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J Abnorm Child Psychol. Author manuscript; available in PMC 2009 November 5.

Published in final edited form as:
J Abnorm Child Psychol. 2008 November ; 36(8): 1227–1236. doi:10.1007/s10802-008-9245-5.

The development of aggression during adolescence: Sex differences in trajectories of physical and social aggression among youth in rural areas

Katherine J. Karriker-Jaffe[1], **Vangie A. Foshee**[1], **Susan T. Ennett**[1], and **Chirayath Suchindran**[2]

[1]Department of Health Behavior and Health Education, University of North Carolina at Chapel Hill, Chapel Hill, NC

[2]Department of Biostatistics, University of North Carolina at Chapel Hill, Chapel Hill, NC

Abstract

Few studies have examined the development of social aggression over time or described trajectories of aggressive behaviors for youth living in rural areas. We compared the timing and patterns of physical and social aggression and examined sex differences in development using five waves of in-school surveys administered over 2.5 years. The sample (N=5151) was 50.0% female, 52.1% white and 38.2% African-American. At baseline the average age was 13.1 years. Multilevel growth curve models showed that physical and social aggression followed curvilinear trajectories from ages 11 to 18, with increases in each type of aggression followed by subsequent declines. Physical aggression peaked around age 15; social aggression peaked around age 14. Boys consistently perpetrated more physical aggression than girls, but the trajectories were parallel. Girls and boys perpetrated the same amount of social aggression at all ages. We discuss implications for prevention programming to address the marked increases in both types of aggression observed during early adolescence.

Keywords

adolescent behavior; aggression; latent growth curve; multilevel models

Longitudinal studies of the developmental trajectories of aggression can illuminate changes in perpetration over time and can depict typical behavioral patterns that characterize adolescent development. However, trajectories of different types of aggression and sex differences in the development of aggression have not been adequately documented, particularly in nonmetropolitan areas. The present study addresses these issues by examining trajectories of both physical and social aggression and describing how they differ for males and females using longitudinal data collected in three predominantly rural counties in the southeastern United States.

Aggression takes many forms, ranging from social and verbal aggression to physical aggression and more serious kinds of violence. Physical aggression includes behaviors that threaten or cause physical harm, such as threats of bodily harm, physical fighting and violent crimes such as robbery, rape and homicide (Loeber & Hay, 1997; Yonas, O'Campo, Burke, Peak, & Gielen, 2005). In contrast, social aggression encompasses various forms of non-physical aggression,

Correspondence concerning this manuscript should be addressed to Katherine Karriker-Jaffe, who is now at the Alcohol Research Group, 6475 Christie Avenue, Suite 400, Emeryville, CA 94608-1010. Phone: (650)245-1977. Fax: (510)985-6459. kkarrikerjaffe@arg.org.

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such as indirect and relational aggression, in which behaviors are focused on damaging social relationships rather than inflicting or threatening physical harm (Archer & Coyne, 2005). Socially aggressive behaviors include gossiping (Xie, Swift, Cairns, & Cairns, 2002), excluding or alienating someone socially (Xie, Swift et al., 2002), and trying or threatening to damage someone's social standing within a group (Crick & Grotpeter, 1995). Both types of aggression are common among youth in nonmetropolitan areas (Farrell, Kung, White, & Valois, 2000).

Although many studies have focused on the etiology of aggression, few have compared developmental trajectories of these behaviors during adolescence. Physical and social aggression have different relationships with risk factors and psychosocial variables (Crick & Grotpeter, 1995; Xie, Swift et al., 2002), and they have different consequences for perpetrators and victims (Lagerspetz, Björkqvist, & Peltonen, 1988). For example, social aggression is less likely than physical aggression to be detected and punished by authority figures or to be avenged by victims (Xie, Cairns, & Cairns, 2005). This study examines the development of physical and social aggression from ages 11 to 18 using multilevel growth curve models to determine whether both types of aggression follow similar developmental trajectories.

Statistical procedures such as multilevel and random effects modeling describe developmental changes by depicting patterns, or trajectories, of behavior over several months or years using repeated measures of an outcome variable (Raudenbush, 2001). With few exceptions, longitudinal trajectories of physical aggression (Aber, Brown, & Jones, 2003; Farrell, Sullivan, Esposito, Meyer, & Valois, 2005) and violence (Sampson, Morenoff, & Raudenbush, 2005) exhibit a curvilinear pattern that shows an increase in activity during early adolescence that peaks late in adolescence and then declines. Curvilinear trajectories have been described for similar outcomes such as delinquency as well (Farrell et al., 2005; Windle, 2000), but one study of Dutch adolescents depicted a negative linear trajectory using parents' reports of their child's aggression from ages 4 to 25 (Bongers, Koot, van der Ende, & Verhulst, 2003). Age-offending curves, which use aggregated cross-sectional data to depict the prevalence of aggressive or antisocial behaviors for different age groups, also suggest curvilinear trends during adolescence and young adulthood (Benson, 2002; Elliott, 1994; Fergusson & Horwood, 2002; Loeber & Hay, 1997; Tolan, Gorman-Smith, & Loeber, 2000). For example, the Pittsburgh Youth Study showed curvilinear trends in aggression among boys that peaked between 15 and 16 years of age and then started to decline (Loeber & Hay, 1997).

Generally, aggressive behaviors progress from less to more severe over the course of adolescent development (Loeber & Hay, 1997; Tolan et al., 2000). Although no studies have compared the development of physical and social aggression during adolescence, some research suggests that the trajectories of these two types of aggression may differ (Loeber & Hay, 1997; Tolan et al., 2000). For example, one study of urban, high-risk, African-American and Latino boys noted higher prevalence rates, an earlier age of onset and an earlier peak age of involvement for socially aggressive behaviors such as teasing or being mean to others when compared to physically aggressive behaviors such as physical fighting or violent crimes (Tolan et al., 2000). Similarly, other studies suggest that social aggression may increase between the ages of 8 and 14 years of age (Connor, 2002), or that it may peak in late childhood or preadolescence (Archer & Coyne, 2005), which is earlier than the peak age of involvement typically observed for physical aggression. In contrast, some studies have found that social aggression develops later in adolescence, as social skills and awareness of interpersonal relationships become more advanced (Archer & Coyne, 2005; Cairns, Cairns, Neckerman, Ferguson, & Gariépy, 1989; Xie, Swift et al., 2002). However, most research on social aggression has been cross-sectional (Conway, 2005), and no studies have described developmental trajectories of social aggression during adolescence. Thus, the first aim of this study was to describe the trajectories for physical and social aggression. We expected the average trajectories for both physical and social

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aggression to be curvilinear, with a positive linear slope and a negative quadratic slope. We also ascertained whether the average trajectory for social aggression showed a higher initial level (reflecting an earlier age of onset) or an earlier peak age (indicating an earlier age of desistance) than the average trajectory for physical aggression.

Although average trajectories are informative, there are important sex differences in aggression during adolescence that suggest that the developmental trajectories may differ for males and females. Males typically have higher rates of involvement in physical aggression and violence than females (Blitstein, Murray, Lytle, Birnbaum, & Perry, 2005; Blum et al., 2000; Bongers et al., 2003; Elliott, 1994; Farrell et al., 2000; Farrell et al., 2005; Fergusson & Horwood, 2002; Heimer & DeCoster, 1999; Loeber & Hay, 1997; Xie, Cairns, & Cairns, 2002), and data from national surveys suggest that male high school students in the U.S. are more likely than females to get in physical fights and to take weapons to school (U.S. Department of Health and Human Services, 2000). Despite sex differences in prevalence, curvilinear patterns of physical aggression and violence appear for both males and females in trajectory studies (Farrell et al., 2005; Sampson et al., 2005) and in sex-stratified age-offending curves (Elliott, 1994; Fergusson & Horwood, 2002; Loeber & Hay, 1997). However, the developmental trajectories for males and females may differ in several ways. Silverthorn and Frick (1999) hypothesize that antisocial behaviors among girls are delayed when compared to boys. This hypothesis is supported by studies showing that females exhibit a later age of onset than males for most aggressive behaviors (Connor, 2002; Fergusson & Horwood, 2002; Loeber & Hay, 1997). These data suggest that the trajectories for the boys in our sample would show higher initial levels of physical aggression than the trajectories for girls. Additionally, sex differences in physical aggression become more extreme throughout puberty, as males continue involvement in aggression after females have begun the process of desistance (Fergusson & Horwood, 2002; Loeber & Hay, 1997). In fact, longitudinal studies have determined that young women have rates of serious violence that are just one-quarter those of young men by age 17 (U.S. Department of Health and Human Services, 2001), and some evidence suggests that the age-offending curve for crime committed by girls may peak as early as age 14 (Molnar, Browne, Cerdá, & Buka, 2005). These studies suggest that boys' physical aggression trajectories would have later peak ages of involvement than the girls' trajectories.

In contrast to physical aggression, many studies suggest that social aggression is more common among girls than boys at all ages (Archer & Coyne, 2005; Connor, 2002; Crick, 1997; Crick & Grotpeter, 1995; Kulig, Hall, & Grant Kalischuk, 2006; Xie, Swift et al., 2002), although one study found few sex differences in social aggression in a sample of rural sixth graders in the southeastern U.S. (Farrell et al., 2000). Since no longitudinal studies have described the trajectories of social aggression during adolescence for either males or females, there is little evidence to suggest specific differences in boys' and girls' developmental trajectories of social aggression during adolescence. To better understand sex differences in physical and social aggression perpetration during adolescence, the second aim of this study was to determine whether sex predicts aspects of trajectories of physical and social aggression between ages 11 and 18. As noted above, we expected the average trajectories of physical and social aggression for both males and females to be curvilinear, with a positive linear slope and a negative quadratic slope. Additionally, we hypothesized that adolescent males would show higher initial levels of physical aggression than adolescent females, but adolescent females would show higher initial levels of social aggression than males. We also expected adolescent females to show an earlier peak age of involvement in both physical and social aggression than males.

Methods

The data for this study come from the longitudinal, school-based Context of Adolescent Substance Use Study, which was designed to investigate contextual influences on adolescent

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substance abuse and aggression, with a focus on peer networks, family characteristics and neighborhood factors (Ennett et al., 2006). The study included adolescents from the public schools in three predominantly rural counties in North Carolina. These counties are eligible for targeted federal funds for health services due to their rural location and low population density and are classified as nonmetropolitan areas with access to an interstate highway (Ricketts, Johnson-Webb, & Randolph, 1999). As shown in Table 1, these counties also have greater proportions of African-Americans than does the general United States population, and the median household income and median housing value are lower than the national medians (U.S. Census Bureau, 2002).

Study Design

The Context of Adolescent Substance Use Study consisted of three components: (1) in-school surveys with adolescents (county-wide census), (2) telephone interviews with a randomly sampled cohort of parents, and (3) linking U.S. Census data with geocoded addresses. This paper includes data from all five waves of the in-school surveys, and the analyses account for clustering of students resulting from the school-based data collection procedures.

Five waves of data were collected from adolescents in schools every 6 months between spring 2002 and spring 2004, beginning when the students were in sixth, seventh or eighth grade and ending when they were in eighth, ninth or tenth grade. At each wave, all adolescents in the public schools in the three study counties were eligible for participation (approximately 6,100 students) except those who could not complete the questionnaire in English (approximately 15 students) and those who attended only special education classes (approximately 300 students). The average response rate across all waves was 81.1%.

At each wave, new students who met the inclusion criteria entered the study. Parents were notified about the study and had the opportunity to refuse consent for their child's participation at the beginning of each academic year and whenever a new student became eligible for the study. Trained research assistants administered questionnaires on at least two different occasions at each school to allow those students who had been absent on the primary day of data collection to participate in the study on the make-up day. To maintain confidentiality, all teachers remained at their desks while the students completed their questionnaires, and the students placed their questionnaires in envelopes before returning them to the data collectors. The Public Health Institutional Review Board at The University of North Carolina at Chapel Hill approved all study protocols.

Student addresses received from the schools were sent to a commercial geocoding firm to be matched with U.S. Census block groups. Almost all (99.6%) of the Wave 1 addresses were successfully geocoded, and the geocodes included all block groups in the three study counties (n=113), as well as some additional block groups from surrounding areas (n=40). Because schools draw their students from different neighborhoods, we used the students' neighborhoods (defined by the Wave 1 block group) as the unit of clustering. Although neighborhoods are imperfectly clustered within schools, other researchers have found similar results when comparing data on adolescent outcomes clustered by school to data clustered by neighborhood (Cook, Herman, Phillips, & Settersten, 2002). Additionally, studies have found that U.S. census block groups adequately delineate social and structural determinants of health and health behavior (Cook, Shagle, & Degirmencioglu, 1997; Krieger et al., 2002).

Sample

The analysis sample (N=5151) includes those adolescents who completed a Wave 1 questionnaire, except for those who were younger than 11 or older than 16.5 (N=26) at Wave 1, those who did not give their birth date or sex on any of the five questionnaires (N=8), and

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those without a Wave 1 block group geocode (N=35). The age restriction was imposed to limit the number of students who were out of the typical age range for their grade, and the block group was necessary to account for similarities among students from the same neighborhood.

The students completed the Wave 1 survey at thirteen different schools drawn from 153 block groups. Overall response rates for the analysis sample ranged from 86.4% at Wave 2 to 79.4% at Wave 5. Of the students in the sample, 55.8% participated in the study at all five waves, 15.5% participated in four waves, 15.1% in three waves, 5.4% at just two waves and 8.2% only at Wave 1. Procedures for imputing missing data are described in the analysis section.

At Wave 1, the sample was approximately equally divided among the sixth (35.5%), seventh (33.1%) and eighth (31.4%) grades, and the majority of students (95.6%) were between the ages of 11 and 14 (*M*=13.1 years). Half (50.0%) of the sample was female, and 51.2% of the students were white, 38.2% were black or African-American, 3.8% were Hispanic or Latino and 5.9% were another race or ethnicity (including multiracial or mixed race, American Indian or Native American, Asian or Pacific Islander, or "other"). Most students (80.0%) lived with two parents (including biological and step-parents), and 73.1% had at least one parent with some college, community college or technical school training. At Wave 1, 48.5% of students had perpetrated physical aggression (45.1% of sixth graders, 48.1% of seventh graders, and 53.0% of eighth graders) and 69.5% had perpetrated social aggression (64.3% of sixth graders, 69.3% of seventh graders, and 75.6% of eighth graders).

Measures

Although there are many metrics for the passage of time in longitudinal studies (Curran & Willoughby, 2003), to be consistent with prior research on youth aggression, this study models both outcomes as a function of chronological age. To reduce errors associated with birth dates reported incorrectly by younger respondents, age was calculated based on the modal birth date (modal month, modal day and modal year) for all available waves of data. Age was centered by subtracting 11 (the youngest age in the sample at Wave 1) so that the intercepts could be interpreted easily.

Physical and social aggression were measured at all five waves. The physical aggression scale (Farrell et al., 2000) assessed how many times in the past three months the respondent had been in a fight in which someone was hit, hit or slapped another kid, threatened to hurt a teacher, and threatened someone with a weapon. The social aggression scale (Farrell et al., 2000) included the following items: excluded another student from his or her group of friends, spread a false rumor about someone, picked on someone, and started a fight between other people. The response options for each item were *none* (0), *1–2 times* (1), *3–5 times* (2), *6–9 times* (3), or *10 or more times* (4). The responses were summed to form a continuous total score for each type of aggression, such that higher scores indicated higher levels of aggression. To adjust for skewness, the total aggression scores were log-transformed after adding a constant. The Cronbach's alpha ranged from .68 for both the physical aggression scale (*M*=1.27, *SD*=2.03) and the social aggression scale (*M*=2.09, *SD*=2.48) at Wave 1 to .86 for the physical aggression scale (*M*=1.36, *SD*=2.94) and .83 for the social aggression scale (*M*=2.05, *SD*=3.20) at Wave 5.

We determined values for the demographic variables based on all available data across the five waves of questionnaires. Sex was coded with female as the reference category. The analyses control for other demographic characteristics, including the adolescent's race or ethnicity, parent education, and family structure. The student's self-reported race or ethnicity was based on the modal response across all waves, and it was represented by three mutually-exclusive dummy variables (black or African-American, Hispanic or Latino, or other race/ethnicity) with white as the reference category. Parent education was measured by the highest level of

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education attained by either parent, and it included *less than a high school education* (0), *graduated from high school* (1), *some college, community college or technical school* (2), *graduated from community college or technical school* (3), *graduated from college* (4), and *graduate or professional school after college* (5). Family structure was a dichotomous variable indicating residence in a single-parent household at any time during the study, with continuous residence in a two-parent household as the reference group.

Imputation of Missing Data

Missing values are common in longitudinal research with adolescents (Faden et al., 2004). To minimize the possible impact of attrition over time, missing values were replaced using multiple imputation procedures (Rubin, 1987). First, we specified a missingness equation to guide the imputation. This equation included the dependent variables at all five waves, the independent variables, variables highly correlated with the outcomes from all five waves, variables containing special information about the sample and other variables thought to be associated with missingness (Allison, 2000; Horton & Lipsitz, 2001; Patrician, 2002). All of the variables included in the imputation were either continuous or dichotomous (Allison, 2005), and we confirmed that the variables were not collinear using eigenanalysis (Belsley, Kuh, & Welsch, 1980) and by inspecting variance inflation factors (Neter, Wasserman, & Kutner, 1990). Then we used SAS PROC MI (SAS Institute, 2003) to impute ten sets of missing values based on the missingness equation using the Markov Chain Monte Carlo (MCMC) specification (Yuan, 2000). We bounded the imputed values to the valid ranges of the data, and we allowed all imputed dichotomous variables to range between 0 and 1 rather than rounding the values, in accordance with the recommendations of Allison (2005). Finally, the analysis results were combined across the ten imputed datasets using SAS PROC MIANALYZE (Horton & Lipsitz, 2001), which accounts for the uncertainty of the imputation process when calculating summary test statistics, parameter estimates and standard errors. All models had relative efficiencies greater than .95, which suggests that the number of imputations was sufficient to achieve stable estimates (Horton & Lipsitz, 2001).

Analysis Strategy

We used multilevel growth curves to model each outcome (physical and social aggression) from ages 11 to 18. All analyses used PROC MIXED in SAS version 9.1 on a SunOS 5.9 platform (SAS Institute, 2003) using a restricted maximum likelihood estimation process and the Kenward-Roger adjustment of the standard errors and degrees of freedom for more conservative tests of the fixed effects (Kenward & Roger, 1997).

Multilevel Models—Random effects models (including multilevel models and latent growth curve analyses) can be used to describe patterns or trajectories of behavior over time, as well as to assess predictors of those trajectories (Curran & Willoughby, 2003; Guo & Hipp, 2004; Raudenbush & Bryk, 2002). In the modeling process, within-person (level-1) models define a trajectory for each individual in the sample, and then between-person, individual-level (level-2) models provide the means and variance of the trajectories across the individuals in each cluster (Curran & Willoughby, 2003). Additional level-3 models provide information on the variability of trajectories between clusters. A general multilevel equation with individual-level predictors can be specified as:

$$\boldsymbol{Y}_{tij}=\boldsymbol{\pi}_{0ij}+\boldsymbol{\pi}_{1ij}(\mathrm{AGE})_{tij}+\boldsymbol{\pi}_{2ij}\left(\mathrm{AGE}^{2}\right)_{tij}+\mathbf{e}_{tij} \qquad i=1,\ldots,5151;j=1,\ldots,153 \tag{1}$$

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$$\pi_{pij}=\beta_{p0j}+\sum_{q=1}^{Q_p}\beta_{pqj}X_{qij}+r_{pij} \qquad p=0, 1, 2 \tag{2}$$

$$\beta_{pqj}=\gamma_{pq0}+u_{pqj} \qquad p=0, 1, 2; q=0, 1, \ldots, Q_p \tag{3}$$

The level-1 model (1) denotes change over time within individuals. In this study, Y_{tij} represents the observed aggression score at age t for child i in neighborhood j, and it is a function of a quadratic curve plus random error (e_{tij}). Thus, π_{0ij} is the total aggression score of child$_{ij}$ at age 11, π_{1ij} is the linear slope for aggression for child$_{ij}$, and π_{2ij} is the quadratic slope for child$_{ij}$. The level-2 models (2) denote differences between individuals within clusters, and they are used to predict the parameters from the level-1 model. To test the study hypotheses, we used sex to predict the intercept, linear slope and quadratic slope from the level-1 model. Based on preliminary analyses, we also allowed the control variables (race/ethnicity, parent education and family structure) to predict the level-1 intercept and linear slope. β_{p0j} is the intercept for neighborhood j in modeling the child effect π_{pij}, where X_{qij} is one of the Q_p individual-level covariates characteristic of child i in neighborhood j. β_{pqj} represents the effect of X_{qij} on the pth growth parameter, and r_{pij} are the random effects for each child. The level-3 model (3) accounts for clustering within neighborhoods by adding a random effect for each neighborhood (u_{00j}) when predicting the intercept from the level-2 model (β_{00j}). The level-2 linear and quadratic slopes are fixed between neighborhoods ($u_{1qj} = 0$ and $u_{2qj} = 0$).

Based on preliminary analysis, we included three random effects in the models (neighborhood intercept, individual intercept and individual linear slope), and we allowed the level-2 random effects to correlate. At the individual level, the random effects indicate variability of individual trajectories. At the neighborhood level, the random effects indicate the level of variability across the different neighborhoods in the sample.

Analyses to Test Study Hypotheses—In accordance with the first aim of the study (to describe the trajectories of physical and social aggression), we used unconditional models to depict the observed aggression score at age t for child i in neighborhood j as a function of a quadratic curve plus random error terms for each cluster (u_{00j}), for each child within each cluster (r_{0ij} and r_{1ij}), and for each child over time (e_{tij}). We used the unconditional models and a model including sex as a covariate to test the hypotheses about curvilinear trajectories. To test whether the aggression trajectories were curvilinear, we first assessed whether the trajectories were flat (if a joint F-test indicated that both the linear and quadratic slopes were not significantly different from zero). Then, we evaluated whether there was a significant positive linear slope, and finally we confirmed whether there was a significant negative quadratic slope. Under a quadratic model, the peak age is obtained from the first derivative using a ratio of the regression coefficients ($-B_{age}/2B_{age\text{-}squared}$). A Taylor series approximation (the delta method) was used to obtain the standard error of the estimated peak age for physical and social aggression (Sen & Singer, 1993). Because the MIANALYZE procedure does not include the covariance parameters from mixed models, we combined the covariance parameters for the unconditional models across the ten imputed datasets using the formulas provided by Rubin and Schafer (1997). We also calculated the correlation between the random individual intercept and the random individual linear slope to describe how initial levels of aggression were related to change over time.

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The second aim of the study was to determine whether sex predicts the initial levels and trajectories of physical and social aggression. For these analyses, we used conditional models that included sex, interactions of sex with age and age-squared, and the individual-level control variables (main effects and interactions with age) as predictors of the two types of aggression. The conditional models were simplified using backwards elimination to remove any product terms involving sex and age or age-squared that were not statistically significant, but interactions involving the control variables and age were not trimmed from the model.

Results

The unconditional models describing the basic physical and social aggression trajectories are presented in Table 2. In accordance with our hypotheses, the joint *F*-tests of the linear and quadratic slopes for physical aggression (F (2, 81.38) = 31.86, $p < .01$) and social aggression (F (2, 169.12) = 56.83, $p < .01$) and the direction of the coefficients (significant positive linear slopes and significant negative quadratic slopes) suggest that the trajectories for both physical and social aggression were curvilinear, with initial increases in aggression followed by declining values after age 14.9 for physical aggression and after age 13.8 for social aggression. As hypothesized, the initial levels of social aggression were higher than the initial levels of physical aggression among the students in the study, and social aggression peaked 12 months earlier than physical aggression.

Description of the random effects also comes from the unconditional models (see Table 2). For physical aggression, the variances of the three random effects were significant. The random neighborhood intercept indicates that there was significant variation between neighborhoods in the initial levels of physical aggression. The random individual intercept shows there was significant variation in the initial levels of physical aggression between individuals nested within neighborhoods, and the random individual slope indicates there was significant variation in the linear change over time between individuals nested within neighborhoods. There was a strong negative correlation between the random individual intercept and the random linear slope ($r = -0.56$), which suggests that those adolescents who had higher initial levels of physical aggression showed slower rates of linear change over time. In contrast, those who had lower initial levels of physical aggression increased more rapidly over time.

For social aggression, the variances of two of the random effects were significant. The random individual intercept and the random individual slope indicate that there was significant variation in both the initial levels and linear change in social aggression over time between individuals nested within neighborhoods. There was not a significant amount of variation between neighborhoods in the initial levels of social aggression. As with physical aggression, there was a strong negative correlation between the random individual intercept and the random linear slope ($r = -0.68$) for social aggression. Those adolescents who had higher initial levels of social aggression showed slower rates of linear change over time, and those who had lower initial levels of social aggression increased more rapidly over time.

Results from the reduced conditional models also are presented in Table 2. In accordance with our hypotheses, joint *F*-tests from conditional models assessing the effect of sex alone (not shown) for physical aggression (F (2, 80.25) = 30.42, $p < .01$) and social aggression (F (2, 167.61) = 56.84, $p < .01$) and the direction of the coefficients (both outcomes showed significant positive linear slopes and significant negative quadratic slopes) suggest that the trajectories for both physical and social aggression were curvilinear even when accounting for sex. There was partial support for our hypotheses about sex differences in the trajectories. There was a significant main effect for sex for physical aggression, but not for social aggression. This indicates that males had higher initial levels of physical aggression than females, but there was no significant difference in the levels of social aggression at age 11 between males and females.

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The final reduced model was a main effects model, and there were no significant interactions between sex and age-squared or age. Thus, the growth curves for males and females were the same shape, and there was no support for the hypothesis regarding sex differences in the peak age of involvement in physical or social aggression. Essentially, the curves for males and females were parallel for physical aggression, with males perpetrating more than females at all ages, and the curves for social aggression were not significantly different for males and females in terms of shape or magnitude.

Discussion

This study used multilevel growth curve models to document aggression trajectories during adolescence. Perpetration of physical and social aggression followed curvilinear trajectories from ages 11 to 18, with increases in each type of aggression followed by subsequent declines. Girls had significantly lower initial levels of physical aggression than boys at age 11, and boys consistently perpetrated more physical aggression than girls did, although the trajectories were parallel. There was no sex difference in the initial levels of social aggression, and girls and boys perpetrated the same amount of social aggression at all ages studied.

As hypothesized, the trajectories for both physical and social aggression were curvilinear. These findings are similar to results from other studies that have observed curvilinear patterns of physical aggression (Farrell & Sullivan, 2004; Farrell et al., 2005), violence (Sampson et al., 2005), and delinquency (Windle, 2000) during adolescence, but they directly contradict studies that suggest a negative linear trend in adolescent aggression over time (Bongers et al., 2003; Cairns et al., 1989; Lauritsen, 1998). Additionally, the peak ages of involvement in physical and social aggression are comparable to the findings of Farrell and colleagues (2005), who determined that physical aggression peaked in seventh and eighth grade (ages 13 to 14) in two samples of adolescents from rural and urban areas. However, the peak ages for the outcomes in the current study were earlier than the peak ages documented by others for more serious violent behaviors. For example, Sampson and colleagues (2005) found the highest levels of violence among young adults to be between ages 17 and 18. The progression from perpetration of minor aggression to committing more serious acts of violence in samples of boys has been established by Loeber and Hay (1997) and Tolan, Gorman-Smith and Loeber (2000), among others. The timing of the increase in aggression for both boys and girls in the current study is consistent with the developmental patterns described by these researchers, although future studies should seek to reproduce these findings in other samples of adolescents since the confidence intervals around the peak ages for our sample were wide (particularly for physical aggression).

In accordance with our hypotheses, social aggression began at higher levels and peaked 12 months earlier than physical aggression. We are unable to compare these findings to those of other researchers, since no studies have described developmental trajectories of social aggression during adolescence. Other studies show that social aggression begins to increase in late childhood and early adolescence (Connor, 2002; Xie et al., 2005), which is what our findings suggest. However, different authors have suggested that social aggression develops later than physical aggression, since it is dependent upon the development of advanced social skills (Archer & Coyne, 2005; Pepler & Craig, 2005). One explanation is that variations in the conceptualization and measurement of social aggression contribute to the differences observed across studies. Social aggression is difficult to measure well among adolescents (Archer & Coyne, 2005), and some studies rely on teacher- or peer-reports of behavior, rather than asking adolescents to describe their own socially aggressive behaviors. This may partially explain the differences noted between studies. Alternatively, it may be that there are two developmental peaks for physical aggression, one in early childhood (Connor, 2002) and one in adolescence (Connor, 2002; Moffitt, 1993), and that social aggression is most prevalent in between the two

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physical aggression stages. Thus, social aggression would appear after early childhood physical aggression but before physical aggression begins to increase again in adolescence. The contribution of future longitudinal studies of aggression would be maximized by spanning childhood to late adolescence, as well as by including multiple sources of data on both physically and socially aggressive behaviors to better document the transitions between diverse types of aggression during adolescent development.

The negative correlation that we observed between the individual intercept and the linear slope suggests that adolescents who had higher initial levels of physical and social aggression showed slower linear increases in perpetration over time. This is predicted by Moffitt's (1993) developmental taxonomy of antisocial behavior, in that life-course persistent trajectories should start at high levels and stay high over time, demonstrating a high intercept and slow linear change. In contrast, Moffitt (1993) hypothesizes that adolescence-limited trajectories should start at lower levels but show a more rapid increase (and a more rapid deceleration) over time. Few trajectory studies have examined the correlation between initial levels and rates of change over time. In a study of delinquency during adolescence, Windle (2000) described trajectories in which the intercept was positively correlated with the linear slope but negatively correlated with the quadratic slope, which is somewhat different from what Moffitt's taxonomy would suggest. Since we had data from only five points in time, we were unable to allow the quadratic slope to vary randomly; thus, it is unclear whether there were individual differences in acceleration or deceleration over time in this sample.

The hypotheses about sex differences in the aggression trajectories were partially supported. There was a significant main effect of sex on initial levels of physical aggression, with males perpetrating more physical aggression than females, but there was no effect of sex on initial levels of social aggression. Physical aggression perpetrated by girls may be more likely to be negatively sanctioned by peers and authorities such as teachers or parents than social aggression (Archer & Coyne, 2005; Crick, 1997; Xie, Swift et al., 2002), which may contribute to the sex differences in levels of physical aggression documented in this study and by others (Blum et al., 2000; Bongers et al., 2003; Farrell et al., 2000; Farrell et al., 2005; Fergusson & Horwood, 2002; Loeber & Hay, 1997; Sampson et al., 2005; Xie, Cairns et al., 2002). Most studies suggest that females engage in more social aggression than males (Archer & Coyne, 2005; Connor, 2002; Crick, 1997; Crick & Grotpeter, 1995; Xie, Swift et al., 2002), but the lack of a significant effect of sex on initial levels of social aggression that we documented is similar to the findings of Farrell and colleagues (2000) and Conway (2005). Future aggression research involving both children and adolescents should include measures of socially aggressive behaviors to further examine sex differences in the etiology of this type of aggression.

There was no support for the hypothesis regarding sex differences in the peak age of involvement in physical or social aggression. Other studies have shown that both males and females follow curvilinear trajectories of aggression and violence during adolescence (Farrell et al., 2005; Sampson et al., 2005), and Farrell and colleagues (2005) also noted that there were no sex differences in the peak ages of involvement in either aggression or delinquency. Since few studies have explicitly examined the nature of sex differences in the development of youth risk behaviors such as aggression, there is great promise for future investigations of this topic.

This study has several methodological strengths. First, a large census of adolescents completed five waves of questionnaires across three counties. The response rates for the in-school surveys were high, and the adolescent sample was demographically diverse. We also replaced missing data using multiple imputation procedures that used many established predictors of physical and social aggression to fill in missing values in order to minimize attrition bias. This study does have limitations that deserve mention. Because our sample was from a predominantly rural area, the generalizability of the results may be limited to similar contexts, particularly

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those with large populations of African-Americans or with lower median incomes than the national levels. However, we found levels of physical and social aggression that were similar to those documented in other studies with youth of similar ages (Farrell et al., 2000), and the trajectory patterns we documented resemble those from other studies.

Understanding sex differences in the development of various types of aggression during adolescence can guide the development of violence prevention programs. The high rates of aggressive behaviors documented for our rural sample suggest that such programs should address social and physical aggression perpetrated by both males and females and that interventions should begin early to have the most impact on aggression during adolescence. Expanding the targeted behaviors and the audiences for prevention initiatives will help to alleviate the problem of youth violence in the future.

Acknowledgments

The Context of Adolescent Substance Use study was funded by the National Institute on Drug Abuse (R01 DA16669) and the Centers for Disease Control and Prevention (R49 CCV423114). We would like to thank Thad Benefield, John Hipp, and Bob Faris for their programming assistance, and Karl Bauman and Daniel Bauer for reviewing early drafts of this manuscript.

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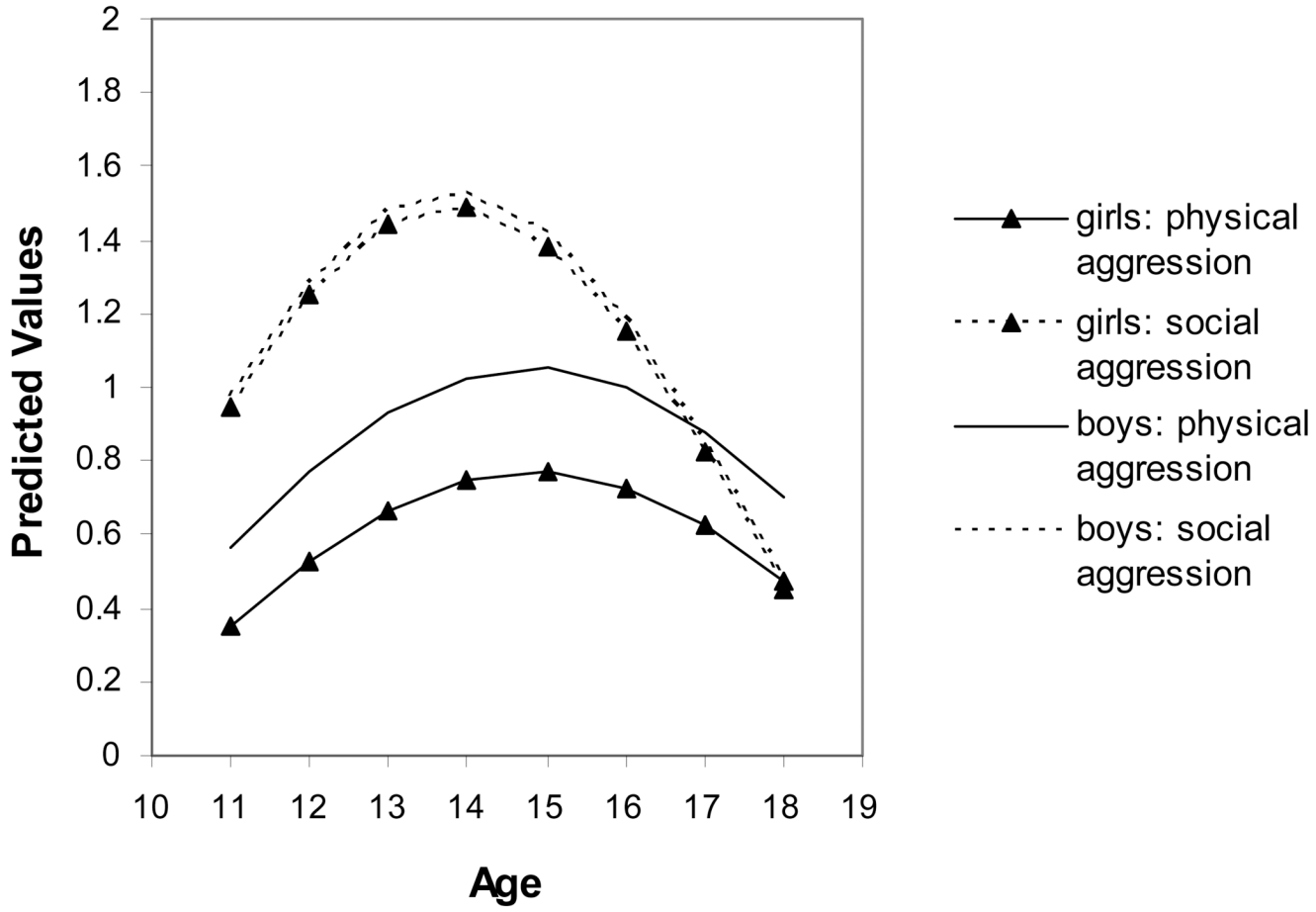

Figure 1.
Sex-specific conditional trajectories of physical and social aggression from ages 11 to 18

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Table 1

Comparison of demographic data for United States and study counties

	United States	Study Counties
Demographic composition (%)		
Black/African-American	12.2	27.7
White	75.1	68.8
Hispanic/Latino [a]	12.5	3.5
Living in rural area [b] (%)	21.0	59.9
Lived in same house for at least 5 years (%)	54.1	58.3
Median housing value in 1999	$111,800	$89,400
Median household income in 1999	$41,994	$36,567
Income in 1999 below poverty level (%)	12.4	14.1
For blacks/African-Americans	24.9	26.9
For whites	9.1	8.5
People over age 16 who are unemployed (%)	5.7	6.1
For blacks/African-Americans	11.6	11.0
For whites	4.6	4.4
People over age 25 with less than high school education (%)	19.6	23.0
For blacks/African-Americans	27.7	36.5
For whites	16.4	17.8
People over age 25 who attended at least some college (%)	51.8	46.1
For blacks/African-Americans	42.5	28.9
For whites	54.1	52.3

Note. Data from U.S. Census (2002).

[a] Hispanic/Latino not mutually exclusive with other race/ethnicity categories.

[b] Rural is defined as a place of less than 2,500 persons. All urban residents in the study counties lived in urban clusters of less than 50,000 persons.

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Table 2

Unconditional and reduced conditional models of physical and social aggression from age 11 to age 18 (N=5,151)

	Unconditional Models			
	Physical Aggression		**Soical Aggression**	
Fixed effects	**B**	**95% CI**	**B**	**95% CI**
Intercept	0.37*	(0.31, 0.43)	0.67**	(0.62, 0.73)
Age	0.14**	(0.11, 0.18)	0.17**	(0.14, 0.21)
Age-squared	−0.02*	(−0.02, −0.01)	−0.03**	(−0.04, −0.02)
Random effects	Mean	95% CI	Mean	95% CI
Individual intercept	0.26*	(0.21, 0.31)	0.42*	(0.35, 0.48)
Individual linear slope	0.02*	(0.01, 0.02)	0.03*	(0.02, 0.03)
Neighborhood intercept	0.01*	(0.01, 0.02)	0.002	(−0.001, 0.005)
	Mean	95% CI	Mean	95% CI
Peak age (years)	14.88	(13.94, 15.83)	13.82	(13.33, 14.31)
	Reduced Conditional Models			
	Physical Aggression		Social Aggression	
Fixed effects	B	95% CI	B	95% CI
Intercept	0.26**	(0.16, 0.35)	0.59**	(0.49, 0.70)
Age	0.12**	(0.08, 0.16)	0.16**	(0.12, 0.21)
Age-squared	−0.02**	(−0.02, −0.01)	−0.03**	(−0.04, −0.02)
Sex	0.14**	(0.12, 0.17)	0.01	(−0.01, 0.05)

Note.CI = confidence interval. The conditional models control for race/ethnicity, parent education, and family structure.

* $p < .05$.

** $p < .01$.