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Is puberty starting earlier in urban South Africa?

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ABSTRACT Age at the initiation of pubertal development was estimated for 401 Black (212 boys) and 206 White (100 boys) urban South African adolescents born in Soweto-Johannesburg in 1990. Average age at the initiation of puberty, assessed by age at the transition from Tanner stage 1 to Tanner stage 2 for breast/genitalia or pubic hair development ranged between 9.8 and 10.5 years. There were no statistically significant differences in age at initiation between genders or ethnic groups. Age at the initiation of pubertal development has remained stable over the last 10 to 15 years, with the exception of pubic hair in boys which has declined on average 1.3 years over a decade. There is evidence to suggest that the tempo of pubertal maturation is increasing in girls born in the Soweto-Johannesburg area, however, the evidence is less clear for boys.

INTRODUCTION

Against a background of nutritional, social, and economic change, there has been relatively little contemporary research on the timing of pubertal development in urban South Africa. Knowledge of the timing of puberty is of continuing social and public health interest, given that early developers, in particular, are at an increased risk of negative health outcomes in both adolescence and adulthood (see for example, Anderson et al., 2003; Mendle et al., 2007). Although narrowing of the age of onset between unconstrained and previously constrained children would suggest a positive improvement in the nutrition and well being of those in the constrained group. Whilst there have been a number of studies of pubertal development of urban South African Black adolescents (Richardson and Pieters, 1977; Richardson et al., 1983; Channing-Pearce and Solomon, 1987; Cameron and Wright, 1990; Cameron et al., 1993; Norris and Richter, 2005) and one study of White girls (Channing-Pearce and Solomon, 1987), few have used robust collection and analysis methods to determine average age at the initiation of puberty. The lack of contemporary pubertal development data prevents researchers from gauging how recent socio-political changes and environmental transitions have influenced population health and well-being in South Africa. This study therefore aimed to determine current age at the initiation of puberty for urban Black and White South African adolescents and to examine the evidence for a secular change in age at pubertal development in recent decades.

SUBJECTS AND METHODS

Longitudinal Tanner ratings (Tanner, 1962) were available for a total of 401 Black (212 boys) and 206 White (100 boys) adolescents who were part of the Bone-Health (BH) sub-sample of the Birth-to-Twenty (Bt20) birth cohort set in Soweto-Johannesburg, South Africa (Richter et al., 2007). Tanner ratings were available annually for six time points with years 9 and 10 being physician assessed and years 11 onwards being self-assessed using a validated pubertal development questionnaire (Norris and Richter, 2005). The adolescents and their caregivers provided written informed consent and ethical approval was obtained from the University of the Witwatersrand Committee for Research on Human Subjects.

All data analyses were undertaken using SPSS version 15.0 (Chicago, IL). Data from the current study were collected in categorical yearly age groups and cumulative percentage plots constructed. Median age at the initiation of pubic hair and breast/genitalia development were derived by fitting a logistic curve to these cumulative percentage data for each gender-ethnic group. Equation 1 was used to fit the logistic model and equation 2 was used to derive achievement percentiles:

$$y = 1 / (1/u + (b_0 * (b_1 t))) \quad (1)$$

$$t = \ln((1/y - 1/u) / b_0) / \ln b_1 \quad (2)$$

where y = % achieved, u = upper boundary (100%), b_0 = b coefficient, b_1 = constant and t = age (years).

In addition to the data from the current study, data from two previous studies set in Soweto-Johannesburg were used to investigate the evidence for a secular change in age at the initiation of puberty between 1988 and 2004 (Cameron and Wright, 1990; Cameron et al., 1993). Ninety-five percent confidence intervals (95% CI) were calculated from mean/median and standard error measures provided in previous studies.

The other studies of pubertal development in urban South Africa were excluded from the secular change analysis within the current study due to a lack of appropriate sampling, data collection, and/or analysis methods. For example, the cross-sectional study of Channing-Pearce and Solomon (1987) reduced the five Tanner stages into three stages: pre-adolescence (Tanner stage 1), adolescence (Tanner stages 2-4) and maturity (Tanner stage 5), thus reducing the sensitivity of pubertal assessment and influencing the efficacy of the results. Due to a lack of knowledge about the appropriateness and robustness of the statistical techniques used, both the 1977 and 1983 studies by Richardson et al. were excluded. The Norris and Richter (2005) study was also excluded as this cross-sectional study was primarily designed to validate a pubertal self-assessment technique, and therefore, cannot be used to report average age of initiation of puberty..

RESULTS

Table 1 provides median age and 95% confidence intervals at the initiation of genitalia and pubic hair development in boys and breast and pubic hair development in girls. There were no statistically significant differences in age at initiation between genders or ethnic groups.

Table 2 shows the average age and 95% confidence intervals at the initiation of breast/genitalia and pubic hair development for three studies of pubertal development in urban South Africa. The age at initiation of genitalia development in boys and breast and pubic hair development in girls has remained stable over the past 10 to 15 years with no statistically significant differences between studies. Only pubic hair development in boys has shown a statistically significant ($p < 0.05$) decline in age at initiation between 1992 (12.4 years; 95% CI 12.2, 12.6) and 2004 (10.8 years; 95% CI 9.6, 12.0).

DISCUSSION

The results from this study indicate that age at the initiation of puberty for urban Black South African adolescents has remained stable over the last 10-15 years, with the exception of pubic hair development in boys which has shown an average decline of 1.3 years. Whilst age at the initiation of puberty has remained stable, recent work with the same data has shown evidence for a statistically significant positive secular trend in age at menarche (average decline of 0.5 years per decade) for urban Black South African girls (Jones et al., 2008). These data and those from the current study indicate that the tempo of pubertal maturation could therefore be increasing (i.e. duration is reducing) in girls born in the Soweto-Johannesburg area as age at initiation has remained stable, but menarche, an event which occurs in the latter stages of puberty is occurring earlier. It was not possible to determine if this trend was apparent for boys in this cohort given the lack of a clearly discernable event equivalent to menarche and the evidence for a decline in pubic hair between 1992 and 2004. However, this decline may be attributable to the

differences in assessment technique used in the two studies i.e. physician assessed (Cameron et al, 1993) vs. adolescent self-assessed (current study) as boys may overrate their development. The issue of overrating was highlighted in the Norris and Richter (2005) validation study which showed that 14% of boys overrated their pubic hair development when compared to physician assessment.

The concurrent plateau in age at the initiation of puberty and a decline in age at menarche have also been shown in Dutch and Swedish samples (de Muinck Keizer-Schrama and Mul, 2001). Conversely, a small number of US studies have shown the opposite pattern with a concurrent decline in age at initiation and a plateau in age at menarche (for reviews see Parent et al., 2003; Kaplowitz, 2006). Whilst the pattern of secular change is contradictory between South Africa and the US, there is no statistically significant difference in age at menarche and at the initiation of breast development between the two settings (based on data from Wu and colleagues (2002)). This suggests that the environmental factors that promote or constrain the maturation of the hypothalamic-pituitary-gonadal (HPG) and hypothalamic-pituitary-adrenal (HPA) axes may be context specific. For example, in the urban Black South African context, the environmental constraints on maturation such as poor nutrition may have differing influences on the timing of secondary sexual characteristic development and that of menarche. Age at menarche may be more sensitive to environmental constraint and is continuing to decline in parallel to improving socio-economic and nutritional conditions and as yet, has not reached a “genetic ceiling”. In contrast, age at the initiation of puberty

may have stabilized due to a reduction in the sensitivity of the HPG and HPA axes to environmental constraint as a result of reaching a “genetic ceiling”.

CONCLUSION

This article provides the most contemporary and methodologically robust estimates of age at the initiation of genitalia development in boys, breast development in girls, and pubic hair development in both sexes for urban Black South African adolescents. Age at the initiation of puberty for urban South Africa adolescents has remained stable over the last 10 to 15 years, in contrast to age at menarche which has been shown to be declining, suggesting that the tempo of pubertal maturation in girls born in the Soweto-Johannesburg area is increasing.

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TABLE 1. Estimates of median age (95% confidence intervals) at the onset of pubertal development of urban Black and White South African adolescents

	Boys		Girls	
	Black (n = 212)	White (100)	Black (n = 189)	White (n = 106)
Genitalia/Breast	10.4 (8.4, 12.4)	9.8 (9.4, 10.2)	10.1 (9.3, 10.9)	10.2 (8.2, 12.2)
Pubic Hair	10.8 (9.6, 12.0)	10.2 (8.4, 12.0)	10.3 (9.3, 11.3)	10.5 (8.7, 12.3)

TABLE 2. Estimates of average age (95% confidence intervals) at the onset of pubertal development of urban South African adolescents between 1988 and 2004

Year	Black Boys		Black Girls		Reference
	G2	PH2	B2	PH2	
1988	-	-	10.4 (10.2, 10.6)	-	Cameron and Wright (1990)
1992	10.5 (10.2, 10.8)	12.4 (12.2, 12.6)	10.1 (9.9, 10.3)	10.1 (9.9, 10.3)	Cameron et al. (1993)
2004	10.4 (8.4, 12.4)	10.8* (9.6, 12.0)	10.1 (9.3, 10.9)	10.3 (9.3, 11.3)	Current study

G2 Tanner genitalia stage 2

PH2 Tanner pubic hair stage 2

B2 Tanner breast stage 2

* P<0.05 (between studies)