

## Pubertal timing and health-related behaviours in adolescence - socio-economic outcomes in a follow-up study from Finland

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### Abstract

**Background.** Pubertal timing is connected with health-related lifestyle in adulthood. We studied whether early or late pubertal timing is predictive of socio-economic outcomes in early adulthood and whether the associations are mediated by health behaviours.

**Methods.** Survey data (1981, 1983, 1985, 1987) from samples of 14-year-old Finns (N=4246, response rate 85%) were linked with respondents' attained educational level, socio-economic and labour market position in 2001 (ages 28-34). Ages of menarche and first ejaculation indicated pubertal timing.

**Results.** As compared to adolescents with average age pubertal timing, boys and girls maturing at an early age more often participated in health-compromising behaviours, while those maturing at a later age participated less frequently. Pubertal timing was not associated with attained educational level or socio-economic position in girls and not with labour market position at the time of follow-up in either sex. In boys, independently of health behaviours, early or late onset of puberty predicted low educational level, while late onset predicted low socio-economic position.

**Conclusion.** Timing of puberty has a stronger connection with socio-economic outcomes in boys than in girls. Deviance from the normative pace of physical development, especially late maturation, is among boys slightly depicted in the hierarchy of socio-economic positions of the society. As pubertal timing is connected with health-related behaviours – especially with smoking – the pacing of developmental transitions should be considered in planning programmes preventing unhealthy behavioural patterns often linked with negative attitudes towards schooling.

*Key words:* pubertal timing, health behaviours, educational level, socio-economic position, labour market position

### Introduction

Later maturing boys may experience problems in constructing their educational careers, but this seems not to occur in girls.[1] Since maturational timing may be associated with factors influencing the course of life from adolescence to adulthood, we studied its role in forming individuals' educational and socio-economic trajectories and entry into the labour market.

Associations between pubertal timing and various problem behaviours have been observed, and earlier or later maturation as compared to peers has been regarded as causing difficulties in psychosocial adaptation.[2-4] Substance abuse is related to early maturation, but research has mostly concentrated on girls.[5-9] Boys have been studied less. However, some evidence exists about associations between boys' early pubertal timing

and psychosocial problems [9-11] and health-risk behaviours.[12-14]

A Swedish study showed that boys who by skeletal growth had been classified as having developed early exhibited more advanced drinking habits at age 14 than normally maturing boys did.[15] Still, excessive drinking was likewise more frequent among late maturing boys. In another study, measuring pubertal development using the Tanner stages for genital development and pubic hair, earlier maturers were found to participate more in substance use than on-time or late-maturing boys.[10] In a Finnish twin study, pubertal development influenced substance use but in a very complex way.[16]

In contrast, early maturation in boys has sometimes been described as having many positive effects. It may rather promote



psychosocial adjustment while later maturation constitutes a risk for poor adjustment [4,17-19], lower achievement [20,21], self-esteem or confidence, depression and less happiness.[17,22] Deviance from the normative pace of physical development has been hypothesized to influence boys more seriously than girls.[19] Despite associations observed between pubertal timing and behaviour, evidence of long-term influences of these connections is scarce.

Health-compromising behaviours are related to school experiences and anticipate a low educational level.[23] Although education and socio-economic position of individuals are strongly correlated, they indicate different dimensions of social status.[24,25] Generally, education predicts socio-economic position and, further, socio-economic position predicts competitiveness in the labour market and shapes the resources that a person accrues for acquiring one's livelihood and place in the system of societal status hierarchies. The formation of young people's educational and socio-economic pathways, as well as their developmental processes, in many ways depend on familial circumstances.[23,26,27] For example, earlier menarche has been observed in girls with high socio-economic backgrounds,[28] and being exposed to familial distress or living in a family missing either of the biological parents may be related to early puberty.[29,30]

Contrary to girls, whose onset of puberty coincides with age of menarche, in boys, no such salient biological event happens. Among them, pubertal timing has often been measured by the development of body composition and secondary sexual characteristics. One way to measure the

timing of puberty is to record the age at onset of ejaculations.[31-33] Plenty of research exists about the psychosocial correlates of menarche,[7,13] but few dealing with those of onset of ejaculations.[13,34]

We examined how boys and girls experiencing their pubertal timing early or at a later age differ in their health-related behaviours and socio-economic outcomes from those experiencing their pubertal timing at an average age. The hypotheses are:

- 1) early or late pubertal timing predicts lower educational level and socio-economic position as well as higher probability of not being gainfully employed in early middle age as compared to average pubertal timing;
- 2) health-behaviours, school achievement and socio-demographic background mediate associations between pubertal timing and socio-economic outcomes.

## Subjects and methods

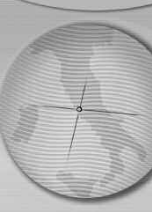
### Design and subjects

Baseline data were collected between 1979 and 1989 in the Adolescent Health and Lifestyle Survey in Finland (AHLS) using structured and self-administered postal questionnaires, followed by two re-inquiries to non-respondents. Nationally representative samples of 14-year-old boys and girls born within a specified range of birthdates between 1966 and 1972 (N= 4246, Table 1) were drawn each study year from the Population Register Center, which maintains information on all permanent residents of the country.

Follow-up data were obtained from national registries. As all samples were linked with follow-up data, participants in the longitudinal data

**Table 1. The design of the follow-up study: Dates of birth of the survey samples, year at baseline survey, sample size, number of participants, participation rate, and age at follow-up in 2001**

Baseline survey			Follow-up		
Year of birth of the survey samples	Year of baseline survey	Sample size	Number of participants	Participation rate, %	Age at follow-up in 2001
<b>BOYS</b>					
1966	1981	559	488	87	34
1968	1983	547	429	78	32
1970	1985	532	395	74	30
1972	1987	489	416	85	28
Total		2127	1728	81	
<b>GIRLS</b>					
1966	1981	596	548	92	34
1968	1983	558	482	86	32
1970	1985	490	433	88	30
1972	1987	475	432	91	28
Total		2119	1895	89	



comprised those who had responded to the baseline surveys, in total 3623 respondents (Table 1). The participation rates varied between 74% and 92%.

The follow-up ended in 2001, the last updated year with available follow-up data. The sample members had by then reached ages 28-34, and most of them had completed at least their first educational qualification after compulsory schooling.[35,36] Statistics Finland performed data linkage according to a contract with the researchers specifying the rights and duties of both contracting parties, including obligation to guarantee that the respondents' identities are not disclosed. Identification of study subjects was not available for the researchers at any stage. Data Protection Ombudsman approved the study protocol.

### **Outcome variables (adulthood)**

#### ***Attained educational level***

The highest attained educational level described the person's highest completed education by year 2001.[35,37] Four consecutive categories were: no education after compulsory schooling (9-10 years in schooling; 13% of respondents), upper secondary (11-12 years; 45%), lower tertiary (13-14 years; 22%), upper tertiary (at least 16 years; 20%).

#### ***Socio-economic position***

Socio-economic position in 2001 was categorized as entrepreneur (7%), upper white collar (18%), lower white collar (29%), blue collar (27%), and other (19%). In statistical analyses, a three category variable was used: high (entrepreneur or upper white collar), middle (lower white collar), and low (blue collar or other).

#### ***Labour market position***

Labour market position in 2000 was categorized as gainfully employed (13%), unemployed (9%), other (78%). Of these, a dichotomous variable was formed: at work and not at work.

### **Predictor variables (at baseline)**

#### ***Pubertal timing***

Boys/girls were asked, "How old were you when you had your first ejaculation/menstruation?" With precision of measurement being one year, pubertal timing was classified in three categories. In boys, the categories were: at age 12 or earlier (early), at 13 or 14 (average), not occurred by time of inquiry (late). In girls, categories were: at age 11 or earlier (early), at 12 or 13 (average), at age 14

(late). The proportions belonging to categories early, average and late were 18%, 38% and 44% in boys and 13%, 65%, and 22% in girls, respectively. Proportions of missing responses were 8% in boys and 1% in girls.

#### ***Other developmental measurements***

Participants were asked their *body height* in centimeters. It was categorized using distribution quartiles as cutpoints (calculated separately for sexes).

*Body mass index* (BMI) was calculated by dividing squared body height by body weight. The distribution quartiles were used as cutpoints (calculated separately for sexes).

#### ***Health behaviours***

*Smoking*: never tried, experimental or occasional, smokes daily.

*Alcohol drinking style* combined information from two variables: how often respondent used alcohol, and how often he/she became really drunk. Categories were abstinence, occasional drinking, and recurring drinking (includes recurring drunkenness, i.e. respondent drinks alcohol at least once a month, or drinks alcohol until really drunk at least once a month).

*Daily coffee drinking* was measured as number of cups of coffee a person drank daily: none, 1-3, at least 4.

*Teeth brushing*: several times a day, about once a day, less frequently.

*Physical exercise* during free-time was inquired by asking how often the respondent participated in exercise organized by their school or workplace (physical training lessons excluded), by sports clubs, by other associations or clubs, or in exercise practiced alone or with friends or family members. For each, item categories were: never, less than once a month, 1-2 times a month, about once a week, 2-3 times a week, 4-5 times a week, approximately daily. Of these, a sum-index was constructed by summarizing points from 1 to 7 according to response category (category "never" gave 1 point and category "approximately daily" gave 7 points, etc.). Distribution quartiles were used as cutpoints.

#### ***Social background***

*Father's or other guardian's educational level*: high (12 years or more in education), middle (9-11 years), and low (at most 8 years).

*Father's or other guardian's occupation*: upper white-collar employee, lower white-collar employee, farmer, and blue-collar employee.

*Family type*: living with both parents, other



(parents not living together; father, mother or both dead; not living with parents).

### **School achievement**

Respondents reported their own assessment of their position in class, according to average school grades in the preceding end-of-term school report: much better, slightly better, about class average, poorer.

### **Statistical analysis**

It was investigated whether pubertal timing was statistically significantly associated with each of the outcome variables, and whether the associations were accounted for by health behaviours, social background and/or school achievement. Ordinal and binary logistic regression analysis was applied.[38] First, univariate analyses of predictor variables with attained educational level were carried out. Then, a multivariate model was fitted including, first, pubertal timing, and, second, every significant predictor one at a time, in order to determine if these accounted for the significance of pubertal timing in predicting the outcome. The same procedure was then repeated for the other two outcome variables. In order to minimize the amount of missing cases, the final multivariate models were re-fitted using only those predictors, which retained independent and statistically significant associations with the outcome variables. These models are reported in Tables 2-4. Baseline year was forced into models when it proved to be statistically significant. Categories giving approximately equal odds ratios were combined.

Model parameters were presented as cumulative odds ratios (COR) and odds ratios (OR) with 95% confidence intervals (CI). For every predictor, category with lowest probability of higher level of the outcome variable was taken as reference group. A p-value of <0.05 was used as cut-off point of significance. The Statistical Package for Social Sciences (SPSS 12.0 for Windows) was used.

## **Results**

### **Pubertal timing and health behaviours**

**Boys.** Smoking, teeth brushing activity, alcohol drinking style and number of daily cups of coffee differed according to pubertal timing (Figure 1). Later maturing boys were most often among those who had never tried smoking, while among early maturing ones, even daily smoking was more frequent. Of early maturing boys, 78% had at least experimented with smoking, while the

respective percentage among late maturing boys was 57%. Alcohol drinking style showed a similar pattern in that only 36% of late maturing boys used alcohol compared to 77% of early maturing boys. The difference in abstinence between groups of late and early maturation was 31%. Differences in coffee drinking and teeth brushing were present as well: more coffee was drunk by early than late maturing boys, but regular and frequent tooth brushing was more typical of boys experiencing earlier puberty as compared to late maturing ones.

**Girls.** Pubertal timing was statistically significantly associated with smoking, alcohol drinking style and teeth brushing (Figure 1). Girls maturing early smoked more frequently, and one-fifth of them smoked daily. While one-third of early maturing girls had never tried smoking, half of late maturing girls had never tried smoking, and only 6% of them smoked daily. Association between alcohol drinking style and pubertal timing was analogous with alcohol use being clearly more common among early than late maturing girls. An opposite association between teeth brushing frequency and pubertal timing was observed: girls experiencing early pubertal timing took better care of their teeth than girls experiencing late puberty. There were no statistically significant differences between pubertal timing and coffee drinking or physical exercise participation.

### **Pubertal timing, other developmental indicators and school achievement**

**Boys.** Pubertal timing was highly significantly associated with body height and BMI; with tallness and high values for BMI indicating early pubertal timing and vice versa (for both,  $p < 0.001$ ; detailed results not shown). Pubertal timing was not significantly associated with school achievement.

**Girls.** Tallness and high values for BMI were related to early pubertal timing, and shortness with late pubertal timing (for both,  $p < 0.001$ ). Pubertal timing was not significantly associated with school achievement.

### **Pubertal timing and sociodemographic background**

**Boys.** Father's low educational level signified late pubertal timing ( $p = 0.007$ ; detailed results not shown). Early maturation was typical of boys whose fathers had high occupational positions, while sons of blue collar fathers and farmers most often experienced late pubertal timing ( $p = 0.045$ ). Timing of puberty did not differ between family types.

**Girls.** There were no statistically significant associations between indicators of social background and pubertal timing.



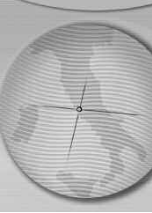
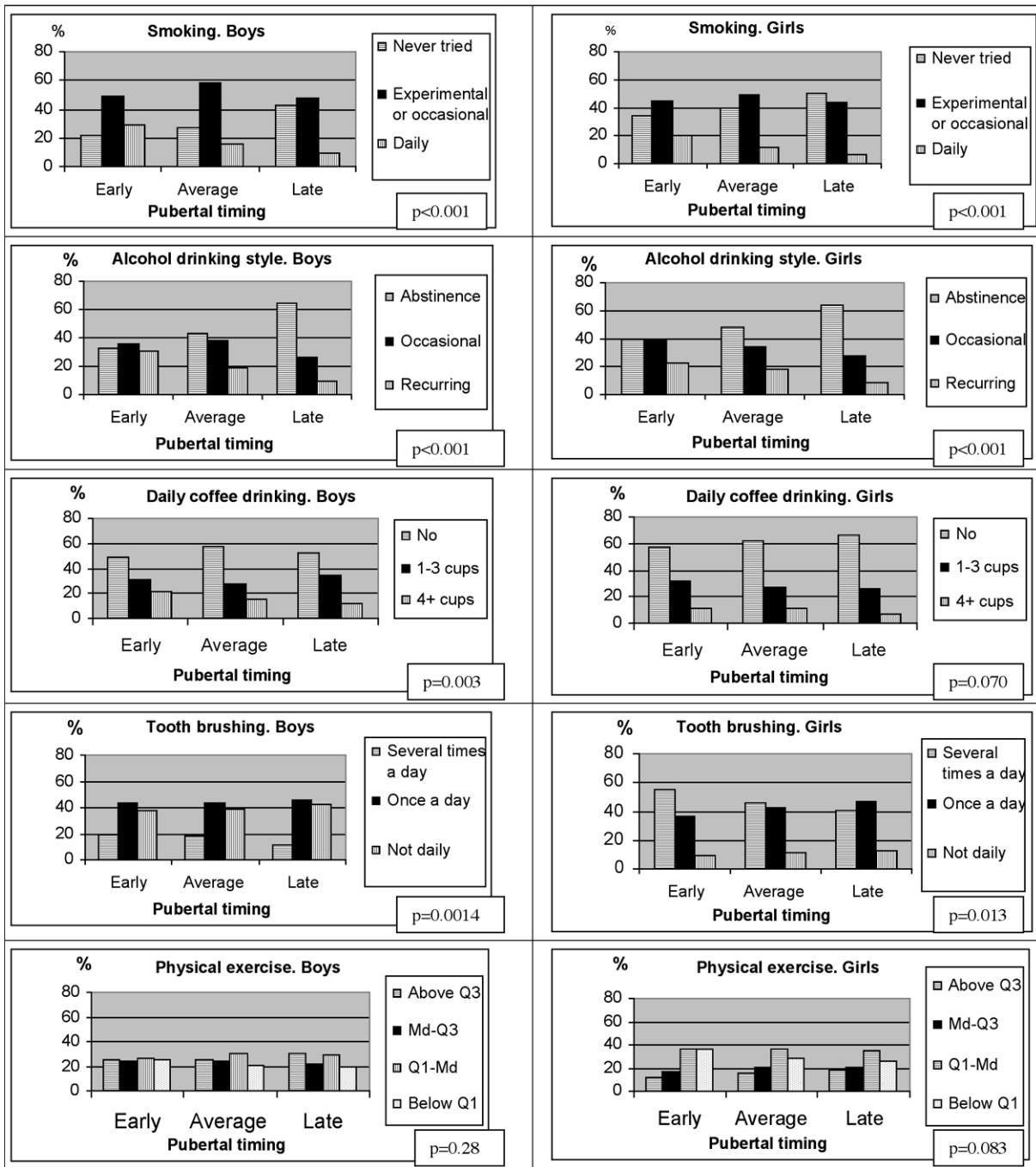


Figure 1. Health behaviours according to pubertal timing in 14-year-old boys and girls. Percentages of cases in behavioural categories according to pubertal timing



**Predicting attained educational level by pubertal timing and other baseline predictors**

**Univariate associations**

**Boys.** Both early and late pubertal timing were predictive of low educational level as compared to average pubertal timing (Table 2). Belonging to the two tallest quartiles of body height indicated a high educational level. BMI showed no predictive value. Father's high educational level and occupational position, and living with both

parents was predictive of attaining a high educational level. All behaviour variables were strongly associated with attained educational levels in that health-promoting behavioural patterns predicted high educational levels. Better school achievement meant a higher probability of reaching a high educational level.

**Girls.** Pubertal timing did not predict educational level (Table 2). At most median level body height indicated high educational level, but BMI was not a

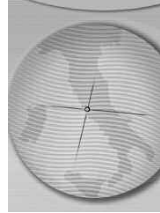


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Table 2. Univariate and multivariate associations between high attained educational levels in adulthood and pubertal timing, other developmental indicators, social background, and school achievement at age 14

	BOYS		GIRLS	
	Univariate p value, COR and 95% CI	Multivariate COR and 95% CI	Univariate p value, COR and 95% CI	Multivariate COR and 95% CI
<b>PUBERTAL TIMING</b>	<b>0.004</b>		<b>10.16</b>	<b>..</b>
Early	<b>0.69 (0.53-0.90)</b>	<b>0.74 (0.55-0.98)</b>	<b>0.87 (0.67-1.1)</b>	
Late	<b>0.74 (0.60-0.91)</b>	<b>0.76 (0.61-0.95)</b>	<b>0.84 (0.68-1.02)</b>	
Middle (ref)	1	1	1	
<b>OTHER DEVELOPMENTAL INDICATORS</b>				
Body height	<b>0.002</b>	<i>NS</i>	<b>&lt;0.001</b>	<i>NS</i>
Above median	<b>1.3 (1.1-1.6)</b>		<b>1.4 (1.2-1.6)</b>	
At most median (ref)			1	
Body mass index (BMI)	<b>0.54</b>	<b>..</b>		<b>..</b>
<b>SOCIAL BACKGROUND</b>				
Father's education	<b>&lt;0.001</b>	<i>NS</i>	<b>&lt;0.001</b>	<i>NS</i>
High	<b>3.6 (2.8-4.8)</b>		<b>3.3 (2.5-4.3)</b>	
Middle	<b>1.8 (1.4-2.4)</b>		<b>1.9 (1.5-2.4)</b>	
Low (ref)	1		1	
Father's occupation	<b>&lt;0.001</b>		<b>&lt;0.001</b>	
Upper white collar	<b>3.5 (2.7-4.5)</b>	<b>2.2 (1.7-2.8)</b>	<b>3.2 (2.5-4.1)</b>	<b>2.1 (1.6-2.7)</b>
Lower white collar	<b>1.6 (1.3-2.0)</b>	<b>1.6 (1.2-2.0)</b>	<b>1.6 (1.3-1.9)</b>	<b>1.5 (1.3-1.9)</b>
Farmer or blue collar (ref)	1	1	1	1
Family type	<b>&lt;0.001</b>		<b>&lt;0.001</b>	
Both parents	<b>2.2 (1.7-2.7)</b>	<b>1.6 (1.2-2.1)</b>	<b>2.1 (1.7-2.6)</b>	<b>1.7 (1.3-2.1)</b>
Other (ref)	1	1	1	1
<b>SCHOOL ACHIEVEMENT</b>				
	<b>&lt;0.001</b>		<b>&lt;0.001</b>	
Much above average	<b>21.1 (15.1-29.6)</b>	<b>13.5 (9.3-19.6)</b>	<b>23.3 (16.6-32.7)</b>	<b>16.4 (9.11.5-23.5)</b>
Slightly above average	<b>7.5 (5.7-9.8)</b>	<b>6.1 (4.5-8.3)</b>	<b>8.7 (6.4-11.8)</b>	<b>6.8 (4.9-9.3)</b>
Average	<b>2.4 (1.9-3.1)</b>	<b>2.2 (1.7-2.2)</b>	<b>2.8 (2.1-3.7)</b>	<b>2.5 (1.8-3.4)</b>
Below average (ref)	1	1	1	1
<b>HEALTH BEHAVIOURS</b>				
Smoking	<b>&lt;0.001</b>		<b>&lt;0.001</b>	
Never tried	<b>4.1 (3.1-5.5)</b>	<b>2.2 (1.6-3.1)</b>	<b>4.1 (3.1-5.5)</b>	<b>1.9 (1.4-2.6)</b>
Experimental or occasional	<b>2.6 (1.9-3.4)</b>	<b>1.6 (1.2-2.2)</b>	<b>3.1 (2.3-4.1)</b>	<b>1.7 (1.3-2.3)</b>
More than once/Daily (ref)	1	1	1	1
Alcohol drinking style	<b>&lt;0.001</b>	<i>NS</i>	<b>&lt;0.001</b>	<i>NS</i>
Abstinence or occasional	<b>1.6 (1.3-2.0)</b>		<b>1.7 (1.4-2.2)</b>	
Recurring drinking (ref)	1		1	
Tooth brushing	<b>&lt;0.001</b>	<i>NS</i>	<b>&lt;0.001</b>	<i>NS</i>
Several times a day	<b>3.0 (2.3-4.0)</b>		<b>2.4 (1.8-3.2)</b>	
About once a day	<b>2.0 (1.7-2.5)</b>		<b>1.8 (1.4-2.4)</b>	
Less frequently (ref)	1		1	
Coffee drinking	<b>&lt;0.001</b>	<i>NS</i>	<b>&lt;0.001</b>	
No	<b>1.8 (1.5-2.2)</b>		<b>2.0 (1.6-2.3)</b>	<b>1.3 (1.1-1.5)</b>
Yes (ref)	1		1	
Physical exercise	<b>&lt;0.001</b>		<b>&lt;0.001</b>	<i>NS</i>
Above lower quartile	<b>2.0 (1.6-2.5)</b>	<b>1.6 (1.2-2.1)</b>	<b>1.5 (1.3-1.9)</b>	
At most lower quartile (ref)	1	1	1	

Statistically significant CORs in bold. Categories having COR values close to each other were combined. The final models reported include only for predictors retaining statistically significant associations with the outcome variable. Variables not included in the multivariate analysis denoted by ..



significant predictor. Father's high educational level and occupational position, and living with both parents were predictive of attaining a high educational level, and so was better school achievement. Health-promoting behavioural pattern predicted high educational level.

#### ***Multivariate analysis for attained educational level***

**Boys.** With other explanatory variables one at a time added to model already including pubertal timing, it appeared that inclusion of sociodemographic variables did not render pubertal timing insignificant. After inclusion of school achievement, late maturation lost its significance (for early maturation,  $COR=0.69$ , 95%  $CI:0.53-0.91$ ). Among behaviour variables, after taking smoking into account, the role of early maturation changed to insignificant (for late maturation,  $COR=0.63$ , 95%  $CI:0.51-0.78$ ). No other behavioural variables had a similar effect. In the final multivariate model, however, both early and late pubertal timing independently predicted the attainment of a low educational level along with father's occupational position, family type, school achievement, smoking and participation in physical exercise. Yet,  $CORs$  for early and late maturation differed only slightly from one.

**Girls.** Pubertal timing was not included, because no association emerged between it and attained educational level. Variables that independently predicted educational level were father's occupational position, family type, school achievement, smoking, and coffee drinking.

#### ***Predicting socio-economic position by pubertal timing and other baseline predictors***

##### ***Univariate associations***

**Boys.** Early and late pubertal timing were predictive of low socio-economic position as compared to middle pubertal timing (Table 3). Boys in two tallest categories of body height most probably reached highest socio-economic positions. BMI showed no predictive power here. Father's high educational level and occupational position, living with both parents, and good school achievement predicted high socio-economic position. Not smoking, or smoking only occasionally, not using alcohol recurrently, drinking coffee, brushing teeth frequently, and taking part in physical exercise emerged as predictors of high socio-economic level, while alcohol drinking style was not a significant predictor.

**Girls.** Pubertal timing did not predict socio-economic position (Table 3). Girls in the two tallest categories of body height most probably

reached highest socio-economic positions. BMI showed no predictive power. Father's high educational level and occupational position, living with both parents, and good school achievement predicted high socio-economic position. Health-promoting behavioural patterns indicated achievement of high socio-economic position, with alcohol use playing a role too.

#### ***Multivariate analysis for socio-economic position***

**Boys.** Inclusion of sociodemographic variables did not render pubertal timing insignificant, neither did taking into account school achievement. Among behaviour variables, inclusion of smoking in the model made the role of early maturation insignificant (for late pubertal timing,  $COR=0.58$ , 95%  $CI:0.47-0.72$ ). No other behavioural variables had a similar effect. In final multivariate model, both early and late onset of puberty emerged as predicting low socio-economic position, although  $COR$  for early maturation differed only slightly from one. Other independent predictors were body height, father's occupational position, school achievement, smoking, and alcohol drinking style.

**Girls.** Pubertal timing was not included in the model, since it was not associated with socio-economic position. Independent predictors of socio-economic position were body height, father's occupation, school achievement, and teeth brushing frequency.

#### ***Predicting labour market position by pubertal timing and other baseline predictors***

##### ***Univariate associations***

**Boys.** Pubertal timing did not predict labour market position, and neither did other developmental indicators (Table 4). Living with both parents and better school achievement predicted being at work. Not smoking and brushing teeth daily emerged as predictors of being at work.

**Girls.** Pubertal timing did not predict labour market position (Table 4). Girls not belonging to the lowest quartile of body height, whose fathers were lower white collar employees, and those with better school achievement had a high probability of being at work. Health-promoting behavioural patterns in terms of not smoking or smoking only occasionally, using alcohol at most occasionally, and frequent tooth brushing were predictors for being at work.

#### ***Multivariate analysis for socio-economic position***

**Boys.** School achievement and living in nuclear family appeared as independent predictors of labour market position.



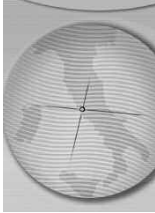
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**Table 3. Univariate and multivariate associations between high socio-economic positions in adulthood and pubertal timing, other developmental indicators, social background, and school achievement at age 14**

	BOYS		GIRLS	
	Univariate p value, COR and 95% CI	Multivariate COR and 95% CI	Univariate p value, COR and 95% CI	Multivariate COR and 95% CI
<b>PUBERTAL TIMING</b>	<b>&lt;0.001</b>		<b>0.24</b>	<b>..</b>
Early	<b>0.72 (0.54-0.94)</b>	<b>0.72 (0.53-0.97)</b>	<b>1.1 (0.88-1.5)</b>	
Late	<b>0.66 (0.54-0.82)</b>	<b>0.67 (0.53-0.85)</b>	<b>0.89 (0.72-1.1)</b>	
Middle (ref)	<b>1</b>	<b>1</b>	<b>1</b>	
<b>OTHER DEVELOPMENTAL INDICATORS</b>				
<b>Body height</b>	<b>&lt;0.001</b>		<b>&lt;0.001</b>	
Above median	<b>1.4 (1.3-1.7)</b>	<b>1.4 (1.1-1.7)</b>	<b>1.4 (1.2-1.7)</b>	<b>1.4 (1.1-1.6)</b>
At most median (ref)	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>Body mass index (BMI)</b>	<b>0.21</b>	<b>..</b>	<b>0.44</b>	<b>..</b>
<b>SOCIAL BACKGROUND</b>				
<b>Father's education</b>	<b>&lt;0.001</b>	<b>NS</b>	<b>&lt;0.001</b>	<b>NS</b>
High	<b>2.5 (1.9-3.3)</b>		<b>1.9 (1.4-2.5)</b>	
Middle	<b>1.4 (1.0-1.8)</b>		<b>1.6 (1.2-2.1)</b>	
Low (ref)	<b>1</b>		<b>1</b>	
<b>Father's occupation</b>	<b>&lt;0.001</b>		<b>&lt;0.001</b>	
Upper white collar	<b>3.0 (2.3-3.9)</b>	<b>2.2 (1.7-3.0)</b>	<b>2.2 (1.7-2.8)</b>	<b>1.6 (1.2-2.1)</b>
Lower white collar/farmer (ref)	<b>1.5 (1.2-1.9)</b>	<b>1.5 (1.2-1.9)</b>	<b>1.5 (1.2-1.8)</b>	<b>1.4 (1.1-1.7)</b>
Blue collar	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>Family type</b>	<b>&lt;0.001</b>	<b>0.004</b>		
Both parents	<b>1.7 (1.3-2.2)</b>	<b>1.4 (1.1-1.7)</b>		
Other (ref)	<b>1 NS</b>	<b>1 NS</b>		
<b>SCHOOL ACHIEVEMENT</b>				
	<b>&lt;0.001</b>		<b>7.2 (5.1-10.2)</b>	<b>5.8 (4.1-8.2)</b>
Much above average	<b>13.1 (9.3-18.5)</b>	<b>8.8 (6.0-12.9)</b>	<b>4.2 (3.1-5.7)</b>	<b>3.6 (2.6-5.0)</b>
Slightly above average	<b>4.2 (3.2-5.5)</b>	<b>3.3 (2.4-4.5)</b>	<b>2.1 (1.6-2.9)</b>	<b>1.9 (1.4-2.6)</b>
Average	<b>2.2 (1.7-2.8)</b>	<b>1.9 (1.4-2.5)</b>	<b>1</b>	<b>1</b>
Below average (ref)	<b>1</b>	<b>1 &lt;0.001</b>		
<b>HEALTH BEHAVIOURS</b>				
<b>Smoking</b>	<b>&lt;0.001</b>		<b>&lt;0.001</b>	<b>NS</b>
Never tried	<b>2.9 (2.1-3.9)</b>	<b>1.9 (1.3-2.8)</b>	<b>2.2 (1.6-3.0)</b>	
Experimental or occasional (ref)	<b>2.1 (1.6-2.9)</b>	<b>1.7 (1.2-2.4)</b>	<b>1.7 (1.3-2.3)</b>	
More than once/Daily	<b>1</b>	<b>1</b>	<b>1</b>	
<b>Alcohol drinking style</b>	<b>0.001</b>		<b>0.15</b>	<b>..</b>
Abstinence or occasional (ref)	<b>1.4 (1.2-1.7)</b>	<b>1.4 (1.1-1.8)</b>		
Recurring drinking	<b>1</b>	<b>1</b>		
<b>Tooth brushing</b>	<b>&lt;0.001</b>	<b>NS</b>	<b>&lt;0.001</b>	
Several times a day	<b>2.5 (1.9-3.3)</b>		<b>2.0 (1.5-2.7)</b>	<b>1.4 (1.01-1.9)</b>
About once a day	<b>1.9 (1.5-2.3)</b>		<b>1.7 (1.3-2.3)</b>	<b>1.4 (0.99-1.8)</b>
Less frequently (ref)	<b>1</b>		<b>1</b>	<b>1</b>
<b>Coffee drinking</b>	<b>&lt;0.001</b>	<b>NS</b>	<b>&lt;0.001</b>	<b>NS</b>
No	<b>1.8 (1.5-2.2)</b>		<b>1.4 (1.2-1.7)</b>	
Yes (ref)	<b>1</b>		<b>1</b>	
<b>Physical exercise</b>	<b>0.003</b>	<b>NS</b>	<b>0.004</b>	<b>NS</b>
Above lower quartile	<b>1.4 (1.1-1.8)</b>		<b>1.3 (1.1-1.6)</b>	
At most lower quartile (ref)	<b>1</b>		<b>1</b>	

Statistically significant CORs in bold. Categories having COR values close to each other were combined. The final models reported include only for predictors retaining statistically significant associations with the outcome variable. Variables not included in the multivariate analysis denoted by . .





**Table 4. Univariate and multivariate associations between labour market position (being at work) in adulthood and pubertal timing, other developmental indicators, social background, and school achievement at age 14**

	BOYS		GIRLS	
	Univariate p value, COR and 95% CI	Multivariate COR and 95% CI	Univariate p value, COR and 95% CI	Multivariate COR and 95% CI
PUBERTAL TIMING	0.33	..	0.53	..
OTHER DEVELOPMENTAL INDICATORS				
Body height	0.71	..	0.030	
Above lower quartile			1.4 (1.1-1.7)	1.4 (1.1-1.7)
Below lower quartile (ref)			1	1
Body mass index (BMI)	0.19	..	0.052	..
SOCIAL BACKGROUND				
Father's education	0.94	..	0.31	..
Father's occupation	NS	..	0.031	NS
Lower white collar			1.3 (1.02-1.7)	
Other (ref)			1	
Family type	<0.001		0.38	..
Both parents	1.8 (1.3-2.4)	1.6 (1.2-2.2)		
Other (ref)	1	1		
SCHOOL ACHIEVEMENT				
	0.003		<0.001	
Much above average	2.2 (1.3-3.5)	2.1 (1.3-3.4)	2.2 (1.5-3.2)	2.0 (1.4-3.0)
Slightly above average	1.7 (1.2-2.4)	1.6 (1.1-2.4)	1.9 (1.4-2.7)	1.8 (1.3-2.5)
Average	1.4 (1.001-1.9)	1.3 (0.98-1.8)	1.4 (1.01-1.9)	1.3 (0.95-1.9)
Below average (ref)	1	1	1	1
HEALTH BEHAVIOURS				
Smoking	0.001	NS	0.004	NS
Never tried	1.8 (1.3-2.6)		1.7 (1.3-2.4)	
Experimental or occasional	1.8 (1.3-2.6)		1.5 (1.1-2.0)	
More than once/Daily (ref)	1		1	
Alcohol drinking style	0.46	..	0.019	
Abstinence/Occasional			1.4 (1.1-1.8)	1.3 (1.01-1.8)
Recurring (ref)			1	1
Tooth brushing	0.007	NS	0.014	NS
Several times a day	1.4 (0.94-2.0)		1.5 (1.1-2.1)	
About once a day	1.6 (1.2-2.1)		1.6 (1.2-2.3)	
Less frequently (ref)	1		1	
Coffee drinking	0.06	..	0.32	..
Physical exercise	0.76	..	0.39	..

Statistically significant ORs in bold. Categories having OR values close to each other were combined. The final models reported include only for predictors retaining statistically significant associations with the outcome variable. Variables not included in the multivariate analysis denoted by ..

**Girls.** Final multivariate model included body height, school achievement, and - with very modest association - alcohol drinking style.

### Discussion

Pubertal timing was divided into three categories, early, average, and late, with average used as the reference category. This decision was based on former research showing controversial evidence of associations between early or late pubertal timing and factors influencing adolescent courses of

life.[4,11,39] We investigated whether early or late pubertal timing would have far-reaching influences on future educational levels, socio-economic, and labour market positions, and specifically, whether these connections were mediated by health-related behaviours. It has been shown that early maturing girls and probably also late maturing boys may have behavioural problems influencing other developmental processes.[4,15]

A health-compromising behavioural profile was detected among early maturing boys and girls. Teeth



brushing frequency constituted an exception: early maturing adolescents took the best care of their teeth. Otherwise, early maturing adolescents showed much "unhealthier" behavioural profile, in that smoking and alcohol use were clearly practiced more. Thus, some such milestones of adolescent age development, as depicted in adult-like health-related behaviours, may be passed by early maturing adolescents at an earlier stage than by later maturing ones. Our findings agree with those of the Finnish twin research,[16] which, also showed that the stability of pubertal development relative to peers across adolescence affects the influence of pubertal development on substance use. This means that measuring the level of pubertal timing only at one reference point is not enough, but longitudinal studies are needed in identifying the circumstances under which pubertal development influences psychological and behavioural outcomes.[5] During this development, various external influences play a role, e.g. the sex of peers most frequently socialized by adolescents maturing earlier or later.[40,41]

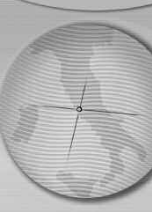
Pubertal timing of boys was strongly associated with family background, in that the father's low educational level and socio-economic position pointed to late pubertal timing. This tendency of socio-economic factors influencing biological maturation has previously been observed among girls,[42] although not strongly in recent years.[43] The strong association of body height both with pubertal timing and later socio-economic outcomes in this material indicate mutual associations between dimensions of physical and other forms of personal development[34,44,45] Association between family type and pubertal timing was observed in boys only, which highlights their vulnerability in the face of familial problems. Previous research has neglected boys, and the influences of negative factors operating in families on pubertal timing have been considered only in girls.[29,30,46] Although boys' pubertal timing predicted socio-economic outcomes independently of family-related factors, father's socio-economic position still rules as a factor influencing the young people's careers. The strongest predictor of every studied outcome was the adolescent's school achievement, which is strongly connected with the family background.[23]

Among behaviours, only smoking mediated the association between pubertal timing and the two first outcome variables. It also was a strong independent predictor of socio-economic outcomes. Smoking has been found to relate to negative attitudes toward schoolgoing,[47] and to anticipate becoming tracked into educational

routes eventually leading to lower educational levels.[48] Should earlier maturing adolescents also adopt earlier smoking habits, it may among them form part of a lifestyle where education is less valued. Although alcohol drinking was typical of early maturing adolescents, its role in the formation of educational and social class careers was not decisive. These two behaviours may have different bases during adolescence: while the habit of daily smoking may indicate rejection of achievement ideology or adoption of working class values, experimentation with alcohol may be confined to recreational and peer contexts only. It is possible that problems related to the pace of biological maturation may not be captured by studying health behaviours. Rather, other characteristics of individuals connected with physical development might be important sources of success at school and later in occupational careers. These may include self-esteem [4,49,50] or satisfaction with bodily appearance [51]. According to a Finnish study, during the short time period between ages 13 and 14, remarkable changes in self-image take place induced by psychological, cognitive and biological development.[50]

Overall, the present study suggests that deviance from the normative, or average, pace of physical development may influence boys' later socio-economic outcomes more seriously [19,52] than those of girls. Although pubertal timing did not influence the risk of not being gainfully employed, it nevertheless slightly influenced the range of socio-economic positions available for young men. Being ahead of boys in pubertal development, girls may be in a more fortunate position in making educational decisions when they are topical. Among late maturing boys, a more childlike lifestyle and attitudes and the coincidence of pubertal turmoil with important transition periods of school career may represent one factor for weakening of resources for coping and planning for future.[53,54] Comparisons between societies with potentially different youth cultures and different educational systems would be fruitful in discussing what early or late onset of puberty signifies for boys and girls, and whether school systems interact with the developmental pace in a negative way towards boys.[54]

The process of pubertal development consists of various maturational events defining pubertal status at a given age [3]. The possible sources of bias caused by self-reports of the onset of ejaculation and age of menarche have been discussed in a former article of the research group.[1] Reliance on any one indicator



necessarily ignores the complexity of pubertal processes and their associations with behavioural outcomes. Also, the pace of pubertal development varies so that some adolescents may be physically more mature than their peers, e.g. at age 12, but normative by age 14.[16]

### Conclusions

The timing of puberty has a stronger connection with socio-economic outcomes in boys than in girls. Deviance from the normative pace of physical development, especially late maturation is weakly depicted in the hierarchy of socio-economic positions of the society. As pubertal timing is connected with health-related behaviours, especially smoking, the pacing of developmental transitions should be taken into account when planning programmes to prevent unhealthy behavioural patterns, often linked with negative attitudes towards schooling.

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### References

- 1) Koivusilta L, Rimpelä A. Pubertal timing and educational careers: a longitudinal study. *Ann Hum Biol* 2004;31(4):446-65.
- 2) Dorn LD, Chrousos GP. The neurobiology of stress: understanding regulation of affect during female biological transitions. *Sem Reprod Endocrinol* 1997;15(1):19-35.
- 3) Brooks-Gunn J, Warren MP. Measuring physical status and timing in early adolescence: a developmental perspective. *J Youth Adolesc* 1985;14:163-89.
- 4) Silbereisen RK, Kracke B. Self-reported maturational timing and adaptation in adolescence. In: Schulenberg J, Maggs JL, Hurrelmann K, editors. *Health risks and developmental transitions during adolescence*. Cambridge: Cambridge University Press, 1997:85-109.
- 5) Dick DM, Rose RJ, Viken RJ, Kaprio J. Pubertal timing and substance use: associations between and within families across late adolescence. *Dev Psychol* 2000;36(2):180-9.
- 6) Hayward C, Killen J, Wilson D, Hammer LD, Litt IF, Kraemer HC, et al. Psychiatric risk associated with early puberty in adolescent girls. *J Am Acad Child Adolesc Psychiatry* 1997;36(2):255-62.
- 7) Magnusson D, Stattin H, Allen VA. Differential maturation among girls and its relevance to social adjustment: a longitudinal perspective. In: Featherman DL, Lerner RM, editors. *Life-span development and behaviour* (Vol. 7). New York: Academic Press, 1986:135-72.
- 8) Wilson DM, Killen JD, Hayward C, et al. Timing and rate of sexual maturation and the onset of cigarette and alcohol use among teenage girls. *Arch Pediatr Adolesc Med* 1994;148(8):789-95.
- 9) Ge X, Conger RD, Elder GH Jr. Pubertal transition, stressful life events, and the emergence of gender differences in adolescent depressive symptoms. *Dev Psychol* 2001;37(3):404-17.
- 10) Tschann JM, Adler NE, Irwin CE Jr, Millstein SG, Turner RA, Kegeles SM. Initiation of substance use in early adolescence:

the roles of pubertal timing and emotional distress. *Health Psychol* 1994;13(4):326-33.

- 11) Williams J, Dunlop L. Pubertal timing and self-reported delinquency among male adolescents. *J Adolesc* 1999;22(1):157-71.
- 12) Edgarth K. Sexual behaviour and early coitarche in a national sample of 17-year-old Swedish boys. *Acta Paediatr* 2002;91(9):985-91.
- 13) Kaltiala-Heino R, Marttunen M, Rantanen P, Rimpelä M. Early puberty is associated with mental health problems in middle adolescence. *Soc Sci Med* 2003;57(6):1055-64.
- 14) Kaltiala-Heino R, Rissanen A, Rimpelä M, Rantanen P. Early puberty and early sexual activity are associated with bulimic type eating pathology in middle adolescence. *J Adolesc Health* 2001;28(4):346-52.
- 15) Andersson TA, Magnusson D. Biological maturation in adolescence and the development of drinking habits and alcohol abuse among young males: A prospective longitudinal study. *J Youth Adolesc* 1990;19(1):33-41.
- 16) Dick DM, Rose RJ, Pulkkinen L, Kaprio J. Measuring puberty and understanding its impact: a longitudinal study of adolescent twins. *J Youth Adolesc* 2001;30(4):385-99.
- 17) Graber JA, Seeley JR, Brooks-Gunn J, Lewinsohn PM. Is pubertal timing associated with psychopathology in young adulthood. *J Am Acad Child Adolesc Psychiatry* 2004;43(6):718-26.
- 18) Laitinen-Krispijn S, van der Erde J, Hazebroek-Kampschreur AAMJ, Verhulst F. Pubertal maturation and the development of behavioural and emotional problems in early adolescence. *Acta Psychiatr Scand* 1999;99:16-25.
- 19) Nottelman ED, Susman EJ, Inoff-Germain G, Cutler GB, Loriaux DL, Chrousos GP. Developmental processes in early adolescence: Relationships between adolescent adjustment problems and chronological age, pubertal stage, and puberty-related serum hormone levels. *J Pediatr* 1987;110:473-80.
- 20) Dubas JS, Garber JA, Petersen AC. A longitudinal investigation of adolescents' changing perceptions of pubertal timing. *Dev Psychol* 1991;27(4):580-86.
- 21) Petersen AC, Crockett LJ. Biological correlates of spatial ability and mathematical performance. *Ann N Y Acad Sci* 1987;517:69-86.
- 22) Siegel JM, Yancey AK, Aneshensel CS, Schuler R. Body image, perceived pubertal timing, and adolescent mental health. *J Adolesc Health* 1999;25(2):155-65.
- 23) Koivusilta L, Rimpelä A, Vikat A. Health behaviours and health in adolescence as predictors of educational level in adulthood: a follow-up study from Finland. *Soc Sci Med* 2003;57(4):577-93.
- 24) Liberatos P, Link BG, Kelsey JL. The measurement of social class in epidemiology. *Epidemiol Rev* 1988;10:87-121.
- 25) Weber M. Class, status and party. In: Gerth H, Mills CW, editors. *From Max Weber: Essays in sociology*. New York: Oxford University Press, 1946.
- 26) Eriksson R, Jonsson JO. Introduction. Explaining class inequality in education: The Swedish test case. In: Eriksson R, Jonsson JO. *Can education be equalized? The Swedish case in comparative perspective*, editors. Oxford: Westview Press, 1996:1-64.
- 27) Lundberg O. The impact of childhood living conditions on illness and mortality in adulthood. *Soc Sci Med* 1993;36(8):1047-52.
- 28) Adair LS. Size at birth predicts age at menarche. *Pediatrics* 2001;107(4):E59.
- 29) Ellis BJ, Garber J. Psychosocial antecedents of variation in girls' pubertal timing: maternal depression, stepfather presence, and marital and family stress. *Child Dev* 2000;71(2):485-501.
- 30) Hulanicka B, Gronkiewicz L, Koniarek J. Effect of familial distress on growth and maturation of girls: a longitudinal study. *Am J Hum Biol* 2001;13(6):771-76.
- 31) Carlier JG, Steeno OP. Oigarche: The age at first ejaculation. *Andrologia* 1985;17(1):104-6.



- 32) Kulin H, Frontera M, Demers L, Bartholomew M, Lloyd T. The onset of sperm production in pubertal boys. Relationship to gonadotropin excretion. *Am J Dis Child* 1989;143(2):190-3.
- 33) Nielsen C, Skakkebaek N, Darling J, et al. Longitudinal study of testosterone and luteinizing hormone (LH) in relation to spermarche, pubic hair, height, and sitting height in normal boys. *Acta Endocrinol* 1986;279(Suppl):98-106.
- 34) Ji CY. Age at spermarche and comparison of growth and performance of pre- and post-spermarcheal Chinese boys. *Am J Hum Biol* 2001;13(1):35-43.
- 35) Repo A. Register of Completed Education and Degrees. Helsinki: Statistics Finland, Education Statistics, 1997.
- 36) Statistics Finland. The 25-35-year-old Finnish population according to highest completed education, age and gender in 1998. Population statistics from the Register of Completed Education and Degrees. Helsinki: Statistics Finland, 2000.
- 37) Statistics Finland. Statistical Yearbook of Finland 2002. Official Statistics of Finland. Hämeenlinna: Karisto, 2002.
- 38) Hosmer DW, Lemeshow S. Applied logistic regression. New York: Wiley & Sons, 2000.
- 39) Brooks-Gunn J, Petersen AC, Eichhorn D. The study of maturational timing effects in adolescence. *J Youth Adolesc* 1985;14:149-61.
- 40) Caspi A, Lynam D, Moffitt TE, Silva PA. Unraveling girls' delinquency: biological, dispositional, and contextual contributions to adolescent misbehaviour. *Dev Psychol* 1993;29(1):19-30.
- 41) Ge X, Conger RD, Elder GH. Coming of age too early: Pubertal influences on girls' vulnerability to psychological distress. *Child Dev* 1996;67(6):3386-3400.
- 42) Hauspie RC, Vercauteren M, Susanne C. Secular changes in growth and maturation: an update. *Acta Paediatr* 1997;423(Suppl):20-7.
- 43) Padez C. Social background and age at menarche in Portuguese university students: a note on the secular changes in Portugal. *Am J Hum Biol* 2003;15(3):415-27.
- 44) Dorn LD, Dahl RE, Williamson DE, et al. Developmental markers in adolescence: implications for studies of pubertal processes. *J Youth Adolesc* 2003;32(5):315-24.
- 45) Silventoinen K, Lahelma E, Lundberg O, Rahkonen O. Body height, birth cohort and social background in Finland and Sweden. *Eur J Public Health* 2001;11(2):124-9.
- 46) Maestripieri D, Roney JR, DeBias N, Durante KM, Spaepen GM. Father absence, menarche and interest in infants among adolescent girls. *Dev Sci* 2004;7(5):560-6.
- 47) Glendinning A, Shucksmith J, Hendry L. Social class and adolescent smoking behaviour. *Soc Sci Med* 1994;38(10):1449-60.
- 48) Koivusilta L, Rimpelä A, Rimpelä M, Vikat A. Health behavior-based selection into educational tracks starts in early adolescence. *Health Educ Res* 2001;16(2):201-14.
- 49) Alsaker FD. Pubertal timing, overweight, and psychological adjustment. *J Early Adolesc* 1992; 12(4):396-419.
- 50) Sinkkonen J, Anttila R, Siimes MA. Pubertal maturation and changes in self-image in early adolescent Finnish boys. *J Youth Adolesc* 1998;27(2):209-18.
- 51) O'dea JA, Abraham S. Onset of disordered eating attitudes and behaviors in early adolescence: interplay of pubertal status, gender, weight, and age. *Adolescence* 1999;34(136):671-9.
- 52) Benjet C, Hernández-Guzmán L. A short-term longitudinal study of pubertal change, gender, and psychological well-being of Mexican early adolescents. *J Youth Adolesc* 2002;31(6):429-42.
- 53) Simmons RG, Blyth DA, Bulcroft RA. The social-psychological effects of puberty on white males. In: Simmons RG, Blyth DA, editors. *Moving into adolescence. The impact of pubertal change and school context*. Hawthorne, New York: Walter de Gruyter, 1987:171-199.
- 54) Koenig LJ, Gladstone TR. Pubertal development and school transition. Joint influences on depressive symptoms in middle and late adolescents. *Behav Modif* 1998;22(3):335-57.