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11 Psychosocial factors predicting pubertal onset

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Throughout the past century biopsychosocial models of adolescent development have increased in both their promotion and prevalence (reviewed by Susman, 1997). The biological process of puberty is the typical initiator of the adolescent period of human development (Petersen, 1985). Thus, it is not surprising that the majority of adolescent biopsychosocial research has considered pubertal timing or status (Graber, Petersen, and Brooks-Gunn, 1996) as predictors of social (e.g., Meschke and Silbereisen, 1997; Meschke, *et al.*, 2001) and psychological outcomes (Susman, *et al.*, 1985).

The timing of pubertal onset has potentially negative implications for subsequent psychological and physical health (see chapter 12). Research indicates that early onset of puberty is associated with an increased likelihood of adolescent problem behavior (Caspi and Moffitt, 1991; Steinberg, 1989), depression, anxiety (Brooks-Gunn, 1988; Susman, *et al.*, 1985), and breast cancer in women (Kampert, Whittemore, and Paffenbarger, 1988). The potential health consequences of early reproductive maturation have motivated researchers to investigate the possible predictors of pubertal timing.

Recently, environmental factors have been related to pubertal development (reviewed by Kim, Smith, and Palermiti, 1997). Stress is the environmental factor of interest and has typically been divided into two categories of predictors: physical stressors and psychosocial stressors. Increased physical stressors (e.g., decreased nutritional intake or increased exercise; Brooks-Gunn and Warren, 1985; Frisch, 1983) are more often associated with delayed pubertal timing. Psychosocial stressors (e.g., family conflict or depressed mood; Brooks-Gunn and Warren, 1985; Frisch, 1983; Graber, Brooks-Gunn, and Warren, 1995) are often associated with accelerated pubertal timing.

The goal of this chapter is to briefly review the literature describing the relation between psychosocial factors and pubertal timing, including an overview of specific models. Data from the Michigan Study of Adolescent

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Life Transitions (MSALT) are then used to reexamine several established psychosocial predictors of puberty and also to introduce the potential relation between previously untested stressors and pubertal timing.

Puberty prediction models

Neurobiological perspective

Psychosocial predictors, particularly stress, have been associated with hormonal changes that could delay pubertal timing (Susman, *et al.*, 1989b). Stress (e.g., sexual abuse; Trickett and Putman, 1993, or living with an alcoholic parent; Malo and Tremblay, 1997) is believed to activate the hypothalamic-pituitary-adrenal (HPA) axis that results in an increase in adrenocorticotropin hormone (ACTH) and cortisol levels. This increase is accompanied by the suppression of gonadal steroids (Susman, Dorn, and Chrousos, 1991; Susman, *et al.*, 1989a; Susman, *et al.*, 1989b). Thus prepubescent stress mediated by gonadal functioning appears to delay pubertal timing (Susman, *et al.*, 1989b). For example, intensive exercise has been associated with high cortisol levels (Luger, *et al.*, 1987) and highly trained female ballet dancers compared to nonballet dancers have experienced a delay in pubertal timing (Warren, *et al.*, 1986).

Sociobiological perspective

Expanding on the previous work of Draper and Harpending (1982), Belsky, Steinberg, and Draper (1991) developed a theoretical explanation for the potential hastening effect of stress on pubertal timing. In summary, they argued that high levels of stress, such as child abuse, economic deprivation, marital discord, and psychological distress, especially during ages 5 to 7 years, would accelerate pubertal development for boys and girls (see chapter 10). High levels of stress would encourage youth to perceive their environment as risky or harmful. Earlier pubertal timing would increase their chances of leaving the stressful environment earlier. In other words, early pubertal development ultimately allows adolescents to transition to adulthood earlier, including leaving the parental home and establishing their own families (Chisholm, 1993; Simpson, 1999).

Belsky and his colleagues (1991) assume that gender differences exist in the relation between stress and pubertal timing. Depression is thought to mediate the association between stress and accelerated pubertal timing for females, as depression is hypothesized to predict a higher proportion

of body fat, which in turn increases the likelihood of earlier pubertal maturation. For males, high levels of stress may increase their androgen level, resulting in greater aggressive and noncompliant behavior and possibly earlier pubertal timing. Together, aggressiveness and early pubertal timing are likely to increase boys' risk of early fatherhood, providing the opportunity to leave a stressful family situation.

Psychosocial factors associated with puberty

Both the neurobiological and sociobiological models of the relation between psychosocial issues and pubertal timing emphasize the effects of stress. Research to date on the psychosocial influences of pubertal timing have primarily focused on stress and stress responses associated with the family of origin, as suggested by Belsky and colleagues (1991). Studies have investigated both stressful family environments and stressful family relationships during the formative years.

Family composition

Family size has been examined in relation to pubertal timing for girls. Some have argued that increased family size reflects increased psychosocial stress due to a decrease in access to "parental resources" (Surbey, 1998), specifically limited availability of parental investment for each additional child. This psychosocial stress would in turn lead to earlier maturation. However, research suggests that increased family size, specifically a larger number of siblings, is associated with delayed menarche. Two studies have found that for each additional sibling, menarche is delayed by at least two months (Malina, *et al.*, 1997; Stukovsky, Valsik, and Bulaistirbu, 1967). Other studies have reported conflicting findings. Jones and colleagues (1972) found no association between total number of children in the family and menarcheal timing. However, they did find a significant association between number of younger brothers and delayed menarche. Surbey (1990) reported no association at all between number of siblings and menarche.

Father absence has been associated with accelerated menarcheal timing in several studies. Early research indicated that women whose fathers were absent before the age of 6, reached menarche earlier than those whose fathers were not absent (Jones, *et al.*, 1972). More recent studies of family composition and menarche revealed similar but more detailed results. Surbey (1990) found that girls who experienced father absence reached menarche earlier than those with both parents present or those who experienced mother absence. Similarly, girls who experienced the

absence of both parents reached menarche earlier than those with both parents present or mother absence only. Further analyses were conducted to examine the effects of stepfather presence on girls with absent biological fathers. The presence of an unrelated male accelerated menarche among girls with absent fathers, but not significantly. The mean age of menarche was compared for girls who experienced father absence prior to the age of 10 and those who experienced father absence after the age of 10. The results were significant for earlier father absence and early menarche (Surbey, 1990).

Other studies have produced supporting results. Among those who experienced father absence, menarcheal age was significantly inversely associated with the number of years of father absence (Moffitt, *et al.*, 1992). Girls from divorced families also reported significantly earlier menarche than girls from intact families (Wierson, Long, and Forehand, 1993), however this sample only included families with married parents or those who had experienced divorce in the preceding twelve months. Girls who experienced father absence or divorce more than twelve months prior to the study were excluded.

Contrary to the aforementioned findings, one study found that while early menarche was significantly associated with father absence during late adolescence, it was not associated with father absence in early or late childhood (Campbell and Udry, 1995). These findings seem to contradict the sociobiological argument, in that father absence in the causally relevant time period does not appear to be associated with early menarche. However, marital conflict and/or a stressful family environment during early childhood may have preceded father absence in late adolescence.

Most recently, two studies have sought to clarify the role of father absence in predicting pubertal timing. Ellis and colleagues (1999) examined the timing of menarche in girls from single-mother households as compared with two-parent households. Significant associations were detected between living in a single-mother home at age 5 and earlier menarche, as compared with always married two-parent households and compared with all two-parent households.

Ellis and Garber (2000) also found a significant association between father absence and early menarche.[1] However, they further examined this association in light of stepfather presence. These analyses revealed no association of pubertal timing with the age of the girl at the time of father absence. However, there was a significant relation between pubertal timing and age at which an unrelated father figure became present. The younger the daughter when the unrelated father figure arrived, the more likely she was to report earlier onset of puberty.

Although antecedents to reproductive development in boys are studied much less frequently, the effects of father absence on spermarche were examined in one study. In this case, father absence for at least one year during childhood was associated with earlier spermarche (Kim and Smith, 1998b).

Family environments

Stressful relationships in childhood revolve primarily around parent–child relationships. Several studies have examined the association of specific parent–child relationships with pubertal timing. To date, the findings have been somewhat inconsistent and also indicate distinct gender-specific effects of conflictual parent–child relationships on the timing of puberty. For girls, mother–daughter conflict has been associated consistently with earlier menarche (Kim and Smith, 1998a; Kim, Smith, and Palermiti, 1997; Steinberg, 1988), as has parent–child conflict in general (Graber, Brooks-Gunn, and Warren, 1995; Moffitt, *et al.*, 1992). Father–daughter conflict, however, has not shown the same significant association with early menarche (Kim, Smith, and Palermiti, 1997; Steinberg, 1988).

For boys, parent–child conflict has not been consistently associated with age at spermarche. One study found no association between parent–child conflict and maturational development in boys (Steinberg, 1988). Another found that greater emotional distance from mother throughout childhood was associated with earlier spermarche (Kim and Smith, 1999). Malo and Tremblay (1997) found that boys with alcoholic fathers reported being punished more often than boys with nonalcoholic fathers (possibly indicating parent–child conflict) and were more likely to have delayed pubertal onset.

Stressful environments during childhood are predominantly located in the family and the home. Stress-filled environments may be the result of marital conflict or parental stress and their subsequent coping behaviors. Several studies have examined the influence of stressful family environments on pubertal timing.

In one study, greater family conflict at age 7 was significantly associated with early menarche, regardless of the girl's body weight at age 9 (Moffitt, *et al.*, 1992). In another study, more parental marital conflict (as reported by the mother) was associated with earlier menarche (Wierson, Long, and Forehand, 1993). However, no association between the adolescent's reported perception of marital conflict and earlier menarche was detected. Early menarche has been associated with a stressful family life (Kim and Smith, 1998a), as well as with parental marital conflict in early childhood and parental marital unhappiness throughout childhood (Kim

and Smith, 1998b; Kim and Smith, 1999). Parental marital conflict and parental marital unhappiness in early childhood were also associated with early spermarche (Kim and Smith, 1998b; Kim, Smith, and Palermiti, 1997).

Internalizing/externalizing behavior

Researchers have investigated the possible association between internalizing (depression, anxiety) and externalizing (aggression) behaviors and early onset of puberty. Early studies produced somewhat conflicting results. This may not be surprising, however, if body weight is the hypothesized intermediary between depression and menarcheal timing. While overeating behaviors may characterize a stress response for some, others may engage in anorexic eating behaviors. Thus, depressive affect could be associated with either extreme of the body weight spectrum.

Moffit and colleagues (1992) found no significant association between internalizing or externalizing behavior at age 7 and subsequent early menarche. However, they did note a trend for behavior problems and later menarche. Graber, Brooks-Gunn, and Warren (1995) also found no significant association between internalizing or externalizing behaviors and early menarche. However, they reported a significant association between depressive affect and earlier maturation. More recently, Kim and Smith (1998a) reported that more anxiety and internalizing symptoms were associated with earlier menarche.

Malo and Tremblay (1997) found that boys with alcoholic fathers were more likely to be rated by their teachers as anxious or disruptive and were more likely to have delayed maturation. However, the association between these two variables was not directly evaluated. Conversely, two other studies reported that boys with more externalizing (aggressive/unruly) symptoms (Kim, Smith, and Palermiti, 1997), and less anxiety/depression in later childhood (Kim and Smith, 1999) were more likely to experience earlier spermarche.

Expanding the types of stressors to examine: results of a study

To date, most of the stressors examined in relation to pubertal timing have been related primarily to family stressors (e.g., family–teen conflict, father absence). Youth are also likely to experience stress from a variety of sources that previously have not been considered as predictors of pubertal timing (Susman, *et al.*, 1989a; D'Aurora and Fimian, 1988). For the purpose of this chapter, three stressors, unexamined previously in relation to pubertal timing, were included: (1) math anxiety, (2) school anxiety, and (3) economic anxiety.

Method

Sample

The data we used came from waves 1, 2, 5, and 6 of the Michigan Study of Adolescent Life Transitions (MSALT) (see Eccles, *et al.*, 1989 for full sample details). MSALT began in 1983, when the respondents were in sixth grade in ten school districts in southeastern Michigan. Wave 1 data were collected in 1983, when the participants were ages 9.7 to 12.9 years (over 87% of the youth were 10.5 to 11 years of age). Wave 2 data were collected six months later. Wave 5 data were collected in 1988, when the respondents were in tenth grade. Wave 6 data were collected two years later. The students were in their senior year of high school.

Data from these waves were used to examine the proximal correlates of pubertal timing. In this sample, 22.7 percent of the sample reported reaching puberty prior to wave 1 data collection and approximately 84.2 percent of the respondents reported having reached puberty by wave 5 of data collection. Retrospective reports of pubertal timing from wave 5 data were used to measure pubertal timing and status. Requiring that respondents participated in waves 1 and 2, and either wave 5 or 6, yielded a subsample of 412 males and 484 females. The sample is primarily middle or working class, from small urban or suburban communities, and White (over 90%).

Measures

The dependent variable was pubertal timing. Because Cox regression analysis was conducted, both a censoring and a timing variable were necessary for the dependent measure. The censoring and timing variables were based on wave 5 data. Males and females responded to the question: "Kids your age grow at different rates, but usually everyone has a time when they grew faster than at other ages. Has this happened to you yet? Yes (*1*; postpubertal) or no (*0*; prepubertal)." The timing variable for the postpubertal respondents was based on the question: "If yes, what grade were you in when this happened (grade and season)?" The timing variable for the prepubescent respondents was their grade at the time they answered the survey.

The reliability of the participants' subjective account of growth spurt was examined using two methods. Growth spurt measure was measured

for boys (not girls) at wave 6. The correlation coefficient between these two measures was .47 ($p<.001$). When the difference between the two waves of data was calculated, 66 percent of the boys had a difference of one year or less. Over 28 percent of the boys reported the same grade of growth spurt for waves 5 (tenth grade) and 6 (twelfth grade) of data collection. For girls, grade of breast development and growth spurt were both measured at wave 5. These measures were also significantly correlated ($r=.21$; $p<.01$). The reliability of the dependent measure must be taken into account in relation to the findings. An objective, prospective measure of growth spurt would have been more ideal.

Self-reports of pubertal timing appear to be quite reliable. A strong positive relation exists between subjective pubertal timing and biological development, particularly in regards to height and weight (Silbereisen and Kracke, 1997). Self-reported fast developers recounted higher height and weight levels than their slower developing peers (Silbereisen and Kracke, 1993). Height spurt also provided a salient experience on which to base subjective pubertal timing. In addition to height and weight, research has shown a significant positive correlation between subjective pubertal timing and menarche for girls (Silbereisen, *et al.*, 1989). Subjective pubertal timing has also displayed moderate stability over time (Dubas, Graber, and Petersen, 1991).

These measures were structured for proportional hazards regression. If the person had experienced puberty, then the timing value was based on the grade and season that the event was reported. If the person reported being prepubescent, then timing was the grade of the person at wave 5 ($n=150$). Based on timing of growth spurt, postpubertal females reported earlier pubertal timing than postpubertal males (females ($M=7.31$, $SD=1.26$); males ($M=8.06$, $SD=1.43$), $t(744)=-7.61$, $p<.001$).

The predictors, drawn primarily from wave 1 data, represent a variety of psychosocial stressors. Measures of family structure included (a) time spent in a divorced family and (b) total number of siblings. Parent–adolescent conflict was included as the family stress measure. Adolescent stressors included self-esteem and risk-taking behavior. Finally, several new stressors were considered: math anxiety, school anxiety, and economic anxiety.

Time with divorced parents ($M=.87$; $SD=2.32$), from waves 5 and 6, was based on the question: "What is your parents' current marital status?" (1 = *married*; 2 = *divorced*; 3 = *widowed*; 4 = *separated*; 5 = *other*). If the students reported their parents as either divorced or separated, the time spent with divorced parents was calculated with the question: "How long has this been their marital status?" The categorical responses were converted to reflect the mean time of each interval. Thus, .5 = *less than 6 months*; .75 = *6 months to a year*; 1.5 = *1.1 to 2 years*; 2.5 = *2.1 to 3 years*; 4 = *3.1–5 years*; 7.5 = *5.1 to 10 years*; 12.5 = *10.1 to 15 years*; and 15 = *over 15 years*. If the question was not answered in wave 5, wave 6 responses to the same question were used. In both cases the value was adjusted to reflect the number of years spent with divorced parents at the time of wave 1 data collection.

Total number of siblings ($M=1.78$; $SD=1.27$) was also from waves 5 or 6 data. Only biological and adopted siblings were included in this tally. If data from wave 5 were not available, wave 6 data were used.

Parent–teen conflict ($M=1.79$; $SD=.87$) is measured as: "I have a lot of fights with my parents about their rules and decisions for me" (1 = *never true*; 4 = *always true*).

Self-esteem ($\alpha=.66$; $M=2.87$; $SD=.71$) is based on the mean of four items. Two items were reverse coded so that a high score reflects a high level of self-esteem. An example is "Some kids wish they were different." Responses fell on a 4-point scale with 1 = "*really true for me*" and 4 = "*really not true for me*," as based on the work of Harder (1979). Threats to one's self-esteem have been noted as sources of childhood stress (D'Aurora and Fimian, 1988).

Risk-taking, wave 2 ($\alpha=.78$; $M=10.46$; $SD=13.13$) included eight items. Each of the items was prefaced by "In the last three weeks at school, about how many times did you . . ." Examples of risk-taking activities were "punch or push around another student," "wise off and disrupt class," and "bring alcohol or drugs to school." Responses could range from 0 to 12 or more. The composite risk-taking measure is the sum of events reported by the respondents.

Three anxiety or stress measures were included as predictors. Reported alpha levels refer to the subsample of MSALT participants included in this study. The scale score for each respondent was the unit-weight mean value of all the items included in the scale.

Math anxiety, wave 1 ($\alpha=.89$; $M=3.26$; $SD=1.43$) included ten items such as "Before you take a test in math, how nervous do you get?" (1 = *I'm not nervous at all*; 7 = *I'm very nervous*) and "Math makes me feel like I'm lost in a jungle of numbers and I can't find my way out" (1 = *I never feel this way*; 7 = *I often feel this way*).

School anxiety, wave 1 ($\alpha=.69$; $M=2.53$; $SD=.82$) was measured with three items: "How worried do you get about getting your school work in on time" (1 = *not at all worried*; 4 = *very worried*); "How nervous do you get when the teacher hands back grades on a class assignment"; and "How nervous do you get when you only have a short time to do a hard assignment?" (1 = *not at all nervous*; 4 = *very nervous*).

Economic anxiety ($\alpha = .76$; $M = 2.90$; $SD = .96$) included three items: "Do you worry that your parents might not have a job in the future?"; "Do you worry that you will not be able to get a good job when you are an adult?"; "Do you ever worry that your family might not have enough money to pay for things?" (1 = *never*; 7 = *always*).

Results

Descriptive analyses

All analyses were conducted using the SAS statistical package. Prior to conducting the primary analyses, correlation matrixes of the predictors and dependent variable (whether or not the person had experienced puberty) by gender were analyzed. In examining the correlation matrixes, particular attention was given to the correlation values between the various predictors. A high correlation value between the predictors increases the likelihood of multicollinearity. The correlation coefficients ranged from −.33 to .37, thus issues of multicollinearity were not considered to be a substantial threat (Affifi and Clark, 1990).

Predicting pubertal timing

Event history analysis was utilized to examine pubertal timing and its association with psychosocial predictors. In event history analysis a hazard rate, or the instantaneous risk that the event (puberty) will occur at a given moment if the event has not occurred before this time (Yamaguchi, 1991), is calculated. The results of proportional hazards regression are interpreted using risk ratios based on parameter estimates. If the risk ratio is less than 1.0 then an increase in the predictor value would be related to later timing of the event, or a decrease in the hazard rate. A risk ratio exceeding 1.0 means that as the unit value of the predictor increases, the hazard rate also increases, that is, earlier timing of the event (SAS Institute, 1990). For example, if math anxiety has a risk ratio of 1.75 regarding pubertal timing, for each unit of increase in math anxiety, persons who have not yet experienced puberty would increase their hazard rate, or likelihood of entering puberty, by 75 percent.

Two hierarchical models predicting pubertal timing were analyzed by gender. An ecological approach guides both models (Bronfenbrenner, 1988). Specifically, family composition members are entered first, followed by individual stress issues. Stressors related to family and school issues are entered into the model last. With each new step added to the models, it was of interest whether additional predictors increased the

Table 11.1. *Proportional hazards regression to pubertal timing: hierarchical family composition, adolescent stress, and family stress models of pubertal timing for females and males*

	Risk ratios					
Predictor	Female	Female	Female	Male	Male	Male
Family composition						
Time with divorced parents, wave 1	1.02	1.02	1.02	1.00	1.00	1.00
Total number of siblings, waves 5, 6	0.92*	0.92*	0.92+	1.01	1.01	1.01
Adolescent stress						
Self-esteem, wave 1		1.02	1.08		1.01	1.02
Risk-taking behavior, wave 2		0.99	0.99		1.00	1.00
Family stress						
Parent–teen conflict			1.28***			1.03
Total subjects	484	484	484	412	412	412
Number who are postpubertal	381	381	381	365	365	365
Number censored	103	103	103	47	47	47
Percent censored	21.28	21.28	21.28	11.41	11.41	11.41
Chi-squared	5.39	6.68	20.28**	0.07	1.76	1.99
Change in chi-squared		1.29	13.60***		1.69	0.23

+ p<.10 *p<.05 **p<.01 ***p<.001

strength of the model. This was determined by calculating whether there was a significant increase in the chi-squared value of the expanded model, as compared to the previous model.

The first model incorporates stressors associated with the sociobiological model (Belsky, Steinberg, and Draper, 1991; Chisholm, 1993) as predictors of pubertal timing. The first step included time with divorced parents and total number of siblings (see table 11.1). This model was not significant for males or females. Adolescent self-esteem and risk-taking were added in step two of the model. Again, this model was not significant for males or females. Parent–teen conflict was added in the final step of the model. This model was significant for females and resulted in a significant increase in the model's chi-squared value [χ^2 (1, $N = 484$) = 13.60, $p < .001$]. Higher levels of parent–teen conflict were associated with earlier pubertal timing for females. In addition, total number of siblings approached significance for females. Females with more siblings reported somewhat later pubertal timing.

Table 11.2. *Proportional hazards regression to pubertal timing: hierarchical family composition, family stress, and adolescent stress models of pubertal timing for females and males*

	Risk ratios							
Predictor	Female	Female	Female	Female	Male	Male	Male	Male
Family composition								
Time with divorced parents, wave 1	1.02	1.02	1.02	1.02	1.00	1.00	1.00	1.00
Total number of siblings, waves 5, 6	0.92*	0.92+	0.93+	0.93	1.01	1.01	1.01	1.01
Family and adolescent stress								
Self-esteem, wave 1		1.08	1.06	1.07		1.02	0.96	0.97
Risk-taking behavior, wave 2		0.99	0.99+	0.99		1.00	0.99+	1.00
Parent–teen conflict, wave 1		1.28***	1.30***	1.29***		1.03	1.05	1.03
School stress								
Math anxiety, wave 1			0.97	0.97			1.01	0.98
School anxiety, wave 1			1.00	1.00			0.78***	0.76***
Future worries								
Economic anxiety, wave 1				1.04				1.14*
Total subjects	484	484	484	484	412	412	412	412
Number who are postpubertal	381	381	381	381	365	365	365	365
Number censored	103	103	103	103	47	47	47	47
Percent censored	21.28	21.28	21.28	21.28	11.41	11.41	11.41	11.41
Chi-squared	5.36	20.28**	20.85**	21.37**	0.07	1.99	14.40*	19.26*
Change in chi-squared		14.92**	0.57	0.52		1.02	12.41**	4.86*

+ p<.10 *p<.05 **p<.01 ***p<.001

The first step of the second model (see table 11.2) included family composition measures. Again this step was not significant for males or females. In the second step, family and adolescent stressors (conflict, self-esteem, and risk-taking behavior) were added. This model was significant only for females [χ^2 $(3, N = 484) = 14.92, p<.01$]. Higher levels of parent–teen conflict were associated with earlier pubertal timing. Also, as in the previous model, total number of siblings was approaching significance. School-related stressors were added in the second step of the model. These additional predictors resulted in a significant increase in the model's chi-squared value for males [χ^2 $(2, N = 412) = 12.41, p<.01$]. This model was significant for males and females. Higher levels of conflict were associated with earlier pubertal timing for females. Higher levels of school anxiety were related to delayed pubertal timing for males.

In the final step of the second model, the measure of economic anxiety was added. This addition resulted in a significant increase in the chi-squared value for males [$(\chi^2$ $(1, N = 412) = 4.86, p<.05$]. The model was significant for males and females. Parent–teen conflict was still a significant predictor for females. For males, school anxiety remained a significant predictor, and, in addition, higher levels of economic anxiety were associated with earlier pubertal development ($p<.05$).

Discussion

A number of precarious outcomes have been associated with earlier pubertal timing, including earlier initiation of intercourse (Meschke, *et al.*, 2001; Meschke and Silbereisen, 1997) and higher levels of risk-taking behavior (Caspi and Moffit, 1991; see also chapter 12). Researchers have recently put forth efforts to understand factors influencing pubertal timing (e.g., Surbey, 1990; Belsky, Steinberg, and Draper, 1991). In particular, the relation between stress and pubertal timing demands further attention. Based on the review of the literature and subsequent analyses, several recommendations for future research can be made.

Gender differences in the patterns of predictors of pubertal timing are quite pervasive. Previous research has focused primarily on females. In turn, readers might be quick to conclude that female pubertal timing is particularly sensitive to stressors. However, based on the analyses conducted here, male pubertal timing can also be related to stress. Inconsistency in the significance of predictors by gender occurs frequently, as exemplified by this chapter's analyses. Perhaps most interesting is the significant relation between social stressors and pubertal timing for females (e.g., parent–teen conflict) compared with the significance of economic anxiety as a predictor of male pubertal timing.

These results may reflect the effects of gender socialization (Lytton and Romney, 1991). In a metaanalysis including 172 studies, Lytton and Romney (1991) concluded that parents emphasize achievement, restrictiveness, and disciplinary strictness to boys, whereas warmth and encouragement of dependence are emphasized slightly more to girls. The effects of differential parental encouragement of same gender-typed activities could have broader implications. Differential encouragement to various tasks in early childhood may account for the differences in responsibility.

Similar findings by gender have been reported by a number of researchers. Elder and his colleagues (1985) reported a differential effect of economic hardship by gender for parents of adolescents. Specifically, the parenting skills of fathers were negatively impacted by economic hardship, whereas maternal parenting behavior did not vary significantly with income loss. In examining the reasons underlying suicide in Japan, Lester and Saito (1999) found that job stress was prominent for males, whereas psychiatric problems were most common for female suicide victims. Hraba and his colleagues (1996) examined the association of social network events and economic events with depression. Although males and females reported similar exposure levels to social network events and economic events, male depression was more closely linked to economic events and female depression was significantly associated with social network events.

Future research should also examine more closely the relation between the timing of the stressor and pubertal timing. Different findings and assumptions support the possibility of various critical periods regarding stress and pubertal timing. Nottelmann and Susman (1989, as in Susman, Dorn, and Chrousos, 1991) suggested that during puberty the gonadal axis might be more sensitive to changes in the adrenal axis related to stress. Stimulation of adrenaline secretion due to stress would then be more likely to stimulate the secretion of growth hormones. Belsky and his colleagues (1991) emphasized the importance of stressors prior to age 7. Despite the various assumptions, very few studies have successfully tracked youth from middle childhood through puberty (Moffit, *et al.*, 1992, Ellis *et al.*, 2000).

The initial wave of MSALT data, presented in this chapter, was collected when the students were approximately 11 years old. Yet, several significant relations emerged between the psychosocial stressors and pubertal timing. These findings seem to indicate that stressors during early adolescence also play a role in pubertal timing. More studies should be initiated with respondents younger than 7 that continue to track participants through puberty. Longitudinal studies that are initiated prior to age 7 and which continue throughout adolescence would help identify critical periods regarding the relation between psychosocial predictors and pubertal timing. In this case, the MSALT data are limited, as over 20 percent of the respondents had experienced puberty prior to the initial wave of data collection. Yet, despite the potential benefits to be gained from earlier initiation of longitudinal data collection, the potential enduring nature of the included predictors implies that information about the early developing youth is known.

The analyses conducted in this chapter introduced some psychosocial stressors that were not previously examined in relation to pubertal timing. Two of these new stressors – school anxiety and economic anxiety – were significantly related to male pubertal timing. These findings encourage the incorporation of a greater variety of stressors in studies of pubertal timing.

Interestingly, higher levels of school anxiety were associated with delayed pubertal timing, whereas greater economic anxiety was related to earlier pubertal timing. It can be noted that school anxiety is an internal reaction, that is, all children experience school and regardless of ability or performance, all children can potentially experience school anxiety. This is an experience internal to each child. However, economic anxiety could potentially be relieved if the youth acquired a job. Thus, economic anxiety could serve as an environmental press for maturity, whereas little relief from school anxiety related to physical maturation is likely to occur.

Nottelmann and Welsh (1986) indicated a potential conundrum when examining the relation between stressors and pubertal timing. "tAdjustment and social stressors, adrenal activation, and reproductive maturation may constitute a 'vicious' cycle of interrelated factors during adolescence. Adjustment problems could cause activation of the adrenal glands that would cause gonadal suppression and later maturation. The latter could constitute an added stressor reentering the cycle and potentiating the 'abnormality'" (as in Susman, *et al.*, 1989, p. 349). Greater efforts need to be made to tease out this possible feedback reaction. In addition to various stress measures, more biological predictors need to be measured, including hormone levels. In time, less invasive techniques by which to collect hormonal level data may be developed, increasing the likelihood of standard inclusion of such measures in various studies.

Indeed, the relation between parent–teen conflict and pubertal timing may exemplify such a relation. Specifically, growth spurt is a pubertal event that can be considered midpuberty. Prior to this event hormonal changes have occurred. Although only 20 percent of the sample reported having experienced growth spurt at the time the wave 1 data were

Table 11.3. *Cross-tabulation of parent–adolescent conflict and grade of growth spurt (Percent within grade)*

Grade of growth spurt	Low conflict (value of 1 or 2)	High conflict (value of 3 or 4)
5	78.8	21.2
6	84.3	15.7
7	85.2	14.8
8	87.4	12.6
9	84.3	15.7
10	86.4	13.6

c2 (5, N = 637) = 2.75; p = .74

collected, it is most likely that a substantial portion of the youth had already experienced hormonal changes associated with puberty. Hormonal changes could be influencing greater levels of conflict and not vice versa, as tested in these analyses. However, it is important to note that many researchers have found the *quality* of parent–adolescent conflict may increase but that the *quantity* of conflict remains relatively stable during adolescence (Dekovic, 1999; Galambos and Almeida, 1992; Laursen, Coy, and Collins, 1998). Indeed, a follow-up chi-squared analysis of grade of growth spurt and a dichotomized conflict measure was not significant (see table 11.3).

Existing research, including the analyses presented in this chapter, has taken a variable-centered approach to data interpretation. This approach utilizes methods such as correlational, regression, and structural equation analyses. Such approaches assume that values on a continuous scale for any given variable can be interpreted in a meaningful way for all individuals, without regard to the context in which they exist, including the presence of other behaviors (Magnusson, 1998). For example, high levels of stress may be considered problematic for any adolescent, regardless of the levels of other factors, such as social support or psychological well-being. That is, with this type of approach high levels of stress could be viewed as being as problematic for the straight-A student with high self-esteem as it is for the adolescent who is taking drugs and reporting high levels of depressed mood. Under the variable-centered approach, individuals are considered to differ quantitatively, rather than qualitatively on the dimension under consideration (Magnusson, 1998).

The person-centered approach could supplement our understanding of stress and pubertal timing by taking patterns of behaviors or characteristics within the individual into consideration (Magnusson, 1988). These

patterns of variables within the individual are applied in the formation of groups or typologies. In comparison to the traditional variable-centered approach, the person-centered approach directly accounts for interactions between variables. It is believed that a single variable cannot be fully understood when taken out of context (Magnusson, 1998). The person-centered approach might provide better understanding of why some stressors appear to accelerate pubertal timing (e.g., single mother homes; Ellis and Graber, 2000), whereas other stressors tend to delay puberty (e.g., alcoholic fathers; Malo and Tremblay, 1997).

Potential mediators and moderators of stress levels such as social support and coping mechanisms should be included in future analyses. For example, girls tend to adopt rumination as a coping strategy much more often than boys (Broderick, 1998). Rumination has been associated with greater risk of depression (Fleming and Offord, 1990), which in turn has been associated with a delay in pubertal development (Nottelmann, *et al.*, 1990; Nottelmann and Susman, 1989, as in Susman, Dorn, and Chrousos, 1991). Interaction models, multistep regressions (Baron and Kenny, 1986), and path analyses (Jöreskog and Sörbom, 1996) are likely to more accurately capture mediating and moderating effects. This approach will be pursued in the future.

Over the centuries an acceleration of pubertal timing has been observed (Eveleth and Tanner, 1976). Nutrition has often been cited as the primary influence of this trend (e.g., Brooks-Gunn and Reiter, 1990). Yet in this chapter's analyses, family–teen conflict emerged as a significant factor in the acceleration of female pubertal timing and economic anxiety was associated with accelerated male pubertal timing. On the other hand, school anxiety was related to delayed pubertal timing for males. How do psychosocial measures factor into the observed pubertal timing trends?

The sophistication of research addressing the relation between psychosocial factors and pubertal timing has developed considerably over the past decade. The MSALT analyses included in this chapter further explore gender differences and the variety of psychosocial factors that are associated with puberty. Despite these contributions, it is obvious that greater efforts need to be applied to develop a more solid understanding of the experiences of youth in today's society.

NOTES

1. Ellis and Garber, 2000 found time with a stepfather to be a significant accelerator of female pubertal timing. A measure was created for time spent with a stepparent. This measure was substituted time with divorced parents in the first regression model. Time with a stepparent was not significant for males or females and no changes in the other significant predictors emerged.

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Part 6

Pubertal timing: consequences