnosis of CVD in adulthood.[4] An unhealthy lifestyle characterized by physical inactivity, smoking, and a diet rich in saturated fats and high-calorie foods as well as a high prevalence for childhood obesity are associated with the first changes in the cardiovascular system.[5,6] In this scenario, monitoring metabolic and hemodynamic changes, along with identifying risk groups during adolescence, are necessary to develop effective preventive strategies.

Estudo de Riscos Cardiovasculares em Adolescentes (ERICA) began in 2008 when Brazilian Ministry of Health (SCTIE/DECIT) made a public call for partner institutions to develop a comprehensive epidemiological investigation into the prevalence of metabolic syndrome in adolescents from all over the country.[7] The project was conceived to include a large network of researchers from different areas related to epidemiology and adolescent health, who would work together on the technical and logistical planning needed to conduct the study.

The cross-sectional phase of ERICA was conducted from 2013 to 2014, and it included adolescents from all the Brazilian states and the Federal District. The study was a pioneer in identifying some of the main risk factors for cardiovascular diseases in this population. This review aims to synthesize the main results observed in ERICA to date and presents prospects for new studies connected to the project. Some are already underway; others are in the planning phase.

METHOD

ERICA was a multi-center, school-based, nationwide survey. The study sample was designed to represent the Brazilian adolescent population between the ages of 12 and 17 and evaluate students in the morning and afternoon shifts at public and private schools in urban or rural areas of all the capitals and other municipalities with at least 100,000 inhabitants in all of the federation's states.[8]

The study adopted a complex sampling design intended to accurately represent the nation, its regions, and all the capitals. Therefore, the study's target population was divided into 32 strata (27 capitals and 5 subsets to represent the other municipalities in each macroregion). Within each stratum, schools were selected by the probability proportional to the number of enrolled students between the seventh year of primary school and the third year of High school, and inversely to the distance between the school and the state capital. At each school, three combinations of year and shift (morning or afternoon) were selected. All the students in each of the selected classrooms were invited to participate in the study. Ultimately, 1,247 schools in 124 municipalities with more than

100,000 inhabitants participated in the study. The sample is representative of Brazil, its macroregions, and all of its capitals. Details about the sampling process applied in ERICA can be found in Vasconcellos et al.[9] The study was approved by the Research Ethics Committees of all the country's states. All the participants signed a consent form. Since blood was collected, a free prior informed consent form, signed by parents or guardians, was requested from students in the morning shift (CAAE: 05185212.2.1001.5286 - UFRJ coordination center).

Data were collected to ensure each student's privacy and preferably followed this order: The questionnaire for the student with 105 questions (varying slightly based on the respondent's sex) was filled out directly in a Personal Digital Assistant (PDA) in the classroom; anthropometric measurements, blood pressure tests, and 24-hour diet recalls were collected in another room provided by the school. Also in the schools, blood was collected on the second day of field work, which had been previously scheduled and wherein the adolescents had undergone between 10–12 hours of fasting. Biochemical analysis were performed in a single laboratory, according to the protocol developed for ERICA.[10] In total, 74,589 adolescents completed at least the ERICA questionnaire, while 38,069 of these adolescents (only students in the morning shift classes due to the mandatory fasting) also participated in the blood collection study.[11]

Table 1 provides a summary of the main variables collected in ERICA. The questionnaire for the adolescents was structured in 12 blocks related to social demographic factors and child labor, including questions on behavior such as physical activity, eating habits, sleep duration, alcohol use and smoking, and, on prior diagnoses of morbidities, indicators of common mental disorders and sexual maturation. In addition to the main questionnaire, two other questionnaires were applied. The first was used to evaluate questions related to the school, which were answered by a member of the institution's board; the second was sent for completion by parents or guardians to gather information on the adolescent's family and childhood.[8]

Anthropometric measurements to assess nutritional status were also collected. Blood pressure was measured by following prior standard procedures: the adolescent was seated and at rest, and an appropriate cuff for their arm's circumference was used. In all, three measurements were taken, and the mean of the last two were used for analyses.[8,12] A 24-hour diet recall was applied through software developed for the study,[13] which could estimate the consumption of micro- and macronutrients of specific foods. In a sub-sample (approximately 10% of the total), a second diet recall was applied to estimate the adolescents' usual dietary intake.

Blood was collected to analyze lipids, glycemia, glycated hemoglobin, and insulinemia. Four biorepositories were created for future analyses at four centers (Rio de Janeiro, Rio Grande do Sul, Brasília, and Ceará). Analyses of inflammatory markers, including C-reactive protein (CRP) and adiponectin, and of vitamin D in subsamples were also conducted.

RESULTS

Prevalence of cardiovascular risk factors and cardiovascular-related behaviors in Brazilian adolescents

The initial results sought to describe the prevalence of the main risk factors for CVD and to identify associated

Table 1. Summary of the main variables collected in the Study of Estudo de *Riscos Cardiovasculares em Adolescentes*, ERICA 2013-2014.

Risk factor for cardiovascular disease	Description
Physical activity and sedentary Behaviour	Checklist of activities undertaken in the last week (leisure and locomotion), physical education classes, and total screen time.
Diet [a]	Dietary habits (breakfast, meals with parents, consumption of snacks and diet/light products, etc.) and 24-hour diet recall (micro- and macronutrients, specific foods).
Smoking	Experimentation, initial age, regular use, type of cigarette, passive smoking, and flavored cigarettes.
Alcohol consumption	Initial age, regular consumption, and type of beverage.
Sleep	Sleep duration of sleep on weekdays and on weekends.
Referred morbidity	Hypertension, diabetes, dyslipidemia - age of diagnosis and medication use.
Common mental disorder	General Health Questionnaire (GHQ-12).
Anthropometrics	Body weight, height, waist and arm circumference, body mass index (BMI).
Blood pressure	Systolic and diastolic blood pressure (Omron-705 ®IT blood pressure monitor with appropriate cuff size).
Laboratory exams	Total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, fasting glycemia, glycated hemoglobin, insulinemia.
Complementary exams[b]	C-reactive protein, adiponectin, 25-OH vitamin D.

[a] A second 24-hour diet recall was applied in a subsample to estimate the adolescents' usual consumption; [b] Evaluation performed in a subsample: C-reactive protein, n = 6.316; adiponectin, n = 4.546; 25-OH vitamin D, n = 1.152. HDL: high-density lipoprotein, LDL: low-density lipoprotein

factors and groups at higher risk among Brazilian adolescents. All the estimates presented took into account the sample weights calculated for the study. ERICA was designed to provide information in the distribution of the main cardiovascular risk factors in the Brazilian adolescent population.[14-16] Figure 1 shows the prevalence of these risk factors in Brazilian adolescents.

The most prevalent cardiovascular risk factors in the studied population were low high-density lipoprotein (HDL) cholesterol levels (< 45 mg/dL) and being overweight/obese (Body mass index (BMI) Z-score for sex and age > 1). Altered values of total cholesterol (≥ 170 mg/dL), low-density lipoprotein (LDL) cholesterol (≥ 130 mg/dL), and HDL cholesterol were more frequent in female adolescents. There was a greater prevalence of high blood pressure (above the 95th percentile for sex, age, and height) and high glycated hemoglobin (≥ 5.7%) among male adolescents. As for regional differences, a greater prevalence for being overweight/obese and having high blood pressure was observed in the South, while the prevalence of low HDL cholesterol levels was more frequent in the North (Table 2). The prevalence of cases suggestive of familial hypercholesterolemia was 0.5% (95% confidence interval (CI): 0.34–0.71), with no differences by sex or region.[20]

The occurrence of metabolic syndrome was defined based on the criteria established by the International Diabetes Federation (IDF) for adolescents,[21] which includes the presence of abdominal obesity and at least two of the following components: altered glycemia, blood pressure, triglycerides, and HDL cholesterol. Figure 2 illustrates the prevalence of metabolic syndrome in Brazil and in each region of the country for both sexes. The highest prevalence of metabolic syndrome was observed in the South (3.5%, 95% CI: 2.6%–4.9%); its prevalence was less than 3% in the other regions. No differences were observed between the sexes for the prevalence of metabolic syndrome in the studied adolescents.[22]

Aside from the abovementioned risk factors, behavioral risk factors for CVD were also examined.[23-27] Figure 3 illustrates the prevalence of risk behaviors for CVD for all the adolescents
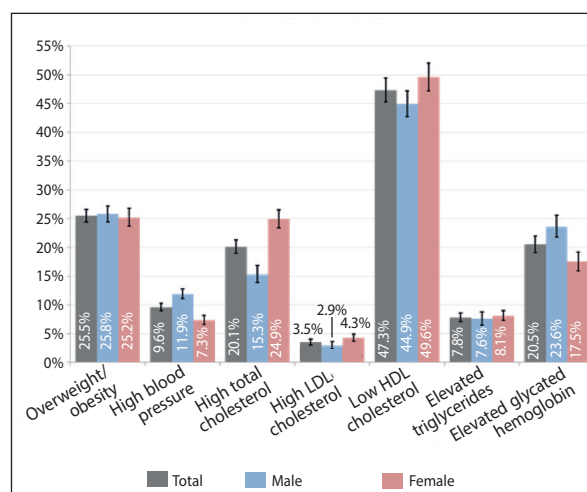

Figure 1. Prevalence of cardiovascular risk factors in Brazilian adolescents, ERICA 2013–2014. Overweight/obesity = body mass index (BMI) Z-score > 1 for sex and age[17]; high blood pressure = systolic or diastolic blood pressure above the 95th percentile for sex, age, and height[12]; high total cholesterol ≥ 170 mg/dL, high LDL cholesterol ≥ 130 mg/dL, elevated triglycerides ≥ 130 mg/dL, low HDL cholesterol < 45 mg/dL[18]; elevated glycated hemoglobin ≥ 5.7%.[19]

and by sex. We highlighted the high prevalence of sedentary lifestyles among Brazilian adolescents, either due to the high prevalence of physical inactivity (< 300 min/week) or excessive screen time, such as TV watching and playing videogames (> 2 hr/day), which was present in one out of two adolescents. The prevalence of risk behaviors was similar between the sexes for most of the risk behaviors evaluated except for physical activity levels and the habit of skipping breakfast (proxy for an unhealthy diet), which were more frequent among female adolescents. The Southern region stood out for its greater prevalence of excessive screen time, a habit of skipping breakfast, and alcohol consumption in comparison to other regions of the country (Table 2).

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Table 2. Prevalence of cardiovasculares risk factors and behavior risk factors according to region in brazilian adolescents, ERICA 2013-2014.

Biological risk factors	Macroregions, % (95% CI)				
	North	Northeast	Midwest	Southeast	South
Overweight/obesity	21.9 (20.8-23.0)	24.3 (22.4-26.3)	23.6 (22.3-24.9)	25.9 (24.0-28.0)	29.7 (28.1-31.3)
High blood pressure	8.4 (7.7-9.2)	8.4 (7.6-9.2)	8.7 (7.9-9.6)	9.8 (8.8-11.0)	12.5 (11.0-14.2)
High total cholesterol	16.5 (15.2-17.8)	18.8 (16.6-21.4)	23.5 (21.7-25.3)	20.0 (18.2-22.5)	22.8 (20.6-25.1)
High LDL cholesterol	2.7 (2.3-3.2)	3.3 (2.8-4.0)	4.3 (3.5-5.1)	3.7 (3.1-4.6)	3.5 (2.6-4.7)
Low HDL cholesterol	58.7 (56.7-60.6)	51.6 (49.7-53.6)	46.2 (43.7-48.4)	45.9 (41.7-49.3)	36.9 (43.7-48.4)
Elevated Triglycerides	9.6 (8.7-10.6)	9.4 (8.2-10.7)	8.7 (7.6-9.9)	6.8 (5.8-8.1)	8.2 (6.4-10.2)
Elevated glycated hemoglobin	23.7 (22.1-25.4)	20.4 (17.1-24.0)	21.5 (19.3-23.8)	20.8 (18.6-23.1)	17.6 (14.4-21.2)
Behavioral risk factors					
Physical inactivity	49.8 (48.7-50.9)	55.7 (53.2-58.1)	50.1 (47.8-52.4)	54.8 (53.5-58.1)	55.8 (53.5-58.1)
Excessive screen time	44.6 (43.0-46.2)	51.6 (48.6-54.6)	57.5 (55.7-59.2)	60.0 (57.8-62.2)	65.0 (63.7-66.2)
Smoking	5.9 (5.2-6.7)	4.7 (4.0-5.6)	6.3 (5.2-7.6)	5.7 (5.0-6.4)	7.3 (6.2-8.7)
Alcohol consumption	14.8 (13.8-15.9)	16.7 (15.2-18.3)	23.3 (21.4-25.2)	22.4 (20.7-24.3)	27.5 (25.3-29.9)
Skipping breakfast	13.7 (12.6-15.0)	18.2 (16.3-20.2)	22.3 (20.2-24.6)	23.2 (21.4-25.2)	29.1 (26.9-31.4)

Cut-off points: Overweight/obesity = body mass index (BMI) Z-score > 1 for sex and age[17]; high blood pressure = systolic or diastolic blood pressure above the 95th percentile for sex, age, and height[12]; high total cholesterol ≥ 170 mg/dL, high LDL cholesterol ≥ 130 mg/dL, elevated triglycerides ≥ 130 mg/dL, low HDL cholesterol < 45 mg/dL[18]; Elevated glycated hemoglobin ≥ 5.7%[19]; physical inactivity < 300 min/week of moderately or vigorously intense physical activity[28]; excessive screen time > 2 hours/day in front of screens[29]; Smoking: smoked at least one day in the last 30 days; alcohol consumption: consumption report in the last 30 days; Skipping breakfast: refers to 'never' having breakfast. 95% CI: 95% confidence interval, %: prevalence, LDL: low-density lipoprotein, HDL: high-density lipoprotein.
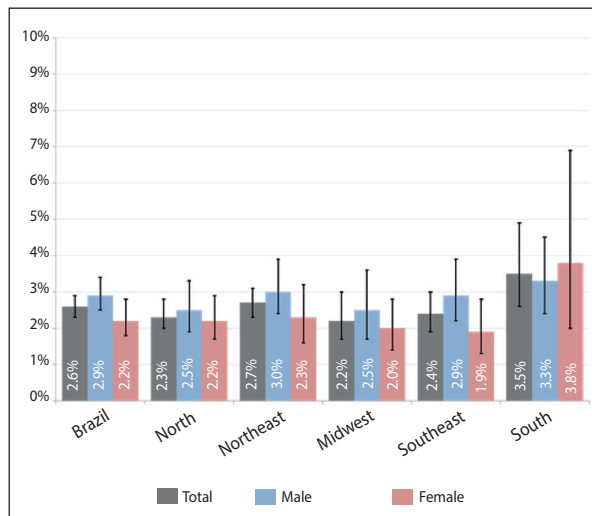

Figure 2. General and regional prevalence of metabolic syndrome in Brazilian adolescents, ERICA 2013-2014. The diagnosis of metabolic syndrome was made based on criteria established by the International Diabetes Federation (IDF) for adolescents.[21]
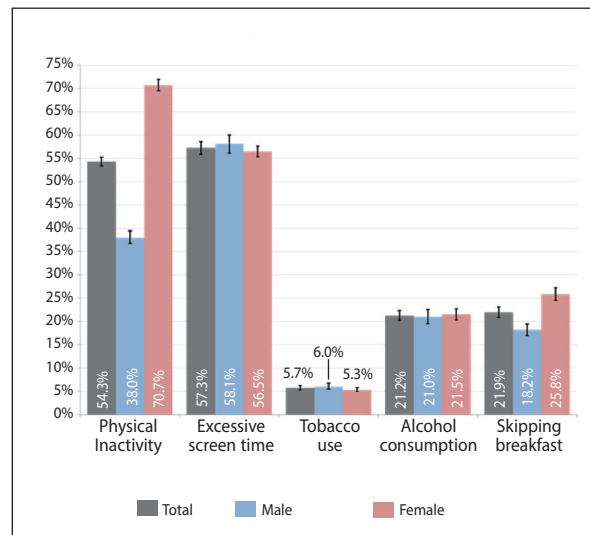

Figure 3. Prevalence of risk behaviors for cardiovascular disease in Brazilian adolescents, ERICA 2013-2014. Physical inactivity < 300 min/week of moderately or vigorously intense activity[28]; Excessive screen time > 2 hours/day[29]; smoking: smoked at least one day in the last 30 days; alcohol consumption: consumption report in the last 30 days; skipping breakfast: refers to 'never' having breakfast.

ASSOCIATIONS BETWEEN CARDIOVASCULAR RISK FACTORS

ERICA's results may also Help us to identify groups at risk and test hypotheses on the association among the cardiovascular risk factors. Overweight and obese adolescents presented with a higher occurrence of metabolic and hemodynamic changes. For example, the prevalence of high blood pressure among Brazilian adolescents is at least three times greater among those with obesity, and 18% of the prevalence of high blood pressure in this age group was attributed exclusively to obesity.[15]

A higher prevalence of metabolic syndrome is also strongly associated with being overweight. Among adolescents with normal weights, the prevalence is 0.1%, while this prevalence reaches 21% in obese adolescents.[22] Moreover, adolescents with general and abdominal obesity presented greater changes in inflammatory markers, represented by

higher concentrations of CRP and lower levels of adiponectin in this group.[30, 31] Adolescents with CRP over 3 mg/L present a prevalence [prevalence ratio (PR): 2.9, 95% CI: 2.0–4.3] of metabolic syndrome that was three times greater than among those with lower levels of this inflammatory marker.[30]

Risk behaviors such as physical inactivity, excessive screen time, a diet poor in fiber, smoking, and excessive alcohol consumption, especially in combination, may double the risk for general (PR:2.29, 95% CI: 1.46–3.61) and abdominal (PR:2.28, 95% CI: 1.42–3.68) obesity among adolescents, an association that seems to be even greater among male adolescents.[32] Smoking alone was also associated with abdominal obesity after adjusting for confounding factors and this relationship was also greater among male adolescents.[33]

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Being overweight also seems to modify the association between screen time and cardiometabolic risk factors. More than six hours of screen time a day increases the chance among overweight adolescents to present a greater number of cardiometabolic risk factors [PR:1.62, 95% CI: 1.18–2.22], an association that was not observed among adolescents with normal weights.[34] Regular physical activity does not seem to be modified by BMI and represents protection for metabolic health among adolescents with normal weights (PR:0.77, 95% CI: 0.6–0.91) and those overweight/obese (PR:0.68, 95% CI: 0.54–0.87).[34]

We also observed that excessive nocturnal sleep, over 12 hours a day, was positively associated with higher concentrations of glycated hemoglobin especially among adolescents in the South and Southeastern regions of the country regardless of nutritional status and other confounding factors.[35]

PERSPECTIVE AND CONCLUSIONS

The results from the ERICA which have been published recently allowed us to accurately estimate the prevalence of the main cardiovascular risk factors among Brazilian adolescents, make regional comparisons, and assess hypotheses on groups at higher risk as well as strategies that may help develop public policies for CVD prevention.

We noted a high prevalence of childhood obesity, which is strongly associated with the increase in cases of high blood pressure. It is important to draw attention to the high prevalence of dyslipidemia and cases suggestive of familial hypercholesterolemia, a disease responsible for 5–10% of premature cardiovascular events, which makes even a low prevalence a cause for concern. Similarly, the high prevalence of disorders in glycemic control and sedentary lifestyles among adolescents is equally worrisome.

Accordingly, we expect that ERICA's initial results may serve as a reference for future research on CVD among Brazilian adolescents and to support public health policies. The way in which the study was conducted also reinforces the importance of forming research networks and of the support of organizations that foment research to perform nationwide studies.

Although the first phase of the study is complete, the group of researchers connected to ERICA remain active. Of the topics which continue to be one of the study's objectives, we may mention the development of reference curves for blood pressure and anthropometric and biochemical variables that will result in the proposition of specific reference values for brazilian adolescents. The paper which contains the reference values for blood pressure has already been accepted for publication and will be available for review in 2018. The study on the prevalence of some morbidities such as type 2 diabetes and severe obesity has not been published but shall be available shortly.

Another focus is on diet among adolescents and seeks to develop an index to evaluate nutritional quality, examine consumption of ultra-processed foods, and advance the study of associations among cardiovascular risk factors in different segments of the population. Georeferencing analyses are currently underway to evaluate socioeconomic indicators and map green areas and other characteristics of the constructed environment while investigating the associations with risk factors. The linkage of ERICA data with other national databases containing health indicators is another strategy that will be implemented.

In 2018, a new stage in the ERICA study began. It is a cohort study that seeks to reassess the adolescents who participated in the study in four capitals: Rio de Janeiro, Porto Alegre, Brasília, and Fortaleza. It will be a major challenge from a methodological standpoint and due to the scarcity of resources for research in Brazil's current scenario. This new stage of the study may bring relevant information regarding CVD development throughout the course of Brazilian youths' lives. Data collection from the study's new stage is initially projected to be completed in 2019.

ACKNOWLEDGMENTS

CONFLICTS OF INTEREST

The author declares that he has no conflicts of interest in this work.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to complete this manuscript. FVC prepared the first version of the manuscript, and KVB and BDS critically reviewed the paper. All the authors collaborated to conduct the research project and data analysis. FVC, KVB, and BDS approved the final version of the manuscript.

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