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Effects of socioeconomic position and social mobility on linear growth from early childhood until adolescence

Efeitos da classe econômica e mobilidade social no crescimento linear desde a infância até a adolescência

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ABSTRACT: ***Objective:*** To assess the effect of socioeconomic position (SEP) in childhood and social mobility on linear growth through adolescence in a population-based cohort. ***Methods:*** Children born in Cuiabá-MT, central-western Brazil, were evaluated during 1994 – 1999. They were first assessed during 1999 – 2000 (0 – 5 years) and again during 2009 – 2011 (10 – 17 years), and their height-for-age was evaluated during these two periods. Awealth index was used to classify the SEP of each child's family as low, medium, or high. Social mobility was categorized as upward mobility or no upward mobility. Linear mixed models were used. ***Results:*** We evaluated 1,716 children (71.4% of baseline) after 10 years, and 60.6% of the families showed upward mobility, with a higher percentage among the lowest economic classes. A higher height-for-age was also observed among those from families with a high SEP both in childhood (low SEP= -0.35 z-score; high SEP= 0.15 z-score, $p < 0.01$) and adolescence (low SEP= -0.01 z-score; high SEP= 0.45 z-score, $p < 0.01$), whereas upward mobility did not affect their linear growth. ***Conclusion:*** Expressive social mobility was observed, but SEP in childhood and social mobility did not greatly influence linear growth through childhood in this central-western Brazilian cohort.

Keywords: Social class. Social mobility. Growth. Cohort study. Adolescent.Child.

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RESUMO: ***Objetivo:*** Avaliar o efeito da classe econômica na infância e mobilidade social no crescimento linear ao longo da adolescência em uma coorte de base populacional. ***Métodos:*** Crianças nascidas entre 1994 – 1999 em Cuiabá-MT, no centro-oeste do Brasil foram avaliadas pela primeira vez durante 1999 – 2000 (0 – 5 anos) e novamente durante 2009 – 2011 (10 – 17 anos), sendo a estatura-para-idade avaliada nestes dois períodos. O Critério Brasil foi usado para classificar a classe econômica da família de cada criança como baixo, médio ou alto. A mobilidade social foi categorizada como mobilidade ascendente ou nenhuma mobilidade ascendente (manutenção e mobilidade descendente). Foram utilizados modelos lineares de efeitos mistos. ***Resultados:*** Foram avaliadas 1.716 crianças (71,4% da linha de base) após 10 anos de seguimento, e 60,6% das famílias mostraram mobilidade ascendente, com uma percentagem mais elevada entre as classes econômicas mais baixas. Também foi observada uma maior altura-para-idade entre aqueles de famílias com elevada classe econômica, tanto na infância (baixa classe econômica= -0,35 z-score; elevada classe econômica = 0,15 z-score, $p < 0,01$) e adolescência (baixa classe econômica= -0,01 z-score; elevada classe econômica= 0,45 z-score, $p < 0,01$), ao passo que a mobilidade ascendente não afetou o crescimento linear. ***Conclusão:*** Foi observada expressiva mobilidade social, mas a classe econômica na infância e a mobilidade social não apresentaram influência significativa na taxa de crescimento linear durante a infância nesta coorte do Centro-Oeste brasileiro.

Palavras-chave: Nível socioeconômico. Mobilidade social. Crescimento. Estudos de coortes. Adolescente. Criança.

INTRODUCTION

Among the social determinants of health, there is a great concern in regarding the effects of socioeconomic gradients in health[1].More specifically, because socioeconomic disadvantages over the course of one's life may hasten poor health.In recent years, the effect ofchildhood socioeconomic position (SEP) and how it may relate to health outcomes in adulthood have been investigated[2]. Systematic review has demonstrated associations between childhood SEP and an increased risk for coronary heart disease, stroke, and all-cause mortality[3]. However, the mechanisms by which adverse social circumstances over the life course increase the risk of adverse health outcomes later on have not yet been fully explained.

Social mobility can be characterized as the individual's trajectory within a social structure over their lifespan, and can be expressed through income, education, social class, or other forms of classification[4]. This type of mobility represents an individual's change from one category to another over a period of time. It is classified as "null" (when no change occurs), "upward" (when a person moves up one or more categories), or "downward" (when a person moves down one or more classes)[5].

Investigation into socioeconomic inequalities in health is a relatively young field in low and middle-income countries (with publications only beginning to appear from the late twentieth century onward)[6,7]. Brazil, even with advances in combating poverty, is still one

of the world's most unequal countries, being the most unequal among the G20 countries[8] in regards to socioeconomic status and health. Between 1973 and 2008, a significant increase of social mobility was observed in Brazil[9]; however, the greatest mobility has occurred in the last decade. Between 2001 and 2011, the 10% poorest section of the country experienced a cumulative revenue growth of 91.2%, while the richest part of the population hadan increase of 16.6% in the same period[10]. Changes in the economy and in public policies reduced social inequality in Brazil[11].

Growth is a widely used measure to gauge the quality of a child's environment because growth failure is linked to a broad range of adverse outcomes in life, and is related to later physical and cognitive development[12,13]. A positive association between SEP and height has been demonstrated in children in high-income countries as well as in low to middle-low income countries[14,15], but few studies have examined the effect of SEP on height in adolescents[16,17].

Investigating the association between SEP and growth trajectories, however, requires longitudinal analyses of repeated height measurements. An investigation of this association in childhood would indicate whether the development of socioeconomic inequalities in adolescent or adult height could be partly attributed to inequalities in linear growth during this critical period.Therefore, this study aimed to evaluate the effect of one's socioeconomic position in childhood and of social mobility on linear growth through adolescence in a population-based cohort.

MATERIAL AND METHODS

SUBJECTS

A cohort of children born between 1994 and 1999 in Cuiabá, the capital of the state of Mato Grosso, in central-western Brazil, was evaluated at primary health clinics from May 1999 to January 2000. Ten vaccination clinics were randomly selected, and the parents or guardians of approximately 240 children randomly chosen from each clinic were interviewed (n = 2405). All guardians who accompanied their children were invited to participate; the refusal rate was of 0.4%. The coverage in Brazil for the diphtheria, pertussis, tetanus (DPT) vaccine at that point was 97%. A full description of the sampling plan had been described previously[18].

All the subjects enrolled at baseline were eligible for follow-up study at their schools between 2009 and 2011. In Brazil, approximately 95% of children aged 10–14 years and 78% of children aged 15 – 17 years attend school[19]. The annual School Census in Brazil was used to identify the cohort;86.8% (n = 2088) of the subjects (now adolescents) and their schools were identified using the child's name, date of birth, and the mother's name. In addition, five deaths were recorded in the Mortality Information System. Further details are provided in the paper by Gonçalves-Silva et al.[18].

Fieldwork was carried out between 2009 and 2011 in public and private schools in Cuiabá as well as in additional cities on one occasion in the follow-up period after 11 years; 14.4% of the baseline children had moved to other cities. One city, Várzea Grande, is geographically and economically integrated toCuiabá. The other subjects had relocated to 17 cities within the state of Mato Grosso (near the capital) and 5 capital cities from other Brazilian states (Campo Grande-MS, Brasília-DF, São Paulo-SP, Rio de Janeiro-RJ, and Goiânia-GO). Information about the subjects' birth (e.g., length and weight) was obtained from hospital records, but all outcomes and the majority of thevariables during childhood and adolescence were measured by a trained team of nutritionists. A pretest of the research protocol and a pilot study were conducted in a similar group of parents (at baseline) and adolescents (at follow-up) in order to test the understanding of the questionnaire, correct possible flaws, and standardize data collection.

MEASURES AND DATA ANALYSIS

At the first evaluation, when the children were under 5years old (1999–2000), information about demographic and socioeconomic characteristics was obtained by interviewing the parents or guardians. From 2009–2011, the subjects (then adolescents) provided information about their socioeconomic and lifestyle factors using a pretested questionnaire. At both interviews, anthropometric measurements (weight and length/height) were collected by trained field workers according to the techniques recommended by Lohman et al.[20]. Using the anthropometric measures obtained at the first interview and during follow-up, the subjects' length/height for age and gender were calculated according to the growth curves published by the World Health Organization (WHO), and were expressed in z-scores[21,22]. The scores were calculated using the WHO Anthro program, version 3.1.

The SEP of the families was based on the number of home appliances, cars, and paid maids, as well as the educational level of the head of the household according to the "Brazil Criterion" of economic classification[23,24]. This system has five classes: A (higher), B, C, D, and E (lower). For our analysis, individuals were reclassified into three SEP groups according to similar analyses by Muraro et al.[25]: low (E class), medium (C and D classes), and high (A and B classes), according to the number of observations at categories. Maternal educational level was categorized as low (less than eight years of school), medium (between eight and eleven years), and high (more than eleven years).

Social mobility was evaluated using the difference between the SEP of families from 1999 – 2000 and from 2009 – 2011, and it was separated into two categories: upward social mobility and no upward social mobility. We considered families with upward mobility as those with an increase of at least one economic class during the study period. Only 3.3% of the families suffered downward mobility, and then they were grouped with those who did not show social mobility, because both groups had no substantial changes in the results.

For the analysis, we considered the theoretical model of pathways by which maternal education might influence early childhood linear growth from Silva et al.[26]. The factors considered were:maternal characteristics like educational level, smoking during pregnancy, height (cm); and child characteristics like gender and birth weight (g). The mean z scores for length/height-for-age in childhood and adolescence were compared using the Student's t-test and analysis of variance (ANOVA). P values for trend were derived from the chi-square test for trend (categorical factors), or for the linear trend test using a one-way ANOVA. For the longitudinal analysis, the outcome was length/height-for-age z-score. Linear mixed effects models (SAS Proc MIXED) were used to assess the effects of early childhood SEP and social mobility on height from birth to adolescence to account for the correlation between measurements[27]. The main effects of time and social mobility, and the interaction between social mobility and time were tested. A significant interaction provides evidence for a differential rate of growth in height over time. Regression residuals were examined graphically to assess the goodness of the fit. Analyses were performed using the Statistical Analysis Systems software package, version 9.3 (SAS Institute, Cary, NC, USA).

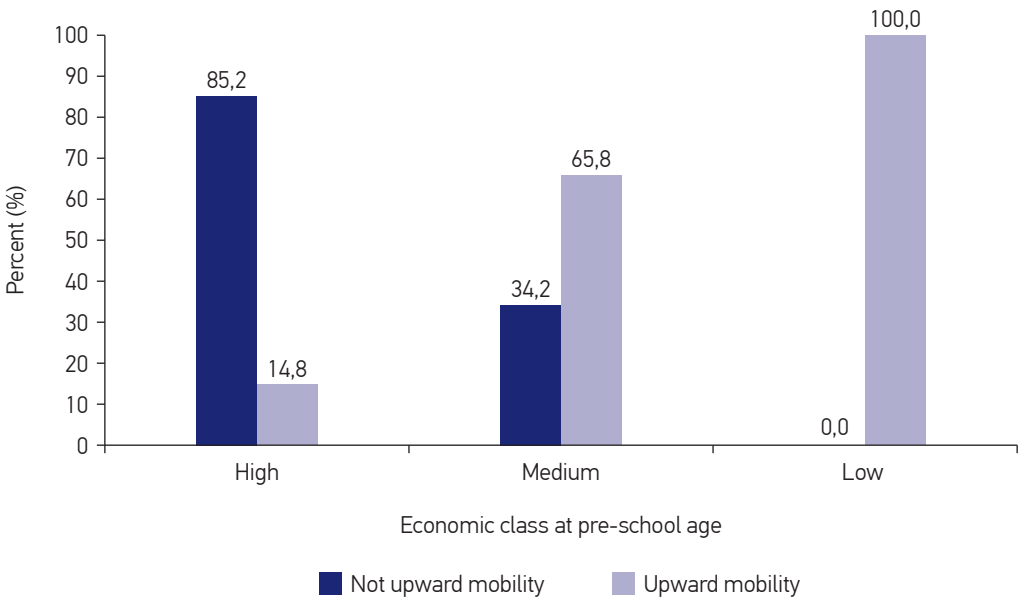
The study was approved by the Ethics Committee of the Júlio Müller University Hospital at the Universidade Federal do Mato Grosso (651/CEP-HUJM/2009 Protocol). Parents or guardians of the participating adolescents provided written informed consent.

RESULTS

At the first evaluation, 2,405 pre-school children had their height and weight measured. Information regarding their length and weight at birth was obtained from hospital records for 2,394 (99.5%) subjects. After approximately 11 years, 1,716 adolescents were measured and interviewed (71.4% of baseline). The average age at childhood was 1.5 years (SD = 1.4), while that at adolescence was 12.1 years (SD = 1.4).

At baseline to 15.3% (n = 263) of children were classified as high economic position, 76.9% (n = 1320) as medium and 7.8% (n = 133) as low. In the follow-up, 40.2% (n = 689) were classified as high and 59.8% (n = 1027) as medium, therefore no children was classified as low economic class (data not shown). Significant upward social mobility was observed in the study population (60.6%), and mobility was more prevalent among families that started out in the lower economic class (Figure 1). Families with a low economic class showed a higher proportion of low maternal education, a higher prevalence of smoking during pregnancy, and a lower mean maternal height. A higher mean of length/height-for-age in both childhood and adolescence was observed among families of higher socioeconomic status (Table 1). There was no difference in birth weight and height-for-age according to social mobility (Table 2).

Linear mixed effects regression, socioeconomic position at preschool age and social mobility had no impact on linear growth until adolescence (Table 3 and Figure 2).



p-values for χ^2 test <0.01.

Figure 1. Social mobility until adolescence, according to economic class at preschool age (n = 1716).

Table 1. Characteristics of the study population, according to the economic position at preschool age of children (n =1,716).

	Total (n =1716)	Economic position at preschool age			
		Low (n =133)	Medium (n = 1320)	High (n = 263)	p-value for trend*
Maternal characteristics					
Educational level (% low)	62.3	87,8	30.9	12.0	0.01
Smoking during pregnancy (%)	9.7	16.5	10.4	3.0	0.01
Height (cm)	158.9 (6.3)	157,4 (6.3)	158,6 (6.2)	161,2 (6.3)	0.01
Child characteristics					
Gender (% boys)	50.7	52.1	51.1	44.4	0.30
Birth weight (g)	3256.30 (499.7)	3229.5 (486.4)	3256.1 (500.9)	3270.8 (501.5)	0.74
Height-for-age (z score)					
Birth	-0.39 (1.29)	-0.49 (1.33)	0.38 (1.30)	-0.37 (1.20)	0.48
Preschool age	-0.18 (1.14)	-0.35 (1.06)	-0.23 (1.15)	0.15 (1.08)	<0.01
Adolescence	0.23 (1.00)	-0.01 (0.93)	0.22 (1.01)	0.45 (0.95)	<0.01

*p-values for trend are derived from χ^2 test for trend (categorical factors) or for the linear trend test of the ANOVA.
BMI =body mass index.
Data were missing for maternal education level (n = 14), smoking during pregnancy (n = 14), height of mother (n = 4), height-for-age at birth (n = 8), and BMI-for-age at birth (n = 11).

Table 2. General characteristics of the population of study, according to social mobility (n =1716).

	Total (n =1716)	Social Mobility		
		Upward mobility (n = 1040)	Not upward mobility (n = 676)	p-value*
Maternal characteristics				
Educational level (% low)	62.3	69.6	52.4	<0.01
Smoking during pregnancy (%)	9.7	11.1	7.7	0.02
Height (cm)	158.9 (6.3)	158.6 (6.3)	159.4 (6.2)	0.02
Child characteristics				
Gender (% boys)	50.7	51.1	50.1	0.71
Birth weight (g)	3256.30 (499.7)	3253.6 (511.6)	3260.5 (481.2)	0.28
Height-for-age (z score)				
Birth	-0.39 (1.29)	-0.39 (1.34)	-0.39 (1.21)	0.94
Preschool age	-0.18 (1.14)	-0.22 (1.13)	-0.13 (1.15)	0.13
Adolescence	0.23 (1.00)	0.20 (1.00)	0.29 (1.00)	0.08

*P-value for Chi-square or ANOVA tests.

Table 3. Linear mixed-effects model with height-for-age (z score) according to socioeconomic position in childhood, maternal educational level, and social mobility between childhood and adolescence.

	Model 1			Model 2		
	B	Standard Error	p-value	B	Standard Error	p-value
MODEL: Socioeconomic position at childhood						
Height-for-age (z score) at birth (intercept)						
Low	-0.29	0.11	0.01	-0.12	0.09	0.19
Medium	-0.18	0.07	0.01	-0.08	0.06	0.15
High	-	-	-	-	-	-
Rate of change of Height-for-age (z score)						
Age* Low	-0.02	0.01	0.13	-0.01	0.01	0.14
Age* Medium	-0.01	0.01	0.35	-0.01	0.01	0.38
Age* High	-	-	-	-	-	-
MODEL: Social Mobility						
Height-for-age (z score) at intercept (birth)						
Upward mobility	-0.02	0.05	0.58	0.01	0.04	0.75
Not upward mobility	-	-	-	-	-	-
Rate of change of Height-for-age (z score)						
Age* Upward mobility	-0.01	0.004	0.15	-0.01	0.004	0.14
Age* Not upward mobility	-	-	-	-	-	-

Model 1: adjusted only for child age; Model 2: adjusted for birth weight, maternal smoking in pregnancy, and maternal height.

DISCUSSION

The present study provides information regarding childhood SEP and also the effect of social mobility on linear growth until adolescence. In general, significant upward social mobility was observed in the study, mainly in families in the lower economic class. Children from families of a higher socioeconomic status at the first evaluation presented a higher mean of height-for-age in childhood and adolescence. The analysis revealed no significant impact of childhood SEP or of social mobility on linear growth until adolescence; those with a low SEP showed no overcompensation for their initial height deficit in comparison to those with a high SEP. Thus, it is possible that inequalities in adolescent health may already be determined in childhood and may be further accentuated by socioeconomic inequalities in behavior and educational attainment in childhood[16,28]. According to Barros et al.[16], a worsening

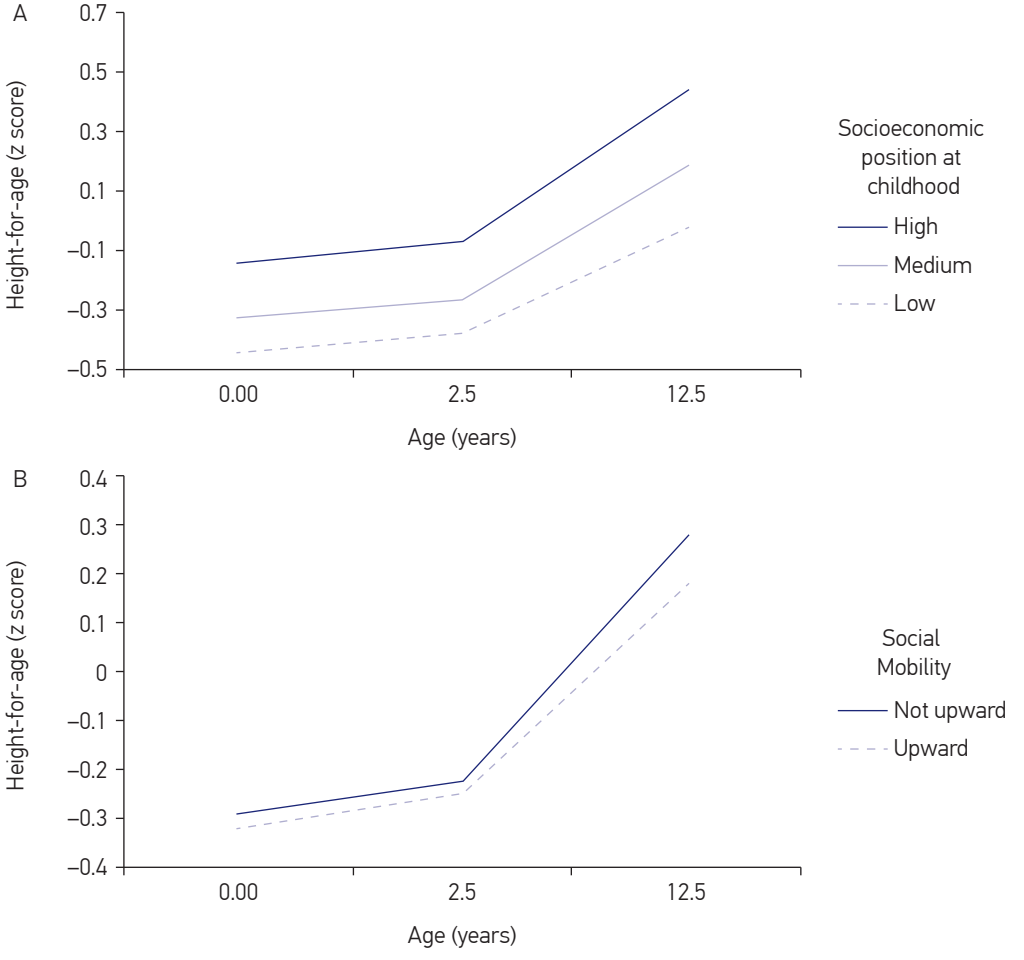


Figure 2. Linear mixed-effects model with height-for-age (z score) according to socioeconomic position in childhood (A) and social mobility (B) between childhood and adolescence.

in SEP between birth and adolescence seems to also limit height, as individuals who were not poor at birth but became poor later on presented a mean height that was intermediate between those who were never poor and those who were poor at birth. However, it should be noted that most of the children in the cohort experienced upward change.

While there seems to be a stronger relationship between a better childhood SEP and more positive health outcomes in childhood[29,30], the relationship with social mobility remains uncertain. Some studies have found an association between social mobility and height in adolescence[16,17], while others have reported a partial or weakrelationship[28,31], ordidnot find any relationship at all.

Barros et al.[16] analyzed the association of height with a change in SEP between birth and 19 years of age in a birth cohort from Pelotas, Brazil. Information on family income in 1982 and 2001 was used to classify the study population. Height showed a similar trend for men and women, with the never poor subjects presenting the highest mean, followed by those who were not poor at birth but later became poor. Those who were poor at birth, regardless of their later status, were the shortest subjects. Howe et al.[28] examined maternal education inequalities across multiple outcomes and how these inequalities changed across childhood and adolescence in the Avon Longitudinal Study of Parents and Children (ALSPAC), a cohort born from 1991–1992 in southwest England (N=5560–11463). Those offspring with a higher maternal education level were taller, and there was evidence of a slight widening of socioeconomic inequalities along with height for ages between 11 and 15 years.

Most studies have assessed just one or two measures of SEP at each stage of the life course[32]. Howe et al.[33] argued that there is no single ideal measure of SEP for all studies and contexts, and advised the use of that which is best suited to the specific research question. Our study evaluated the SEP of the families based upon the number of home appliances, cars, and paid maids, as well as the educational level of the head of the household, for the economic classification. This "Brazil Criterion" was not developed to consider health concerns and social welfare, but it has been used widely in the country and has an association with several morbidities and risk factors in the population[34]. Furthermore, the highest degree of upward mobility among those in the lower economic classes in the present study is similar to that observed in other studies using criteria other than the "Brazil Criterion" used here[16].

The social mobility in our study follows the same trend observed in national data[35]. This significant upward social mobility can be partly explained by the *Bolsa Família* Program (BFP). The BFP, which was created in 2003, is a cash transfer program for poor families that aims to promote immediate poverty alleviation through direct income transfers. In 2009, the BFP reached12.4 millionfamiliesand accounted for12% of thedecline in inequalitymeasured by the Gini Indexin recent years[36].

Attempts to measure the association between intergenerational mobility and health and risk behaviors among adolescents may present some methodological complications. According to Ritterman et al.[37], household and parental indicators of SEP may be useful proxies for the social status of infants and younger children, but are less appropriate in assessing adolescent social positions and social and economic resources.Adolescents may already

have attained a different social position than that of their parents, such as a different educational attainment level or occupational grade. Instead, adolescent class identity may be more influenced by social processes associated with social position, such as national educational systems[38], cultural norms and values, and future expectations[39]. Furthermore, adolescents are in a transition between being defined by their parents' social position and by their own, and it is possible that adolescent social status may be influenced by projections of a potential future socioeconomic trajectory[39].

The key strengths of this study are its use of longitudinal analyses of repeated height measurements and inclusion of the maternal height as a genetic proxy for adolescent height[40]. Maternal height represents influences from genetic and non-genetic factors, including intergenerational factors related to nutrition on growth, which may avoid the development of genetic height potential in low and middle-income countries[41,42].

One limitationof our study was the loss to follow-up (28.6% of baseline);the baseline characteristics of participants and those lost to follow-up were compared in a previous publication[43], and the loss to follow-up was greater among adolescents who had low height-for-age, mothers with less education and among those exposed to maternal smoking during pregnancy.However, few of them were lost due to a refusal to participate in the study, with most of the losses to follow-up occurring by family moving toother states[43]. Another limitation relates to the lack of assessment of the subject's sexual maturation. Furthermore, the information of economic class based onthe adolescent's report would be considered a limitation, but this criterion is generally used in epidemiological studies among adolescents. The results regarding economic disparities in health have been similar to that observed in adults and the elderly, such as the use of health services[44].

CONCLUSION

In conclusion, up to adolescence, we found no evidence that differences in height due to SEP could improve with upward social mobility. Our results suggest that such inequalities in growthare established in early childhood. Other studies with methodological refinement to measure social mobility may contribute to future assessments of social mobility effect on height.

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