

# Pubertal maturation and health risk behaviors in adolescents: a systematic review

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## ABSTRACT

**Background:** The objective of this study is to accomplish a systematic review of the literature describing the association between pubertal maturation and health risk behaviors among adolescents.

**Methods:** It was used the database from MEDLINE/Pubmed, Scopus, Lilacs and Web of Science. The terms used in the research, with its variations, were "puberty", "maturation", "maturity", "risk behaviors", "risk factors", "adolescent" and "student". There were included studies that considered: 1) pre-teens and teenagers aged from 10 to 19 years old; 2) have at least one aspect in regards to pubertal maturation, and at least one behavior of risk (or the data that shows prevalence); 3) observational, transversal and longitudinal studies, and evaluate an association between pubertal maturation and behaviors of risk; 4) be published in scientific journals in the English language; and 5) be published until July, 2015. The quality of the scientific papers was assessed based on the Downs & Black scale.

**Results:** Out of 838 manuscripts found in the databases, after the sorting and applied the eligibility criteria, remained in this systematic review 13 articles. Early maturation was associated significantly with the use of alcohol, cigarettes and illegal drugs, early sexual initiation, sedentary behaviors and involvement in fights, where girls showed higher prevalence.

**Conclusion:** The results of the current study indicates that a pubertal maturation is associated to health risk behaviors among adolescents.

*Key words:* pubertal maturation, health risk behaviors, adolescents, review systematic

## INTRODUCTION

The substantial increase in chronic diseases has aroused concerns, since these are responsible for 60% of global mortality [1,2]. Evidence has shown that the increase has been associated with sedentary lifestyles, which are influenced by technological advances, social

and environmental influences in all ages [3-5].

Adolescence is regarded as a critical period of physical, cognitive and social development that interconnected interfere with the acquisition of healthy habits [6-8]. Furthermore, the evidence indicates that during puberty there is a greater vulnerability for the obtainment of health risk behaviors, since the physiological

changes and adolescent brain development modulate the behavior [9-11]. On this basis, we can observe that the most widely used instruments for assessing the pubertal maturation in transversal and longitudinal studies, are the Menarche's Age (MA), Scale of Pubertal Development (SPD), and scale of Tanner [12-16].

Nevertheless, the growth of health risk behaviors in adolescents has been associated with inadequate diets, decrease in the practice of physical activities and increased sedentary lifestyle [3,17], in addition to the use of licit and illicit drugs, which calls attention to the high prevalence [12,13,18,19]. In addition, there are academic works that show the influences of gender, parental monitoring and peer influences on adolescent behaviors [13,20]. In these studies, self-report measures are predominant in the assessment of health risk behaviors in adolescents [13-16,21-23].

In this context, two systematic reviews explored the use of alcohol, licit and illicit drugs by teenagers [24,25]. There is evidence pointing to the pubertal maturation as a variable that is related to the acquisition of risk behavior [9,11,20], however there is no systematic analysis that assist in interventions and targeting of actions by the professionals who work with adolescents.

Considering this, the objective of this study is to accomplish a systematic review of the literature describing the association between pubertal maturation and health risk behaviors among teenagers.

## METHODS

The study was accomplished following the protocol recommended by PRISMA [26]. The research was conducted using electronic databases such as MEDLINE/Pubmed, Scopus, Lilacs and Web of Science. Searches were carried out in the period from April to July 2015, made around the respective keywords: "pubertal maturation" and "risk behaviors" and its variations. For the pubertal maturation were included the terms "pubertal maturation", "puberty", "maturation", "maturity" and "adolescent", the search for risk behaviors, including the terms "risk behaviors" and "risk factors" in turn for the sample type were "adolescent" and "student", and in every combination were used the Boolean operators "AND" or "OR".

The lists of references were examined to capture relevant articles and searches were carried out in bases of dissertations, theses and reports, however, we were unable to identify studies that treat the subject investigated.

Studies were included that proposed: 1) adolescents aged from 10 to 19 years old; 2) have at least one aspect of pubertal maturation, and at least one risk behavior (or the data that show prevalence); 3) observational, transversal and longitudinal, and evaluate an association between pubertal maturation and risk behavior; 4) be

published in magazines and newspapers in the English language; and 5) be published until July 2015.

The exclusion criteria were: 1) sample with pregnant adolescents; 2) teenagers who had hormonal diseases; 3) adolescents with some kind of syndrome or pathology. These criteria were chosen in order to increase comparability within the academic studies.

The searches were carried out by two researchers KPMA and IKS that independently, researched, extracted the data and assessed the quality of the academic studies through the Downs & Black scale that has 27 items [27]. For use in this study, were dropped as issues 8, 13, 14, 15, 23, 24 and 27, because he referred to studies like clinical trial. The same will be presented through the score obtained from the items evaluated in the scale. The discrepancies found were solved by consensus meetings or through a third evaluator HJM. It was used the check-list Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), proceeding thus with the particular requirements for the development of a systematic review [26].

## RESULTS

### Study selection

Searching electronic databases resulted in 838 articles, of which 445 with repeated titles were discarded. Sorting by titles and abstracts of the 393 remaining articles, resulted in 29 articles for full-text reading, 16 of those were removed because they did not meet the criteria for inclusion, which did not associate the variables studied, the samples did not fully comprehend the age group of 10 to 19 years old. One tested the reproducibility of the instrument, thus, after sorting and applied the eligibility criteria, remained in this systematic review 13 articles (Figure 1).

## STUDY CHARACTERISTICS

### Methods and design

The data presented in table 1, refers to the specific and methodological issues of thirteen articles that were included in the revision. At first, we can observe that were analyzed six longitudinal and six cross-sectional studies, and six which were performed in the United States [13,16,20,22,23,28], two in the Netherlands [12,29], two in Norway [14,15], one in Canada [21], one in France [30] and one in the United Kingdom [31].

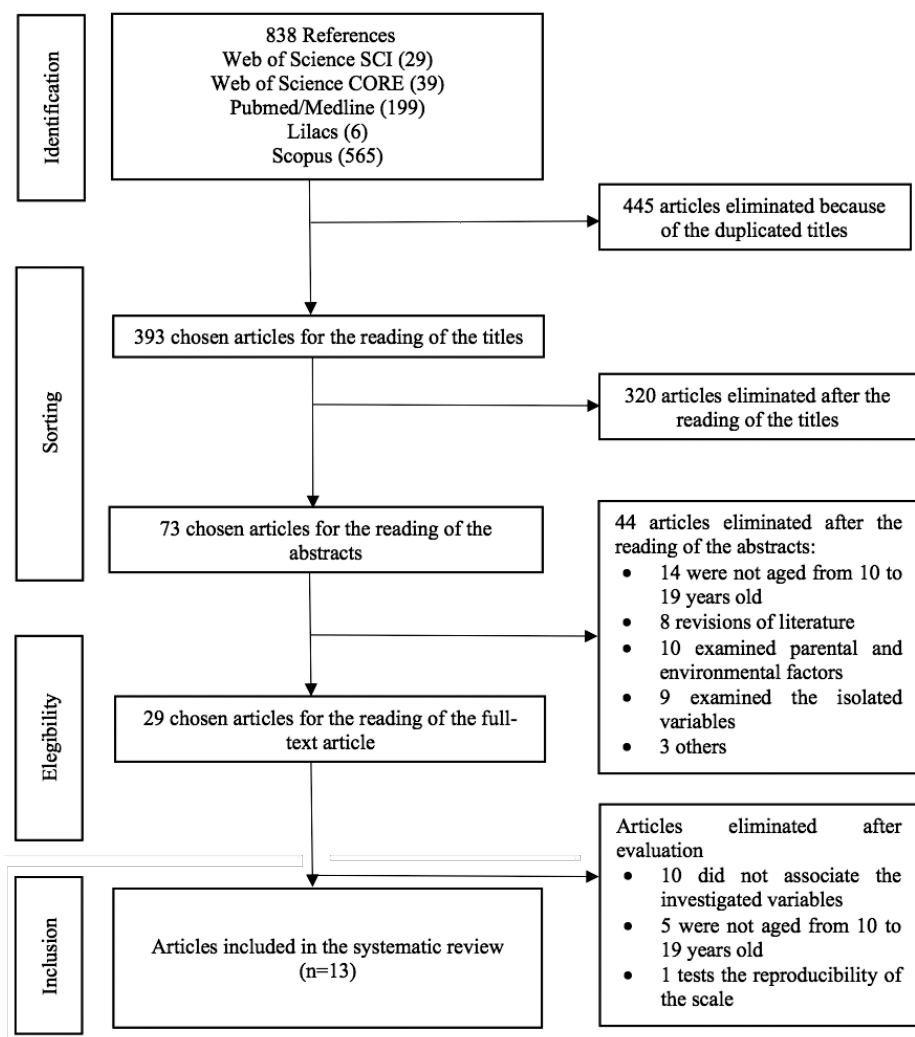
The academic studies published during 1994 to 2014, containing information of 326.202 teenagers, on the other hand the size of the samples ranged from 71

**TABLE 1. Academic studies included in the systematic revision that associated the pubertal maturation with risk behaviors.**

Author, year (country)	N	Mean age or age range (years)	Type	Pubertal Maturation Measure	Risk Behavior Measure	Statistics Treatment	Main results	Quality Score
Verhoef et al (2014) (Netherlands)	430 (girls)	12.2 (SD 0.5)	L	MA	Self-report	Pearson correlation and multiple regression	PM increased the probability to initiate alcohol use.	15
Kong et al (2013) (United States)	3068 (boys and girls)	13 to 18	C	SPD and Self-report	Self-report and Zuckerman-Kuhlman Questionnaire	Chi-square and logistic regression	Significant association between the PM timing with using cigarettes in boys (OR=1.28, $p \leq 0.008$ ) and in girls (OR=1.22, $p \leq 0.008$ ).	18
Al-Sahab et al (2012) (Canada)	295,042 (girls)	14 to 15	C	MA	Self-report	Chi-square and logistic regression and Odds ratio	There was no association between MA and the risk behaviors evaluated.	18
Gaudineau et al (2010) (French)	1,072 (girls)	15	L	MA and Self-report	HBSC Questionnaire	Chi-square and logistic regression and Odds ratio	PM was associated with episodes of drunkenness and premature sexual initiation. MP, $p < 0.001$ , respectively).	18
Jaszyna-Gasior et al (2009) (United States)	71 (girls)	15.2 (SD 1.3)	L	MA	Self-report	Linear regression	Significant association between MA and the initiation of daily smoking habit. ( $\beta = 0.18 \pm 0.09$ , $p = 0.038$ ).	16
Westling et al (2008) (United States)	360 (boys and girls)	10 to 15	C	SPD	Self-report	Logistic regression and Odds ratio	Association between the PM and cigarette and alcohol use, by boys and girls without parental awareness.	19
Van Jaarsveld et al (2007) (United Kingdom)	5,863 (boys and girls)	11 to 16	L	SPD	Questionnaire and Self-report	Logistic multivariate regression and Odds ratio	PM was significantly associated to SB and MVPA in boys (OR=1.23 and 1.32, $p < 0.05$ ) and cigarettes in girls (OR=1.28, $p < 0.005$ ).	19
Lynne et al (2007) (United States)	1366 (boys and girls)	11.7 (SD 0.5)	C	Subjective measure	Youth Self-Report Scale and Self-report	Chi-square and logistic regression and Odds ratio and ANCOVA	PM was a risk factor for aggressive and delinquent behaviors.	15
Bratberg et al (2007) (Norway)	8950 (boys and girls)	13 to 19	C	Questionnaire and SPD	Scale/ Self-report	Logistic regression and Odds ratio	PM was associated to a greater involvement in risk behaviors.	19
Bratberg et al (2005) (Norway)	2,129 (boys and girls)	12 to 18	L	SPD	Self-report	Logistic regression and Odds ratio	PM was significantly associated with the use of alcohol and tobacco by girls in the end of their teen years. (OR=1.7 and 1.5, IC=1.2-2.4 e 1.1-2.2), respectively.	19
Patton et al (2004) (United States and Australia)	5769 (boys and girls)	10 to 15	C	SPD and Tanner's Scale	Self-report	Logistic regression	The PS was associated with the use of substances, puberty (OR= 1.7, IC= 1.4-2.1) and higher levels in post-puberty (OR= 3.1, IC= 2.4-4.2).	21
Bernaards et al (2001) (Netherlands)	619 (boys and girls)	13 to 15	L	CA, SA, PS and Tanner's Scale	Self-report	Logistic regression and Odds ratio	None of the measures to estimate time of biological maturation was significantly associated with smoking.	10
Wilson et al (1994) (United States)	1,463 (girls)	10 to 18	L	Tanner's Scale	Self-report	Chi-square	PM was associated with the youngest age for initiation of both alcohol and tobacco use. MP.	14

L, longitudinal; C, Cross-sectional; MA, menarche's age; SPD, Scale of Pubertal Development; EM, early onset maturation; SB, sedentary behavior; MVPA, moderate-to-vigorous physical activities; PS, pubertal stage; CA, calendar age; SA, skeletal age; PGS, Peak Growth Spurt.

**FIGURE 1. Flowchart with selected phrases from the academic study.**



to 8950 adolescents aged from 10 to 19 years old. It is necessary to emphasize that 38.5% evaluated only girls due to the marked decrease in the Menarche's Age (MA) and consequent Pubertal Maturation (PM) in recent years [12,22,23,30].

As in regards to the instruments used, the Menarche's Age (MA) and Scale of Pubertal Development (SPD) are methods applied in studies evaluated. In addition to these, the Tanner Scale, Chronological Age (CA), Skeletal Age (SA) and Peak Growth Spurt (PGS) has also been widely used, as well as self-reporting measures and questionnaires that subjectively evaluate pubertal maturation.

To evaluate the risk behaviors, the self-reporting measures predominated. In addition to this, criteria such as the Zuckerman-Kuhlman questionnaire, HBSC survey, Youth Self-Report Scale were also used in three articles evaluated.

In regards to the statistical methods used, it was observed a predominance in the applicability of the Chi-square test and linear, logistic and multiple regression

analysis, in order to verify the association between the pubertal maturation and the health risk behaviors.

From these analyses, it was possible to notice that there was a significant association between the Pubertal Maturation (PM) and risk behaviors such as using alcohol, cigarette and illegal drugs, early sexual initiation, sedentary behavior and involvement in fights [15,20,22,30,31]. However, in a study conducted with teenagers from 11 to 16 years old, the Pubertal Maturation (PM) was associated with a longer period intended for MVPA in boys (OR=1.32, p<0.05) [31]. Moreover, the results also show that girls with Pubertal Maturation (PM), presented rates higher than boys do, as concerning the use of alcohol, cigarettes and sexual initiation in early teens.

It is worth recalling that in table 1, the scores obtained from the studies evaluated were based on Downs and Black scale, with an average of 17±2.92 (minimum of 10 and maximum of 21) scores obtained, of the 27 items evaluated.

## DISCUSSION

The evidences thus described in this systematic review indicates that the health risk behaviors are associated to the pubertal maturation. In this manner, it can be noticed that the methods which were used the most to measure the pubertal maturation were the Menarche's Age and Scale of Pubertal Development, due to their validity and practicality for the application of studies with great quantity of samples [12-16,20-22,30,31]. However, the disadvantages of these methods may be related to the subjectivity in the evaluation, which could generate tendencies. On the other hand, in order to evaluate the health risk behaviors, there was a predominance in the use of self-reporting instruments [12-16,20-23,29-31].

Most of the studies were conducted in countries with different socio economical levels, which in turn may influence in a negative manner the acquisition of behaviors of risk, considering that less fortunate adolescents live in places or areas of social vulnerability that exposes them to a greater probability to health risk [14,16,20,22,31].

In this manner, it can be highlighted that the main findings in regards to the studies in this review were: (1) greater involvement among girls in relation to early development with behaviors of risk in the early stages of adolescence when compared to boys [13-16,31]; (2) after puberty these behaviors tends to decrease the variability between the genders and increase the chances of repeating itself from the moment in which the teenagers start to get acquainted with different social contexts [15,20,22,30,31]; (3) it was noticed that during puberty, the use of alcohol, cigarettes, sexual relations of risk, sedentary behaviors, physical inactivity and aggressiveness, occurred with greater frequency among young people that entered puberty precociously [12,13,15,16,20,21-23,29,30].

The use of cigarettes was estimated in one-third of the world's population aged 15 years old or older, 76.3 millions had acquired disorders due to the use of alcohol and 15.3 millions had acquired disorders due to the use of drugs, according to the World Health Organization (WHO) [32]. These behaviors of risk occurred with a greater frequency among teens that matured precociously and in turn without parental knowledge. In addition, as for both genders, parental monitoring moderated the association between the PM and the tentative of using alcohol, but not of cigarettes [13].

On the other hand, teenagers with premature pubertal maturation experienced involvement with sexual relations of risk. Notwithstanding, in research conducted with adolescents victims of violence, it was observed that during puberty the influence of their deviant peers and the fact of entering precociously into puberty increases the risk of premature sexual behavior, however not necessary sexual relation [30,35].

Furthermore, physical inactivity and sedentary behaviors were more frequent among boys with PM, thus

the respective variables presents a substantial increase with early puberty, regardless of gender. Notwithstanding, it is worth remembering that men have a higher involvement in MVPA [14,28,31]. Likewise, it is noticed involvement in fights especially among boys with PM, considering that this increase occurs mainly due to changes in the levels of testosterone during puberty, which in turn are significantly associated with aggressive behavior and eating disorders among teens of the male gender [28,36].

Taking into consideration the results presented, it is worth noting the association between pubertal maturation and behaviors of risk among adolescents in different contexts and in which the physiological, hormonal mechanisms and the development of the adolescent brain explain the vulnerability in regards to the risky decisions that propitiate health risk behaviors [9-11].

Furthermore, the evidences indicate that risky decisions increase during the first part of adolescence by the substantial development of the brain regions linked to emotions, relationships and affections and to the imaturity of cognitive regions. This consists in the idea that puberty plays a differential role in the process, considering that this deregulation between the brain systems involved, which modulates these behaviors of risk could coincide with puberty, but are independent of it [9-11]. Nevertheless, it should be taken into consideration that teenagers with less cognitive capacity and that entered puberty precociously are more likely to be exposed to situations that can cause damage to health [37,38].

Nonetheless, it is important to mention that one of the limitations found in the studies are the methods of evaluation used where the main measurements for maturation amongst the studies were inserted in the revision, in its majority are subjective measurements, in which it has been causing extensive discussions from researchers and specialists in the area.

Based on this, objective and non-invasive methods in order to identify the stage, status or maturational degree are being created as a way to minimize the tendencies that causes the subjective measurements in the studies [33,34]. The result of this are more precise and reproducible informations, minimizing whatever tendencies may interfere in the relations with other variables studied.

In this manner, it is suggested the use of direct methods to evaluate pubertal maturation, taking into consideration the biological individuality of both genders. Based on this, predictive equations are more reliable and valid as for the evaluation of pubertal maturation [33,34].

## CONCLUSION

According to the results presented in the current revision, adolescents with early maturation have greater involvement in behaviors of risk, especially, girls that presented greater prevalence in the studies.

This allows us to conclude that the pubertal maturation are associated with health risk behaviors among adolescents.

Taking into account the evidences aforementioned, the main implications are related to the awareness of health and education professionals that are involved in this stage of the human development, considering that the early onset of puberty is a factor of risk as for the involvement in health risk behaviors. Multidisciplinary projects or programs should be inserted along with promotional and preventive activities, in order to minimize possible health risks among these young people, enabling a healthy lifestyle.

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