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Full Length Research Paper

Age at menarche in Portuguese adolescents - A cross-sectional study with HBSC Portuguese survey

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Early and delayed menarche and early and delayed puberty raise a number of issues for the health and well-being of girls and women. To examine multiple factors associated with early and delayed menarche in a large national representative sample of Portuguese school girls, using the national Portuguese data from the HBSC study. Study provides national representative data of 5050 Portuguese adolescents. This study used a subset of girls, whose mean age was 14.0 years old. Overall, results showed the majority of the girls reported having had menarche between 12 and 13 years old. Having had sexual intercourse, getting involved in fights, sleeping more than eight hours a day, self-reporting overweight or obesity and being on a weight loss diet were significantly and independently associated with early menarche. As for delayed menarche, it was associated with smoking, having had more than two episodes of drunkenness and having had school results below the average. Results are in line with a growing literature that suggests that girls who experience early or delayed menarche are more likely to engage in risk behaviours such as early sexual initiation or alcohol abuse. These results highlight the need to raise awareness and consequently prevention.

Keywords: Early menarche, delayed menarche, associated factors, adolescents, sexuality

INTRODUCTION

Menarche, or the age at which girls begin to menstruate, has been gradually and steadily decreasing since the mid-19th century. Researchers have explored various reasons for this decline, ranging from improved nutrition, environmental toxins, and psychosocial stressors (Al-Awadhi, et al., 2013). Most studies suggest that a number of factors are likely to interact and affect the timing of menarche and other markers of puberty. Analysing early and delayed menarche and early and delayed puberty is

important as it raises a number of issues for the health and well-being of girls and women (Gaudineau, et al., 2010; Godeau, et al. 2008; Mrug, et al., 2008).

Puberty among girls is marked by the development of breast tissue (thelarche), growth of pubic hair (pubarche) and the beginning of menstruation (menarche). The hypothalamus region of the brain secretes the gonadotropin-releasing hormone (GnRH), which starts the process of thelarche and menarche. The secretion of this hormone is, in turn, affected by hormones, enzymes and neurotransmitters in the brain. Breast development is the first sign of puberty and it begins, on average, one to

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two years earlier than it did in the mid-20th century (Biro, Greenspan, & Galvez, 2012). While the average age of menarche has also decreased, its decrease has not been dramatic as has the average age of thelarche. According to Steingraber (2007), the studies of American children indicate that the mean age of thelarche in 2007 was 10 years old for white girls and 9 for African-American girls and when comparing results from 40 years ago, that the process of puberty, - from the start of breast and pubic hair development to menstruation - is starting earlier and taking longer to complete.

Research from the 20th and 21st centuries shows a steady decline in the average age of first menarche. A National Health and Nutrition Examination Survey (NHANES) from the United States indicated an average age of first menarche declined from 12.5 years in 1988-1994 to 12.3 years in 1999-2002, with variations based on race and ethnicity: white girls had an average age of first menarche at 12.52 years old, Non-Hispanic black girls at 12.06 years old, and Mexican-American girls at 12.09 years old (Andersen & Must, 2005). Although these results refer to non-european results, they enlighten a tendency; therefore they are worth referring.

According to Steingraber (2007), since the nineteenth century, the average age of first menarche in Europe has declined at the rate of approximately 4 months a decade. Statistics in Europe indicate an average age of menarche that ranges from 12.3 years old in Greece to 13.3 years in Finland (Steingraber, 2007). In the 2005/06 HBSC study, median age at menarche goes from 12 years 5 months in Italy to 13 years 5 months in Latvia (Currie et al., 2012). Other international statistics on the average age of menarche include 13.0 years for Australia, 13.0 years for Russia and 13.2 years for Norway (Al-Sahab, Arden, Hamadeh, & Tamin, 2010; Parent, 2003).

The timing of puberty can be affected by genetic and environmental factors. One of the strongest predictors of age of menarche is the age at which a child's mother attained menarche. As noted above, racial and ethnic factors may also influence the age of menarche. Some environmental factors that have been associated with early puberty are nutrition, pollution, exposure to endocrine disrupting chemicals, stressful life events, family relationships, socioeconomic status, weight, premature birth, and low birth rate (Walvoord, 2010). In all 34 western countries studied in the 2005/06 HBSC study, age at menarche was inversely correlated with individual BMI (Currie et al. 2012). Several studies have linked television viewing and computer use with the early onset of puberty (Salti et al., 2006; Sigman, 2007). Researchers have speculated that television viewing and computer use disrupts the production of melatonin, a hormone that plays a role in the timing of puberty. Melatonin affects the body's circadian rhythms such as

sleep patterns, body temperatures, and the release of hormones. The production of melatonin is affected by light levels, increasing when it is dark. The levels of light emitted by televisions, computer screens and other electronic devices may be enough to inhibit melatonin production. Low levels of melatonin have been found among girls who experience puberty at an early age.

Within a same biological age, variability exists not only in adolescent's physical appearance which is directly linked to hormonal effects, but more widely in their behaviours. Previous research has described that girls feeling "on-time" regarding their puberty had the most positive feelings in terms of pubertal development (Al-Sahab et al., 2010). Therefore, in agreement with some authors (Biro, Greenspan, & Galvez, 2012; Gaudineau, et al., 2010; Godeau, et al. 2008; Mrug, et al., 2008), anomalies in pubertal timing (early or delayed pubertal development) could be expected to be associated with higher risks of poor health. Early or delayed pubertal development is of particular medical interest in terms of care management and prevention implications. Previous studies on factors associated with early or delayed pubertal development have focused their attention on one specific aspect of health (whether in terms of family environment, physical or psychological factors or risk behaviours) despite the fact that all those factors interact to define global health as given by the World Health Organization (Currie, et al., 2012).

The objective of this paper is to examine multiple factors (health and risk behaviours, physical or psychological factors and social environment) associated with early and delayed menarche in a large national representative sample of school girls, using the Portuguese data from the Health Behaviour in School-aged Children (HBSC) national study.

METHOD

This study was based on data from the Health Behaviour in School-Aged Children (HBSC) Portuguese survey (Matos et al., 2011). The Health Behaviour in School-aged Children (HBSC) is a collaborative WHO study, undertaken in 44 countries with the aim to study school-aged behaviour regarding health and risk behaviours in adolescence. Portugal is part of this group of countries since 1996 (Currie, Samdal, Boyce & Smith, 2000). The HBSC is a school-based survey of adolescents' health behaviours, carried out every 4 years. Collected data is used at a national and international level, using an internationally standardized methodological protocol (Roberts et al., 2009) to gain new vision into young people's health and well-being, so as to understand the social and psychological determinants of health, and to

incorporate policies to improve young people's lives.

The 2010 study provided national representative data of 5050 Portuguese adolescents, randomly chosen from those attending 6th grade, 8th grade (middle school) and 10th grade (high school) during the 2009/2010 academic year. The sample included 52.3% of girls and 47.7% of males, whose mean age was 14.0 years old (standard deviation 1.9). The majority of adolescents were Portuguese (94.4%), 30.8% attended the 6th grade, 31.6% attended the 8th grade and 37.6% attended the 10th grade. This study used a subset of girls (n=2643), whose mean age was 14.0 years old (standard deviation 1.8). The majority of girls were Portuguese (94.4%), 29.2% attended the 6th grade, 30.8% attended the 8th grade and 40.1% attended the 10th grade.

The HBSC 2010 survey was, like the previous waves, nationally representative. All ethical procedures were followed, and school and parental informed consent was obtained. Pupil participation was voluntary and anonymous. Details on methods and data collection are published elsewhere (Matos et al., 2011; Roberts et al., 2009).

Although numerous aspects of health behaviour were addressed in the survey, only those some measuring socio-demographic characteristics, menarche, age at menarche, health behaviours, risk behaviours, physical and psychological factors and social environment were addressed. The main focus of the present study was to identify: a) having had menarche - early menarche (<12 years old) and delayed menarche (>13 years old), and b) the multiple factors (health and risk behaviours, physical or psychological factors and social environment) associated with early and delayed menarche.

Associations between these elements of study were examined descriptively in addition to evaluating their potential for prevention.

Measures

These study included issues related to socio-demographic characteristics (gender and school year), identifying if the participant girls had ever had menarche (Yes/No) and which was their average age of menarche, early (<12 years) and delayed (>13 years) age of menarche, and issues that assessed health behaviours (consumption of fruits – Yes/No, and consumption of vegetables – Yes/No), risk behaviours (daily smoking - Yes/No; daily drinking – Yes/No; episodes of drunkenness - < 2/ ≥ 2; cannabis (“marijuana”) use - < 2/ ≥ 2; sexual intercourse - Yes/No; and involvement in fights - Yes/No), physical and psychological factors (daily sleep - ≤ 8 hours / > 8 hours; being on a diet- Yes/No;

self-reported BMI – normal / thin; overweight / obese; life assessment - not at all satisfied <5 / very satisfied >5; relationship with family - not at all satisfied <5 / very satisfied >5; liking school - Yes/No) and social environment (FAS - medium to high/ low; and school results – above the average/ average to lower).

The 2014 HBSC study did not include some crucial issues such as age of menarche and therefore it was not considered for the sake of this paper.

Data analysis

Analyses and statistical procedures were carried out in the *Statistical Package for Social Sciences* program (SPSS, version 22.0 for Windows). Overall, 2643 girls participated in the 2010 Portuguese HBSC survey and filled in a self-reported HBSC questionnaire. The total number differed according to the sub-sample used (reporting they have had menarche or not, and they have had early (<12 years) menarche, menarche between 12 and 13 years or delayed (>13 years) menarche), and considering that some participants have not replied to some questions.

Frequencies, means, standard deviations, and other descriptive statistics were performed to characterize the sample. Health behaviours, risk behaviours, physical and psychological factors and social environment (FAS and school results) were compared between three groups - early (<12 years) menarche, menarche between 12 and 13 years or delayed (>13 years) menarche-, using Chi-square (χ^2) test. The level for statistical significance was set at $p < .05$. Only significant results were discussed. The associations between several independent variables (sexual intercourse, involvement in fights, daily sleep (>8 hours), self-reported BMI (overweight or obese), daily smoking, drunkenness episodes (≥ 2) and school results (average to lower) and the dependent variables (early (<12 years) menarche and delayed (>13 years) menarche) were ascertained using bivariate logistic regression analysis. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated.

RESULTS

Of the total sample of girls, 1959 referred having had the menarche and the average age of menarche was 11.86 years (standard deviation 1.21). The majority reported having had menarche between 12 and 13 years old (55.4%), 37.2% were classified as having had early menarche (<12 Years) while 7.5% as having had delayed menarche (> 13 years), see table 1.

Table 1 Characteristics of the participants (girls) for the total sample (N= 2643)

		N	%	M	SD
Gender	Girl	2643	100	-	-
School year	6 th grade	771	29.2		
	8 th grade	813	30.8		
	10 th grade	1059	40.1		
Age		2643		13.99	1.81
Menarche					
	No	593	22.4		
	Yes	1959	74.1		
Age of menarche		1959		11.86	1.21
	Early Menarche < 12 Years	728	37.2%		
	Menarche between 12 or 13 Years	1085	55.4%		
	Menarche after 13 Years	146	7.5%		

Association of early menarche (< 12 Years) and delayed menarche (>13 Years) with health protective and compromising behaviour

Factors associated with early and delayed menarche are shown in table 2.

The frequencies of girls that reported having had sexual intercourse (20.6%) were significantly greater among early matured girls than among the other two groups (13.0% and 17.9%), as well as the frequencies of involvement in fights (20.5% versus 16.1% and 11.2%), sleeping more than eight hours a day (25.4% versus 18.4% and 18.0%), being either overweight or obese according to self-reported BMI (21.1% versus 14.0% and 11.7%) and being on weight loss diets (17.5% versus 13.3% and 10.3%).

The frequencies of girls who reported smoking (22.9%) were significantly greater among delayed matured girls than among others (14.5% versus 13.5%), as well as the frequencies of having had more than two life drunkenness episodes (4.2% versus 1.8% and 0.7%) and having had school results below the average (68.8% versus 55.2% and 57.8%).

Using a logistic regression model, an adjusted model (Hosmer and Lemeshow $\chi^2= 3,601$ (4) $p=. 463$) was obtained and the regression equation explained 5% of the variance (Nagelkerke $R^2= .046$) and 63.2% of cases that have had early menarche (<12 years). In this model, the condition of “having had early menarche” was described by the variables “sexual intercourse” (girls who have had sexual intercourse have a 1.9 times greater likelihood of being in this group) [OR 1.87; 95% CI 1.39-2.51; $p \leq 0.001$], “involvement in fights” (girls who were involved in fights, have a probability 1.3 times higher to be in this group) [OR 1.32; 95% CI 1.00-1.74; $p \leq 0.05$], “daily sleep” (>8 hours) (girls who reported sleeping more than 8 hours have a 1.8 times greater likelihood of being in this group) [OR 1.80; 95% CI 1.40-2.32; $p \leq 0.001$], and self-reported BMI (overweight or obese) (girls who

reported having overweight or being obese, have a probability 1.6 times higher to be in this group) [OR 1.55; 95% CI 1.17-2.07; $p \leq 0.010$] (see table 3).

Using a logistic regression model, an adjusted model (Hosmer and Lemeshow $\chi^2= 1,458$ (4) $p=. 834$) was obtained and the regression equation explained 4% of the variance (Nagelkerke $R^2= .038$) and 88.4% of cases that reported having had delayed menarche (>13 years). In this model, the condition of “having had delayed menarche” was explained by the variables “life drunkenness episodes” (≥ 2) (girls who have more drunkenness episodes, have a probability 4.4 times higher to be in this group) [OR 4.43; 95% CI 1.38-14.16; $p \leq 0.05$], “daily smoking” (girls who reported smoking have a 1.7 times greater likelihood of being in this group) [OR 1.69; 95% CI 1.06-2.73; $p \leq 0.001$], and “school results” (average to lower) (girls who reported having bad school results, have a probability 1.6 times higher to be in this group) [OR 1.61; 95% CI 1.09-2.77; $p \leq 0.05$] (see table 4).

DISCUSSION

Age at menarche has largely decreased in most developed countries and seems stabilised at 13 years with 0.5 years variations between countries (Marques, Braquinho & Matos, 2015; Currie et al., 2012; Gaudineau, et al., 2010). The results of this study are in line with this trend, since most Portuguese girls report having had menarche between 12 and 13 years old. The results of this investigation are consistent with past research, suggesting that early and delayed menarche is mainly determined by extrinsic factors, such as living conditions, especially in terms of risk behaviours or physical or psychological factors (Biro, Greenspan, & Galvez, 2012; Mrug, et al., 2008). The findings are important because of their potential impact on early matured girls' behaviours and delayed matured girls' behaviours.

Table 2 Differences between groups and health behaviour, **risky sexual behaviour**, physical and psychological factors, and social environment, for the entire sample that mentioned already having had menarche (n= 1959)

	Early Menarche < 12 Years (N=728)		Menarche between 12 or 13 Years (N=1085)		Menarche after 13 Years (N=146)		χ^2	p
	N	%	N	%	N	%		
Health behaviours								
Consumption of fruits							.302	n.s. / .860
No	15	2.1	22	2.0	2	1.4		
Yes	709	97.9	1056	98.0	142	98.6		
Consumption of vegetables							1.869	n.s./ .393
No	32	4.5	41	3.8	3	2.1		
Yes	684	95.5	1027	96.2	141	97.9		
Risk behaviours								
Daily smoking							9.068	.011*
No	617	85.5	924	86.5	111	77.1		
Yes	105	14.5	144	13.5	33	22.9		
Daily drinking							5.657	n.s / .059
No	640	89.5	969	90.2	118	83.7		
Yes	75	10.5	105	9.8	23	16.3		
Life drunkenness episodes							12.445	.002**
<2	705	98.2	1065	99.3	136	95.8		
≥2	13	1.8	8	0.7	6	4.2		
Life cannabis ("marijuana") use							.781	n.s / .677
<2	694	96.4	1040	97.1	138	97.2		
≥2	26	3.6	31	2.9	4	2.8		
Sexual intercourse							18.898	.000***
No	570	79.4	933	87.0	119	82.1		
Yes	148	20.6	139	13.0	26	17.9		
Involvement in fights							10.019	.007**
No	574	79.5	904	83.9	127	88.8		
Yes	148	20.5	173	16.1	16	11.2		
Physical and pshycological factors								
Daily sleep							13.061	.001***
≤ 8 hours	515	74.6	845	81.6	114	82.0		
> 8 hours	175	25.4	190	18.4	25	18.0		
Being on diet							8.402	.015*
No	599	82.5	938	86.7	130	89.7		
Yes	127	17.5	144	13.3	15	10.3		
Self-reported BMI							16.615	.000***
Normal or thin	519	78.9	857	86.0	106	88.3		
Overweight / obese	139	21.1	140	14.0	14	11.7		
Life assessment							2.235	n.s / .327
Not at all satisfied <5	52	7.3	65	6.1	13	9.0		
Very satisfied >5	659	92.7	1003	93.9	132	91.0		
Relationship with family							1.705	n.s / .426
Not at all satisfied <5	40	5.9	61	5.9	12	8.7		
Very satisfied >5	634	94.1	970	94.1	126	91.3		
Liking school							4.154	n.s / .125
Yes	553	76.1	865	79.9	110	76.4		
No	174	23.9	217	20.1	34	23.6		
Social environment								
FAS ¹							1.022	n.s / .600
Medium to high	633	88.9	953	89.5	124	86.7		
Low	79	11.1	112	10.5	19	13.3		
School results							9.102	.011*
Above the average	325	44.8	456	42.2	45	31.3		
Average to lower	400	55.2	625	57.8	99	68.8		

n.s = not significant * p< .05; ** p< .01; *** p< .001

In bold – values that correspond to an adjusted residual ≥ | 1.9 |

¹ FAS – Family affluence scale

Table 3 Association of early menarche (< 12 Years) with health protective and compromising behaviour

	β	SE	p	95% IC	OR
Sexual Intercourse (Yes)	.626	.150	.000	(1.395 – 2.508)	1.870
Involvement in fights (Yes)	.277	.140	.047	(1.003 – 1.736)	1.320
Daily sleep (>8 hours)	.590	.128	.000	(1.403 – 2.317)	1.803
Being on diet (Yes)	.107	.155	.489	(0.822 – 1.509)	1.113
Self-reported BMI (Overweight/obese)	.442	.146	.003	(1.168 – 2.072)	1.555

OR: adjusted odds ratio; CI: confidence interval

Table 4 Association of delayed menarche (>13 Years) with health protective and compromising behaviour

	β	SE	p	95% IC	OR
Daily smoking (Yes)	.528	.242	.001	(1.055 – 2.725)	1.696
Life drunkenness episodes (≥ 2)	1.487	.594	.029	(1.382 – 14.164)	4.425
School results (Average to lower)	.476	.197	.016	(1.093 – 2.369)	1.609

OR: adjusted odds ratio; CI: confidence interval

Results suggested that having had sexual intercourse, getting involved in fights, sleeping more than eight hours a day, self-reporting overweight or being obese and having weight loss diets were the variables significantly and independently associated with early menarche. As for delayed menarche, it was associated with smoking, having had more than two episodes of drunkenness and having had school results below the average. Although initiation of some of these behaviours in middle or late adolescence may reflect psychologically healthy experimentation (Currie, et al, 2012; Al-Awadhi, et al. 2013), adolescents who initiate health risk behaviours at an early age appear to be at greater risk for negative consequences later in life (Al-Awadhi, et al. 2013).

Early and delayed matured girls may therefore face pressure to engage in behaviours appropriate to their appearance rather than their experience, coping or cognitive skills (Dvornyk & Waqar u, 2012). Therefore, affiliation with an older peer group putatively increases the risk for initiation and addiction because of greater availability of substances, peer modelling of use and biased perceptions of substance use norms, though; it is not possible to confirm this hypothesis from this study's results.

The first type of risk behaviour included in the model and significantly associated with early menarche was early sexual intercourse. Early sexual initiation could have negative effects on health due to the developmental inabilities to deal with consequences of such sexual activity. Studies have shown that it was associated with a lesser use of contraceptive methods and an increase in sexual transmitted diseases exposure (Al-Awadhi, et al. 2013; Parent, et al., 2013).

Furthermore, several research findings suggest that

early sexual activity more likely reflects problems in adolescent development than successful rite of passage (Godeau, et al. 2008): thus it has been found associated with other risk behaviours such as smoking tobacco, higher levels of drunkenness and cannabis use, and frequent evenings out with friends. Drunkenness is an indicator of alcohol misuse and another risk behaviour recurring in adolescence and integration/pressure by peers (Al-Sahab, Arden, Hamadeh, & Tamin, 2012). There is strong association between adolescent alcohol use and an array of other behaviours or conditions, such as smoking and illegal drug use, risky sexual behaviour, disruptive behaviour, depressive and anxiety disorders, eating disorders and obesity (Bralic, et al. 2012; Godeau, et al. 2008; Joinson, Heron, Lewis, Croudace, & Araya, 2011; Richards & Meghan, 2011). There is evidence that these behaviours cluster in young people with high risk lifestyles (Walvoord, 2010).

Potential physical influences of age at menarche include factors such as weight, nutrition and exercise (Marques, Braquinho & Matos, 2015). There is growing evidence that childhood obesity is an important determinant of early menarche and according to some authors, early and delayed pubertal development could result in affiliation with older adolescents, who often experience increased deviance and substance use (Currie, et al, 2012; Marques, Braquinho & Matos, 2015). The World Health Organization recognizes that childhood overweight and obesity have reached epidemic proportions in most industrialized countries. BMI is associated with direct measures of fatness, cardiovascular risk factors, social and psychological problems and with poor general health-related quality of life (Currie, et al, 2012). A high BMI during childhood and

adolescence is associated with an increased risk of adult obesity and premature mortality (Dvornyk, & Waqar ul, 2012). In our study and as hypothesized, self-reported overweight or obesity remained strongly associated with early menarche. However, due to the cross-sectional design of our study, the direction of this association cannot be known. These findings support the need to explore such associations in longitudinal studies.

From heritability studies, it has been shown that genetic factors play a key role in determining age at menarche (Dvornyk, & Waqar ul, 2012). However, relatively little work has been done to unravel the complex interplay of genetic, social and behavioral factors (via epigenetic mechanisms), in explaining the variability in ages at menarche. One such approach would be to use family data and specific family-based studies (intergenerational, sibling and twin studies) across the life course to test specific causal mechanisms and life-course models since they can help in the understanding of whether the timing of risk factors (critical and sensitive periods) are important (Biro, Greenspan, & Galvez, 2012). This analysis could be done in several ways, for instance, by comparing within and between sibling and twin associations for age at menarche where tight control for fixed factors within twin pairs and sibling groups is possible, and by comparing parental-offspring association to test causality for intrauterine exposure.

This study has several limitations due to the cross sectional nature of the study survey, the fact that the study was not originally designed for this particular study, and the fact that it is based on self-reports. Despite these limitations, this study provided novel data about early and delayed menarche with nationally representative data of Portuguese adolescents. Even more the fact that girls participate in the survey close to the time of menarche limits the memory bias, and gives this data great value.

In conclusion, our results add to a growing literature that suggests that both girls who experienced early menarche and girls who experienced delayed menarche are more likely to engage in risk behaviours, such as early sexual initiation or alcohol abuse. These results highlight the need for more awareness and more prevention in the case of early and delayed menarche and the overall need to reinforce health protection around puberty. These results have significant implications for information provision and the targeting of future health education programmes. Further studies should focus on shedding light on the determinants of early and delayed menarche; and on which source or media of information is most effective in educating such adolescents. In terms of prevention, results suggest that there should be a continuing emphasis on teaching about this issue that has proven to be so important for the promotion of healthy women.

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Note¹: FAS - socio-economic status assessed by the Family Affluence Scale (Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T., Richter, M. (2008). Researching health inequalities in adolescents: the development of the Health Behaviour in School-aged Children (HBSC) Family Affluence Scale. *Social Science and Medicine*, 66:1429-36).

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