Published in final edited form as:

Ann Hum Biol. 2012 January ; 39(1): 84–87. doi:10.3109/03014460.2011.632647.

Demographic Differences in Self-Report Pubertal Status among Rural Adolescents in the USA

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Abstract

Background—While sex and racial/ethnic differences in pubertal development have been noted, most of this research has been in urban areas.

Aim—The purpose of this study is to examine demographic differences in pubertal status among a school-based sample of US rural adolescents aged 11 to 16.5 (N=6,425).

Methods—Pubertal status was measured using the Pubertal Development Scale (PDS), a self-report scale of secondary sexual characteristics. We compared pubertal status means by age, sex, and race/ethnicity.

Results—At all ages, females had a higher mean pubertal status than males. Most racial/ethnic differences were between White and Black youth. Between the ages of 11 and 13, Black youth reported more advanced development than White youth. But contrary to research with urban samples, this pattern of development reversed in later adolescence and the reversal was more prominent among males than females. Although there were no differences in pubertal status between White and Latino males, White females had higher mean levels of development than Latino females.

Conclusion—Demographic patterns were both consistent with and different from previous research with urban adolescents, suggesting the need for comparison of demographic patterns of pubertal development in samples that include youth from urban and rural areas.

Keywords

puberty; pubertal status; rural; adolescents

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DECLARATION OF INTEREST

This research was supported by the National Institutes of Health under Ruth L. Kirschstein National Research Service Award F31-DA023326 from the National Institute on Drug Abuse (Cance). The Context of Adolescent Substance Use Study was funded by the National Institute on Drug Abuse R01-DA13459 (Ennett).

INTRODUCTION

Individual onset and progression through puberty can vary dramatically and demographic differences have been noted (Archibald et al. 2003; Biro et al. 2000; Chumlea et al. 2003; Obeidallah et al. 2000; Sun et al. 2002; Tanner 1962). However, most of the research conducted on demographic differences in pubertal development in adolescence has been in urban or suburban areas (Biro et al. 2000; Obeidallah et al. 2000) or has controlled for geographic location without exploring whether the results were driven by an overrepresentation of urban adolescents in the sample (Chumlea et al. 2003; Herman-Giddens 2006; Sun et al. 2002).

There is reason to believe that pubertal development could differ in rural areas. For example, rural adolescents may have differential environmental exposures compared with urban or suburban adolescents (Cherry et al. 2007), some of which have been linked to pubertal development (Biro et al. 2009; Slyper 2006). Previous studies comparing pubertal development among rural and urban youth, primarily from outside the USA, consistently report a delayed onset of puberty in rural adolescents as compared to their urban counterparts (e.g., Campbell et al. 2004; Facchini et al. 2008; Si and Ohsawa 2000). One study of seventh grade White students in the United States found that the differences in pubertal status between urban and suburban youth varied by sex (Robertson et al. 1992). Rural boys were more developed than boys living in the suburban sample, but urban girls were more developed than suburban girls. The purpose of this study is to describe and compare demographic differences in self-reported pubertal status in a school-based sample of rural youth aged 11 to 17.

METHOD

Data are from the Context of Adolescent Substance Use study (Context Study), a school-based longitudinal study of three cohorts of adolescents from three rural North Carolina counties (Ennett et al. 2006). The three counties had a population density of no more than 250 people per square mile at the time of the 2000 U.S. Census, the guideline for rural counties set by the North Carolina Rural Economic Development Center, Inc. Wave 1 began in the Spring of 2002 when adolescents were enrolled in the 6^{th} to 8^{th} grades and data collection occurred every semester until the Spring of 2004 (Wave 5). At each wave, all adolescents in the grades of interest in the sampled schools (eight middle schools, two K-8 schools, six high schools, and three alternative schools) were considered eligible for participation. Response rates ranged from 88% at Wave 1 to 76% at Wave 5. The Context Study was approved by UNC's School of Public Health IRB in the Office of Human Research Ethics. The study received a waiver of written parental consent; written adolescent assent was obtained. Data were collected by the research team in the schools in a group setting using self-administered questionnaires. Completion time for the questionnaire was approximately one hour and there was no monetary compensation for participation in the study.

The current study is from adolescents who participated in at least one data collection wave (N=6,892). Participants missing demographic information were excluded from analyses

(N=295), as were those not ages 11 to 17 (N=172), yielding a final sample of 6,425. Because there was wide variation in age at each wave, the sample was configured into twelve half-year categories (ages 11 to 16.5). Each half-year category was analyzed as a cross-sectional sample, but each adolescent could contribute information on pubertal status to as many as five age categories. The final sample was 50 percent male, 53 percent White, 36 percent African-American, 4 percent Latino, and 7 percent indicated another racial/ethnic category.

Measures

Pubertal status was assessed using five items each for boys and girls from the Pubertal Development Scale (PDS) (Petersen et al. 1988). Both boys and girls were asked about development of body hair growth, skin changes, and height. Boys were asked about voice changes and facial hair growth and girls were asked about breast changes and if they had ever menstruated. Except for menarche (coded dichotomously), the range of items was 1=not yet started to 4=seems complete. Items were averaged to obtain a mean PDS score (alphas by wave ranged from .68 to .73 for females and .76 to .81 for males).

Age was calculated using date of birth and survey completion date. Sex and race/ethnicity were based on modal self-report across all assessments. Race/ethnicity was coded as White, Black or African-American, Latino, and other (included American Indian/Alaska Native, Asian or other Pacific Islander, multiracial, other, and don’t know).

Analyses

Average perceived pubertal status was calculated at each age. The sample was divided by sex (two groups), race/ethnicity (four groups), and by both sex and race/ethnicity (eight groups) to assess subgroup differences. A one-way analysis of variance (ANOVA) model was conducted for each comparison of means. For the models including racial/ethnic groups, *t*-test comparisons were conducted when the overall *F*-statistic was significant. Analyses were conducted using SAS Version 9.1.

RESULTS

Average pubertal status increased with increasing age (M = 2.03, SD = .61 at age 11 to M = 3.18, SD = .59 at age 16.5, F = 469.67, *P* italic> .001). At all ages, females reported higher pubertal development than males (Table I). White and Black youth tended to report more advanced pubertal development compared with Latino youth, but most of the significant differences were between White and Black youth (Table I). Overall, from ages 11.5 to 13, Black participants reported more advanced pubertal status than White participants, but the difference reversed around age 14.5. This pattern of reversal was evident for Black and White males, but was only evident at age 15 among females (Table II). Although there were no significant differences in pubertal status between Latino males and those of other race/ethnicities, Latino females tended to report less pubertal development at most ages than White or Black females.

DISCUSSION

Similar to previous research, self-reported pubertal status scores increased with increasing age and evened out in later adolescence, and females were more developed than males (Archibald et al. 2003; Biro et al. 2000; Chumlea et al. 2003; Obeidallah et al. 2000; Sun et al. 2002; Tanner 1962). Consistent with other studies, Black participants were more developed than White participants at the earlier ages of 11.5 to 13 (Archibald et al. 2003; Chumlea et al. 2003; Obeidallah et al. 2000; Sun et al. 2002). Unexpectedly, the differences reversed later in adolescence, after age 14, regardless of gender. This reversal has not been reported elsewhere, but this is one of the few studies to examine pubertal status in a rural longitudinal sample diverse and large enough to allow for comparisons by age, gender, and race/ethnicity. Previous research has suggested that Black adolescents begin puberty earlier than White adolescents, but that pubertal maturation completes close to the same time (Archibald et al. 2003; Sun et al. 2002). In contrast, White adolescents in this study caught up with Black youth, and, at the oldest age examined of 16.5 years reported more advanced development than Black adolescents.

The issue of tempo, or the speed through which an adolescent progresses through pubertal development, has been understudied, in part due to the lack of longitudinal data. The limited research that has been conducted has shown a reverse association between pubertal onset and pubertal tempo, such that early developing adolescents progress through puberty slower than later developing adolescents (Dorn and Biro 2011). The patterns we observed for Black and White youth may reflect this reversal.

Latino adolescents generally had the lowest pubertal status scores compared with other racial/ethnic groups, a finding more prominent among females. Previous research with female urban adolescents found that Latino and White adolescents had similar rates of pubertal maturation (Biro et al. 2010; Chumlea et al. 2003; Sun et al. 2002). However, two of these studies used age at menarche as the marker for pubertal development and the other used clinician assessment of Tanner stage, and both of these assessment methods of pubertal status have been shown to differ from the PDS (Dorn and Biro 2011). So it is possible that the differences found in this study are due not only to differences in geographic location, but also to differences in measurement.

Adolescents who indicated a racial or ethnic group other than White, Black, or Latino did not have a consistent pattern of comparison with other racial/ethnic groups. This could be because of the smaller sample size of adolescents who were categorized into this group, or because of the varying racial/ethnic identities that were grouped into this category. Larger samples of adolescents from these groups are needed to describe the patterns of self-reported pubertal status in these subgroups.

There are limitations to this study due to the study sample. The youngest adolescents in the study sample were 11 years of age. The first stages of pubertal development typically begin by age 9 or 10, and early developing adolescents could show signs of maturation as early as age 7 or 8, so differences in pubertal status that could be occurring early on in the development process could not be assessed. The adolescents in this study are from a

longitudinal sample, so while each age was treated as a cross-sectional sample, adolescents could be represented in up to five age categories. The greatest impact of this overlap would be in the middle ages of the sample, where there was the most overlap in the ages of the three cohorts. Furthermore, we did not determine if adolescents in this study regressed in their self-report pubertal status over time and, therefore, the results could include these adolescents.

CONCLUSION

The study results suggest there may be different demographic patterns in pubertal status among rural youth compared with urban youth. This supports previous research, both in the United States and in other countries, which found pubertal development differs between urban and rural youth (Campbell et al. 2004; Facchini et al. 2008; Si and Ohsawa 2000; Robertson et al. 1992). However, the findings raise a number of questions that need to be explored in future studies. This study did not collect clinical measures of pubertal development (e.g., physician reported pubertal status, hormones) so it is not possible to assess the validity of the self-reported measure of pubertal status. Past research has suggested that adolescent self-report of pubertal development varies from physician-reported pubertal status (Dorn and Biro 2011). But most of the research on demographic differences in pubertal status, including this study, has been based on adolescents' self-report measures, such as age at first menarche. More research is needed with samples that include urban, suburban, and rural youth and that are demographically diverse to better understand the pubertal development process among rural youth, especially those who identify as non-White. This study highlights the need for longitudinal samples that will allow assessment and comparison of the tempo of puberty across geographic and demographic subgroups.

Acknowledgments

We thank Drs. Antonio Morgan-Lopez, Vangie Foshee, Jo Anne Earp, and Jill Hamm for their feedback.

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Table I

Mean pubertal stage by age, sex, and race/ethnicity.

		Sex				Race/Ethnicity				
Age	**N**	**Total**	**Male**	**Female**	**F-value**	**White**	**Black**	**Latino**	**Other**	**F-value**
11.0	167	2.03	1.86	2.15	9.82**	2.02	2.10	1.79	2.09	1.04
11.5	843	2.20	2.01	2.37	78.76***	2.12	2.35	2.10	2.16	8.74*** *a*
12.0	1555	2.37	2.13	2.58	225.25***	2.28	2.52	2.19	2.45	18.43*** *acdf*
12.5	2315	2.53	2.30	2.72	307.72***	2.47	2.61	2.44	2.61	9.83*** *ad*
13.0	3069	2.69	2.44	2.90	523.57***	2.65	2.74	2.65	2.68	4.60** *a*
13.5	3458	2.83	2.60	3.04	622.63***	2.83	2.85	2.65	2.81	4.55** *bdf*
14.0	3432	2.93	2.72	3.13	592.75***	2.95	2.92	2.81	2.99	3.85** *bf*
14.5	2825	3.03	2.84	3.23	420.93***	3.07	2.99	2.89	3.05	7.04*** *ab*
15.0	2133	3.11	2.92	3.31	323.19***	3.16	3.03	3.05	3.16	9.12*** *ae*
15.5	1410	3.17	2.94	3.38	192.22***	3.23	3.11	3.05	3.19	5.42*** *a*
16.0	762	3.21	3.02	3.45	124.61***	3.31	3.12	2.98	3.15	8.55*** *ab*
16.5	176	3.18	3.07	3.40	13.05***	3.31	3.10	2.94	3.29	2.65

Range of pubertal stage is 1–4, with higher values indicating more advanced pubertal development

a–f Different superscripts indicate significant difference in means: a=White vs. Black, b=White vs. Latino, c=White vs. Other, d=Black vs. Latino, e=Black vs. Other, f=Latino vs. Other

* *p*bold>.05,

** *p* <.01,

*** *p* <.001

Table II

Mean pubertal stage by age and race/ethnicity, among males and females.

	Males					Females				
Age	**White**	**Black**	**Latino**	**Other**	**F-value**	**White**	**Black**	**Latino**	**Other**	**F-value**
11.0	1.77	1.95	1.66	2.15	1.61	2.13	2.28	1.91	2.06	0.65
11.5	1.92	2.15	1.98	2.04	5.91*** *a*	2.29	2.53	2.20	2.28	4.92** *a*
12.0	2.06	2.27	2.09	2.13	8.56*** *a*	2.49	2.73	2.31	2.65	11.16*** *ad*
12.5	2.26	2.37	2.33	2.33	3.70* *a*	2.67	2.79	2.57	2.81	5.49*** *a*
13.0	2.43	2.46	2.55	2.35	1.88	2.87	2.96	2.80	2.89	3.77** *a*
13.5	2.62	2.57	2.53	2.59	1.24	3.03	3.06	2.81	3.01	4.09** *bd*
14.0	2.75	2.66	2.74	2.80	3.95** *a*	3.15	3.13	2.88	3.13	6.01*** *bdf*
14.5	2.88	2.76	2.88	2.85	5.11* *a*	3.26	3.20	2.91	3.22	8.13*** *bdf*
15.0	2.99	2.79	3.00	2.93	11.56*** *a*	3.35	3.26	3.11	3.33	4.74** *ab*
15.5	3.08	2.83	2.92	2.99	10.58*** *a*	3.41	3.36	3.22	3.37	1.38
16.0	3.15	2.85	2.91	2.80	11.55*** *ac*	3.52	3.38	3.12	3.47	3.78* *b*
16.5	3.24	2.95	2.85	3.16	2.77*	3.47	3.37	3.16	3.52	0.50

Range of pubertal stage is 1–4, with higher values indicating more advanced pubertal development

a–f Different superscripts indicate significant difference in means: a=White vs. Black, b=White vs. Latino, c=White vs. Other, d=Black vs. Latino, e=Black vs. Other, f=Latino vs. Other

* $p < .05$,

** $p < .01$,

*** $p < .001$