On the developmental significance of female pubertal timing
This dissertation is dedicated
to my mother, Birgitha, my sister, Sofia,
and the memory of my father, Lennart

“Bryt upp, bryt upp! Den nya dagen gryr.
Oändligt är vårt stora äventyr”.
Karin Boye

“…for right timing is in all things
the most important factor.”
Hesiod
Therése Skoog

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Abstract


Puberty is the process of becoming sexually mature and it has fundamental somatic and psychosocial implications. The focus of this dissertation is on the short- and long-term developmental significance, concerning *soma et psyche*, of female pubertal timing. Four studies were designed and performed to accomplish these aims. Six samples of different ages from different countries and at different time points, comprising several thousand females, some of whom were followed longitudinally, were used. Age at menarche was used as the measure of pubertal maturation. The first main aim of this dissertation was to explore the mechanisms that might explain the well-established link between female pubertal timing and problem behavior and to identify the contextual conditions under which associations are stronger or weaker. Existing explanations are unsatisfactory, and little is known about conditions that might affect the strength of the associations.

For Paper I, we tested and confirmed a peer socialization hypothesis as a satisfactory explanation for the link between early puberty and problematic adjustment. In short, this hypothesis posits that early-developing girls associate with older peers and boyfriends because they feel more mature than their same-age peers and – through these peers and boyfriends – are channeled into more socially advanced behaviors, including problem behavior. This should be particularly true in contexts where heterosexual relationships are sanctioned and where there is an abundance of deviant youth. For Paper II, I used a biopsychosocial approach, and investigated pubertal timing along with self-perceptions of maturity and early romantic relationships. The findings revealed that early puberty had very different implications depending on the psychological and social contexts in which it was embedded. For instance, when early puberty was coupled with feeling mature and having early romantic relationships, it was associated with adjustment problems. When early puberty was coupled with neither, it was not linked to particularly high levels of problem behavior.

In stark contrast to the vast literature on the role of female pubertal timing in adolescence, the literature on long-term implications is remarkably limited. For this reason, the second main aim of this dissertation was to study the adult implications of female pubertal timing. For papers III and IV, we examined the long-term implications of pubertal timing, particularly as it relates to somatic development. The findings suggest that pubertal timing does have future implications for women’s body perception and morphology, with early-developing females having higher body mass in adulthood, but only under certain circumstances. The findings of this dissertation help further understanding of the *soma et psyche* implications of female pubertal timing. They indicate that pubertal timing has concurrent and future implications. It seems, however, that timing is not everything. The developmental significance of female pubertal timing appears to be very different under different contextual conditions. Thus, it is only when girls’ psychological and social contexts are considered that fruitful predictions can be made. As such, the findings have important implications for prevention, policy and practice.

*Keywords*: female, puberty, pubertal timing, development, adjustment, longitudinal study, sexuality, peer relations, weight status, mechanisms, conditions

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_Stora Brandsjöhults gård, March 2008_
List of papers

This dissertation is based on the following papers, which hereafter will be referred to by their Roman numerals.


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1. Introduction

Eight hundred years before Christ, Hesiod, a Greek didactic poet, coined the phrase “Observe due measure, for right timing is in all things the most important factor”. Today, we would say “Timing is everything”. For many years, this expression has been widely used in as different contexts as car sales, cancer therapy, and everyday language. According to the existing research literature, it can be applied to the developmental significance of female puberty as well (Pinyerd & Zipf, 2005).

Adolescence is a period of dramatic emotional, cognitive, social, and biological change (Patton & Viner, 2007). It takes place after what is one of the longest childhood periods of all mammals (Grumbach & Styne, 2003). Some of the most fundamental changes in adolescence are biological, and the biological changes associated with puberty are commonly regarded as a signal of the onset of adolescence (Petersen, 1998). Puberty refers to the biological changes that are needed for sexual maturity, which all healthy individuals experience. With this transition, girls go from having the appearance of children to resemble the appearance of the adult female stereotype (Tanner, 1978). The term puberty stems from *pubertas*, which means adult in Latin, or *pubescere*, which means growing hairy. The Merriam-Webster online dictionary (2007) defines puberty as “the condition of being or the period of becoming first capable of reproducing sexually marked by maturing of the genital organs, development of secondary sex characteristics, and in the human and in higher primates by the first occurrence of menstruation in the female”. Thus, the essence of female puberty is sexual maturation.

Researchers and the public alike have viewed puberty as a period of “sturm und drang” ever since the beginning of the 20th century, and long before that too (e.g., Arnett, 1999; Buchanan, Eccles, Flanagan, Midgley, Fiedlauer, & Harold, 1990; Hall, 1904). Contemporary researchers (see Arnett, 1999) still argue that adolescents are more likely to experience problems than any other age group. Peripubertal youth are seen as difficult to deal with, and people tend to think that temper tantrums are part of youths’ everyday lives (e.g., Holmbeck & Hill, 1988). Fifteen years ago, Buchanan and colleagues (Buchanan, Eccles, & Becker, 1992) concluded, in their review of the literature on the role of the endocrinological aspects of puberty for behavior, that radical hormonal changes during puberty contribute to emotional volatility. Furthermore, there are findings suggesting that puberty does not only affect the developing person, but also his or her parents. When a child (particularly the firstborn) is experiencing puberty, the parents experience changes in marital qualities, showing less positivity and more negativity (Whiteman, McHale, & Crouter, 2007). Thus, puberty has long been regarded as meaning trouble.

There is, however, evidence to suggest that this might not always be true. Somewhat contrary to common belief and the conclusion drawn by Buchanan et al. (1992), Larson and Richards (1994) showed that there was little connection between mood disruptions and pubertal stage (i.e. where in the pubertal process the youth was). Furthermore, others have
argued that experiencing storm and stress is neither universal nor inevitable during this period in life (Arnett, 1999). So, if not all adolescents experience problems during puberty, who will?

The answer seems to involve the timing of the pubertal changes. Research in the adolescent adjustment area suggests that it is rather when (in relation to peers) girls experience puberty – than puberty per se – that is of particular significance for adolescent functioning (Weichold, Pröhl, Büttig, & Silbereisen, 2007). In other words, research has indicated that “timing seems to be everything”. A recent publication has even been called “Puberty-Timing is everything!” (Pinyerd & Zipf, 2005). This seems to be true for somatic aspects, such as weight status and internalizing and externalizing behaviors, and also for substance use, school adjustment and social relationships (e.g., Alsaker, 1995, 1996; Buchanan et al., 1992; Celio, Karnik, & Steiner, 2006; Graber, 2003; Mendle, Turkheimer, & Emery, 2007; Stattin & Magnusson, 1990; Susman, Dorn, & Schiefelbein, 2003; Susman & Rogol, 2004; Waylen & Wolke, 2004, for reviews). In all these areas, it is girls who mature early who are at heightened risk of experiencing difficulties. Why this is and whether pubertal timing continues to play a role in adulthood are largely unknown.

To better understand its developmental significance, I place female puberty within a developmental perspective. The main aim is to investigate the short and long-term developmental significance, concerning soma et psyche, of female pubertal timing. In short, I investigate somatic as well as psychosocial implications of pubertal timing, and I focus on the long-term implications and mechanisms or conditions that might explain its impact. While early puberty puts girls at higher risk of negative outcomes, far from all early maturers have problems. Therefore, I am interested in why some but not other early-developed girls experience difficulties and what other factors may be involved.

1.1 The developing body

Puberty is a biological phenomenon, with psychological and social meaning. Knowledge of the physiological processes of puberty is needed for understanding how puberty might influence development. Puberty comprises several processes, each of which might have different developmental implications. The following section gives a brief description of pubertal changes.

1.1.1 Endocrine changes. Puberty is a phase of anatomical and physiological development during which the sex organs mature and become functional. There is a developmental continuum that starts during the fetal period, goes through puberty, and ends with full sexual maturity (Grumbach & Styne, 2003). Pubertal changes can all be related to the endocrine, or hormonal, system, particularly to the hypothalamic-pituitary-adrenal (HPA) and hypothalamic-pituitary-gonadal (HPG) axes. Adrenarche refers to the maturation of the adrenal gland, which is regulated by the HPA axis. This activation results in increased concentration of adrenal androgens, which takes place during the first phases of puberty.
These androgens, in turn, results in body odor, pubic hair, and often oily skin, including acne. Adrenarche can start at the age of six in females and continue into their thirties (Dorn & Rotenstein, 2004; Grumbach & Styne, 2003). Gonadarche refers to the maturation of the ovaries (gonads). This results in the stimulation of the ovaries, producing sex hormones (estradiol in girls). Gonadarche is caused by activation of the HPG axis. It is related to maturation of the primary sexual characteristics, including menarche, and the development of secondary sexual characteristics (Dorn, Dahl, Woodward, & Biro, 2006). Gonadarche begins around age nine or ten on average (Grumbach & Styne, 2003). It indicates that puberty has started. Adrenarche and gonadarche are the two main endocrinological processes during puberty.

1.1.2 Maturation of primary sexual characteristics. The primary sexual characteristics are physical characteristics of the reproductive system that mature during puberty. The sex organs grow in size and they start to produce sex cells. Girls’ menarche (i.e., their first menstrual period) is related to these changes. Menarche is one of the milestones in female development, and is often taken to indicate fertility. However, it can take another several years before the adolescent girl reaches full sexual maturity. On average, menarche occurs at age 12.6 years in white girls in Western countries (Biro, Huang, Crawford, Lucky, Striegel-Moore, Barton et al., 2006). It occurs in middle or late puberty, about two years after the onset of breast development (Pinyerd & Zipf, 2005). Overall, the purpose of the anatomical and physiological development of the primary sexual characteristics is to make the individual capable of reproduction and to transform a sexually immature girl into a sexually mature woman.

1.1.3 Appearance of secondary sexual characteristics. Secondary sexual characteristics are not directly associated with reproduction. They are what make girls look more similar to the adult female stereotype, and they reflect sexual dimorphism (i.e., sex-determined physical differences). As such, the secondary sexual characteristics signal sexual maturity and reproductive capacity to others. In girls, breast development is one of these changes; the addition of body fat, particularly to the hips, is another. Estradiol primarily targets breast tissue, and the development of breast buds is normally the first sign of puberty in girls (van den Berg, Setiawan, Bartels, Polderman, van der Vaart, & Boomsma, 2006), which occurs approximately two years before menarche (Patton & Viner, 2007).

1.1.4 Growth spurt. In addition to changes in primary and secondary sexual characteristics, a rapid growth spurt takes place that results in adult height and weight. This growth spurt lasts approximately two years (Abassi, 1998). Mean age at peak height velocity is around 11 years in North American girls, and girls’ heights increase around 25-30 centimeters during this period (Abassi, 1998).

Peak weight velocity takes place approximately six months after peak height velocity (Rogol, Roemmich, & Clark, 2002). During this period, there is increased fat and muscle growth. The fat contributes to the typical female hourglass shape as it moves fat from the
middle to the upper and lower parts of the body. Puberty also leads to increased strength and endurance, partly because of musculoskeletal development and partly because of maturation of the respiratory and circulatory organs. These rapid changes in girls’ statures are easily noticed by the adolescents themselves, and also people in their surroundings. Together with breast development, acceleration in growth velocity is one of the first overt signs of pubertal maturation in girls (Grumbach & Styne, 2003; Parent, Teilmann, Juul, Skakkebaek, Toppari, & Bourguignon, 2003).

1.2 Pubertal timing and pubertal status
Social scientists have generally paid attention to two aspects of pubertal maturation, pubertal status and pubertal timing (Costello, Sung, Worthman, & Angold, 2007). Pubertal status refers to the level of maturation a girl has reached at a given point in time. Research on the role of pubertal status has, for instance, examined the influence puberty has on girls’ moods (Buchanan et al., 1992). When examining pubertal status, researchers are interested in the linear effects of pubertal maturation (i.e., if the chance of a given outcome increases, or decreases, as a function of maturation) or how the level of pubertal development impacts on a certain outcome. A body of research has shown, however, that the timing of pubertal changes is more influential than the changes per se for psychosocial adjustment, and also for several physiological factors, such as overweight, breast cancer, and osteoporosis (e.g., Alsaker, 1996; Biro, McMahon, Striegel-Moore, Crawford, Obarzanek, Morrison et al., 2001; Blum, Harris, Must, Phillips, Rand, & Dawson-Hughes, 2001; Brooks-Gunn, Petersen, & Eichorn, 1985; Freedman, Khan, Serdula, Dietz, Srinivasan, & Berenson, 2003; Rockhill, Moorman, & Newman, 1998).

Although puberty is a universal transition, girls differ markedly with respect to how old they are when they experience it. Pubertal timing refers to when – in relation to same-sex, same-age peers girls experience puberty (Costello et al., 2007) – and girls can differ from each other by many years with respect to when they go through puberty. Age at menarche can vary from around 8 to 17 in healthy white girls (Tremblay & Frigon, 2005). Everything up to 2.5 standard deviations from the mean is considered normal and non-pathological (van den Berg et al., 2006). Adolescents also differ with respect to the sequence and tempo of pubertal changes. The duration of puberty varies from one and a half to six years, and the earlier the onset of puberty, the longer is its duration (Pantsiotou, Papadimitriou, Douros, Priftis, Nicolaidou, & Fretzayas, 2008; Pinyerd & Zipf, 2005). The aspect of puberty to which social scientists have paid most attention is individual differences in pubertal timing.

In addition to the difference in pubertal timing between individuals, there is a difference between age cohorts. At least in the Western world, average age at puberty has declined markedly the last century. The age decline seems to have been greatest with regard to the appearance of pubic hair and breasts (Muir, 2006; Parent et al., 2003). Genetic factors, weight
and body fat, amount of daily exercise, intensive athletic activity, protein intake, illness, and environmental stress in childhood have all been linked to age at puberty (Burt, McGue, DeMarte, Krueger, & Iacono, 2006; Graber, Brooks-Gunn, & Warren, 1995). It has been speculated that better nutrition and lower prevalence of illness has contributed to the so-called secular trend. These changes have lead to changes in the age at which girls are considered to experience abnormally early puberty (pubertal praecox or true/central precocious puberty).

1.3 Measuring puberty

Puberty is a process that spans several years and it begins long before there are any overt signs of it, sometimes earlier than age 6 years (Dorn & Rothenstein, 2004). Puberty is governed by hormones whose purpose is to generate sexually maturity and to signal this to others. What is the best way of measuring puberty for research purposes?

Dorn and colleagues (2006) recently published a comprehensive review article on how to measure puberty. Their answer was that there is no such thing as one measure of puberty that is always best, but rather that different research questions require different measures. However, they also argued that it is a limitation of the literature that measures of puberty differ significantly between studies, not only between disciplines or areas of research but also within them, even when research questions are nearly the same. This makes comparisons between studies difficult.

The literature represents many different methodologies concerning puberty. First, informants, such as girls themselves, parents, and medical staff, have been used. Different informants, however, do not always agree on where in the pubertal process a girl is (Schlossberger, Turner, & Irwin, 1992). In most studies, girls themselves or their parents are used as informants. Self-reports are sometimes criticized for being susceptible to biases like self-enhancement and self-deception (e.g., Markey, Markey, & Tinsley, 2003). Certain individual characteristics might affect how girls rate their level of maturity. For instance, obese and non-obese girls rate their breast development differently (Bonat, Pathomvanich, Keil, Field, & Yanovski, 2002), with obese girls being more likely to overestimate their breast development than other girls. Medical staff often use the Tanner ratings procedure, which is used to capture the continuous pubertal growth process (Marshall & Tanner, 1969). The ratings are based on five stages. Which of the five stages girls are at is determined by their breast and pubic hair development. Drawings of girls at different stages are used to see which drawing corresponds most to a specific girl. During the first Tanner stage, there are no manifest signs of gonadarche or secondary sexual characteristics. During the final stage, all necessary overt signs of sexual maturity are present. Menarche typically takes place during one of the later stages. Having medical staff as informants is costly, and the number of participants in studies using this methodology is often limited. Therefore, unless the research is clinical, physical examinations are in many cases not ideal for research purposes. Importantly,
Dorn, Susman, and Ponirakis (2003) showed that different sources of rating, self-reports, parent reports or physical examinations, lead to different conclusions about the links between puberty and adjustment. Thus, all informants have limitations, and basing research on different informants may produce discrepancies in results.

Second, researchers have measured different aspects of puberty, even when having posed similar research questions. An example of this is the study by Costello et al. (2007), which showed that overt signs of puberty (i.e., secondary sexual characteristics), but not hormonal indicators, were linked to youth drinking behavior. Some researchers have used a single item whereas others have used scales comprising several items, or aspects, of puberty. Age at menarche is one of the most commonly used measures (Dorn et al., 2006). Tapping age at menarche is arguably also the easiest way to measure puberty. It is a discrete event that is easily noticeable and that the majority of girls accurately recall (Must, Phillips, Naumova, Blum, Harris, Dawson-Huges, et al., 2002). According to Dorn and colleagues (2006), there are three important factors to consider when using age at menarche as a measure of puberty in research: First, age at menarche is a measure of the more advanced phases of pubertal development; thus, it is incorrect to label those girls who have not yet reached menarche as “prepubertal”. Second, although there is a tendency for girls to experience menarche late in puberty (i.e. during the fourth Tanner stage), there are some inter-individual variations; therefore, girls might be at different levels of maturity concerning secondary sexual characteristics and other aspects of puberty when they have their first menstrual period. Third, although most girls remember how old they were when they experienced menarche correctly, this is not always the case.

The pubertal development scale (PDS), developed by Petersen, Crockett, Richards, & Boxer (1988), on which adolescents rate their physical development, is the most common measure of puberty (Dorn et al., 2006). This measure is about perceived pubertal changes (i.e., breast development, skin, height etc.). Sometimes, girls are asked whether they feel that they matured, or developed, later, earlier, or at the same time as their peers. There is some research suggesting that perceived pubertal maturation or timing might play a greater role in girls’ body image than actual maturation, as measured by physical examination (Dorn et al., 2003). Finally, endocrine measures have been used, but not very often in the social sciences. Although puberty is governed by hormones, it is not until recently that links between hormonal changes and adjustment have been examined. Contrary to the common belief that puberty is a period of “sturm und drang”, research suggests that adolescents are not “victims of raging hormones” (Buchanan et al., 1992). Still, there are some findings that link hormonal levels to aggressive and depressive affects (e.g. Warren & Brooks-Gunn, 1989). Thus, research on puberty includes many different measures, and the research question, and also the age period of
interest, should be regarded when deciding upon which aspects of puberty to tap in a particular study.

Third, different statistical techniques or methodologies have been used. This concerns the use of different cut-off points. Girls are often divided into early, on-time, and late maturers. Sometimes, they are divided into two groups, early and late maturers. Where the cut-off is placed between groups varies markedly between studies. In many cases, girls are not divided into early, on-time, or late maturers. Instead, pubertal timing is treated as a continuous scale, and the relation between pubertal timing and other measures are assumed to be linear. The inconsistency makes comparisons between studies difficult, which is a possible reason why, in some instances, there are considerable divergences in findings between and even within studies (Alsaker, 1995). To avoid misinterpretations, analytic procedures should be carefully described in studies involving puberty.

Most of the above-mentioned measures tap girls’ pubertal stages. To get a measure of pubertal timing, researchers typically use one of these measures and control for age. Either girls are grouped into early, on-time, and late maturers (or just early and late), or pubertal status is measured on a continuum to reflect whether girls are more or less early or late. Age at peak height velocity is a measure of pubertal timing that is designed to reflect how old a girl was when she was growing the fastest. To get a valid measure of age at peak height velocity, repeated measures at short time intervals (preferably as short as 6 months should be used. See Dorn et al., 2006).

In sum, social scientists typically measure the overt signs of puberty. But endocrine aspects of puberty are used at times. When interpreting research findings and conclusions, it is important to keep in mind which aspect of puberty is under study, and that the findings and conclusions might only apply under specific circumstances. It is also important to bear in mind which cut-offs have been used. Different aspects of the pubertal process might be important for different types of research questions, and some aspects might play a more prominent role than others. There is not just one way of measuring puberty. However, striving for concordance between studies with respect to issues of measurement is important for future development of the various areas in this research field.
1.4 Adolescent implications of pubertal timing

The following two sections, Adolescent implications of pubertal timing and Adult implications of pubertal timing, describe the research findings concerning the implications developing at different time points might have for female development. Both sections start with somatic implications, with a focus on weight status, and end with psychosocial implications.

1.4.1 Somatic implications. At what age girls mature seems to have implications for their weight status. During puberty, girls gain more body fat, but early-developing girls seem to gain more weight than their peers in adolescence. Early-developing girls are stouter compared with others (Bini, Celi, Berioli, Bacosi, Stella, Giglio et al., 2000; Biro et al., 2001; Bratberg, Nilsen, Holmen, & Vatten, 2007a; Villa, Yngve, Poortvliet, Grjibovski, Liiv, Sjöström et al., 2007), and this difference persists into adulthood (Freedman, Khan, Serdula, Dietz, Srinivasan, & Berenson, 2003; Garn, LaVelle, Rosenberg, & Hawthorne, 1986; Hulanicka, Lipowicz, Koziel, & Kowalisko, 2007; Must, Naumova, Phillips, Blum, Dawson-Hughes, & Rand, 2005; Wang, Zhao, Liu, Recker, & Deng, 2006). It is still unclear whether the link between developing early and having higher adult BMI (Body mass index) is a result of early maturation per se, whether it only appears because early-developing girls already have higher BMI in childhood and because BMI is stable from childhood to adulthood, or whether it is due to other factors.

High BMI as early as at age 3 has been linked to early puberty (Adair & Gordon-Larsen, 2001; Davison, Susman, & Birch, 2003; He & Karlberg, 2001; Juul, Teilmann, Scheike, Hertel, Holm, Laursen, et al. 2006; Kaplowitz, Slora, Wasserman, Pedlow, & Herman-Giddens, 2001; Lee, Appugliese, Kaciroti, Corwyn, Bradley, & Lumeng, 2007). Furthermore, most of the research (Campbell, Katzmarzyk, Malina, Rao, Pérusse, & Bouchard, 2001; Freedman, Khan, Serdula, Dietz, Srinivasan, & Berenson, 2005; Sandhu, Ben-Shlomo, Cole, Holly, & Davey Smith, 2006) shows that BMI is stable over the lifespan (rs = .40 – .60), although some studies have failed to obtain these moderate to high correlations over longer periods of time (Casey, Dwyer, Coleman, & Valadian, 1992). If the link between early pubertal timing and adult weight status merely reflects the stability of BMI, then it should disappear once childhood BMI is controlled for. Early research showed a link between pubertal timing and adult BMI, and assumed that childhood BMI was not the main causal mechanism (Garn et al., 1986). More recent findings are conflicting. Some studies (Freedman et al., 2003; Must et al., 2005) controlled for early weight status and found no link, whereas others have found a link, at least for males (Kindblom, Lorentzon, Norjavaara, Lönn, Brandberg, Angelhed, et al., 2006).

Given that pubertal timing has an independent impact on adult weight status, a critical question is whether this depends on other conditions, since not all early-developing women are sturdily built. A recent Norwegian study (Bratberg et al., 2007a) suggests that since not all early developers have high postpubertal BMI, there are moderating factors that determine
which early-developing girls will have high postpubertal BMI and which will not. Bratberg and colleagues (2007a) found that only early-developing girls who had high waist circumference in early adolescence had elevated levels of BMI in late adolescence. However, because waist circumference was measured sometime between the ages 12-16, puberty and waist circumference were confounded in that study. Puberty might already have influenced waist circumference in some girls at that age, and thus it cannot be thought of as an independent moderator. Other potential moderators should therefore be explored.

**1.4.2 Psychosocial implications.** In the 1930s, Jones (1938) and later Jones and Mussen (1958) started to examine the behavioral implications of pubertal maturation. Those early studies focused on relations between pubertal timing and personality characteristics in adolescence and young adulthood. The results indicated that, by late adolescence, early-developing girls had higher levels of social inhibition, shyness and irritability, and a tendency to have temper tantrums. These results were interpreted as showing that these girls were low on agreeableness and low on emotional stability. The situation was the opposite for late-developing girls. They were high on agreeableness and emotional stability. Since that early work, the focus has shifted from pubertal implications for personality characteristics to pubertal implications for adjustment, particularly internalizing and externalizing behaviors and substance use.

As described in the previous sections, girls differ markedly in terms of the age at which they experience puberty. As a result, there is a chance that girls are at very different developmental stages, socially, cognitively and emotionally, when they go through puberty. It is easy to envisage that being the first in the class to have breasts is very different from having breasts later than everyone else.

The role of pubertal timing in female adolescent functioning has been the focus of a large body of literature. Several recent reviews of the literature have concluded that girls’ early pubertal timing is linked to adjustment problems in a variety of areas (Alsaker, 1995, 1996; Buchanan et al., 1992; Celio et al., 2006; Connolly et al., 1996; Graber, 2003; Mendle et al. 2007; Stattin & Magnusson, 1990; Susman et al., 2003; Susman & Rogol, 2004). The associations between pubertal timing and various measures of problematic adjustment seem to be stronger in early and mid-adolescence and to diminish in late adolescence (Weichold, Silbereisen, & Schmitt-Rodermund, 2003). Thus, developing early seems to be a risk factor for female development, at least during the early to mid-adolescent years.

Early-developing girls have more problems in a variety of areas. Internalizing problems, including depression, social phobia, and eating disorders increase drastically during adolescence. Girls are affected by these types of problems to a greater degree compared to boys. During childhood, depression prevalence rates are similar among girls and boys. By contrast, from early adolescence and throughout life, females are about twice as likely as men to experience psychological distress, depressive symptoms, and major depressive disorders (Nolen-Hoeksema, 1991).
Among girls, early maturers seem to be particularly likely to experience internalizing problems during adolescence. They have more distress, depressive feelings, and more generalized internalizing difficulties, and are more likely to attempt suicide (Aro & Taipale, 1987; Compian, Gowen, & Hayward, 2004; Ge, Conger, & Elder, 1996, 2001; Graber, Lewinsohn, Seeley, & Brooks-Gunn, 1997; Kaltiala-Heino, Kosunen, & Rimpelä, 2003; Patton, Hibbert, Carlin, Shao, Rosier, Caust et al., 1996; Stice, Presnell, & Bearman, 2001; Wichstrom, 1999; 2000); also, they have a poorer body self-image (Muris, Meesters, van de Blom, & Mayer, 2005; Williams & Currie, 2000). In one study, early-developing girls were found to show more depressive symptoms than on-time and late-developing girls every year from the 7th to the 12th grade (Ge et al., 2001), and at least three studies have found associations between early puberty and suicidal behavior (Graber et al., 1997; Stattin & Magnusson, 1990; Wichstrom, 2000). Others have shown that advanced pubertal maturation at age 11-12 is linked to experiencing stress, but not to other types of psychological difficulties (Simon, Wardle, Jarvis, Stegglees, & Cartwright, 2003). In a recent cross-sectional study, early pubertal timing predicted higher emotional arousal, which in turn predicted increased depressive affect (Graber, Brooks-Gunn, & Warren, 2006). At the same time, it should be said that – when significant associations between pubertal timing and depressive affect are reported – the effects are low to moderate, and the role of pubertal timing differs markedly between studies (e.g., Ge et al., 1996; Wichstrom, 1999).

In addition to depressive symptoms, early-developing girls have low body satisfaction. Body mass is higher on average in early than in late-developing girls (Haynie, 2003), and early-developing girls tend to be more concerned and dissatisfied with their bodies, particularly their weight (Cauffman & Steinberg, 1996; Compian et al., 2004; Crockett & Petersen, 1987; Dorn, Crockett, & Petersen, 1988; Ge, Elder, Regnerus, & Cox, 2001; Graber et al., 1997; Stattin & Magnusson, 1990; Stice et al., 2001; Zehr, Culbert, Sisk, & Klump, 2007). Some suggest that this might produce eating disorders (Graber et al., 1997; Keel, Fulkerson, & Leon, 1997). Earlier reviews of the literature considered the association between poor body image and early pubertal timing to be robustly established (Alsaker, 1995, 1996; Buchanan et al., 1992). In conclusion, early pubertal timing seems to be associated with depressive mood and poor body image in adolescence.

The school is an important part of adolescents’ lives. The main purpose of school is education. However, it also functions as an arena for peer relationship formations, and also many young people find their first romantic partners at school. Achieving in school is not only associated with future educational attainments and professional careers; it is also negatively related to delinquent behavior (Magnusson, Dunér, & Zetterblom, 1975). Early-developing girls have been shown to have more school-related problems, such as non-attendance and lack of school motivation, than other girls, and they are less interested in academic subjects.
(Caspi, 1995; Davies, 1977; Graber et al., 1997; Simmons, Blyth, & McKinney, 1983; Simmons, Blyth, Van Cleave, & Bush, 1979; Simmons, Carlton-Ford, & Blyth, 1987; Stattin & Magnusson, 1990). Late maturers, on the other hand, obtain better grades than other girls during adolescence (Dubas, Graber, & Petersen, 1991). Poor school adjustment among early-developing girls cannot simply be attributed to low IQ, since there are no differences in cognitive ability between early and late-developing girls (Stattin & Magnusson, 1990). It might, however, be that involvement in early romantic relationships is one reason why early-developing girls are less well adjusted at school (see below).

Social relationships outside the family become increasingly important during adolescence. Peer relationships start to play an increasing role early on in adolescence. Adolescents spend more time with their peers, both in school and during leisure time than children (see Zimmer-Bembeck, 2002, for a review). Peers are sources of activities, support, and influence (Savin-Williams & Berndt, 1990) and are usually similar to each other (Dishion, Patterson, & Griesler, 1994; Hartup, 1996; Kandel, 1978, 1985, 1986). This is due to the fact that adolescents choose peers who are similar to themselves, a phenomenon that is referred to as homophily. On the other hand, peers also become more similar over time as they associate with each other.

Research suggests that the peer networks of early-developing girls differ from those of later maturers. There are studies suggesting that early-developing girls have older peers and more male peers, and that they associate more with deviant peers, including adult male sex partners, than do on-time or late-developing girls in mid-adolescence (Costello et al., 2007; Dick et al., 2000; Ge et al., 1996; Haynie, 2003; Lynne, Graber, Nichols, Brooks-Gunn, & Botvin, 2007; Mezzich, Giancola, Lu, Parks, Ratica, & Dunn, 1999; Patton, McMorris, Toumbourou, Hemphill, Donath, & Catalano, 2004; Silbereisen, Petersen, Albrecht, & Kracke, 1989; Silbereisen & Kracke, 1993; Stattin & Magnusson, 1990; Wichstrom, 2001). Recent research has shown that high pubertal status among early adolescents strengthens the association between peer delinquency and the delinquency of the individual (Fergusson, Vitaro, Wanner, & Brendgen, 2007). Put differently, early-developing adolescents with deviant peers are more delinquent than late-developing adolescents with deviant peers. This might be because early-developing girls are more vulnerable to deviant peer influence than other girls. Other explanations are also possible. For instance, early-developed girls associate considerably more with chronologically older peer, and these peers are at the peak of juvenile delinquency, whereas the peers of the later developed girls are chronologically younger and have not yet reached the age when adolescent problem behavior is highest. Thus, the peers of early-developed girls might have more problem behavior than the peers of later developed girls. In sum, early-developing girls seem to be more oriented towards peers, and also to have peers who are older and therefore more socially advanced (and, perhaps, more problem behavior).
Another form of social relations that grows in importance, typically starting from early to mid-adolescence, is relationships with the opposite sex, including romantic relationships. At the beginning, romantic relationships are typically short-lived and take place in the context of other peers. As adolescence passes, the nature of romantic relationships becomes more similar to that of adult romantic relationships (Furman, 2002). By mid-adolescence, most girls and boys have some experience of dating (Buhrmeister & Furman, 1987; Connolly & Johnson, 1996).

Given the amount of time spent with, talking, and thinking about members of the opposite sex, it is scarcely surprising that these relationships have important developmental significance. In some respects, having a romantic partner has been shown to be positive. Romantic relationships in middle and late adolescence have been associated with lower levels of social anxiety (La Greca & Harrison, 2005). Early romantic relationships and having many partners, however, have been associated with an increased risk of problems (Zimmer-Gembeck, Siebenbruner, & Collins, 2001), which indicates that romantic relationships might not always be positive for developing youth. Indeed, most studies have shown links between involvement in romantic relationships and adjustment difficulties (e.g. Darling, Dowdy, Van Horn, & Caldwell, 1999). Early initiation of romantic relationships has been linked to depressive symptoms, body image problems, eating disorders, problem behavior, and poor academic achievements (Cauffman & Steinberg, 1996; Compian et al., 2004; Neemann, Hubbard, & Masten, 1995; Smolak, Levine, & Gralen, 1993), whereas romantic involvement in late adolescence has not (Neeman et al., 1995). Thus, early romantic involvement seems to put girls at risk of internalizing and externalizing problems and substance use.

Although it does not necessarily have to take place in the context of a steady relationship, sexuality is a key aspect of romantic relationships. Adolescent sexuality is a normative developmental phenomenon. Most adolescents in western cultures start engaging in sexual activities, including sexual intercourse, during their teenage years. When in a relationship, adolescents tend to start by embracing and kissing one another, and then proceed to petting and more intimate behaviors including intercourse (Miller & Benson 1999).

As with early involvement in romantic relationships, early onset of sexual activity seems to affect girls negatively. It is associated with having more sexual partners, having intercourse more often, and having older sexual partners (Moore, Miller, Glei, & Morrison, 1995). Having sexual intercourse early in adolescence has also been connected with a variety of problem behaviors (e.g. Pedersen, Samuelsen, & Wichstrom, 2003). Among girls, the problems range from being depressed and having worse body perceptions to being more delinquent, having children in adolescence, and drinking more alcohol than same-age, same-sex peers (Armour & Haynie, 2007; Harvey & Spigner, 1995; Pedersen et al., 2003). In a retrospective study, Mott and Haurin (1988) found that once teenagers had started to engage in sexual activities, they also started to use more substances. Deardorff and colleagues (Deardorff, Gonzales, & Christopher, 2005) have shown that early sexual activities and early
initiation of substance use are linked to teenage pregnancy. Thus, early sexual activities seem also to be associated with girls’ problem behaviors.

Puberty is the process of becoming sexually mature, physically speaking. In addition, girls start to become interested in romantic relationships and sex (e.g. Alsaker, 1996; Furman, Brown, & Feiring, 1999; Waylen & Wolke, 2004), and feelings of being in love increase significantly (Larson, Clore, & Wood, 1999). With puberty, girls start to think of and view themselves differently, and there is an increasing tendency to view one's body as an object for others to look at and evaluate (Lindberg, Grabe, & Hyde, 2007). When girls think about physical maturation, they are often aware that their physical development will arouse interest in boys, and that there are sexual issues connected with their development (O’Sullivan, Heino, Meyer-Bahlburg, & Watkins, 2000). Accordingly, a large body of research has been devoted to the connections between puberty and romantic and sexual behaviors.

Early-developing girls move faster into romantic relationships and sexual activities than other girls. In fact, the link between pubertal status and romantic relationships appears as early as at age 11 (Compian et al., 2004). Early-developing girls have more experience than their same-age peers with different aspects of romantic relationships with boys and sexual issues (feelings of being in love, dating, sexuality, going steady, having older boyfriends, viewing sexual media, having abortions, and being subject to sexual abuse), and they are more likely than late developers to attract attention from boys (Simmons, Blyth, & McKinney, 1983). All this appears in studies performed almost six decades ago (Stone & Barker, 1937, 1939) and also, over the past two or three decades, in both North American and European samples (Aro & Taipale, 1987; Baumeister, Flores, Marín, 1995; Brown, Halpern, & L’Engle, 2005; Cavanagh, 2004; Crockett & Petersen, 1987; Fergusson et al., 2007; Flannery, Rowe, & Gulley, 1993; Goodson, Evans, & Edmundson, 1997; Haynie, 2003; Jorm, Christensen, Rodgers, Jacomb, & Easteal, 2004; Phinney, Jensen, Olsen, & Cundick, 1990; Rodriguez-Tomé, Bariaud, Cohen Zardi, Delmas, Jeanvoine, & Slylagyi, 1993; Schor, 1993; Silbereisen & Kracke, 1993; Simmons & Blyth, 1987; Simmons, Blyth, & McKinney, 1983; Simmons, Blyth, Van Cleave & Bush, 1979; Smith, Udry, & Morris, 1985; Stattin & Magnusson, 1990; Turner, Runtz, & Galambos, 1999; Udry, 1979, 1988; Udry & Billy, 1987; Zelnik, Kantner, & Ford, 1981). It also appears in non-western cultures, such as Hong Kong (Lam, Shi, Ho, Stewart, & Fan, 2002) and North Sudan (Otor & Pandey, 1999). Thus, the link between pubertal development and initiation of sexual relationships seems to be quite robust, and it seems well-established that girls who mature early enter into romantic and sexual relationships earlier than their same-age peers. Against the backdrop of the negative developmental consequences of early sexual behavior and early romantic involvement, it seems reasonable to assume that early-developing girls are therefore over-represented among girls in problematic adjustment situations.

During no other period in life do girls engage in delinquency to the extent that they do during adolescence. In fact, minor delinquency seems to be part of normative adolescence,
with the vast majority breaking the law by drinking or committing petty vandalism (Rutter & Giller, 1984). In one study, 80% of the teenagers between 11.5 and 15 years were found to have engaged in problem behaviors during the preceding month (Maggs, Almeida, & Galambos, 1995). Problem behavior peaks around age 16-17, and then declines in prevalence (Sampson & Laub, 2003).

In accordance with what was presumed above, a large body of literature has established that early-developing girls are over-represented among girls with delinquency, substance use, and other forms of problematic conduct in adolescence. Well over a hundred empirical studies have been devoted to this issue the last 20 years, some of which have made significant contributions to the understanding of the role played by pubertal timing in adolescent girls’ problem behaviors (e.g., Aro & Taipale, 1987; Burt, McGue, DeMarte, Krueger, & Iacono, 2006; Caspi, 1995; Caspi, Lynam, Moffitt, & Silva, 1993; Caspi & Moffitt, 1991; Dick, Rose, Viken, & Kaprio, 2000; Ge, Brody, Conger, & Simons, 2006; Ge, Brody, Conger, Simons, & Murry, 2002; Ge, Conger, & Elder, 1996; Ge, Jin, Natsuaki, Gibbons, Brody, Cutrona, et al., 2006; Graber, Lewinsohn, Seeley, & Brooks-Gunn, 1997; Graber, Seeley, Brooks-Gunn, & Lewinsohn, 2004; Haynie, 2003; Lanza & Collins, 2002; Lynne, Graber, Nichols, Brooks-Gunn, & Botvin, 2007; Martin, Kelly, Rayens, Brogli, Brenzel, Smith et al., 2002; McMaster, Connolly, Pepler, & Craig, 2002; Obeidallah, Brennan, Brooks-Gunn, & Earls, 2004; Patton, McMorris, Toumbourou, Hemphill, Donath, & Catalano, 2004; Silbereisen & Kracke, 1993; Silbereisen & Kracke, 1997; Simmons & Blyth, 1987; Simmons, Blyth, & McKinney, 1983; Simmons, Blyth, Van Cleave, & Bush, 1979; Simmons, Carlton-Ford, & Blyth, 1987; Stattin & Magnusson, 1990; Tschann, Adler, Irwin, Millstein, Turner, & Kegeles, 1994; Wichstrom, 2001; Wiesner & Ittel, 2002; Wilson, Killen, Hayward, Robinson, Hammer, Kraemer et al., 1994). As early as at age 11, early pubertal timing is linked to risky and health-compromising behaviors (e.g. smoking, drinking, and sexual behaviors; Markey et al., 2003). Moreover, early-developing girls have higher rates of experimental and regular tobacco use, externalizing problems, norm violations, delinquency, drug and alcohol use, sensation seeking, antisocial personality, and psychopathology, aggression, school problems, including non-attendance and lack of school motivation, engagement with deviant peers, sexually harassing other-sex peers, and peer support for problem behavior (see Alsaker, 1995, 1996; Buchanan et al., 1992; Celio, Karnik, & Steiner, 2006; Mendle, Turkheimer, & Emery, 2007; Susman et al., 2003; Susman & Rogol, 2004; Pinyerd & Zehr, 2005 for reviews). Different behavioral pathologies, such as conduct disorders, are also linked to early puberty (Burt et al., 2006).

In addition to the steadily growing literature on the connection between pubertal timing and various types of problematic conduct on behalf of early-developing girls, recent findings suggest that there is also a connection between pubertal timing and physical and violent victimization (Haynie & Piquero, 2006). Controlling for girls’ and boys’ own violent delinquency, early matures of both genders reported higher levels of victimization than other
girls and boys. Early-developing girls are also more exposed to maltreatment in childhood than other girls (Costello et al., 2007). These studies show that it is not only that early-developing girls engage in problem behaviors; they are more exposed to them as well.

Although puberty has psychological and social meaning, it only refers to biological maturation and does not necessarily entail maturation in other areas. For instance, puberty might occur long before the girl herself acknowledges the new phase she is entering, in the sense that she also feels or sees herself as mature. As a group, however, early-developing girls feel more mature than their later-developing peers (Stattin & Magnusson, 1990).

One plausible reason for why pubertal timing is more important for girls’ adjustment than pubertal status is the importance of social comparisons in adolescence (Alsaker, 1995). This suggests that girls’ cognitions and perceptions about puberty and their own maturation relative to others may play important roles in the link between pubertal timing and adjustment. The idea is that early developing girls may be viewed and view themselves as different from their peers, which might have negative consequences for them (Siegel, Yancey, Aneshensel & Schuler, 1999). In fact, scholars have argued that it is when adolescents feel more mature than their same-age peers that pubertal timing plays a meaningful role in their psychosocial adjustment (e.g., Alsaker, 1995). This idea is in line with recent research showing that feeling older than one’s age and subjective maturity is linked to antisocial behavior, substance use, and sexual behavior (Arbeau, Galambos, & Jansson, 2007) and a study in which we showed that subjective maturity is linked to antisocial behavior (Andershed, Johansson, & Pepler, 2006). Thus, subjective feelings of maturity might be an important factor in the link between pubertal timing and adjustment.

As maturity has many different meanings to adolescents, like responsible behavior, political views, religious activity, physical maturity, power, and socially advanced behaviors, such as drinking, having serious romantic partners or dressing sexy (Tilton-Weaver, Vitunski, & Galambos, 2001), it is possible that there are subgroups of girls who feel mature for different reasons, and that the adjustment situations of these subgroups might also be different. Assuming that feeling mature is negative might be overly simplistic. Instead, since the reasons for feeling mature may differ between individuals, feeling mature might have different implications. More research is needed to understand if this is the case.

Researchers have studied girls’ pubertal timing in relation to adolescent adjustment in many different areas. Early developing girls have been examined as both agents of action and recipients of actions. The major reviews in this field have all concluded that evidence demonstrating that early pubertal timing is related to adjustment difficulties in several domains has amassed over the last couple of decades (Alsaker, 1995, 1996; Buchanan et al., 1992; Celio et al., 2006; Connolly et al., 1996; Graber, 2003; Mendle et al. 2007; Stattin & Magnusson, 1990; Susman et al., 2003; Susman & Rogol, 2004). The reasons for this remain unclear. There are, however, reasons to believe that early romantic and sexual involvement, and also subjective feelings of maturity, might be important pieces in the puzzle.
1.5 Adult implications of pubertal timing

1.5.1 Somatic implications. As noted in the section on the implications of pubertal timing during the adolescent years, pubertal timing appears to have somatic implications. Early-developing women are at higher risk of certain diseases, such as breast cancer and cardiovascular disease. Experiencing menarche before age 12 increases the risk of breast cancer by 50% compared with experiencing menarche at age 16 (Grumbach & Styne, 2003).

In adolescence, early-developing girls are stouter than other girls (Adair & Gordon-Larsen; Bini et al., 2000; Biro et al., 2001; Bratberg, Nilsen, Holmen, & Vatten, 2007b; Villa et al., 2007), and this difference persists into adulthood. In several studies, women who were the first in their cohort of peers to experience puberty had a higher adult BMI than later-developing women (Freedman et al., 2003; Garn et al., 1986; Hulanicka et al., 2007; Must et al., 2005; Wang et al., 2006). Whether this simply depends on childhood BMI or not, is still controversial. Similarly, little is known about factors that might interact in the link between pubertal timing and adult weight status.

1.5.2 Psychosocial implications. Some of the effects of early puberty on psychological and social factors seem to be limited to adolescence whereas others seem to linger on into adulthood (e.g., Celio et al., 2006; Graber et al., 2004; Stattin & Magnusson, 1990). There also findings that indicate that the situation in adulthood might be reversed compared with that in adolescence. In a study by Dubas (2003), early-developing girls manifested the most delinquency, and late-developing girls the most depression in adolescence. By contrast, in young adulthood (sometime between the ages 19 and 26), early-developing women manifested the most depression, and late-developing girls the most delinquency. The important contribution of this study is that it shows that the role of pubertal timing might be very different in adolescence and adulthood, and it sheds light on the importance of long-term follow-up studies of the role of pubertal timing in female development.

According to Elder (1994), salient events during critical periods in people’s lives have the potential to shape life-course trajectories. I noted earlier in the Introduction that puberty in many ways is a salient event that takes place during a critical period in the lives of adolescent girls. To the extent that prior research linking pubertal timing with adjustment difficulties is correct, based on Elder’s view, we should expect pubertal timing to shape female developmental trajectories into adulthood. But, is this true?

The simple answer is that we do not know. While the literature on the links between pubertal timing and its developmental significance in adolescence is substantial, the opposite is true for the literature on the links between pubertal timing and its developmental significance in adulthood. There is no satisfactory answer to the question of the role played by pubertal timing in psychosocial adjustment in adulthood. There are some studies that have tried to answer this question, but often the follow-ups have only been for a couple of years at best, and the existing findings are conflicting.
There are two main ways of thinking about the long-term consequences of pubertal timing. One is that the effects of pubertal timing are limited to the period when early or late developers are developmentally deviant, which is during early and mid-adolescence. This view is supported by some research showing that pubertal timing is linked to school performance in early to mid-adolescence, but not in late adolescence (Dubas et al., 1991). The other way of thinking is that pubertal timing will continue to play a role in adult life. This view is supported by research showing that early-developing girls have children earlier than other girls (Stattin & Magnusson, 1990). Furthermore, pubertal timing alone might not predict adult adjustment. Perhaps it is only when early puberty co-occurs with certain other factors, like early romantic involvement, that it is predictive of adjustment in adulthood.

Prior research that has followed females over long periods of time has focused on psychopathology, delinquency, family, and career development (e.g., Dubas, 2003; Graber et al., 2004; Stattin & Magnusson, 1990). Some research has shown that early and late-developing women in young adulthood seem to be equally likely to cohabitate or be married (Graber et al., 2004; Stattin & Magnusson, 1990). Other research, however, has shown that early maturers are more likely to marry at an early age than other women (Sandler, Wilcox, & Horney, 1984). A large body of research on the timing of childbearing has shown that girls with early menarche are more likely to become pregnant and to have children early in life, including the teenage years, than girls who develop later (e.g., Deardorff et al., 2005; Hockaday, Crase, Shelley, & Stockdale, 2000; Manlove, 1997; Stattin & Magnusson, 1990; Woodward, Fergusson, & Horwood, 2001). This is not to say that all studies have shown this association. For instance, Graber and colleagues (2004) did not report any differences in motherhood at age 24 between women whose puberty was early or late. Thus, although the majority of studies have shown that early-developing women have children earlier but do not marry earlier, others have failed to do so.

Research findings concerning early developers’ educational attainments are also inconsistent. No difference has been reported between early and on-time developers in terms of educational level at the 12th grade or at age 24 (Dubas et al., 1991; Graber et al., 2004). By contrast, one study (Stattin & Magnusson, 1990) found that, as young adults, early developers had lower educational accomplishments compared with other women. In addition, they had work positions that required lower educational levels than did other women. This could not be explained by lower intelligence or level of parental education.

Finally, researchers have failed to find more social adjustment problems among early-developing women in young adulthood (Dubas, 2003; Graber et al., 2004). In one study, however, early-developing women were over-represented in official criminal records between the ages 18 to 33 years (Stattin & Magnusson, 1990). In most areas of adjustment that have been examined, the findings are conflicting. Thus, there is no straightforward answer to the question of what adulthood holds for early-developing girls, and further longitudinal research is clearly needed.
1.6 Explaining the link between pubertal timing and adjustment

The reasons why early-developing females are at greater risk of adjustment difficulties are still largely unknown. Researchers have forwarded different hypotheses to explain how pubertal experience is related to adjustment. These hypotheses differ extensively on the assumptions they make about development, whether it is puberty status or pubertal timing that is assumed to be linked to adjustment, and which girls (early, on-time, or late maturers) are at greatest risk of having problems.

Explanations can be grouped into three main categories: biological, psychosocial, and selection (Mendle et al., 2007). Biological theories focus on the dramatic hormonal changes during the early stages of puberty, since these are thought to have a direct influence on behavior. Psychosocial explanations are the most commonly used in the social sciences. They focus mainly on contextual influences. A basic idea is that early maturation brings about social changes (e.g., different expectations from adults and different peer networks) for which girls are not cognitively, psychologically, and socially prepared. Some also argue that deviating from the norm, whether it is developing earlier or later than peers, is in itself linked to difficulties.

The selection explanation is based on the fact that early maturation is largely due to genetic factors. Thus, an early-developing mother is likely to have an early-developing daughter. Because early maturers are more likely to have adjustment problems, it is difficult to disentangle the effects that early maturation might have from genetic and family environmental factors. Research, however, suggests that, at least for smoking and alcohol drinking, genetic and family factors do not explain the link between early development and problem behaviors (Dick et al., 2000). Similar conclusions, that there does not seem to exist a common genetic influence on pubertal timing and problem behavior, have been reported by Burt et al. (2006) and Jorm et al. (2004). Moreover, it is thought that the social consequences of early puberty are more important in explaining the link between pubertal timing and adjustment problems than physiological factors (Steingraber, 2007).

The most common hypotheses that have been forwarded concerning the link between pubertal timing and psychosocial adjustment problems in the social science literature are the off time hypothesis, the early timing hypothesis, and the accentuation hypothesis (Caspi & Moffitt, 1991; Dubas, 2003; Ge et al., 1996). According to the off time hypothesis (Eichorn, 1975), or the maturational deviance hypothesis (Alsaker, 1995; Weisner & Ittel, 2002), experiencing puberty earlier or later than most peers is stressful, and will lead to subsequent adjustment difficulties. On the other hand, developing at the same time as most others should not be linked to any particular problems.

The early timing hypothesis is similar to the off time hypothesis. It predicts that early puberty is linked to problem behavior. A variation of the early timing hypothesis is the stage termination hypothesis (Peskin, 1973; Weisner & Ittel, 2002). The idea here is that when puberty starts early, psychological development is interrupted so that girls are less prepared to
resolve the developmental tasks of adolescence. The girls are too emotionally immature and have too limited experience to successfully face the new challenges. According to Peskin (1973), the asexual latency period, during which ego mechanisms needed for coping with the sexual drive of puberty are developed, is substantially shortened for early developing girls. In addition, early-developing girls’ appearances might elicit expectations from adults that are excessively based on the girls’ cognitive, emotional, and social skills. This discrepancy might be stressful for the developing girl. Both the off-time and early timing hypotheses suggest that being out of sync with peers creates internal distress, which in turn spurs girls to engage in problem behavior. Much emphasis is placed on the emotional stress that comes with developing out of sync with one’s peers (Brooks-Gunn & Graber, 1994; Ge et al., 2001; Steinberg & Morris, 2000). Research has failed, however, to show that distress explains the link between early puberty and problem behavior (Tschann et al., 1994; Weisner & Ittel, 2002). Thus, there is still little empirical support for the early timing and the off time explanations.

According to the accentuation hypothesis, periods of discontinuity will accentuate differences between people (Caspi & Moffitt, 1991). Thus, in times of stress and uncertainty, people’s behavioral dispositions will manifest themselves in behavior more clearly than during normal circumstances. Consequently, puberty should not have the same effect on all girls, but should enlarge individual differences that existed before puberty. In the study by Caspi and Moffitt (1991), early-developing girls were found to increase with respect to problem behavior more than on-time and late-developing girls, but this increase was greatest for the early-developing girls with high problem levels before puberty. The accentuation hypothesis does not explain why early-developing girls adopt problem behaviors more than late-developing girls, but it suggests that the acceleration in problem behavior is dependent on conditions that were already at hand much earlier. Nor has the hypothesis, to my knowledge, been supported in other research. It is important to note that none of the hypotheses mentioned make predictions about whether the effects of pubertal timing will be limited to adolescence or whether they will continue into adulthood.
1.7 Remaining questions – limitations of the existing literature

Despite the large body of literature on the physiological, psychological and social meanings of female pubertal timing, many questions remain to be answered with respect to the implications of female pubertal timing. There are three major limitations to the literature. One is a lack of good explanations for the link between early puberty and problem behavior. The second is a lack of comprehensive research that includes biological, psychological and social factors, and their interactions, when predicting any given outcome. The third is a lack of long-term follow-ups and ideas about the longer-term implications of being an early or later-developing girl.

A lack of satisfying explanations and direct tests of the mechanisms that explain the well-established link between pubertal timing and adjustment is one major limitation of the female pubertal timing literature. The current literature provides few comprehensive explanations of the mechanisms linking pubertal timing and concurrent and subsequent adjustment. As far as early pubertal maturation puts adolescents at a higher risk of adjustment difficulties, as has been shown repeatedly in previous studies (e.g., Alsaker, 1995, 1996; Buchanan et al., 1992; Celio, Karnik, & Steiner, 2006; Graber, 2003; Mendle et al. 2007; Stattin & Magnusson, 1990; Susman et al., 2003; Susman & Rogol, 2004; Waylen & Wolke, 2004 for reviews), understanding of why and how early development is linked to difficulties, is crucial. The hypotheses that have been forwarded do not give adequate explanations of why early-developing girls, as opposed to other girls, display more adjustment difficulties in general and in particular with respect to social processes. The explanations have rarely been tested and are often used for explaining findings post-hoc than predicting them.

A limitation related to the lack of established mechanisms is the paucity of research with a biopsychosocial approach to studying development. In the literature, pubertal timing has often been studied as the sole predictor, not as one of many interacting factors or as one part of a whole. Most of the research in the puberty area has been based on a main effects approach (see Graber, 2003). However, there are few reasons to believe that direct effects models are the most appropriate for studying the implications of pubertal timing. Rather, interactive models, including psychological and social factors, should be used. All evidence and all logic point to this. This is highlighted by Graber (2003) who stated that “Interactive models that account for either internal characteristics of the individual or variations in the individual’s environment are the only approaches to explaining pubertiy-psychopathology links that have any basis in logic…” (p. 309). Still, the majority of studies have been based on the main effects approach.

The final major limitation in the female pubertal timing literature is a lack of long-term follow-ups. There is little knowledge of the long-term implications of female pubertal timing. Very few studies have examined the role that pubertal timing has for social adjustment in adulthood, and even fewer have utilized prospective longitudinal designs. The problem this entails is that there is little information on whether the potential effects of pubertal timing in
adolescence linger on into adulthood or whether they are adolescent-limited. Nor is there much information on whether early and late-developing girls show equal levels of problem behavior over time. This issue was addressed by Dubas (2003), who investigated associations between pubertal maturation and adjustment in a Dutch sample that was followed from adolescence into young adulthood. In her study, early-developing girls were found to manifest the most delinquency in adolescence. By contrast, in young adulthood (sometime between the ages 19 and 26), it was the late-developing girls who manifested the most delinquency. Thus, it is possible that late-developing girls display higher levels of problem behavior in late adolescence and/or adulthood, rather than in early and mid-adolescence. With the design used by the vast majority of studies, it is not possible to get information about whether or not this is the case.

Many questions remain as to what future implications girls’ pubertal timing will have. There are several possible answers to these questions. Either pubertal timing only matters in adolescence and thereafter is of little importance, or it matters in adulthood too. If the first is true, this would imply that later-developing females will catch up with their earlier-developing counterparts in terms of problem behavior, or that the early-developing girls would adjust to the behavioral norm (i.e., display similar behavior as most others). If the second is true, then the differences between early and late-developing females would remain in adulthood. There is, however, a third possibility. It may be that pubertal timing has long-term implications, but only under certain circumstances. This third possibility concerns temporal conditions during which the implications of pubertal timing differ. For instance, research on the adolescent years has shown that early pubertal timing is linked to aggressive behavior only if girls live in disadvantaged neighborhoods (Obeidallah et al., 2004). Thus, early puberty might have long-term implications for certain subgroups of girls, but not for others.

In sum, the key remaining research questions, which concern *soma et psyche*, in the female pubertal timing literature are:

- Which mechanisms explain the connections between pubertal timing and concurrent and subsequent adjustment?
- Is the impact of pubertal timing different under different contextual conditions?
- What are the long-term effects of pubertal timing?
2. Aims of the dissertation

This dissertation was designed to extend the prior literatures on female pubertal timing and its concurrent and future implications. Its aim is to investigate the short and long-term developmental significance, concerning *soma et psyche*, of female pubertal timing. It has three purposes. One is to examine mechanisms that might explain the links between pubertal timing and concurrent and future adjustment. Another is to use biopsychosocial models to explore the impact of pubertal timing on behavior. The third is to study the long-term implications of girls’ pubertal timing, with respect to *soma et psyche*.

2.1 The biopsychosocial approach

In the literature, pubertal timing has often been studied as a sole predictor, not as one of several interacting factors or as part of a larger picture. People, however, are biological, psychological, and social beings, and adolescence is a stage in biopsychosocial development. Thus, biological, psychological, and social factors should all play important roles in shaping developmental trajectories. In order to get a better understanding of girls’ adolescent development, we need to consider their functioning and development in its entirety.

The core of developmental psychology lies in person-environment interactions at different levels over time (Magnusson, 1988; Magnusson & Stattin, 1998). Studies in the pubertal timing literature, using direct effects models, have examined direct associations between pubertal timing and given outcomes, such as externalizing behavior and substance use. However, puberty is undoubtedly a biological event that takes place in a social context. Therefore, it seems reasonable to expect that pubertal timing will have different implications in different social contexts, and perhaps also in different psychological contexts (i.e., with regard to individual differences). The biopsychosocial model of development (e.g. Bronfenbrenner & Ceci, 1994; Cairns, 1979; Ford & Lerner, 1992; Magnusson, 1988; Magnusson & Stattin, 1998) forms the theoretical foundation of this dissertation. According to this model, biology, psychological factors, and social context are all significant contributors to an individual’s functioning and development. This is a holistic model of development. It requires that biological, psychological and social factors are considered together to obtain a comprehensive understanding of individual development and functioning, and it entails that it is erroneous to neglect any one of these domains. The idea is that interaction between these three domains of functioning clarifies important developmental processes. It follows from this idea that the effects of physiological systems are not autonomous and isolated, but are responsive to psychological and social factors. Thus, when adopting a biopsychosocial approach, rather than being very general, researchers strive to make statements about development and behavior that are specific and concern subgroups of individuals in their developmental contexts.
Applied to the study of psychosocial implications of pubertal maturation, the model requires that puberty should be examined together with psychological factors and the social context that developing adolescents are in for the achievement of a better understanding of its developmental significance. One could also argue that the model suggests that biological, or physical, disposition creates an inclination for adolescents to behave in certain ways and that this behavioral tendency is manifested in certain social contexts. Thus, person-environment interactions should be key research objects in research on pubertal maturation.

According to the biopsychosocial model of development, (pubertal) timing is not everything. A thorough understanding of the implications of female puberty requires consideration of psychological and social factors that act alongside maturational timing. Neglecting to do so might conceal the possibility that the link between pubertal timing and any given somatic or psychosocial outcome depends on other conditions (biological, psychological and/or social), and that early-developing females’ concurrent and future lives might be radically different because of them.

2.2 The peer socialization hypothesis

A limitation that is related to the paucity of research in which a biopsychosocial approach to the study of development has been adopted is a lack of established mechanisms through which pubertal timing is related to a behavioral outcome. The peer socialization hypothesis was advanced by Stattin and Magnusson (1990) to offer such a mechanism and it states that early-developing girls will tend to affiliate with peers who are similar to them in biological maturation, and that these will be chronologically older peers. In addition, early-developing girls will establish romantic relationships with boys earlier than their same-age peers, most often with older boys, because they perceive older boys as similar to them in maturity (Rowe & Rodgers, 1994). Because older adolescents are on average engaged in more problem behavior than younger adolescents (Sampson & Laub, 2003) and boys have more problem behavior than girls, girls who join older peer groups and who have romantic relationships with boys at an early age will have peers who have more problem behavior than their same-age peers, and these older peers and boyfriends will socialize them into the same kinds of behaviors. The girls will be encouraged and supported in this kind of behavior by their peers, and will to a greater extent be brought into leisure-time settings in which these types of behaviors are normative. Thus, affiliating with advanced peers, including older boyfriends, is a mechanism through which early developing girls develop problem behavior. Although the peer socialization hypothesis takes into account relationships with peers of both genders, romantic relationships with boys should play a more important explanatory role with respect to problem behavior. These are potentially the most negative influences, because on average boys score higher than girls on problem behavior at every age. Note that the peer socialization hypothesis places no emphasis on internal stress, as the earlier mentioned hypotheses do, but focuses instead on the implications that early puberty has for peer relationships (Magnusson,
In sum, the peer socialization hypothesis states that the link between early development and problem behavior appears because early-developing girls seek out similar peers in the same way that everyone else does, but in so doing, they find themselves in older, more socially advanced peer groups and they adopt the behavior which is normative in these contexts.

The peer socialization hypothesis has the advantage, compared with other hypotheses, of being based on established principles of peer affiliation and influence, and previous longitudinal research supports this hypothesis. In one study, the early-developing girls’ problem behavior was found to be largely due to greater romantic interests and relationships (Stattin & Magnusson, 1990). In another study, controlling for relevant selection factors, the highest self-reported delinquency and number of delinquent peers were found among the early-developing girls who had entered mixed-sex schools, where there is ample opportunity for meeting boys, rather than among all-girls schools (Caspi, 1995). In a third study, having delinquent peers at Grade 6 was found to mediate the association between perceived pubertal timing and delinquency and aggression at Grades 6 through 8 (Lynne et al., 2007). In a Norwegian study (Wichstrom, 1999), pubertal timing was linked to frequent alcohol intoxication, a link that was mediated by peer problem behavior. Haynie (2003) found that time spent with peers, involvement in romantic relationships, and having deviant peers, together with parental relations, mediated the link between pubertal timing and party delinquency. Finally, early developing girls who had substance-using peers were more willing and had a greater intention to use substances themselves two years later than later-developing girls with substance-using peers (Ge et al., 2006). Although the longitudinal studies that have examined the role of peers in the link between early puberty and problem behavior have had different focuses, these findings are all in line with the peer socialization hypothesis.

There are, however, some basic issues that are still in question. One of the most critical is whether romantic relationships with boys play a mediating role, or are themselves problem behaviors that have some other cause. Another is whether independent reports of peers’ behaviors will yield the same results as past studies, where information about peers has come from the girls themselves. A third is whether the other peers who enter into relationships with younger girls are more problematic than others of their age. A fourth remaining question concerns where early-developing girls meet the peers that eventually might socialize them into problem behavior. These unanswered questions indicate that the peer socialization hypothesis still needs more empirical support to be accepted as an explanation for the differences in social adjustment between early and later developed girls. Perhaps the most critical remaining question concerns the contextual conditions under which we would expect the processes described by the peer socialization hypothesis.
2.2.1 The role of contexts. One idea that has been forwarded is that the implications that early puberty has for behavior depend on contextual conditions. The contextual amplification hypothesis is a person-environment interactional hypothesis, which deals with the link between early puberty and problem behavior (Ge, Natsuaki, Jin, & Biehl, 2007). It has been developed against the backdrop that associations between early puberty and problem behavior have not always been found, and – even when found – the magnitude of the effect of pubertal timing on problem behavior is modest. Ge and colleagues (2007) argue that the explanation for these findings is that the role of pubertal timing in development depends upon the social contexts in which puberty occurs. In other words, contextual conditions are thought to play a central role in moderating the effects of pubertal timing on girls’ problem behavior. It is assumed that early puberty is particularly detrimental when the surrounding context is adverse (i.e. disadvantaged neighborhood, harsh parenting etc.). By contrast, the chances that early-developing girls will have problems decrease if the environment is supportive. Thus, according to this hypothesis, the link between pubertal timing and problem behavior will be more or less strong depending on certain features of the context. In a poor social context, the link between early puberty and problem behavior should be amplified. In line with this general idea, research has shown that geographic residency (rural versus urban area), neighborhood, (advantaged versus disadvantaged, where girls are more likely to encounter deviant peers), and type of school (girls only versus mixed, where there are more opportunities to meet boys) all seem to moderate the link between early puberty and problem behavior (Caspi et al., 1993; Dick et al., 2000; Obeidallah, Brennan, Brokks-Gunn, & Earls, 2004). Neighborhood also seems to moderate the link between early puberty and associating with deviant peers (Ge et al., 2002). In fact, drs have frequently been referred to as an important feature of a context that increases the negative impact of early puberty in this literature (Caspi et al., 1993; Ge et al., 2002; Obeidallah et al., 2004). Thus, contextual circumstances might increase or decrease the risks that are associated with early puberty.

Precisely why early-developing girls are more negatively affected by poor contexts than other girls is not specified in the contextual amplification approach. This approach considers the conditions under which the early puberty-problem behavior link is most likely to occur, whereas the peer socialization hypothesis considers the mechanisms linking early puberty and problem behavior. Thus, the peer socialization and contextual amplification hypotheses could be viewed as complementary, and – if verified – provide a better understanding of the link between early puberty and adjustment difficulties among girls than is offered by other theoretical models.
2.3 Purpose of the papers in the dissertation

The main aim of this dissertation is to investigate the short and long-term developmental significance, concerning *soma et psyche*, of female pubertal timing. It has three purposes. The first is to examine mechanisms that might explain the links between pubertal timing and concurrent and future adjustment. This is the aim of Paper I. In that paper, we report on the development and testing of the peer socialization hypothesis in four different studies using five different samples. The main idea of the peer socialization approach is that the reason why early-developing girls have been found to have relatively high levels of problematic conduct in adolescence is that they start engaging with older peers and boyfriends, and – through them – are socialized into more socially advanced behaviors, including problem behavior. This hypothesis builds on previous research showing that people seek out others who are like them, and that romantic relationships in adolescence are linked to problem behavior. It is hypothesized that these links are strongest in contexts where there is an over-representation of deviant youth and in cultures where heterosexual relationships among adolescents are sanctioned.

The second purpose is to use a biopsychosocial model and a person-oriented approach to explore the developmental significance of pubertal timing. This is done in Paper II. The idea underlying the paper is that more accurate information would be obtained if biological, psychological, and social predictors are considered together, rather than if pubertal timing is considered as a sole independent variable. In Paper II, I examine a biological factor (girls’ ages at menarche), a psychological factor (girls’ self-perceptions of maturity), and a social factor (early romantic relationships with boys) simultaneously in an attempt to obtain a more comprehensive understanding of the role of pubertal timing in girls’ adjustment. In Paper I, we assume that early-developing girls feel more mature than their same-sex peers and that they therefore affiliate with older peers. For the study reported in Paper II, girls’ perceptions of their own maturity are included in the analyses. It is hypothesized that early-developing girls who feel mature and who have early romantic relationships with boys will have the most problematic adjustment. Scholars have suggested that the reason why pubertal timing is linked to adjustment is that early-developing youth feel different from other youth (e.g., Alsaker, 1995). Maturity can mean many different things to young people, however (Tilton-Weaver et al., 2001). Socially advanced behavior is certainly one, but responsible behavior is another. Therefore, I argue that early-developing girls do not act more deviantly simply because they feel mature. They might just as well act maturely and responsibly. Thus, it is hypothesized that early-developing girls who do not have early sexual relationships, but who feel mature, should not have particularly high levels of problematic conduct.

Because there is a dearth of long-term follow-ups of females with early and late puberty, the third purpose of this dissertation is to study the long-term implications of girls’ pubertal timing. Findings are presented in papers III and IV, based on two different prospective longitudinal samples. The implications of interest concern *soma et psyche*. In Paper III, we
ask what future implications pubertal timing has for females’ weight status, body perception, and quality of life. Against the backdrop of the literature showing that early-developing girls are more depressed in adolescence, it is of great importance to understand whether early maturers will have lower subjective well-being and perceived poorer quality of life in adulthood. To my knowledge, no study has followed females from middle childhood to midlife in order to examine the role played by pubertal timing with respect to midlife life satisfaction. In Paper IV, we pose four different questions. The two main questions are whether pubertal timing has a unique predictive impact on adult weight status after controlling for childhood weight status, and whether appetite moderates the link between pubertal timing and adult weight status. The first question is posed because of the controversy concerning the role of childhood weight status in the link between pubertal timing and subsequent weight status. The second question is posed because previous research has shown that it is likely that there are meaningful subgroups of early-developing girls whose adult weight statuses might be radically different. Appetite has previously been linked to later body mass, even after controlling for concurrent body mass (Lee & Song, 2007). Thus, if early pubertal timing predicts adult weight status, there are reasons to believe that a large appetite may strengthen the link between early pubertal timing and adult weight status. Because of the nature of Paper IV (long-term follow-up and integration of biological and psychological factors), it meets both the second and the third purposes of this dissertation.
3. Method

3.1 Participants and procedures

This dissertation uses six different samples. Paper I uses five different samples and Papers II, III, and IV use one sample each. The samples differ in terms of: (1) size (Ns range from 90 to 955), (2) the age of the participants at time of the data collections (age ranges from 8 to 43 years), (3) when the information was collected (the earliest information used in this dissertation was collected in the 1960th and the latest data was gathered in 2002), and (4) where the data was collected (in three different municipalities in Sweden and in one municipality in Slovakia). Taken together, the samples capture girls in different locations, at different time periods, and at different ages. Given that the findings will point in the same direction, the chances that they depend on sample characteristics are small. Table 1 shows an overall description of the samples.

3.1.1 Sample I. Sample I was used for papers I, II, and III. This sample comes from the longitudinal research program Individual Development and Adaptation (IDA). The IDA project was started by Professor David Magnusson at the Department of Psychology, Stockholm University, in mid-1964 (Magnusson et al., 1975; Magnusson, 1988). Professor Lars R Bergman is the current scientific leader. The broader focus of this study was on how individual and environmental factors, and also their interactions, influence psychosocial development over the lifespan. The so-called interactionist perspective on development has guided research within the IDA program (Magnusson, 1988).

The participants come from the medium-sized Swedish town of Örebro. At the outset of the investigation in 1965, Örebro had about 80,000 inhabitants. It has expanded over time. In 1985 there were approximately 120,000 persons living in Örebro and in year 2000 130,000. Given the population of Sweden (currently 9 million), Örebro is a relatively large city by national standards. The economy of Örebro was at the initiation of the study dominated by a prominent footwear industry, but has diversified over time into engineering plants, printing shops, and a food and paper industry. Additionally, Örebro is home to a large hospital and university. A city-based comparison (Stattin, Magnusson, & Reichel, 1986) showed that Örebro had rates of crime comparable to similar-sized cities in Sweden (50,000-100,000 inhabitants), and moderately lower rates of crime compared with Sweden’s largest cities (i.e., Stockholm, Göteborg, Malmö).

The first data were collected when the participants were 10 years-old and data gathering is still in progress. The target sample comprised all children who in 1965 attended normal grade 3 schooling in public compulsory school. There were no private schools in the community at this time. The total number of children was 1,027. Of those, 510 were girls and 517 boys.

Thus far, data have been collected at ages 10, 13, 15, 16, 17, 18, 27, and 43 for the female participants. The sample size has grown over time. This is because girls who moved into the...
community entered the study while girls who left the community did not leave the study. At the last data collection, in 1998, 682 women participated. At age 27, participants filled out postal questionnaires containing questions concerning childbirth, education, work, and drinking habits. Of those who participated in adolescence, 90% took part in the follow-up at age 27. When the women were 43 years of age, in 1998, they were interviewed about various aspects of their adjustment situations. The participation rate was 89%.

Extensive data have been collected from different sources: from the children themselves information was collected about, for instance, intelligence, school performance, adjustment to school, anxiety, psychosomatic symptoms, bullying, and vocational preferences; from the teachers information was collected about, for instance, ratings of aggression, motor restlessness, lack of concentration, and certain symptoms; from the parents information was collected about, for instance, education and vocation, conditions of living, family situation in general and problems with the child; from peers information was collected about, for instance, social relations; test information was collected about, for instance, achievement and intelligence; register information was collected from official records about, for instance, school grades and number of hours absent from school (Magnusson et al., 1975).

3.1.2 Sample II. Sample II was used for Paper I. This sample comes from a Swedish longitudinal study that was started in the fall of 2001 by researchers at the Center for Developmental Research (CDR) at Örebro University (the 10 to 18 study). The main focus of the study was to understand the risk and protective factors and etiological mechanisms behind antisocial, delinquent behavior. “10 to 18” is a 6-year longitudinal investigation that has been conducted in one entire community, Köping, in central Sweden. The community has around 26,000 inhabitants. The unemployment rate is the same as the Swedish average and the average income is slightly lower than the national mean. This particular community was chosen because it met several research criteria. First, it has its own high school, so youths remain in the community’s school system over the entire adolescent period. Second, it does not offer youth easy access to neighboring towns, so most youths have their leisure time peer associations inside the community. Third, it has a population of a size that enables all potentially influential peers to be included in the study. The community harbors 13 schools and 158 classes in the age range covered. Professor Margaret Kerr and Professor Håkan Stattin are the project leaders.

The participants were all the children and adolescents in the town who were between the ages of 10 and 18 (N = 3,000), or more specifically all children in grades four through 12. They were followed annually from 2001 to 2007. Participants were recruited by asking all youth in grades four to 12 to participate in the study. Parents were informed about the study beforehand by mail and meetings in the community. They received a pre-stamped postcard that they could return if they did not want their child to participate. One percent did so. Thus, active consent was obtained from the children and passive consent was obtained from the parents. Data collections were performed during normal school hours. Participants were asked
to name their peers; because virtually all youth aged 10 to 18 took part in the study (90% and over), there are self-reported, independent data from both the target participants and their peers. The benefit of this design is that the peer data are not susceptible to reporter or reporting bias, which often inflates similarity (Iannotti, Bush, & Weinfurt, 1996).

For Paper I, data from girls in grades 8 and 9 during the school year 2001-2002 were used. During this school year there were 3,174 participants aged 10 to 18 in the community’s schools in total. Data were collected twice (in fall and spring) separated by 4 months. At the first data collection, of all 334 girls listed at school in grades 8 and 9, 309 (93%) were present, and at the second 302 (90%). Information was obtained through self-report questionnaires that were filled out by youth during school hours.

3.1.3 Sample III. Sample III was used for Paper I. This sample comes from a Slovakian study, which was conducted in the fall of 1995 by researchers at the Institute of Experimental Psychology, Slovak Academy of Sciences, in Bratislava. Professor Zdena Ruiselova was responsible for the data collection. The participating 15-year-old girls took part in broad surveys of self-experienced symptoms and adjustment problems. The cohort consisted of freshmen in all high schools in a town (Banská Bystrica) of about 90,000 in central Slovakia. There were 1,018 girls registered in the town for the spring term. From among these, data were collected for 955. Hence, the participation rate was 94%. The average age of the girls was 14 years and 5 months. Trained test leaders were used during data collections, and the students answered the questions in their regular classrooms. The procedure was identical to that used with samples I and IV.

3.1.4 Sample IV. Sample IV was used for Paper I. This sample came from a study with a focus on exploring self-experienced symptoms and adjustment problems among 15-year-old girls. Professor Håkan Stattin is the project leader. This study was designed to be a repeat of the IDA study (see Sample II). It was performed as an identical replication of the original study. The study was conducted in the same community, Örebro. It comprised all the adolescent girls attending grade 8 in this community in the 1995-96 school year. Hence, it is referred to as the “95-96 study”. Data collections were made on two occasions – November 1995 and May 1996 – just as in the earlier IDA study. This sample included 602 girls; 529 (88%) of them were present and filled out the questionnaire at the November data collection. Trained test leaders were used, and the pupils answered the questions in their regular classrooms.

3.1.5 Sample V. Sample VI was used for Paper I. This sample comes from a short-term longitudinal study that started in the fall of 1998 and ended in the spring of 2000. The project is normally referred to as the “Short-term longitudinal study”. Professor Margaret Kerr and Professor Håkan Stattin were the project leaders. The focus of this study was on testing the causal links in a model of family communication processes, on discovering how children and parents react to each other over time, on how those reactions change their relationships, and on how their relationships are linked to delinquency and other forms of adjustment.
The participants came from the same medium-sized Swedish town, Örebro, which is described under Sample I. Information was collected from students, parents, and teachers. The participants were in grade 8 when the study began. The target sample comprised 1,279 students (48% boys; 52% girls). Of the 1,279 students, 1,186 (93%) with a mean age of 14.4, were present on the day of the first data collection, and answered the questionnaires. The data were collected during normal school hours. Parents were informed about the study beforehand by mail. They received a pre-stamped postcard that they could return if they did not want their child to participate. Twelve parents did so. In the spring of 2000, approximately 18 months later, 1,057 out of the 1,279 (83%) students participated in data collections that were performed in class rooms, again by using self-report questionnaires. At this time, the participants were attending 9th grade. Eighty-seven per cent of the participants were born in Sweden.

3.1.6 Sample VI. Sample VI was used for Paper IV. This sample came from a Swedish longitudinal study that was started in the mid-1950s by researchers at the Clinic for the Study of Children’s Development and Health at the Karolinska Hospital in Stockholm. The study was part of a larger international investigation that was organized by Centre International de l’Enfance in Paris. Professor Håkan Stattin is the current project leader. The focus of the study is on somatic, psychological, and social development. However, it also comprises information, among other things, on parent-child relationships, sexual development, sleep, social and economic circumstances, child behavior, school performance, criminality, and substance use.

Participants were recruited by asking every fourth pregnant mother who registered at the Solna Prenatal Clinic in (a Stockholm suburb) from April 1955 to April 1958 to participate in a longitudinal pediatric study. Hence, the study is referred to as the “Solna Study”. Because virtually all Swedish pregnant mothers receive prenatal care, the selected women were assumed to be representative of Swedish mothers living in urban areas at this time. Seventeen mothers moved out of the community during their pregnancy, and seven mothers were unable to participate due to various reasons. In such circumstances, the next fourth mother was invited to participate in the study. The number of mothers who agreed to participate was 198. Six withdrew because of abortion and four because of stillbirths, while five were excluded because of low childbirth weights (under 2,000 grams). Further, a pilot group of 29 children, who were contacted either before or just after birth, were added to the study. In total, 183 children plus the 29 children from the pilot group made up the sample. Of these, 122 were boys and 90 girls. Data from the 90 girls were used for Paper IV.

The children were assessed six times during their first year of life, twice during their second year, and once per year up to age 18 thereafter. Data collections in adulthood took place at ages 21, 25, and 37. Up to 18 months, participants were examined as close as possible to their birthdays to avoid age effects. From 18 months and onwards, this was within four weeks before or after their birthdays. Eighty-five and 90 per cent participated at ages 25 and
37, respectively. Information was collected through somatic registrations, medical examinations, interviews, inventories, ratings, objective tests, sociometric methods, and projective techniques. Multiple investigations have shown the sample to be representative of people living in Swedish urban communities (e.g., Karlberg, Engström, Lichtenstein, & Svennberg, 1968).
Table 1.
Characteristics of the six samples used in this dissertation.

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3.2 Measures

3.2.1 Paper I. Study 1. *Normbreaking behavior*, used for the Swedish 1971-96 comparison, was a scale aggregated from eleven items in the so-called Symptoms Questionnaire about shoplifting, alcohol abuse, signature forgery, pilfering, using hashish, vandalism, evasion of payment, physically hitting somebody, harassment, and loitering in town in evenings (Magnusson et al., 1975). Responses were on a 5-point scale: (1) no, (2) once, (3) 2-3 times, (4) 4-10 times, and (5) more than 10 times. Alpha reliability for the scale was .75 in 1971 and .84 in 1996.

*Normbreaking behavior*, used for a cross-cultural comparison, was taken from the Norm Inventory (Magnusson et al., 1975). The instrument covered eight norm-violating activities: at home (ignoring parents’ prohibitions, staying out late without permission); at school (cheating on an exam, playing truant); and, during leisure time (smoking hashish, getting drunk, shoplifting, loitering in town in the evenings). For each of these, participants reported on their own evaluations. The answers were given on 7-point scales with the alternatives: (1) very foolish, (2) foolish, (3) rather foolish, (4) not really OK, (5) rather OK, (6) OK, and (7) quite OK. The measure of the girls’ own norm violation consisted of answers to the question how many times the girls had performed each of the eight norm-violating behaviors. Answers were given on 5-point Likert scales with the alternatives: never (1), once (2), 2-3 times (3), 4-10 times (4), and more than 10 times (5).

Behavioral intentions in connection with normbreaking. For each of the eight norm-violating activities in the Norm Inventory, descriptions of concrete instances were constructed. Situations depicting the different types of norm-violating activities were presented, and the girls were asked about their own behavioral intentions to breach respective norms (“What do you think you would do in this situation?”) on 7-point scales, such as: would definitely not cheat (1), would probably not (2), would perhaps not (3), uncertain what to do (4), would perhaps (5), would probably (6), and would definitely (7). The eight norm-violating activities for each of the different norm dimensions (evaluations, behavioral intentions, and own norm-violating behaviors) were aggregated into broader scales. Alpha reliability for the normbreaking behavior (own behavior) scale was .84 for Swedish girls and .81 for the Slovakian girls. For the two other scales (evaluations, behavioral intentions), the alphas varied between .84 and .90 for the Swedish and Slovakian samples. Hence, very small departures from homogeneity for the scales were found between girls in the two countries.

Romantic relationships with boys. Three items measured how advanced the girls’ relationships with boys were. One was about perceived sexual maturation: “Do you feel sexually more experienced than your age-mates?” The response options were: never (1), seldom (2), sometimes (3), rather often (4), and very often (5). Another question was about intercourse: “Have you had sexual intercourse?” The response options were: no (1), yes, once (2), and yes, several times (3). The third question was about having a steady boyfriend: “Have you now or have you had a steady relationship were a boy?” The response options were: have
never had, don’t want to have (1), have never had, but want to now (2), have had earlier, but not now (3), have now, but not earlier (4), and have now, and have had earlier (5). The final item was transformed into a trichotomized measure in the calculations. Scale values 1 and 2 were coded 1, value 3 was coded 2, and values 4 and 5 were coded 3. Alpha reliability for this 3-item scale on romantic relationships with boys was .70 in 1971 and .74 for the 1996 sample.

Pubertal timing. Information on age at menarche was requested in the Symptoms Questionnaire. It was originally coded in 6 categories: before age 10 (1), between 10 and 11 (2), between 11 and 12 (3), between 12 and 13 (4), after age 13 (5), and have not yet had my first period (6). In all studies in Paper I, a condensed four-scale measure was used, differentiating between girls who had their menarche: before 11 years (1), between 11 and 12 (2), between 12 and 13 (3) and 13 and later (4). The coding highlights variations in early timing – commensurate with the theoretical interest – rather than covering the whole age variation of pubertal timing. Using the IDA sample, Stattin and Magnusson (1990) compared this self-report measure with bone ossification and weight and height measures at the age of 13 years. They found strong support for the validity of self-reported age at menarche as a measure of girls’ pubertal timing.

Study 2. School and free-time peer groups. Girls were asked whether they belonged to a group (containing at least three persons) that hanged out together at school. If they mentioned such a group, they were asked to list the names of all the youngsters who belonged to this group. They could mention up to ten school peers in total. The participants were also asked if they belonged to a group that hanged out together in their free time. If they belonged to such a group, they were asked to list the names of the persons who belonged to this group. They could mention up to ten free-time peers in total.

Age and delinquency of peers. The peers in the school group and the peers in the free-time group were identified through class lists. For each peer mentioned, we added their gender and age (according to year and month). Because these peers in most cases answered our questionnaires, we computed a summary score of delinquency based on their self-reported delinquent activities. Thus, delinquency (and also age and gender) in peers was not ascertained through reports of the participants who mentioned these peers, but through self-reports of the peers themselves. The delinquency measure was composed of 22 questions. Youths answered these questions about their behavior over the past year: “Have you taken things from a store, stand, or shop without paying?”, “Have you been caught by the police for something you have done?”, “Have you, on purpose, destroyed things, such as windows, street lights, telephone booths, benches, gardens, etc.?”, “Have you taken money from home that was not yours?”, “Have you been part of painting graffiti, or writing with markers or spray paint on, For instance, a sidewalk?”, “Have you participated in breaking into a home, shop, stand, storage building or other buildings with the intention of taking things?”, “Have you stolen something from someone’s pocket or bag?”, “Have you bought or sold something that you knew or thought had been stolen?”, “Have you taken a bicycle without permission?”,
“Have you threatened or forced someone to give you money, cigarettes, or anything else?”,
“Have you taken part in a fight on the street in town?”, “Have you carried a weapon (e.g.,
brass knuckles, club, knife, switchblade, or some other weapon)?”, “Have you participated in
taking a car without permission?”, “Have you taken a moped, motorcycle, or Vespa without
permission?”, “Have you been part of hitting someone so that you believed or knew that he or
she needed to be treated at the hospital?”, “Have you intentionally hurt someone with a knife,
switchblade, brass knuckles, or some other weapon?”, “Have you taken part in threatening or
forcing someone to do something that he or she didn’t want to do?”, Have you snuck out
without paying (e.g., at movies, a café, on the train or bus, or somewhere else?”, “Have you
taken part in stealing something from a car?”, “Have you drunk so much beer, liquor, or wine
that you got drunk?”, “Have you smoked hashish (marijuana, cannabis)?”, and “Have you
used any drugs other than hashish (marijuana, cannabis)?”. Alpha reliability for a scale
summing these items was .92.

**Sexuality and steady relationships.** The participants were asked “Have you had sexual
intercourse?” and answered on a three point scale ranging from (1) no, never (2) yes, once, to
(3) yes, several times. They were also asked if they had a steady boyfriend relationship,
answered on a 5-point Likert scale: (1) have never had, and do not want to, (2) have never
had, but can think about it now, (3) have had, but not now, (4) have now, but have not had
earlier, and (5) have now and have had earlier. The measure was recoded as reported in
Study 1

**Activities the last month with free-time peer groups.** Participants were asked what
activities they had undertaken with their free-time peers the last month. They answered
separately (1. no, 2 yes, once, and 3. yes, several times) for the following 11 activities:
Studied, Watched TV/videos, Played hookey, Talked on the telephone/chatted, Shoplifted,
Used the computer, internet, or played TV videogames, Drank alcohol until you were drunk,
Kept secrets from parents, Talked about things that are illegal, Went out looking for boys, and
Did other things, apart from shoplifting, for which one could get caught by the police.

**Study 3. Youth center participation.** The 1998 cohort of participants responded to a
question of whether they usually attended youth centers in the town (1. No, 2. Yes); if they did
so, they were asked how many evenings per week they typically were there. The response
options for the 1970 cohort were on a 5-point scale, ranging from no participation to
participation every evening of the week. Note that an adolescent has to be 13 years of age to
gain entrance to these centers.

**The 1970 cohort**

**Romantic relationships with boys.** Three items measured how advanced the girls’
relationships to boys were; the items were identical to those described in Study 1.
Problem behavior was the same scale in the Norm Inventory previously described under Study 1.

Peer involvement at age 13 was a composite measure based on three questions “How many peers do you have that you are together with really often after school?” “How many evenings per week do you usually meet your peers?” and “How many evenings per week do you usually spend at home?” (reversed). The inter-item correlation for these three measures was acceptable, at .34, but the alpha for the three-question peer involvement scale was low, at .64.

The 1998 Cohort

Romantic relationships with boys. The girls answered 3 questions on romantic relationships with boys: “Do you have, or have you ever had a steady boyfriend?”, Have you had sexual intercourse?”, and “If you have a boyfriend/girlfriend, how often do you see each other?”. Alpha reliability was .75 (see Study 1).

Delinquency. The 1998 cohort responded to a delinquency questionnaire. They answered 15 questions about whether they had engaged in certain behaviors during the past year. Responses were on a 5-point scale ranging from “never” (1) to “more than 10 times” (5). The questions were about: shoplifting; being caught by the police for something they had done; vandalizing public or private property; taking money from home; creating graffiti; breaking into a building; stealing from someone’s pocket or bag; buying or selling stolen goods; stealing a bike; being in a physical fight in public; carrying a weapon; stealing a car; stealing a moped or motorcycle; using marijuana or hashish; and using other drugs. Alpha reliability was .72.

Peer involvement. The participants reported how many nights per week they usually socialized with friends. The response options ranged from one to seven days per week.

The 1970 Cohort – follow-up

Romantic relationships with boys. At the average age of 14 years and 10 months (grade 8) girls in the sample reported whether they had sexual intercourse on a 3-point scale (alternative responses: 1. no, 2. yes, once, and 3. yes, several times).

Youth recreation-center attendance. At age 13 (grade 6), the girls reported the frequency with which they attended any of the youth recreation centers operating in the town of Örebro. Center attendance was coded on a 5-point scale ranging from no participation, to participation every evening of the week (Mahoney, Stattin, & Magnusson, 2001).

Registered delinquency. Information about criminal offense was obtained from official registers. For underage offending (below age 15), information about juvenile offending was obtained from local welfare authorities. Information about registered offenses between age 15 and age 30 were obtained from police registers. Only three of the girls were underage
offenders. At age 30, 38 (7.5%) of the 510 girls with data on age at menarche were registered by the police for one or several criminal offenses.

**Study 4. Social Behavior.** Information about behavioral problems came from teacher ratings and peer nominations when the participants were 10 and 13 years of age. Data included teacher ratings concerning aggressiveness, concentration problems, motor restlessness (the latter two, measures that have been used as global indicators of hyperactive behavior), disharmony, and school fatigue. Teacher ratings were made on a 7-point scale, where higher values indicate more of the rated construct (Magnusson et al., 1975). It should be noted that in most cases the teachers who made these ratings had had the opportunity to observe the girls over three years. The teachers who had been the head teachers from age 7 to 10 made the age 10 ratings, and the teachers who had been the head teacher from age 10 to 13 made the age 13 ratings. In almost all cases, the teachers who made the ratings at age 10 were different from the teachers who did the ratings three years later.

**Intelligence.** An intelligence test, the Westrin Intelligence Test (WIT III), was administered to the participants at age 14. The test contains four subtests measuring inductive ability, verbal comprehension, deduction, and spatial ability. The manual reports a split-half reliability of .93.

**Grades.** Grades in Swedish and Mathematics were available for the girls at the ages of 10 and 13. The head teachers provided them on 5-point scales, with 5 being the best grade. We aggregated the grades over the two subjects.

**Popularity in the class.** To assess popularity at ages 10 and 13, students were asked to imagine that they were being transferred to another classroom, but that not all of their classmates could go to the new room (c.f., Magnusson et al., 1975). They were then asked to rank all of their classmates in the order in which they would like them to move along. The students were asked to rank girls and boys separately. The rankings were then combined across all informants and standardized to form a continuum of popularity. A constant of 3 was added to avoid negative scores. Higher scores on this measure reflect a greater number of peer nominations (labeled popularity).

**Perceived popularity.** The participants were also asked about how they, themselves, would be scored according to nominations of their peers in the class. This measure, perceived popularity, was a self-report measure on where in their peer ranks the girl thought that she was placed.

**Poor peer relationships.** Four items made up a scale measuring poor peer relationships at school at age 10: “Do you enjoy the peers in your class?”, “Do you have fun with peers during the breaks?”, “Can you play with those you want to play with during the breaks?”, and “How many of your classmates do you like?” Alpha reliability for the 4-item scale was .65 (inter-item correlation was .31). Six items made up a similar measure of poor peer relationships at school at age 13: “Do you have a really good friend in your class?”, “Do you enjoy your
classmates?, “Do you have a good time during the breaks?”, “Do peers pick on you during the breaks?”, “How many of your classmates do you like?”, and “Do you get along well with your classmates?”. Alpha reliability for the age 13 measure was .78 (inter-item correlation was .37).

**Parental concerns.** When the girls were 10 years of age, their parents were asked if they had any concerns in the following domains with respect to the child: pocket money, TV-watching, doing homework, curfew time, peer relationships, smoking, and alcohol or sniffing, and disobedience. The response scale was a dichotomized measure: Yes or No. Alpha reliability for the scale combining these eight domains was .66. A similar parental concern scales was made up at age 13, with an alpha reliability of .74. It involved seven questions to parents about the child’s pocket-money, TV-watching, doing homework, curfew time, peer relationships, disobedience, and going to bed.

**Thrill seeking** was a subscale of the Youth Psychopathic traits Inventory (YPI), an adolescent self-report measure of psychopathic personality traits (Andershed, Kerr, Stattin, & Levander, 2002). The following 9 items, reported on a 4-point scale ranging from (1) does not apply , to (4) apply precisely, are included: "I get bored quickly by doing the same thing over,” ”I get bored quickly and I like change,” ”I like to do things just for the thrill of it,” ”I like to do exciting and dangerous things, even if it is forbidden or illegal,” ”I like people that are involved in exciting and unexpected activities,” ”I have an unusually great need for change,” ”I’m drawn to places where exciting things happen,” ”I like having ’lively and active’ surroundings,” and ”To be on the move, traveling, change, and excitement – that’s the kind of life I like.” The alpha reliability was .82.

**Impulsivity** was a subscale of the Karolinska Scales of Personality (KSP). The following six items were answered on a 4-point Likert scale (1 = never agree, 2 = rarely agree, 3 = sometimes agree, and 4 = always agree) ”I have a tendency to act on the spur of the moment without really thinking ahead,” ”I usually get so excited over new ideas and suggestions that I forget to check if there are any disadvantages,” ”I often throw myself too hastily into things,” ”I am a very conscientious person (rev.),” ”I usually talk before I think,” and ”I consider myself an impulsive person.” Alpha reliability was .82.

The **risk taking** scale contained items from different self-report instruments to measure psychopathic traits. Unless otherwise stated, youths responded on a 5-point scale from strongly disagree (1) to strongly agree (5). The items were as follows: ”I would do almost anything on dare;” ”I dare to do things that others do not” (response scale: 1 = true, 2 = false); ”I enjoy traveling in cars at high speed;” ”I have often done something dangerous just for the thrill of it;” ”I enjoy taking chances;” ”I would never do something dangerous just for the thrill of it” (reversed); ”I enjoy gambling for large stakes;” ”I enjoy doing wild things;” and ”I would do almost anything on a dare” versus “I tend to be a fairly cautious person” (dichotomized measure). The alpha reliability was .83.
**Normbreaking.** The measure of normbreaking behavior was taken from the Norm Inventory at the average age of 14 years and 10 months (Magnusson et al., 1975), which consisted of eight norm-violating activities: at home (ignoring parents’ prohibitions, staying out late without permission), at school (cheating on an exam, playing truant), and during leisure time (smoking hashish, getting drunk, shoplifting, loitering in town in the evenings). See above.

*Romantic relationships with boys.* Four items measured how advanced the girls’ relationships to boys were at age 14 years and 10 months. Girls were asked about their perceived sexual maturation, perceived popularity among boys, sexual intercourse, and steady boyfriend relationships; the alpha for this scale was rather low, at .61, with an inter-item correlation of .29.

### 3.2.2 Paper II.

For this paper, age at menarche was used as the measure of girls’ pubertal timing. Girls were asked about their ages at menarche in grade 8 (the age of 15). Five girls (1%) had their first menstruation before the age of 10, 46 (9%) between 10 and 11 years, 117 (22.9%) between 11 and 12 years, 207 (40.6%) between 12 and 13, and 106 (20.8%) at the age of 13 or later; 29 girls (5.7%) had not had their first menstruation at the time of data collection. Thus, the typical age of menarche among the girls in the sample was between 12 and 13 years. In addition, we created a categorical measure. Girls, who had their menarche before age 12, were assigned to an early developers group. Girls, who had their menarche after age 12, were assigned to a later developers group.

Second, I was interested in girls’ self-perceptions of their maturity. In grade 8, in a questionnaire that measured different aspects of peer and parent relations, girls were asked if they felt more or less mature than their classmates, on a 5-point scale with the scale values: (1) not at all as mature as most others; (2) not really as mature as most others; (3) about as mature as most others; (4) somewhat more mature; and (5) much more mature than most others. In addition to this continuous measure, we created a dichotomized measure dividing the girls into groups of girls who felt more mature than their peers (scores 4 and 5) and girls who did not feel more mature than their peers (scores 1, 2, and 3). This is a measure of girls’ subjective perception of their maturity. When asked to describe the concept of maturity, adolescents rarely talk about physical aspects. Instead, the majority focuses on psychosocial or “genuine” aspects of maturity (Tilton-Weaver et al., 2001). Thus, it is more likely that girls were thinking of their behaviors rather than their physical maturity when asked this question.

Third, I was interested in girls’ level of engagement in heterosexual relations (referred to in Paper II as “romantic relationships with boys”). Four items measured how advanced the girls’ heterosexual relationships with boys were in grade 8. Girls were asked about their perceived sexual maturation, “Do you feel sexually more experienced than your age-mates (1=never, 2=seldom, 3=sometimes, 4=rather often, and 5=very often), intercourse, “Have you had sexual intercourse?” (1=no, 2=yes, once, and 3=yes, several times), attitude towards intercourse (1=very foolish to 7=totally OK), and steady boyfriend relations “Do you have or
have you had a steady relation to a boy?” (1 = have never had, don’t want to have, 2 = have never had, but I want one now, 3 = have had earlier, but not now, 4 = have now, but not earlier, and 5 = have now, and have had earlier). Since the items had different numbers of response alternatives, we standardized them before computing the composite scale. Alpha reliability for this scale was .73. The girls were then further divided into a group with little experience of heterosexual relationships and a group with a lot of experience of heterosexual relationships, using a median split.

I divided the girls into eight subgroups based on the dichotomous measures of pubertal timing, perceived maturity, and heterosexual relations. The first group consisted of later-developing girls who did not feel more mature than their peers, and who had little experience of heterosexual relationships (the Reference Group; \(n = 131\)). The second group contained later-developing girls who did not feel more mature than their peers, and who had a lot of experience of heterosexual relationships (the Late Relationship-Only Group; \(n = 87\)). The third group consisted of later-developing girls who felt more mature than their peers, and who had little experience of heterosexual relationships (the Late Mature-Only Group; \(n = 22\)). The fourth group contained later-developing girls who felt more mature than their peers, and who had a lot of experience of heterosexual relationships (the Late Precocious Group; \(n = 30\)). The fifth group consisted of early-developing girls who did not feel more mature than their peers, and who had little experience of heterosexual relationships (the Premature Group; \(n = 32\)). The sixth group consisted of early-developing girls who did not feel more mature than their peers, and who had a lot of experience of heterosexual relationships (the Early Relationship-Only Group; \(n = 50\)). The seventh group consisted of early-developing girls who felt more mature than their peers, and who had little experience of heterosexual relationships (the Early Mature-Only Group; \(n = 13\)). The eighth group consisted of early-developing girls who felt more mature than their peers, and who had a lot experience of heterosexual relationships (the Early Precocious Group; \(n = 41\)).

I employed a scale comprising seven items to measure problematic parent relations. Examples of items were: “Do your parents listen to you?”, and “Are your parents disappointed with you?” The scale was internally consistent (\(\alpha = .87\)). Girls’ adjustment to school was examined in grade 8. This was measured on a scale comprising nine items. Some of the items were: “Are you satisfied with your school work?”, “Is it important to perform well in school?”, and “Are your teachers fair to you?” Alpha reliability for this scale was .83. How many peers of different sorts the girls had and how often they associated with peers was explored in grade 8. Girls reported the number of peers they had and how many days per week they met with their peers (peer regularity). Girls’ normbreaking was a scale aggregated from eleven questions about shoplifting, signature forgery, pilfering, using hashish, vandalism, evasion of payment, physical aggression, harassment, and loitering, which were posed in grade 8 (Magnusson et al., 1975). The 5-point scale had the following response options: 1 = no, 2 = once, 3 = 2-3 times, 4 = 4-10 times, and 5 = more than 10 times. Alpha
reliability for the scale was .73. I wanted to explore girls’ alcohol drinking separately from other types of normbreaking behaviors, because of the heightened awareness of adolescent girls’ drinking behavior. Girls were asked whether they had ever been drunk. The response scale was the same as for the items tapping normbreaking.

At age 26, participants filled out postal questionnaires covering educational-vocational career, family life, working conditions, social networks, and free-time activities. Among other things, the women were asked about their family lives, educational attainments, work-life, and alcohol-drinking. First, it was asked if they were married/cohabitant or not. The response options were (1) no or (2) yes. Participants were also asked how many children they had. Response options were: none, one, two, three, four, five, six, or seven. The mean number of children was .66. Participants also reported on the age of their oldest child. Females reported on their level of education on an 8-point scale, ranging from no education past compulsory school (ending at age 16) to at least four years of university studies (at age 26). In addition, they were asked whether they were in employment, and they answered an open question about their types of employment at the age of 26. From this information, job descriptions were coded on an 8-point work position scale according to the minimum education required for each kind of employment. Furthermore, women were asked about their alcohol drinking habits. They reported on how much alcohol they drank at the most during one occasion and how often they drank alcohol. Information about criminal offenses was obtained from official registers. For juvenile offending (below the age of 15), information was obtained from local welfare authorities. Information about registered offense between the age of 15 and the age of 30 were obtained from police registers.

At age 43, the women reported on the number of children they had given birth to. This measure includes children still living with the participant and children who had already left their parental homes. The women reported on whether they lived with a husband or had a cohabitant. Participants’ educational levels were investigated. Answers were coded on a 7-point scale ranging from no education past compulsory school, to at least a university degree. There was also an “other” response option. This option was omitted from the analyses. The women reported on their partners’ highest educational level on 10-point scales, where 10 indicated the highest education level (a university degree).

3.2.3 Paper III. Height. Females’ heights were measured at ages 13 and 43 during physical examinations.

Weight. Females’ weights were measured at ages 13 and 43 during physical examinations.

Body Mass index (BMI). The formula for calculating BMI is weight (in kilograms) divided by height (in meters) squared. The higher BMI a woman has, the stouter she is. There are strong correlations between BMI, fat mass, and percentage of body fat in children, adolescents, and adults (Daniels, Khoury, & Morrison, 1997; Pietrobelli, Faith, Allison, Gallagher, Chiumello, & Heymsfield, 1998).
Waist circumference in centimeters was measured during physical examinations at age 43.

Hip circumference in centimeters was measured during physical examinations at age 43.

Physical fitness. At age 43, the women graded their physical fitness as their ability to walk, jog, or run 2 km. They were asked if they agreed to one of the following statements: (1) I cannot walk 2 kilometers without a rest, (2) I can walk 2 kilometers without a rest, (3) I can jog 2 kilometers if I stop and rest a couple of times, (4) I can jog 2 kilometers without a rest, (5) I can run 2 kilometers at a good speed, if I can stop and rest a couple of times, (6) I can run 2 kilometers at a good speed without a rest, and (7) I can run 2 kilometers at high speed without rest.

Dieting. When the women were 43 years-old, they were asked “How often do you diet?” Answers ranged from (1) No, never to (3) Yes, often or almost always.

Quality of life. Positive affect was measured using a scale comprising nine questions concerning women’s feelings of being happy, satisfied, forward looking, relaxed, calm and peaceful, etc. during the past month (alpha = .92). Positive affect was measured using the scale “General positive affect” in the Mental Health Inventory (Veit & Ware, 1983). Self-image was a scale that measured positive self-perception. It contained four questions, like “I am proud of the type of person I have become” (alpha = .72). Family satisfaction was tapped by one item asking subjects “Are you happy with your family life?” Work satisfaction was measured on a scale comprising four items, such as “I am satisfied with my current work position” (alpha = 0.84). Women reported on their leisure satisfaction by answering a single question about how happy they were with their leisure time. Life satisfaction, finally, was assessed using two questions, “Are you satisfied with your life” and “How do you like your current life?” The correlation between these two items was 0.35.

3.2.4 Paper IV. Age at menarche. From age 10 to 16, girls were asked whether their menstrual bleeding had occurred. This was done every third month during telephone interviews.

Body mass index (BMI). Trained staff collected information on height (in centimeters) and weight (in kilograms with an accuracy of .1 kilograms) during medical examinations when participants were 8, 25, and 37 years-old. We used this information to calculate participants’ BMI. Females’ BMI scores were computed using the same formula as in Paper III.

Appetite. At each year between ages 6 to 16, parents were asked if their child had had a good appetite. Answers were given on 5-point scales. Response options were: (0) never, (1) seldom, (2) sometimes, (3) often, and (4) always. A higher score indicated a higher appetite. We scored the girls’ appetites one year before their menarche in an attempt to compare girls’ appetites when they were at approximately the same physical maturity level, and thus avoid confounding pubertal maturation and appetite. The average year-to-year correlation for the appetite measure was \( r = .59 \), with \( rs \) ranging from .45 to .73.
3.3 Statistical analyses

The majority of the calculations for the studies were performed using SPSS 13.0 or 14.0. In Paper II, I also used the CFA module in the SLEIPNER 2.0 software (Bergman & El-Khoury, 1998). This was to enable a configural frequency analysis (CFA) to test developmental trajectories (Lienert & zur Oeveste, 1985). The CFA module uses the exact binomial test to perform configural frequency analyses. Frequencies with which configurations of certain categorical variables are observed are examined. A CFA is used to test special cells, in crosstabulations or contingency tables, in which expected and observed frequencies for each configuration are compared. An outcome is labeled a “type” when the observed frequency in a cell significantly exceeds the expected frequency. Conversely, when the expected frequency in a cell significantly exceeds the observed frequency, the outcome is labeled an “antitype”. Thus, this is a person-oriented rather than a variable-oriented approach to analyzing data; it focuses on characteristics of individuals or subgroups rather than relations between variables in the total population. A CFA is a recommended analytical tool when adopting a biopsychosocial approach, where biological, psychological, and social factors are viewed as deeply intertwined (Lemay, 1999).

Moderation and mediation were tested according to Baron and Kenny (1986). These two concepts are often confused, and therefore it is important to define them. Moderation concerns an interaction effect, where the association between two variables (A and B) depends on the level of a third variable (C). Ge et al.’s (2007) contextual amplification hypothesis builds on the idea of moderation, in which the link between pubertal timing and adjustment depends on how adverse or resourceful the context is. Mediation concerns mechanisms, where the association between two variables (A and C) is explained by a third variable (B), so that A leads to B and B leads to C.

The level of significance was set at $p \leq 0.05$. 
4. Results
In the section below, I present the specific research questions, hypotheses, and results in each of the four papers.

4.1 Paper I
The aim of Paper I was to show whether the peer socialization hypothesis satisfactorily explains the link between female pubertal timing and problem behavior. The peer socialization hypothesis states that there is a link between early pubertal timing and girls’ problem behavior because early-developing girls start affiliating with older peers and boyfriends, and through them are channeled into socially advanced behaviors. It is assumed that the link between pubertal timing and problem behavior should be strongest in contexts where heterosexual relationships between adolescents are sanctioned and where there is an over-representation of deviant youth. Paper I reports on four different studies.

4.1.1 The research question of Study 1. The purpose of this study was to compare two countries – Sweden and Slovakia – which differ considerably with respect to people’s views on adolescent sexuality, with Slovakia being more conservative and Sweden being more liberal. Because of this difference, we predicted that if romantic relationships with boys increase the risk of problem behavior for early developing girls, then the link between pubertal timing and problem behavior, should be stronger for Swedish than for Slovakian girls. We predicted that the findings obtained for the Swedish girls would hold for a current and a 30-year-old sample.

4.1.2 The findings of Study 1. Early pubertal timing was associated with problem behavior and romantic relationships with boys, and normbreaking behavior was significantly associated with the three measures of romantic relationships with boys in both Swedish cohorts. When romantic relationships with boys were controlled for, pubertal timing was not significantly associated with problem behavior in the 1970 cohort, but associated significantly, albeit at a low level, in the 1995 cohort. Thus, the mediation model was largely supported in both cohorts.

No differences were found between the countries with respect to age at menarche. Early-developing girls in Sweden were considerably more experienced with boys than early-developing girls in Slovakia. Pubertal timing was significantly associated with normbreaking in the Swedish, but not the Slovakian, cohort. Romantic relationships with boys were correlated with normbreaking among girls in both cohorts.

4.1.3 The conclusion of Study 1. The findings indicate that the conditions favorable to peer socialization have apparently been met over at least two generations in Sweden. But the same mechanisms do not seem to operate in Slovakia. Specifically, when young adolescent girls’ contacts with boys are restricted, early pubertal maturation is not linked to problem behavior.
4.1.4 The research question of Study 2. The purpose of the second study was to explore whether chronological age and delinquency of peers differ between early- and late-developing girls. Our hypothesis was that we would not find much difference between the early- and the late-developing girls if the focus was on the peers met only at school, or peers met both at school and during leisure time. This was because girls are not free to choose the peers with which they associate at school. For instance, grade-9 girls are the oldest at their school, and therefore it is impossible for them to associate with older peers at school. We should, on the other hand, expect that the peers met exclusively in free time to be older and more delinquent. We used information from all youths in the community; with this whole-community design, we obtained information about the social behavior of the girls’ peers, uncontaminated by the girls’ own perceptions and biases.

4.1.5 The findings of Study 2. Early-developing girls reported having more often kept secrets from their parents and drunken alcohol to intoxication in company of their free-time peers the last month than the late-developing girls. They also tended to have played hookey more often with their free-time peers \( (p < .10) \). The peers in the free-time group for the early-developing girls were chronologically older than they were for the late-developing girls, and the peers in the free-time group were also more delinquent than were the free-time peers of the late-developing girls. There were scarcely any differences between the early- and the late-developing girls with regard to the age and delinquency characterization of the group of peers exclusively met at school and the peers who were met both at school and during leisure time.

4.1.6 The conclusion of Study 2. Our hypothesis was supported. The peers met at school did not differ in terms of age or delinquency between girls of different pubertal timing, but peers met exclusively during free time did differ in this respect, with early-developing girls having more deviant and older peers who they had met outside school.

4.1.7 The research question of Study 3. If the peer socialization hypothesis is correct, early pubertal timing should be linked to problem behaviors in leisure settings that provide affiliation with more advanced or more problematic peer groups, and less in settings that do not provide access to more advanced peers and behaviors. In the third study, we explored one example of such a setting: neighborhood youth recreation centers. These centers have the characteristics that theoretically should enhance the peer socialization effect. Thus, if the peer socialization hypothesis is correct, then early pubertal maturation should be more strongly linked to normbreaking among girls who attend these centers than among those who do not.

4.1.8 The findings of Study 3. The findings for the 1970 and the 1998 cohorts were similar. Pubertal timing, center attendance, and romantic relationships with boys were all unique predictors of delinquent behavior in multiple regression analyses. In the group of late-developing girls, delinquency was low among those who had little experience of romantic relationships with boys as well as among those who had much of such relationships. If early-
developing girls had little experience of romantic relationships with boys, their delinquency was low, but delinquent behavior on their part was much more common if they were heavily involved with boys.

In agreement with the hypothesis that early maturation should have particularly high levels of delinquency if they associate with romantic partners and attend youth centers, we found that among girls who seldom visited youth recreation centers, delinquent behavior was slightly higher among those who had a lot of experience of romantic relationships with boys than among those who had little. This was somewhat more pronounced among the early-developing girls. Of those who frequently visited youth recreation centers, delinquency was not associated with engagement in romantic relationships with boys among the late-developing girls. By contrast, for the early-developing group of girls who were frequent attendees of youth recreation centers, those who had little experience of romantic relationships with boys showed little delinquent behavior, while delinquent behavior was considerably more common among the early-developing girls who had a lot of experience of romantic relationships with boys.

The results were similar when romantic relationships were replaced by peer involvement. Among early maturers, low peer involvement was associated with very low delinquency scores, whereas high peer interaction was associated with very high delinquency scores. The predicted three-way interaction between peer involvement, center attendance, and pubertal timing appeared in one of the two cohorts. In the 1998 cohort, the three-way interaction was significant. Peer involvement was related to delinquency for girls who matured early, but not for those who matured later, and frequent youth center attendance seemed to amplify this effect. In summary, the main results of these analyses are that particularly high delinquency scores are found among the early-developing girls who visit the centers often and engage often with their peers. Thus, the findings are consistent with predictions from the peer socialization hypothesis and from the idea that the youth centers are a context that can amplify the peer socialization effect.

Finally, we were interested in the long-term implications of the constellation of pubertal timing, early romantic relationships, and attending youth centers. We compared the percentage of police reports among the early-developing girls who did not attend youth recreation centers frequently in early adolescence and had not had sexual intercourse at an early age with that among the early-developing girls who either visited these centers often or had had sexual experiences (see Figure 4.8 in Paper I). Three times as many of the early-developing girls who either had early romantic relationships or who visited youth centers were registered for an offense by age 35 than was case for the group those who had neither. None of the late-developing groups showed a prevalence higher than 12.5%. Note that the percentage of the early-developing girls who showed this particular combination of frequently attending youth recreation centers and having early sexual experiences was considerably higher (31.3%).
4.1.9 The conclusion of Study 3. Being an (a) early-developing girl, with (b) a lot of involvement either in romantic relationships or with peers and (c) visiting youth recreation centers where there is an over-representation of deviant youth in early to mid-adolescence, implies a risk factor for adolescent normbreaking and future criminality.

4.1.10 The research question of Study 4. In the fourth study, we examined whether potential differences in normbreaking behavior in mid-adolescence between early and later developed girls can be traced back to personality characteristics and individual differences in problem behavior even at the age of 10, when most girls are pre-pubertal.

4.1.11 The finding of Study 4. There was a small but significant correlation, suggesting that the earlier girls developed, the more motor restlessness they displayed at age 10. At age 13, teachers rated the early-developing girls as being more restless and as having more concentration problems. The question was, however, if the associations between pubertal timing and romantic relationships with boys, and between pubertal timing and normbreaking, can be explained by early motor restlessness. Age 10 (and age 13) motor restless was a significant predictor of both age 15 normbreaking and romantic relationships with boys at age 15. Pubertal timing, though, was a stronger predictor of normbreaking and romantic relationships. We found no significant interaction between the two. Apparently, early motor restlessness and pubertal timing are two independent predictors of later normbreaking and romantic relationships with boys.

We also examined whether puberty accentuates motor restlessness over time (from age 10 to age 13), and whether such accentuation leads to problem behavior in mid-adolescence. Motor restlessness changed from age 10 to age 13. This change is also a significant predictor of later normbreaking and romantic relationships with boys, but the change did not seem to interact with pubertal timing. Finally, pubertal maturation was found to be a unique predictor of mid-adolescent normbreaking over and above the other terms in the model. This suggests that early puberty does not accentuate individual differences behavior problems that existed before puberty.

Some personality characteristics (thrill seeking, impulsivity, risk taking, and sensation seeking) might be connected with an adventurous life style, including problem behavior an dearly romantic relationships, and in fact, explain most of the interrelations we observed in this paper (and the previous studies) and provide a reasonable rival hypothesis to the peer socialization hypothesis.

The personality characteristics measures were significantly associated with problem behavior, romantic relationships with boys and with peer involvement. Finally, all characteristics except impulsivity correlated significantly with youth center attendance. They did not, however, rival the peer socialization hypothesis. Thrill seeking and sensation seeking, were not significantly associated with pubertal timing whereas the other two correlated with pubertal timing on a low level. In a multiple regression analysis with delinquency as the
dependent variable, pubertal timing was a significant predictor even when all four personality measures were entered in the first step.

In order to examine whether controlling for personality characteristics eliminates the effects of the previously reported three-way interactions, we tested whether pubertal timing, center attendance, and heterosexual (or peer) involvement predicts delinquency, and we entered a broad measure of risk prone personality as another main predictor. When the measure of risk prone personality was entered as a predictor for delinquency along with pubertal maturation, center attendance, and heterosexual involvement, pubertal maturation remained a significant predictor. The slope of the interaction term Heterosexual involvement x Center attendance x Puberty was almost identical to what it had been before risk prone personality was entered. The findings were similar when heterosexual involvement was substituted for peer interaction.

4.1.12 The conclusion of Study 4. We concluded that differences in mid-adolescent problem behavior and romantic relationships with boys between early- and late-developing girls cannot be accounted for by factors that are already present in late childhood or by personality characteristics.

As a whole, Paper I lends strong support to the peer socialization hypothesis. The alternative explanations that we tested did not provide an explanation for the link between early pubertal timing and problem behavior.

4.2 Paper II

4.2.1 The research question of Paper II. The idea was to consider multiple predictors simultaneously. I examined a biological factor (girls’ age at menarche), a psychological factor (girls’ self-perceptions of maturity), and a social factor (early romantic relationships with boys) simultaneously in an attempt to obtain a more comprehensive understanding of the role played by pubertal timing in girls’ adjustment. For Paper I, we assumed that early-developing girls feel more mature than their same-sex peers and that they therefore affiliate with older peers. For Paper II, girls’ perceptions of their own maturity were included in the reported analyses. It was hypothesized that early-developing girls who feel mature and who have early romantic relationships with boys will have the most problematic adjustment. I also argued that early-developing girls do not necessarily act more deviantly simply because they feel mature. They may just as well act maturely and responsibly. Thus, it was also hypothesized that early-developing girls who do not have early sexual relationships, but who feel mature, will not show particularly high levels of problematic conduct.

4.2.2 The findings of Paper II. First, I examined the zero-order correlations between pubertal timing, romantic relationships with boys, and self-perceptions of maturity on the one hand, and the adjustment measures on the other. The results showed that early pubertal timing was related to having problematic parent relations, poor school adjustment, a larger number of peers, larger numbers of older and working peers, more normbreaking behavior, and greater
intoxication in adolescence. Early pubertal timing was associated with having older children, low educational levels, and lower work positions in young adulthood.

Having romantic relationships by age 14-15 was related to having problematic parent relations, poor school adjustment, a larger number of peers, larger numbers of older and working peers, a higher frequency of meeting one’s peers, more normbreaking behavior, and greater intoxication in adolescence. Having romantic relationships by age 14-15 was associated with having older children, low educational levels, lower work positions, high alcohol consumption, and criminality in young adulthood.

Perceiving oneself to be more mature than same-age peers in mid-adolescence was related to having more peers, more older and working peers, and more normbreaking behavior and drunkenness in mid-adolescence.

Second, I examined the eight subgroups of girls. They were based on early and late pubertal timing, romantic relationships with boys, and self-perceptions of maturity. There follows below a summary of how each group differed from the others (see also Table 2 in Paper II). Only groups that differed significantly from the other groups are included.

- the Late Relationship-Only Group (late puberty, much relationships, low perceived maturity): high alcohol consumption in young adulthood;
- the Late Mature-Only Group (late puberty, little relationships, high perceived maturity): few adjustment difficulties in school and low frequency of intoxication in adolescence and low number of children, high educational achievement, and high work positions in young adulthood;
- the Premature Group (early puberty, little relationships, low perceived maturity): low level of normbreaking in adolescence;
- the Early Relationship-Only Group (early puberty, much relationships, low perceived maturity): poor school adjustment;
- the Early Mature-Only Group (early puberty, little relationships, high perceived maturity): the least problematic parent relations and low level of normbreaking in adolescence;
- the Early Precocious Group (early puberty, much relationships, high perceived maturity): the most problematic parent relations, poor school adjustment, high number of peers, older and working peers, frequent peer contacts, high level of normbreaking, and intoxication in adolescence and high number of children; old first-borns, low educational achievement, and low work positions in young adulthood.

In sum, there were significant differences between many of the subgroups. In line with the hypothesis, the adjustment situations of early-developing girls were very different depending on how they viewed themselves and whether they had early romantic relationships. The Early Mature-Only group did not have any particular adjustment difficulties. By contrast, the Early Precocious group had pronounced problems in many of the areas examined. Thus,
the combination of pubertal timing, perceived maturity, and romantic relationships seems to be a fruitful predictor of female adjustment.

I also performed trajectory analyses using CFA. I examined the eight subgroups of girls to see whether it was typical or antitypical for members of any of the groups to be mothers in young adulthood (see Table 5 in Paper II). The trajectory analyses showed that it was typical for members of the Early Precocious and the Early Relationship-Only groups to be mothers in young adulthood. By contrast, it was not typical for members of the Early Premature and the Early Mature-Only groups to have children in young adulthood. Furthermore, it was not typical to have children in young adulthood among any of the trajectories involving late-developing females. By contrast, it was typical for the reference group (late puberty, little experience of romantic relationships, and low perceived maturity) not to have children in young adulthood. Thus, the trajectory analyses supported the previous findings by showing that the life situations of early-developing females, even in adulthood, are radically different depending on social and psychological contexts during adolescence.

Finally, I examined the life situations of women in midlife. There were few differences between the sub-groups concerning midlife adjustment. There were, however, differences in educational levels between the groups. The Late Mature-Only group showed the highest educational achievements in midlife, and also had partners with the highest educational levels. Early maturers who had much experience of early heterosexual relationships (the Precocious and the Early Relationships-Only groups) had partners with the lowest educational achievements.

4.2.2 The conclusion of Paper II. In conclusion, early pubertal timing was found to be associated with adjustment difficulties in several areas, but when pubertal timing was considered together with psychological and social factors, a more differentiated picture emerged. In fact, the findings indicate that certain subgroups of early-developing females might be among those who are the best adjusted.

4.3 Paper III

4.3.1 The research question of Paper III. The aim of Paper III was to examine the short- and long-term implications of early female puberty concerning soma et psyche, since there is little information about the long-term consequences of female pubertal timing.

4.3.2 The findings of Paper III. The results showed that at age 13 there was a negative correlation between weight and height on the one hand and age at menarche on the other, with the early-developing girls being heavier and taller than their peers. The degree of pubertal maturation was also reflected by higher scores on the body mass index (BMI) among the early-developing girls. The direction of difference in height between the early and the late group was reversed by age 43, when the group of early-developing females was on average 3 cm shorter than the late-developing group. However, they were 6 kg heavier. Thus, BMI at age 43 was 3 units higher among the women who had had an early menarche compared with
those with late menarche. In accordance with their higher BMI values, early maturers’ waistlines and the circumference of their hips were on average 6 cm wider than those of late-developing females. These differences were significant. At the age of 43, the early-developed women were less physically fit and reported dieting more often than the other women. Early-developing females were as happy with themselves, and their work and family, as later-developing females, and they did not seem to differ in positive affect from the later-developed women in midlife.

4.3.3 The conclusion of Paper III. In sum, this study indicates that early puberty has long-term somatic effects in terms of weight status, body perception, and fitness, but no psychological implications for women, at least not concerning life satisfaction. What is left to find out is whether the implications of early puberty for weight status are similar for all early-developing girls or whether there are subgroups of early maturers whose weight status might be markedly different, and also whether childhood weight status explains the link between early puberty and weight status.

4.4 Paper IV

4.4.1 The research question of Paper IV. The aim of Paper IV was to examine the impact of pubertal timing on adult weight status, and the roles childhood weight status and appetite might play in any such link.

4.4.2 The findings of Paper IV. The results indicate that body mass index (BMI) tracks over time. BMI at age 8 correlated moderately with BMI at ages 25 and 37, and the association between BMI at age 25 and age 37 was strong. Furthermore, age at menarche was associated with BMI at all ages. Thus, girls with high BMI entered puberty sooner than others; the earlier girls experienced menarche the higher was their BMI in adulthood.

We ran hierarchical regression analyses with adult BMI (ages 25 and 37) as the dependent variable to examine whether pubertal timing had an independent predictive impact on adult weight status over and above childhood weight status (see Table 3 in Paper IV). Together, childhood BMI and age at menarche explained 31% of the variance in BMI at age 37, and they both emerged as significant predictors. BMI at age 8 emerged as the strongest predictor. The results were similar for predicting BMI at age 25. Thus, age at menarche was associated with adult weight status irrespective of childhood weight status.

Next, we tested whether appetite moderated the link between pubertal timing and adult weight status. First, one year before menarche there was a trend for early-developing girls to have larger appetites than late-developing girls. Moreover, appetite at age 8 and BMI at age 8 were not significantly correlated ($p > .10$). To test the moderating question (see Table 4 in Paper IV), we entered age at menarche and appetite one year before age at menarche in the first step of a hierarchical regression analysis predicting BMI at age 25. Together, age at menarche and appetite explained 18% of the variance. Age at menarche emerged as the strongest predictor. At a second step, we entered the interaction term (age at
menarche*appetite). Together, age at menarche, appetite, and the interaction term explained 26% of the variance, and all three emerged as significant predictors of BMI at age 25. We performed the same procedure with BMI at age 37. The results were similar. Age at menarche was not related to adult weight status for girls with small appetites, but was for those with large appetites. Among girls with large appetites, early age at menarche was linked to high adult weight status, but late age at menarche was not.

4.4.3 The conclusion of Paper IV. The findings suggest that pubertal timing is associated with adult weight status irrespective of child weight status, but only under certain circumstances. Appetite seems to moderate the link between pubertal timing and adult weight status. Thus, although the findings support the idea that early pubertal timing is a risk factor for high BMI, they also indicate that early-developing females will only have high BMI if they have large appetites.
5. General discussion
5.1 The findings of the four papers and how they relate to previous research

The biological, psychological, and social implications of girls’ puberty have long interested social scientists. Today, that interest is more intense than ever. Just since 2005, 511 studies have appeared in PsychINFO with the term puberty or pubertal in their abstracts (information retrieved on March 3, 2008). Girls who enter puberty early are more likely than other girls to develop internalizing and externalizing problems and to use substances (see reviews by Alsaker, 1995, 1996; Buchanan et al., 1992; Graber, 2003; Stattin & Magnusson, 1990; Susman et al., 2003; Susman & Rogol, 2004). Two additional major reviews have appeared recently (Celio et al., 2006; Mendle et al., 2007). Thus, puberty is a hot topic and early puberty, in particular, seems to be a risk factor for girls’ development.

Research on female pubertal timing has suffered from several major limitations. One is a lack of good explanations for the link between early puberty and problem behavior. Another is a lack of comprehensive research that includes biological, psychological, and social factors when predicting any given outcome, and the general use of direct effect models rather than interactive models when examining the possible implications of female pubertal timing for behavior (see Graber, 2003). A third limitation is a lack of long-term follow-ups.

In a programmatic line of research, I have investigated the short- and long-term developmental significance, concerning *soma et psyche*, of female pubertal timing. The dissertation comprises four papers. The aim of each of those papers has been to overcome one or several of the limitations from which the female pubertal timing literature has been suffering.

5.1.1 Support for the peer socialization hypothesis. The peer socialization hypothesis represents an attempt to give a comprehensive explanation for the link between early puberty and problem behavior in adolescence. In brief, the peer socialization hypothesis rests on: (a) ideas concerning selection and socialization from the literature on adolescent peer affiliation (Dishion et al., 1994; Hartup, 1996; Kandel, 1978; 1986), and (b) the established link between timing of puberty and initiation of sexual involvement (e.g., Aro & Taipale, 1987; Brown et al., 2005; Cavanagh, 2004; Flannery et al., 1993; Flannery et al., 1993; Flannery et al., 1993; Haynie, 2003; Jorm et al., 2004; Rowe, Rodgers, & Meseck-Bushey, 1989; Silbereisen & Kracke, 1997; Simmons & Blyth, 1987; Stattin & Magnusson, 1990; Udry & Billy, 1987). The hypothesis is that early-developing girls select friends and romantic partners in the same way that most people tend to select similar others to affiliate with. We tend to select others as friends and partners who in important respects are similar to ourselves. In this case, early-developing girls will select and be selected by peers who match them in terms of physical maturity. The peers who are similar in maturity will typically be chronologically older, and in early adolescence this means that on average they will be more involved in problem behaviors than the girls’ same-age peers. Once
early-developing girls form these peer affiliations, they will be socialized into the higher levels of problem behaviors that those peers are already engaged in. The hypothesis is, further, that early-developing girls will be more interested in romantic relationships than other girls of their age, and, for this reason, some of the peers they affiliate with will be older boys, who will on average be more involved in problem behavior than boys of their age. This will intensify the socialization into problem behaviors.

For Paper I, we performed a series of studies designed to test the peer socialization hypothesis at different contextual levels (cultural, school, and neighborhood). At a macro level, we predicted and tested differences between contexts in which the peer socialization effect should be more or less likely to appear. We did this by using samples from two cultures. We also tested the peer socialization hypothesis at micro levels: first by comparing peer affiliation in different everyday contexts like school and leisure, and then by comparing girls who chose to spend their free time in a setting where problematic youths often congregate with girls who spend their leisure time in other settings. Through this contextual perspective on pubertal maturation, we attempted to overcome some of the limitations from which the female pubertal timing literature has been suffering.

In the first study, we used samples from two different cultures – Sweden, in which the attitudes toward teenage romance and sexuality are more tolerant, and Slovakia, in which the attitudes are more restrictive. If contact with boys explains the link between early puberty and problem behavior, then in Slovakia, where heterosexual contacts are more restricted, there should be no link between pubertal timing and problem behavior. In Sweden, where heterosexual contacts are more permissible, pubertal timing should be linked to problem behavior. We found that in both cultures heterosexual contact was linked to problem behavior, which is consistent with the peer-socialization hypothesis. As predicted, however, the link between early puberty and problem behavior appeared in Sweden but not in Slovakia, thus suggesting that norms concerning teenage romance and sexuality at a macro level can facilitate or dampen the peer socialization effect. Thus, the results are consistent with the predictions of the peer socialization hypothesis, and they show contextual amplification at the level of cultural context.

In the second study, we turned to more proximal, everyday contexts – in-school versus out-of-school contexts. According to the peer socialization hypothesis, early-developing girls select friends and romantic partners who are similar to them, namely older peers. Previous research, however, has found that early-developing girls do not differ from late-developing girls with respect to proportion of older friends (Haynie, 2003). But this research used school roster nomination strategies, which only allow participants to nominate peers at school as friends. Our argument was that, at school, girls are restricted in affiliating with older peers because of the age-graded nature of school activities; in contexts outside school, they are freer to associate with older peers. This argument is in line with previous research showing that as adolescent girls move from 6th to 10th grade, they affiliate more often with older boys, who
they typically meet outside school (Poulin & Pedersen, 2007). The prediction of the peer socialization hypothesis is that early- and later-developing girls will have similar in-school friends who do not differ in terms of chronological age or delinquency, but the out-of-school friends of early-developing girls will be chronologically older and higher on delinquency than the out-of-school friends of later-developing girls. We tested this hypothesis using data from a whole-community study in which girls reported on the peers they engaged with in and out of school. The results were consistent with our predictions. Early-developing girls had out-of-school friends who were older and more delinquent than were the friends of the later-developing girls. The friends met at school did not differ in age or delinquency between the early- and later-developing girls. In these results there is evidence for the basic premise of the peer socialization hypothesis – that early-developing girls affiliate with older peers, but only in certain contexts.

In the third study of Paper I, we focused on a leisure context – neighborhood youth centers – where delinquent youths are known to congregate (e.g., Mahoney et al., 2001). According to the peer socialization hypothesis, if early-developing girls spend a lot of time in contexts where delinquent boys hang out, they will be more like to be socialized into delinquency than early-developing girls who do not spend time in those contexts. We predicted and showed a 3-way interaction in which girls who (a) developed early, (b) attended the youth centers, and (c) were romantically involved with boys showed the highest levels of self-reported delinquency in adolescence and registered criminality in adulthood.

The findings that these types of free-time contexts facilitate the link between early puberty and problem behavior is in line with previous research showing that early-developing girls in adverse social contexts fare worse in terms of social adjustment than early-developing girls in more affluent milieus (Biehl, Natsuaki, & Ge, 2007; Ge et al., 1996, 2002, 2006; Obeidallah et al., 2004). Early-developing girls engage more in violent behavior and other types of problem behavior in disadvantaged areas or in unsupportive families (Ge et al., 2002; Obeidallah et al., 2004). Early-developing girls with substance abusing peers form more favorable images of using substances than girls who develop later (Ge et al., 2006). Early-developing girls who experience negative life events have higher levels of depressive symptoms (Ge et al., 2001). Early-developing girls with mixed-sex friends show higher levels of distress than other girls (Ge et al., 1996). Finally, early-developing youth with alcohol-consuming peers are likely to develop higher levels of alcohol use (Biehl et al., 2007). Thus, the findings in this dissertation converge with previous research in showing that contextual conditions play an important role in the link between pubertal timing and adjustment. In addition, the present findings also highlight the mechanisms (i.e., peer socialization) that drive the well-established associations between pubertal timing and problem behavior. The findings of the first three studies provide empirical evidence for the ideas of peer socialization and contextual amplification (see “Combining the peer socialization and contextual amplification hypotheses” below), but it might be asked whether pre-existing characteristics of the girls
who choose to attend the youth centers and get involved with boys might explain their problem behavior better than peer socialization does.

In the fourth study of Paper I, we answered the question raised above. Can differences in problem behavior between early- and later-developing girls be explained by differences that already existed before puberty? If they can, then early pubertal timing does not usher in new behaviors, but transfers the differences that existed in childhood to adolescent life. We tested this idea by examining individual differences in problem behavior at age 10 and personality characteristics. The results showed that early problems and pubertal timing were independent predictors of later problem behavior and romantic relationships with boys. Pubertal timing did not seem to accentuate problem behavior for girls who were already problematic early on. We concluded that the links between pubertal timing and mid-adolescent problem behavior, and between pubertal timing and romantic relationships with boys, cannot be explained by problems that existed before puberty or risk prone personality characteristics. We concluded that the results presented in Paper I provide evidence for the peer socialization hypothesis. The link between girls’ early puberty and problem behavior seems to be a function of normal social processes in which youths affiliate with others who are similar to them. The peer socialization hypothesis offers several advantages over other hypotheses that have been forwarded to explain the link between early puberty and problem behavior as it offers a specific explanation of the mechanisms linking pubertal timing and adjustment, and is able to synthesize the existing literature.

5.1.2 Combining the peer socialization and the contextual amplification hypotheses. The peer socialization hypothesis states the mechanisms linking early puberty and problem behavior, or how this link is established. The contextual amplification hypothesis, on the other hand, states the conditions under which the early puberty-problem behavior link is most likely to occur. The conditions hypothesized most likely to strengthen the early puberty-problem behavior link are adverse contexts, such as a poor neighborhood. As with the peer socialization hypothesis, the contextual amplification hypothesis is well supported by empirical findings (e.g., Biehl et al., 2007; Ge et al., 1996, 2002, 2006, in press; Obeidallah et al., 2004). One of several explanations for contextual amplification is that girls in troubled neighborhoods are more likely than other girls to meet and be influenced by deviant peers (Ge et al., 2002). By combining the two hypotheses, it was possible for us to specify some of the contextual conditions under which peer socialization should be more or less likely to operate.

The findings in Paper I, specifically in studies 1 and 3, not only supported the peer socialization hypothesis, but also the contextual amplification hypothesis (Ge et al., 2007). An example of this was the finding in Study 3 that youth center attendance, which in some sense could be called “adverse”, because the centers are visited by many deviant youth (Mahoney et al., 2001), strengthened the association between early puberty and early romantic relationship, and also that between early puberty and problem behavior.
The peer socialization and the contextual amplification hypotheses are probably best viewed as complementary rather than competing. The peer socialization hypothesis states how early puberty and problem behavior are linked. But for preventive and other purposes, knowledge about when this process is most likely to occur is of central importance. This is how the contextual amplification hypothesis enters the picture, since it states the contexts in which this link should be the strongest. Combining the two ideas should give better understanding of the developmental significance of female puberty, and a better chance to predict when the link is likely to appear, thereby potentially enabling prevention of the negative outcomes associated with early puberty.

The contextual amplification hypothesis does not specify under which societal or cultural conditions the link between early pubertal timing and problematic adjustment is most likely to occur, since it focuses more on micro and meso levels rather than the macro contextual level. By contrast, in Paper I, we had hypotheses about macro contextual factors that might come into play. In our predictions of the contexts in which we should expect a stronger link between early puberty and problem behavior, we went beyond the idea of contextual amplification hypothesis since we hypothesized and found support for the idea that if contact with boys explains the link between early puberty and problem behavior, then in a cultural context, where heterosexual contacts are more restricted, there will be no link between pubertal timing and problem behavior. In a cultural context where heterosexual contacts are permissible, pubertal timing will be linked to problem behavior. In conclusion, the peer socialization and the contextual amplification hypotheses could be used simultaneously in order to get a better understanding of the developmental significance of female puberty.

In Paper II, I examined the roles played by romantic relationships and subjective perceptions of maturity in mid-adolescence in the link between female pubertal timing and adjustment in adolescence and adulthood. I argued that a main effects approach to the study of pubertal timing provides a limited means of fully understanding the role of pubertal timing in girls’ adjustment. I aimed to overcome the problems of a lack of information about the long-term implications of female pubertal timing and of a lack of interactive models by investigating pubertal timing in the context of psychological and social factors.

Aspects of maturity are typically linked to problem behavior in developmental theory (e.g., Moffitt, 1993). In Paper I, we assumed that early-developing girls feel more mature than their same-sex peers and that they therefore affiliate with older peers. This is an important part of the peer socialization hypothesis linking early puberty and problem behavior. However, it was never tested in that paper. For Paper II, a measure of girls’ subjective perceptions of maturity was included in the analyses. Feeling older than one’s age and subjective maturity have recently been linked to substance use and advanced sexual behavior (Andershed et al., 2006; Arbeau et al., 2007). In accordance, I hypothesized that early-developing girls who felt mature and who had early romantic relationships with boys (the Early Precocious Group) should have high levels of problematic adjustment (see also Alsaker,
1995). But, maturity can mean many different things to young people (Tilton-Weaver et al., 2001). Socially advanced behavior is certainly one, but responsible behavior, or genuine maturity, is certainly another. Therefore, I argued, early-developing girls do not necessarily act more deviantly simply because they feel mature. They might just as well act maturely and responsibly. Thus, it was hypothesized that early-developing girls who do not have early sexual relationships, but who feel mature, will not have particularly high levels of problematic conduct (the Early Mature-Only Group). This is in contrast with some earlier developmental theory (e.g., Moffitt, 1993).

The findings of Paper II were in line with this expectation. They showed that the Early Precocious Group had high levels of problem behavior in mid-adolescence, in line with the general idea that early puberty is linked to problem behavior (Alsaker, 1995, 1996; Celio et al., 2006; Graber, 2003; Mendle et al., 2007; Stattin & Magnusson, 1990; Susman et al., 2003; Susman & Rogol, 2004). In stark contrast to this was the finding that members of the Early Mature-Only Group were among those girls who were in the least problematic adjustment situations. This nuances the findings of Arbeau and colleagues (2007), who reported that feeling older than one’s age is linked to problem behavior. It is also noteworthy that those early-developing girls who were romantically involved early, but who did not feel more mature than their peers (the Early Relationship-Only Group), did not stand out as problematic either. Thus, arguing that feelings of maturity on behalf of early-developing girls are linked to problem behavior seems to be a simplistic assumption. I conclude that pubertal timing or feelings of maturity alone has limited predictive value. A biopsychosocial approach (Cairns, 1979; Bronfenbrenner & Ceci, 1994; Ford & Lerner, 1992; Magnusson, 1988; Magnusson & Stattin, 1998), where pubertal timing is considered in the context of the developing girls’ view of themselves, and in the context of romantic relationships, provides a much fuller picture of the girl’s development. As such, the findings presented in Paper II build on and extend the findings in Paper I.

An additional important piece of information is that there is a link between feeling older than one’s age and the age of one’s current partner – with adolescent girls who feel older than their age having older romantic partners (Arbeau et al., 2007). This might indicate that the ages of the romantic partners of the Early Relationship-Only and the Early Precocious Groups are different, with the Early Precocious Group having older romantic partners. Since older adolescents have more problem behavior than younger (Sampson & Laub, 2003), this might explain why the Early Precocious Group was more deviant than the Early Relationship-Group. Further research is needed to discover if this is the case.

One of the aims of Paper III was to overcome the limitation of the literature concerning a lack of information about the long-term implications of female pubertal timing. Very few studies have examined what role pubertal timing plays in social adjustment in adulthood, and even fewer of them have prospective longitudinal designs. For Paper III, we examined the short- and long-term implications of female pubertal timing concerning soma et psyche. We
did this by using a sample of women who are now in their fifties, and who have been followed in a longitudinal study from age 10. The results indicated that pubertal timing has implications for females’ weight status in adolescence and in adulthood. In adulthood, early-developed women were less physically fit and they reported dieting more often than other women. They also had higher BMI and were shorter than other women. The latter finding is in line with previous research (e.g., Freedman et al., 2003; Garn et al., 1986; Hulanicka et al., 2007; Must et al., 2005; Wang et al., 2006). Early-developing females did not, however, differ from other women in terms of perceived life satisfaction. Thus, we conclude that pubertal timing has very long-term implications for women’s weight and physical status, and dieting. By contrast, it seems to have little implications for adult women’s life satisfaction.

Paper III raises many questions. First, there is the traditional chicken and egg dilemma. Does early puberty lead to high BMI or does high BMI lead to early puberty? Or, can the tracking of BMI (Campbell et al., 2001; Sandhu et al., 2006) explain why early developing girls have higher peri- and postpubertal BMI? Second, not all early developing girls have high postpubertal BMI. Are there moderating factors affecting the strength of the relation between early puberty and adult weight status?

In Paper IV, we attempted to answer these two questions. We did this by examining the impact of pubertal timing on adult weight status, looking at the roles of childhood weight status and appetite in this link. Appetite was included as a possible moderator. We used a longitudinal sample of women, who have been followed from birth to adulthood. We tested whether the link between pubertal timing and adult weight status still existed after statistically controlling for childhood weight status. We also tested whether appetite moderated the link between pubertal timing and adult weight status by employing a multiple regression analysis, with interaction between pubertal timing and appetite as one of the predictors. The results indicated that pubertal timing was associated with adult weight status irrespective of childhood weight status. This finding is in contrast to earlier findings (Freedman et al., 2003; Must et al., 2005), showing that the link between pubertal timing and adult weight status is largely a result of childhood weight status affecting both pubertal timing (Adair & Gordon-Larsen, 2001; Davison et al., 2003; He & Karlberg, 2001; Juul et al. 2006; Kaplowitz et al., 2001; Lee et al., 2007) and adult weight status (Campbell et al., 2001; Freedman et al., 2005; Sandhu et al., 2006). Thus, this finding needs further exploration.

Previous research, including that presented in Paper III, has shown that early pubertal timing predicts higher body mass in adolescence and adulthood (Adair & Gordon-Larsen; Bini et al., 2000; Biro et al., 2001; Bratberg et al., 2007a; Freedman et al., 2003; Garn et al., 1986; Hulanicka et al., 2007; Must et al., 2005; Villa et al., 2007; Wang et al., 2006). Yet, few studies have examined whether there are conditions that moderate this link. One exception is the study by Bratberg et al. (2007a), which showed that only early matures with high waist circumference in early adolescence had elevated levels of BMI in late adolescence. However, because waist circumference was measured sometime between ages 12 and 16, puberty and
waist circumference were confounded in that study. In light of the previously reported independent predictive impact of appetite on later body mass index (Lee & Song, 2007), we examined whether appetite could be a moderator of the link between early puberty and adult weight status. The results in Paper IV indicated that pubertal timing is not related to adult BMI for girls with small appetites, but is for those with large appetites. Among girls with large appetites, early puberty is linked to high adult BMI, but late puberty is not. Thus, we conclude that early pubertal timing seems to predispose females to higher adult BMI, irrespective of childhood BMI. But, their level of energy intake seems to make this outcome more or less likely.

The mechanisms underlying this finding are unknown. Answers might lie in hormonal, lifestyle, or psychological factors. Physical activity is one example of a lifestyle factor that might help explain the finding. Energy intake and expenditure largely determine a person’s BMI. Early-developing girls are less physically active than later-developing girls (Baker, Birch, Trost, & Davison, 2007), and it might be that, given equal energy intake, their energy balances are more likely to be in surplus than those of late-developing girls (see Garn et al., 1986). But these are only speculations.

The findings in Paper IV might shed some new light on the literature showing a link between early pubertal timing and somatic problems, such as breast cancer, and also psychological problems, such as eating disorders and poor body perception. In conclusion, the findings in Paper III are in accordance with previous research in suggesting that early pubertal timing is linked to adult weight status. Paper IV builds on these findings in showing that pubertal timing is an independent predictor of adult BMI. It also shows that it is only among early-developing girls with high appetites that we find this link.

5.2 The studies as a whole – the biopsychosocial approach

The papers in this dissertation have all presented investigations of the developmental significance of female puberty. They have concerned the biological, psychological, and social implications of pubertal timing. Taken together, biological, psychological, and social factors provide more comprehensive understanding of the role of pubertal timing in female development, than if either one of those domains would have been examined in isolation.

Much of the research in this dissertation was guided by the biopsychosocial approach (e.g. Cairns, 1979; Bronfenbrenner & Ceci, 1994; Ford & Lerner, 1992; Magnusson, 1988; Magnusson & Stattin, 1998). According to the biopsychosocial model of development, there is a dynamic interaction between biological, psychological, and social components, and these interactions predict the development of any given outcome. As a whole, the papers indicate that biological changes in puberty, and specifically the timing of those changes, play a significant role in female development. However, all papers showed that knowledge about a girl’s pubertal timing alone is not enough to make fruitful predictions about her development. Rather, behavioral outcomes of pubertal timing depend on other vital circumstances.
A main effects approach can sometimes lead to erroneous conclusions. An informative example comes from Swedish research on school performance. This research has shown that immigrants perform worse in school, as measured by school grades (Swedish National Agency for Education, 2004). This would be the conclusion if a main effects approach or a direct effect model was used. However, if other characteristics of the school pupils are taken into consideration, such as gender, a completely new picture emerges. Then, what researchers have found is that immigrant girls perform better than boys born in and outside of Sweden applies to (the Swedish National Agency for Education, 2004)! Thus, immigrant girls perform better than Swedish boys. This authentic example clearly shows that a main effects approach sometimes can be misleading and that interactive models, as those used in this dissertation, are to be preferred.

Is puberty in general and early puberty in particular to be thought of as involving pathological processes? “In many cases, authors have drawn conclusions about outcomes from pubertal timing alone: …this risk factor of early maturation is significant and calls for clinical and social intervention…” (Celio et al., 2006, p. 1269); “Detrimental psychological outcomes associated with early pubertal timing in adolescent girls” (Mendle et al., 2007, p. 151); “Early pubertal timing associates with mental health problems in middle adolescence” (Kaltiala-Heino, Marttunen, Rantanen, & Rimpelä, 2003, p. 1063); and, “Early puberty in girls is associated with a startling number of psychopathologies and health problems” (Steingraber, 2007). I have a different viewpoint, which is based on the fact that there is little empirical support for the common belief that maturing earlier per se as opposed to maturing later should be particularly stressful and therefore result in various types of problems. In fact, research has falsified the idea (Tschann et al., 1994; Wiesner & Ittel, 2002). I view early puberty as a non-pathological process. Rather than being a result of a pathological process, the link between early puberty and problem behavior is a consequence of normal processes. The findings in this dissertation clearly indicate that early maturation need not to be associated with “detrimental psychological outcomes”. For instance, in Paper II, early-developing girls who felt more mature than their classmates, and who were not particularly involved in romantic relationships at an early age, were characterized by having the least problematic parent relations and a low level of problem behavior in adolescence. Thus, the psychosocial implications of pubertal timing seem to differ depending on other conditions in females’ lives.

The same phenomenon seems to be the case for bodily development. In this line of inquiry, researchers have concluded that early pubertal timing is linked to higher body mass in adulthood (e.g., Freedman et al., 2003; Garn et al., 1986; Hulanicka et al., 2007; Must et al., 2005; Wang et al., 2006). This was also what we found in Paper III. The findings of Paper IV, however, clearly revealed that the association between pubertal timing and adult weight status only holds under certain conditions. According to the findings, this condition was a large instead of a small appetite. As with the psychosocial implications, the bodily implications of pubertal timing seem to differ depending on other conditions in females’ lives.
The majority of the papers in this dissertation have employed interactive models, although admittedly they only comprise a small number of potential mediators and moderators. Still, the findings demonstrate the importance of adopting a broad biopsychosocial perspective and using interactive models in the study of the developmental significance of female puberty. Future research, using large samples to avoid a lack of statistical power and including even more potential moderators and mediators, should address the issue of interactive approaches further.

In sum, the models we use for predicting the impact of female pubertal timing should not only include measures of pubertal timing but also internal characteristics of developing girls and variations in girls’ environments. This is the only way that we can fully understanding the developmental significance of girls’ pubertal maturation and it will provide a favorable base for developing effective preventive interventions.

5.3 Methodological limitations and strengths
This dissertation has certain limitations and strengths that should be noted. First, parts of the papers in this dissertation were based on self-report questionnaires as the sole source of information. This might be problematic as social desirability and other reporter biases might come into play. In the majority of the studies, however, self-reports were used alongside other sources of information. These sources of information were parental reports and physical examinations conducted by medical staff.

Second, a related limitation is the use of a sole measure of pubertal timing (i.e., age at menarche). This poses several problems. For instance, early-developing girls experience a shorter period of time between the first appearance of secondary sexual characteristics and menarche than later-developing girls (Pantsiotou et al., 2008). This means that, at pubertal onset, the differences between girls with early and late menarche in secondary sexual characteristics are larger than they are at the time of menarche. Using age at menarche as the sole measure of pubertal timing might have had the effect of making the analyses more conservative. Thus, for some of the research questions, it would perhaps have been better to use a measure of age at pubertal onset instead of, or even better, in addition to, age at menarche.

Third, some of the samples are rather old. Because things may have changed since the data were collected, the extent to which the findings can be generalized to girls growing up today is unclear. This problem, however, is inherent in any design involving long-term follow-ups, and is not possible to avoid. Note that the findings in Paper I suggest that the role of puberty, at least in adjustment, is similar now compared with what it was 30 years ago for the issues of romantic relationships with boys and problem behavior.

Fourth, the vast majority of girls in all the samples were Caucasian. We do not know whether the findings can be generalized to other ethnic groups. Concerning the peer socialization idea, since there is a link between pubertal timing and sexual behavior and
problem behavior in other ethnic groups as well (Ge et al., 2002; Lam et al., 2002), it seems likely that the same processes might also apply to other ethnic groups.

Fifth, socioeconomic status (SES) was not included in any of the analyses. In North American samples, pubertal timing is linked to SES, with girls from lower socioeconomic strata developing at an earlier age (Ellis & Essex, 2007). Given that SES is linked to problem behavior, it could be a potential third variable explaining the link between early pubertal timing and problem behavior. However, pubertal timing does not appear to be associated with SES in Scandinavian samples (Bratberg, 2007). Therefore, the chance is small that the findings in this dissertation could be explained by girls’ SES.

Sixth, all the studies were characterized by heteronormativity. This is a general limitation in adolescent research. Adolescent romantic relationships constitute a major part of several of the studies in this dissertation. Still, only heterosexual relationships were considered. We did not explore the role of homosexual relationships in any of the papers.

Is it possible that early homosexual relationships mediate the link between early puberty and problem behavior in the same manner as heterosexual relationships appear to? There seems to be no association between age at menarche and sexual orientation among women (Bogaert & Friesen, 2002). Moreover, since we expected heterosexual relationships to explain the link between early puberty and problem behavior, based on previous findings showing that boys are on average more deviant than girls (Lahey, Van Hulle, Waldman, Rodgers, D’Onofrio, Pedlow, et al., 2006), homosexual relationships would not be expected to link early puberty and problem behavior in the way heterosexual relationships seem to. Future research is needed, however, to explore this issue.

Seventh, I have not distinguished between girls who experienced puberty early but within the normal range and those with true precocious puberty. In all papers, girls with menarche before age 10 were given the same score on the age-at-menarche measure. Not many girls experienced menarche this early. The effect that this might have on the findings is that it limits statistical power, and thus increases the chance of a Type II error. This means that the statistical tests of this dissertation became more conservative as a result of this grouping of girls.

Eighth, the scales that I and my colleagues have used in the papers have different numbers of response options. When there are more response options, it is easier to detect a correlation between two variables than when there are fewer response options. This is a problem of restricted range.

This dissertation had a particular focus on the role of early puberty in female development. Still, the role of puberty in female development might be curvilinear as well as linear. Many of the analyses in this dissertation did not permit curvilinear interpretations of the date. This is an issue for future research.

Despite these limitations, the papers in this dissertation have significant advantages. These include, but are not limited to, the following: (1) the biopsychosocial approach to study
of the developmental significance of female puberty, (2) the use of several samples that differ in terms of size, age of participants at time of data collections, the timing of the gathering of information, and the country in which the data were collected, (3) the prospective longitudinal research design, (4) the limited attrition rates, and (5) the close link between theory and empirical testing. Perhaps the most important strength of this dissertation is the use of one specific idea, the peer socialization idea, the systematic testing of this idea, and the support these tests lent to the idea. It is my hope that other researchers in the pubertal timing area can base their research on this part of this dissertation.

When interpreting the results, it is also important to note that the results apply to girls as a group and not every single individual. Not all early-developing girls who have early sexual relationships or who have a large appetite will end up with problem behaviors or a high adult BMI, for instance. Furthermore, in this dissertation I have examined statistical significance, not clinical relevance. These are two different things. Even though an association is statistically significant, it might only be of modest clinical relevance. Thus, many early-developing females thrive in adolescence and adulthood. The findings should be interpreted with this in mind.

5.4 Implications for policy, prevention, and practice

The findings in this dissertation have several implications for future preventive efforts and also for policy-making and practice. For professionals who work with children and teenagers, the findings of this dissertation should provide valuable information. Healthcare personnel, school teachers, social workers, parents, and others who come into contact with pubertal girls should be informed about the role that pubertal timing plays in adolescent adjustment. As a whole, the findings point to the need for selective preventive social interventions, targeting early-developing girls and perhaps also their parents.

There is a clear difference between early pubertal timing and many other potential risk factors. By contrast with many other risk factors, there is not much to do about the early maturation per se. The main factors that affect pubertal timing (e.g., genetic heritability) are largely out of reach of preventive efforts. From a preventive perspective, perhaps the most important and promising thing to note is that many, if not all, problems that are connected to early puberty in girls develop several years after puberty has started. Here, there is room for preventive efforts, whether they target early-developing girls in particular or whether they are universal.

The findings have a particular bearing on school policies. In Sweden, sexuality education in school is compulsory. Most of this education takes place during the 8th grade, when students are around ages 14-15. The findings in this dissertation suggest that many girls, in particular those who mature early, start having sex earlier than that. Early onset of intercourse
is a risk factor for many later problems (Cornelius, Clark, Reynolds, Kiriscia, & Tarter, 2007; Magnusson, 2001). Furthermore, the earlier a girl has sex, the greater the chance that she does not use any contraceptive (Wellings, Nanchahal, Macdowall, McManus, Erens, Mercer, et al., 2001), hence increasing the risk of teenage pregnancy and sexually transmitted infections. If we want sexuality education to count, and to matter for those who appear to be in need of it the most, then school policies regarding such education need to change. One idea is that the school nurse could complement ordinary teaching by addressing sexual issues earlier, during regular visits in early adolescence, particularly focusing on early-developing girls.

What is the role of parents? Previous studies suggest that early-developing adolescents have more conflicts with their parents than others (Steinberg, 1987). This dissertation shows that it is the early-developing girls who feel more mature than their classmates, and who have early romantic relationships, who have particularly high levels of problematic parent relations. It is possible that good parenting may mitigate the negative effects that are associated with early pubertal development in girls (Ge et al., 2002). Therefore, preventive interventions could include parenting programs. Strengthening parent-child relations, increasing conflict-resolution skills, and promoting family cohesion would be important components of any such efforts. Research on whether this is the right way to tackle these issues needs to be conducted.

A few years ago, Swedish national radio broadcast a program about the secular trend in pubertal maturation. The topics concerned were based on the fact that, over the last century, girls have experienced menarche at earlier and earlier ages. There was a hotline that parents could call. One parent who did was a mother who said that she was very worried because her 10 year-old daughter showed signs of impending puberty, and she asked whether this was to be regarded as atypical or pathological.

This anecdote highlights the importance of being able to provide high-quality information about the psychosocial meaning of early pubertal maturation to parents. Graber et al. (1997) reasoned that “it is unlikely that parents are aware of the risks of early maturation for girls” (p. 1774), and that they should receive comprehensive information about pubertal development. I agree with the latter statement that parents should be informed about puberty. I think it is important that parents are informed about what happens to their children as they go through puberty, and that this information should include biological, as well as emotional and social aspects of the pubertal transition. Such information would help parents assist their children, and may also ease some of their own worries. To the contrary, I disagree with the statement that parents are unaware of the risks associated with early puberty. I think it is very likely, as the anecdote above suggests and previous research shows (O’Sullivan et al., 2000), that parents believe that early puberty constitutes a risk in girls’ development. Therefore, it is even more important to be able to give them accurate information. Just saying that early maturation is a risk reflects an overly simplistic assumption. Early puberty in girls does not

1 In this dissertation, a risk factor is defined as a factor that is empirically linked to problem behavior. It does not imply causality.
equal problems. As has been shown in this dissertation, it is only under certain circumstances that early pubertal timing in girls is linked to adjustment difficulties. Therefore, parents should be informed about the circumstances and conditions under which early puberty constitutes a risk for problem development.

As girls go through puberty, giving parents and those who work with adolescent girls and boys, accurate information about the potential risks associated with puberty, and in particular with girls who develop early, may help those adults guide and assist adolescents as they navigate their way through this eventful time of their lives. On the other hand, there is a great risk that this type of information will be given to parents at the time when most adolescents experience puberty. Then, however important the information may be, parents with early-developing daughters will receive it too late for them to make the best use of it. Therefore, the timing of the information provided to parents, teachers, and others, is of pivotal importance.

When girls experience puberty, they gain weight in terms of muscles and fat. This is how it should be. A problem, however, might arise when girls gain too much weight (or too little). The present dissertation suggests that early-developing females might be at higher risk of developing overweight, regardless of their childhood BMI, than other girls. This, however, seems only to hold for early matures with large appetites. Thus, if overweight is to be prevented, then targeting early-developing girls’ eating behaviors might be one measure that can be taken. One has to bear in mind that I did not examine overweight as such, but rather normal variations in BMI, and that the BMI of most early matures may be considered as normal. Nevertheless, the mean BMI of early-developing adult women, presented in Paper III, was above the cut-off for overweight.

Finally, it is of crucial importance to promote research that develops and investigates effective preventive efforts that can be directed at early-developing girls. This dissertation suggests that is particularly those early-developed girls who initiate early romantic relationships with boys and who feel mature who are at risk of adjustment difficulties and who will have lower educational attainment in young adulthood. Therefore, specific efforts should be developed, targeted, and evaluated with regards to these girls. Moreover, because girls’ social networks seem to be a mechanism linking early pubertal maturation and concurrent and future adjustment problems, preventive efforts should have elements of social intervention.

5.5 Future research directions

Puberty constitutes one of the most radical changes in people’s lives, since it takes individuals from reproductive immaturity to complete reproductive competence. Although the psychological and social implications of puberty have long interested social scientists, many questions remain to be answered.

This dissertation provides a theoretical framework for explaining the link between early pubertal timing and problem behavior. Future research that builds on and tests this idea is
needed and encouraged. Although the findings in this dissertation supported the peer socialization hypothesis, some of its premises were not tested. This should be investigated in future studies.

Human behavior is contextual. It is difficult to image an acting individual without thinking about the contextual conditions. Context is an important piece in the puzzle of the link between puberty and adjustment. This is clearly shown in Paper I and Paper II and in previous research (Biehl et al., 2007; Ge et al., 1996, 2002, 2006; Obeidallah et al., 2004). However, this is an area that needs to be further developed. For instance, we will need to achieve better understanding of the context in which early-developing girls spend their time. Furthermore, an interesting question is how a girl’s own maturational standing affects the peer group. Previous research, including the studies in this dissertation, has only focused on how the peer group influences the developing girl.

More research should be devoted to testing and specifying the various assumptions of the peer socialization hypothesis. A reason for this is that we need more detailed information in order to know what advice to give to parents and professionals who work with young girls. The role of parents is one aspect that is yet to be understood. One of the other unanswered questions is how early-developing girls are brought into older peer networks. Are they the ones who drive this process or is it older peers? There is still no information about the process through which early maturing girls start to engage with older peers and boyfriends. A further unanswered question is the role played by the early-developing girls’ best friends? Do early-developing girls change best friends if they do not mature according to their own physical development, or do they stay the same? This is an interesting issue in light of previous findings showing that adolescent girls with romantic partners have better relationships with their best friends (Kuttler & La Greca, 2004), which early-developing are more likely to have.

Methodology development is one area for future research. Specifically, the research field should strive to achieve consensus concerning how puberty is to be operationalized and measured. Indeed, some of the discrepancy in previous research may be due to methodological issues (see Alsaker, 1996, 1995).

Future studies should attempt to incorporate several aspects of the pubertal changes, in order to understand whether it is changes in hormone levels, the development of secondary sexual characteristics, or any other changes during puberty, which are most important for the short-term and long-term effects of pubertal timing. The measures should be of both objective (e.g. physiological and anatomical measures) and subjective (e.g. self-reports of where in the pubertal processes adolescent perceive that they are) nature. Much research on the psychosocial aspects and meanings of puberty has used a sole indicator of puberty. This has often been age at menarche. This is also true for this dissertation. In research on the implications of pubertal timing on subsequent weight status and related issues, using several measures of pubertal maturation might be particularly important as research has shown that
the correlation between age at menarche, which is a common measure of pubertal onset, and the actual onset, has been decreasing and is now around .40 (Biro et al., 2006).

Also, understanding the connections between pubertal timing, adjustment, and cognitive and neurological development should be an area for future inquiry. For instance, it would be interesting to know whether the links between pubertal timing and adjustment are moderated by the level of adolescents’ cognitive development.

While much research has focused on the developmental implications of female puberty, male puberty has received relatively little attention. This is in contrast with many other research areas. Thus, more research should be devoted to understanding the implications of male puberty in general and its long-term effects in particular, since this is a field where almost no research has been conducted.

5.5.1 Changing societies – does research keep up? Just as adolescence is a time of change, the living conditions of adolescents change from one generation to the next. Unfortunately, research questions and research designs in developmental research do not always change accordingly. The development of information technology the last decade has brought about a radical change in how adolescents live their lives. Mobile phones, computers, and the Internet have entered adolescents’ lives and have strong impact on their social relationships, school work, and leisure time. Today, the Internet is a very important medium for adolescents (Rideout, Foehr, Roberts, & Brodie, 1999) and teenagers spend much of their leisure time, and also school time, online. The vast majority of adolescents in Western countries use it (Skoog, Stattin, & Kerr, in press); the Internet offers an array of activities and, as a user, one can get information about virtually anything. This latter aspect is a source of concern, for professionals, parents, and others alike. They pose questions like “What kinds of information do adolescents come into contact with on the net?” “Can I find out which web sites my son or daughter has visited?” and “Do I have the right to monitor my son’s or daughter’s use of the Internet?”

Sexually explicit material is rife on the Internet, and a lot of the concerns that parents and others have relate to it. Considering that most parents are unaware of what their children are viewing online (Cameron, Salazar, Bernhardt, Burgess-Whitman, Wingood, & DiClemente, 2005), the concerns are scarcely surprising.

Information technology in general and adolescents’ use of the Internet in particular provide a good example of a domain that has been subject to massive change lasting recent years, and in which there is a lack of research and knowledge. To my knowledge, there is only one study that has examined the role of pubertal timing in adolescents’ online activities (Skoog et al., in press). In that study, we examined whether early, on-time, and late-developing boys differ in what they do online. First, we investigated boys’ access to computers and the Internet. Second, we investigated what boys usually do online. Third, we examined whom boys chat with on the Internet. We studied the puberty-Internet use link at age 14, which according to past research, is around the time when pubertal timing varies most
among boys (Tanner, 1978). Virtually all the boys reported that they had access to a computer at home and that they used the Internet. Early, on-time, and late-developing boys did not differ in terms of looking for information for school, buying goods online, and most of the other Internet activities. There was one key difference between the groups. Early maturers reported downloading and viewing pornography significantly more often than the other boys. The early maturers also differed from other boys in terms of watching and downloading films and watching and downloading music, but these differences were not significant after Bonferroni correction. Regardless of whether viewing pornography makes a positive, neutral, or negative contribution to boys’ development, early maturers’ viewing and downloading of pornographic material should be of relevance to parents and those working with youth. The findings emphasize the need for further investigation of the impact of Internet pornography on the development of adolescents.

In addition, that study highlights the need for research questions and research designs to develop in concordance with the changing and developing living conditions of youths. Our study (Skoog et al., in press) asked questions in a new area in which pubertal timing might play a role, but it did not employ a novel or an innovative research design. This should be explored further. In sum, the literature on pubertal timing and adjustment needs to make advances, and investigate the living conditions of today’s, not yesterday’s, youth. As such, the study calls for more timely reporting when exploring the role of pubertal timing in adjustment.

5.6 Summary and final remarks
In a programmatic line of research, I have investigated the developmental significance, concerning *soma et psyche*, of female puberty in this dissertation. Puberty is one of the most radical transitions that people undergo. It signifies the change from sexual immaturity to maturity and reproductive capability. It signals to the developing person, and also to others, that a child is entering a new stage in life. Although puberty is a universal phenomenon that all healthy people experience, individuals vary markedly with respect to the age at which pubertal changes occur. A large body of literature has shown that when girls experience puberty earlier than their peers they are at increased risk of later medical problems as well as adjustment difficulties. The earlier girls mature, the more problems they seem to have. However, there are few reasons to believe that direct effects models are appropriate for studying the implications of pubertal timing (see Graber, 2003). Still, the majority of studies have employed main effects approaches. The findings in this dissertation highlight the importance of using interactive models, including psychological and social mediators or moderators. This seems to hold for the implications of puberty for *soma et psyche*.

Concerning *soma*, the findings indicate that early puberty is linked to high body mass, not only in childhood but also in adolescence and adulthood, and being less fit as an adult. However, the link between early puberty and high adult weight status is only present under
certain circumstances; it is only when early-developing females have large appetites that they have higher adult BMI. Thus, the variation in the timing of a normal biological process that all healthy people undergo seems to have implications for future somatic status, but only during certain circumstances.

Concerning psyche, the results suggest that early puberty seems to be a risk factor in female development under certain circumstances. To be an early-developing girl who feels mature and who has a socially advanced peer network, particularly early romantic relationships with boys in mid-adolescence, seems to constitute a particular risk. This finding supports the peer socialization hypothesis, according to which early-developing girls select friends and romantic partners who are similar to them, in the same way that all people select similar others with whom to affiliate. In this case, the peers who are similar in maturity will be older, and in early adolescence this means that, on average, they will be more involved in problem behaviors than the girls’ same-age peers. This is also true for the boyfriends of the early matures. Once early-developing girls form these affiliations, they will be socialized into the higher levels of problem behaviors that those peers are already engaged in. Thus, the link between girls’ early puberty and problem behavior seems to be a function of normal social processes in which youths affiliate with others who are similar to them.

The main contributions of the research presented in this dissertation are that it: (1) extended our understanding of the link between pubertal timing and girls’ problem behavior, (2) provided a theoretical framework on which future research can be built, (3) documented correlates concerning both soma et psyche of pubertal timing in adulthood, (4) highlighted the importance of having a biopsychosocial approach, and (5) identified factors potentially important for preventive interventions.

Eight hundred years before Christ, Hesiod said: “…for right timing is in all things the most important factor”. In today’s language we would say “timing is everything”. Can this common expression be applied to the developmental significance of female puberty? A large body of research has shown that the timing of pubertal changes is important for adolescent functioning. A recent publication has even been called “Puberty – Timing is everything!” (Pinyerd & Zipf, 2005). But is timing really everything? The answer of this dissertation is no. Timing seems to be an important piece in the puzzle, yes, but it is far from everything. It is only by acknowledging that people are biological, psychological, and social beings, and that their development is continuously affected by biological, psychological, and social factors, that we can fully understand the developmental significance of female puberty. The fact that psychological and social factors interact with pubertal timing in its role in human development has important implications for prevention, since psychological and social conditions and mechanisms can be the targets of preventive interventions.
5.7 Conclusions

• When, in relation to their peers, girls enter puberty seems to play a developmentally significant biological, psychological, and social role in their adult and adolescent lives.

• Timing, however, does not seem to be everything with respect to the role of puberty in female development, since pubertal timing seems to have different implications under different conditions.

• The biopsychosocial model, which provided the theoretical foundation for the studies in this dissertation, highlights the need to study puberty in the light of behavior and the social context in order to get full understanding of its developmental significance.

• The peer socialization hypothesis, which says that early-developing girls move in peer circles with more advanced social behavior, proved to provide a good explanation of the well-established link between pubertal timing and problem behavior. Thus, the link between girls’ early puberty and problem behavior seems to be a function of normal social processes in which youths associate with others who are similar to them.

• Early pubertal puberty seems to predispose females to higher adult BMI, irrespective of childhood BMI. But, females’ level of energy intake seems to make this outcome more or less likely.

• Providing knowledge about the conditions that interact with pubertal timing with respect to its role in development would be an important step in preventing the problems that have been associated with early puberty among females.
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