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Short communication

Trends and correlates of age at menarche in Colombia: Results from a nationally representative survey

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ABSTRACT

Surveillance of age at menarche could provide useful information on the impact of changing environmental conditions on child health. Nevertheless, nationally representative data are exceedingly rare. The aim of this study was to examine trends and sociodemographic correlates of age at menarche of Colombian girls. The study sample included 15,441 girls born between 1992 and 2000 who participated in the Colombian National Nutrition Survey of 2010. We estimated median menarcheal age using Kaplan–Meier time-to-event analyses. Hazard ratios with 95% confidence intervals were estimated with Cox regression models. The median age at menarche was 12.6 years. There was an estimated decline of 0.54 years/decade ($P < 0.001$) over the birth years; this decline was only observed among girls from urban areas, and was more pronounced among girls from wealthier versus poorer families. Child height and BMI, maternal BMI and education, and family wealth were each inversely associated with menarcheal age whereas food insecurity and number of children in the household were positively associated with age at menarche. In conclusion, a negative trend in age at menarche is ongoing in Colombia, especially in groups most likely to benefit from socioeconomic development.

1. Introduction

Age at menarche, a measureable indicator of puberty onset, is a sensitive marker of environmental and socioeconomic conditions at the population level (Deardorff et al., 2014). In lower-income countries, socioeconomic status is inversely associated with age at menarche, and improvements of socioeconomic conditions are typically followed by declines in the timing of puberty onset (Cole, 2000; Tanner, 1990). For example, recent studies in Nigeria and Bangladesh found that girls from families of higher socioeconomic status, as indicated by parental education and/or occupation, had an earlier age at menarche compared to girls from families of lower socioeconomic status (Hossain et al., 2010; Onyiriuka and Egbagbe, 2013).

Monitoring age at menarche at the country level could be highly relevant to document the effects of environmental conditions on child health because the timing of puberty is related to health outcomes during adolescence (Deardorff et al., 2005; Glynn et al., 2014; Vaughan et al., 2015), final height (Yousefi et al., 2013), and adult disease risk and survival (Charalampopoulos et al., 2014; He et al., 2010; Horn et al., 2014). Nevertheless, availability of data on age at menarche at the national level is exceedingly rare (Sommer, 2013). The Colombian National Nutrition Survey of 2010 for the first time included a question on age at

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menarche among girls. Whereas a previous investigation documented a negative trend in age at menarche in this country (Villamor et al., 2009), the study sample was not representative. The availability of nationally representative data on menarche in Colombia constitutes an unprecedented opportunity to examine recent trends and correlates of the timing of puberty in a country undergoing rapid political and economic transformations.

The aim of this study was to examine recent trends and socioeconomic correlates of age at menarche of Colombian girls born between 1992 and 2000, using data from a nationally representative survey.

2. Methods

2.1. Study population

The Colombian National Nutrition Survey (ENSIN) was conducted in 2010 by the Colombian Institute of Family Welfare (Instituto Colombiano de Bienestar Familiar, ICBF) in conjunction with the Colombian Demographic and Health Survey (ENDS). Briefly, a multistage stratified sampling scheme was employed to select participants representing 99% of the Colombian population. All municipalities from the thirty-two departments in the country were grouped into strata based on similar geographic and sociodemographic characteristics. One municipality was randomly chosen from each stratum with the probability of being chosen proportional to the population size. Clusters of about ten households were randomly selected within strata and all household members were invited to participate. A total 50,670 households were included, representing 4987 clusters from 258 strata.

Trained personnel administered questionnaires to the head of each household to obtain demographic information as well as food insecurity and wealth measures. Anthropometric measurements were collected on each member of the family with standardized techniques and calibrated instruments. Research personnel measured height with a stadiometer (Diseños Flores SR. Ltda, Lima, Perú) to the nearest millimeter, and weight with SECA 872 scales to the nearest 100 grams. Girls aged 10 to less than 18 years were asked to recall the age in years and months when their first menstrual period had occurred or if it had not yet occurred.

2.2. Data sources

The survey included 188,599 people; 16,940 were girls 10 to <18 years of age. We excluded 1499 girls with missing information on menarche or who answered "don't know" to the question on age at menarche. The final sample comprised 15,441 girls born 1992–2000.

The primary outcome was age at menarche, estimated in decimal years. The exposures were year of birth, race/ethnicity, the girls' height and body mass index (BMI, kg/m^2), maternal height, BMI, and education level, number of children <18 living in the household, urbanicity, food insecurity, wealth index, and country region. Race/ethnicity was categorized as Indigenous, Afro-Colombian (survey response options black/mulato/Afro-Descendant, *raizal*, or *Palenquero*), or Mestizo-Caucasian (all others). Height-for-age and BMI-for-age *z* scores were calculated based on the World Health Organization reference (de Onis et al., 2007). Maternal BMI was estimated from measured height and weight as kg/m^2. Urbanicity, food insecurity, and wealth index were defined and categorized as previously described (Herran et al., 2015).

2.3. Ethical considerations

Participation consent was obtained prior to enrolment by the ICBF. The Health Sciences and Behavioral Sciences Institutional Review Board at the University of Michigan determined that analyses of these anonymized data were exempt from review.

2.4. Statistical analysis

Analyses were conducted with the use of the complex survey design routines of Stata statistical software package version 13 (StataCorp, College Station, TX, USA). We utilized time-to-event analytic techniques including the Kaplan–Meier method and Cox proportional hazards models because these methods properly account for right-censoring in the data (Kleinbaum and Klein, 2012) due to the inclusion of both pre- and post-menarcheal girls. These methods allow to combine information on menarcheal age from post-menarcheal girls with the last known age when menarche had not occurred from pre-menarcheal girls in the estimation of the population median age at menarche. In addition, proportional hazards modeling provides interpretable probability ratios of menarche by categories of predictors. This cannot be achieved with other methods, including the "status quo" (Henneberg and Louw, 1995).

We estimated the weighted median age at menarche by categories of predictors using Kaplan–Meier cumulative probabilities from birth. For girls who had not yet experienced menarche, the censoring time was age at interview, estimated as date of interview minus birthdate. Cox proportional hazards models were used to estimate hazard ratios of menarche, accounting for the complex survey design. For ordinal predictors, we conducted tests for linear trend by introducing into the model a variable representing ordered categories as a continuous covariate. For nominal characteristics, we conducted Type III Wald Tests. Adjusted hazard ratios and 95% confidence intervals (95% CI) were estimated with a model that included all predictors but excluded potential mediators on causal pathways.

We examined the relation of year of birth and age at menarche overall and stratified by levels of urbanicity, wealth, and race/ethnicity. Birth years 1998 through 2000 were combined because <10% of girls born after 1998 had experienced menarche at the time of interview and statistical power was very low for years 1999 and 2000 separately. Trends in age at menarche over time (years/decade) were estimated as the slope of linear regression models with median age at menarche as the outcome and year of birth as the predictor. The statistical