

## ASSESSING SECULAR TREND IN PUBERTY TIMING AMONG GIRLS: EARLY ONSET OF THELARCHE

Arjeta RAUFI<sup>1</sup>, Marina KRSTEVSKA KONSTANTINOVA<sup>2</sup>, Miranda ABAZI MISIMI<sup>1</sup>

<sup>1</sup> Children's Department, Clinical Hospital in Tetovo, Faculty of Medical Science in Tetovo, R.N. Macedonia

<sup>2</sup> University Children's Hospital, Faculty of Medicine, St's. Cyril and Methodius University in Skopje, R.N. Macedonia

\*Corresponding author: email: arjeta.raufi@unite.edu.mk

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### Abstract

Secular trends in puberty refer to the changes observed over time in the onset and progression of puberty in populations. One of the most notable secular trends in recent years it is the declining age of puberty timing. The secular trend in early breast development (thelarche) refers to the observed phenomenon of girls entering puberty at progressively younger ages over successive generations.

The aim of this study is to assess the breast development stages among girls, comparing four ethnicities in the northwestern part of North Macedonia.

**Material and methods:** An assessment of breast development stages was conducted, which included the cross-sectional study evaluation of 480 sampled girls aged 6-13 years from four different ethnicities. Breast development was assessed using Tanner and Whitehouse method which categorizes breast development into five stages (B1 to B5) based on specific physical characteristics.

**Results:** The prevalence of breast development stages according to age shows that B2 increased gradually from 2.6% at 6+ years to 8.0% at 7+, 13.5% at 8+, and 30.6% at 9+. The highest prevalence was observed at 10+ years with 43.1% and at 11+ years with 25.8%.

The mean age of reaching breast development stage B2 in the entire sample of girls was 9.38 +/- 1.3 years. Among the four ethnicities, the lowest average age was observed among Roma girls (9.11 +/- 1.19 years), followed by Turkish girls (9.13 +/- 0.63 years), Macedonian girls (9.41 +/- 1.22 years), and Albanian girls (9.43 +/- 1.44 years).

**Conclusion:** At our study the prevalence of stage B2 breast development at 6 and 7 years, is worth emphasizing because the occurrence of secondary sexual characteristics before the age of 8 may indicate a possible sign of early onset of puberty. Early thelarche, occurring before the age of 8, has become a topic of interest due to its potential psychological, social, and long-term health implications.

*Keywords:* puberty, breast development, secular trends, North Macedonia

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### Introduction

Secular trends in puberty refer to the observed changes over time in the onset and progression of puberty in populations. One of the most notable secular trends in recent years is the declining age of puberty timing (Karlberg, 2002). Thelarche, which marks the beginning of puberty, is the onset of breast development in girls which represents one of the first significant secondary sexual characteristics. It involves the enlargement and budding of breast tissue, often accompanied by hormonal changes and other physical transformations. The timing of thelarche varies among individuals and can be influenced by a combination of genetic, environmental, and hormonal factors. While the average age for breast development has historically been around 10 or 11 years, there have been noticeable trends towards earlier onset over the past few decades. Girls today are experiencing breast development as early as 7 or 8 years of age (Eckert-Lind et al., 2020). The reasons behind early thelarche are multifactorial and complex. One contributing factor may be the overall improvement in healthcare and nutrition, which has resulted in better overall health and an earlier onset of puberty (Bygdell et al., 2018). Additionally, exposure to certain environmental factors, such

as endocrine-disrupting chemicals (Eskenazi et al., 2017), (Fisher & Eugster, 2014) may play a role in altering hormonal balance and influencing the timing of breast development (Durmaz et al., 2018). Genetic factors and ethnicity have also been associated with variations in thelarche onset. Furthermore, early thelarche has been associated with a slightly increased risk of certain health conditions later in life, such as breast cancer and polycystic ovary syndrome (PCOS)(Goldberg et al., 2020). This accelerating trend raises important questions about its causes, consequences, and possible interventions.

The aim of this study was to assess the breast development stages among girls, comparing four ethnicities in the southwestern part of North Macedonia.

**Material and methods:** A cross-sectional study of 480 girls aged between 6-13 years from four different ethnicities between February and April 2022 was conducted. Before conducting any physical examination, informed consent from the parent or guardian and also from the girl was obtained. Breast development was assessed using Tanner and Whitehouse method which categorizes breast development into five stages (B1 to B5) based on specific physical characteristics. These stages reflect the progression of breast development during puberty as follows:

B1: Pre-pubertal stage with no breast tissue development.

B2: Breast bud stage characterized by the elevation of a small mound of breast tissue, typically located beneath the areola.

B3: Further enlargement of breast tissue and the development of an increased breast mound.

B4: Areola and nipple form a secondary mound above the level of the breast.

B5: Mature breast stage where the breast is fully developed, with the areola returning to its normal contour.

The data obtained with the research were processed in SPSS software package, version 22.0 for Windows.

Results: In the entire sample of girls, the prevalence of B1 breast development stages was 49%, followed by the prevalence of B2 at 16.7%, B3 at 16.2%, and B4 at 18.1%. None of the girls had reached stage B5. The prevalence of breast development stages according to age shows that B2 increased gradually from 2.6% at 6+ years to 8.0% at 7+, 13.5% at 8+, and 30.6% at 9+. The highest prevalence was observed in 10+ years with 43.1% and in 11+ years with 25.8%.

**Table1.** Prevalence distribution of stage of breast development by age

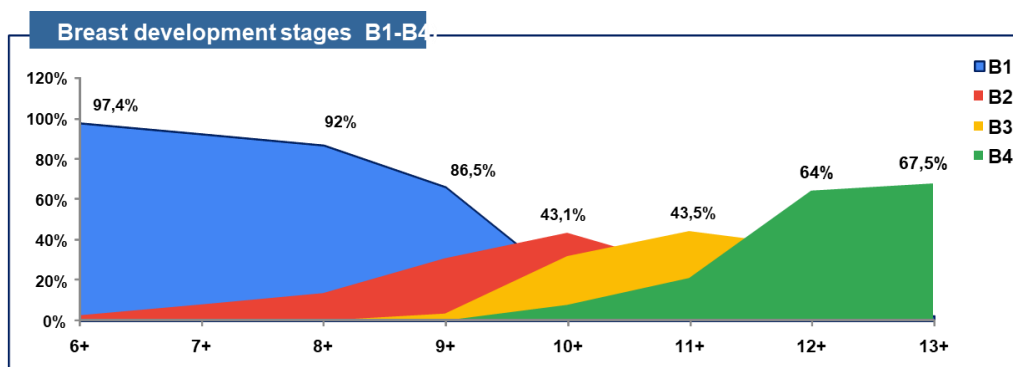
| Parameters                           | Age- Years |       |       |       |       |       |       |       |        |       |
|--------------------------------------|------------|-------|-------|-------|-------|-------|-------|-------|--------|-------|
|                                      | 6+         | 7+    | 8+    | 9+    | 10+   | 11+   | 12+   | 13+   | Вкупно |       |
| Breast development stages            |            |       |       |       |       |       |       |       |        |       |
| B1                                   | N          | 37    | 80    | 45    | 56    | 9     | 6     | 0     | 2      | 235   |
|                                      | %          | 97,4% | 92,0% | 86,5% | 65,9% | 17,6% | 9,7%  | 0%    | 2,5%   | 49,0% |
| B2                                   | N          | 1     | 7     | 7     | 26    | 22    | 16    | 0     | 1      | 80    |
|                                      | %          | 2,6%  | 8,0%  | 13,5% | 30,6% | 43,1% | 25,8% | 0,0%  | 1,2%   | 16,7% |
| B3                                   | N          | 0     | 0     | 0     | 3     | 16    | 27    | 9     | 23     | 78    |
|                                      | %          | 0%    | 0%    | 0%    | 3,5%  | 31,4% | 43,5% | 36,0% | 28,8%  | 16,2% |
| B4                                   | N          | 0     | 0     | 0     | 0     | 4     | 13    | 16    | 54     | 87    |
|                                      | %          | 0%    | 0%    | 0%    | 0%    | 7,8%  | 21,0% | 64,0% | 67,5%  | 18,1% |
| All sample                           |            | 38    | 87    | 52    | 85    | 51    | 62    | 25    | 80     | 480   |
| B1-B5 → stages of breast development |            |       |       |       |       |       |       |       |        |       |
| B5 – no cases                        |            |       |       |       |       |       |       |       |        |       |

The mean age of reaching breast development stage B2 in the entire sample of girls was 9.38 +/- 1.3 years. Among the four ethnicities, the lowest average age was observed among Roma girls (9.11 +/- 1.19 years), followed by Turkish girls (9.13 +/- 0.63 years), Macedonian girls (9.41 +/- 1.22 years), and Albanian girls (9.43 +/- 1.44 years).

**Table 2.** Mean age of breast development stages in four ethnicities

| Ethnicity |            | Mean age |            |                       |
|-----------|------------|----------|------------|-----------------------|
|           |            | N        | Mean±SD    | P                     |
| B1        | Macedonian | 71       | 7,89±1,38  | X2(3)=8,300; p=0,040* |
|           | Albanian   | 124      | 7,60±1,30  |                       |
|           | Turkish    | 25       | 8,18±0,92  |                       |
|           | Roma       | 15       | 7,63±1,29  |                       |
| All       |            | 235      | 7,75±1,03  |                       |
| B2        | Macedonian | 26       | 9,41±1,22  | X2(3)=1,172; p=0,760  |
|           | Albanian   | 43       | 9,43±1,44  |                       |
|           | Turkish    | 6        | 9,13±0,63  |                       |
|           | Roma       | 5        | 9,11±1,19  |                       |
| All       |            | 80       | 9,38±1,30  |                       |
| B3        | Macedonian | 30       | 11,06±1,23 | X2(3)=4,242; p=0,237  |
|           | Albanian   | 34       | 11,51±1,06 |                       |
|           | Turkish    | 13       | 11,78±1,18 |                       |
|           | Roma       | 1        | 10,33±0,00 |                       |
| All       |            | All      | 11,37±1,17 |                       |
| B4        | Macedonian | 37       | 12,34±0,83 | X2(3)=0,049; p=0,997  |
|           | Albanian   | 43       | 12,33±0,95 |                       |
|           | Turkish    | 4        | 12,21±0,95 |                       |
|           | Roma       | 3        | 12,22±1,03 |                       |
| All       |            | All      | 12,32±0,89 |                       |

The prevalence of B2 among girls with Macedonian ethnicity was 6.2% at 7+ years of age and reached a maximum of 38.5% at 10+ years. For girls of Albanian ethnicity, the prevalence of B2 was 3.6% at 6+ years of age and reached a maximum of 46.9% at 10+ years. Girls of Turkish ethnicity had a prevalence of B2 at 8+ years of age of 18.2%, with a maximum of 25% at 10+ years. In the sample of girls from the Roma ethnic group, the prevalence of B2 was 40 % at 9+ years of age , with maximum of 50 % at 10+ years.



**Graf 1.** Breast development stages B1- B5 (B5- no cases)

For  $p < 0.05$ , a significant difference between the ethnicities was determined in relation to the average age of registering the B1 stage of breast development, in addition to a significantly higher average age among girls of Turkish ethnicity compared to other ethnicities (Kruskal-Wallis H test:  $X^2(3) = 8.300$ ;  $p = 0.040$ ). For  $p > 0.05$ , there was no significant difference between the ethnicities regarding the average age of registration of B2 ( $p = 0.760$ ), B3 ( $p = 0.237$ ), and B4 ( $p = 0.997$ ) stages of breast development.

## Discussion

Secular trends in height, weight, and puberty in children demonstrate the complex interaction between genetic factors and the influence of external factors. Some studies suggest increased exposure to certain environmental chemicals, known as endocrine-disrupting chemicals (EDCs), found in a wide variety of everyday products, such as plastics, pesticides, and personal care products. These chemicals can mimic or interfere with the body's natural hormones and may affect the timing of puberty. Additionally, there is a growing body of research suggesting that increased body weight in children is a factor in the earlier onset of puberty.

The first cross-sectional study in America by (Herman-Giddens et al., 1997), conducted between 1992 and 1993, collected data from young white and African-American girls. In this study, the mean age at onset of breast development stage B2 was  $9.96 \pm 1.82$  years for white girls and  $8.87 \pm 1.93$  years for African-American girls.

(Lee et al., 2001), compared two large cross-sectional studies and found that 50% of girls in the United States reach stage B2 breast development between the ages of 9.5 to 9.7 years. These studies also indicated that about 14% of girls reach stage B2 by age 8, with one study reporting that approximately 6% show the onset of breast development by the age of 7.

The study by (Wu et al., 2002), supplemented data from the 1988-1994 NANES III-Third National Health and Nutrition Examination Survey. The average age at onset of breast development stage B2 was 9.5 years for black girls, 9.8 years for Mexican girls, and 10.3 years for white girls.

European studies have also confirmed the downward trend in the age of thelarche in the European population.

According to (Akslae et al., 2009) Akslae et al., 2009 in a cross-sectional study conducted in Copenhagen, were puberty in girls aged 5.6 to 20.0 years in 1991-1993 and 2006-2008 was investigated. Mean age at stage B2 is significantly earlier in the 2006 cohort with 9.86 years, compared to the 1991 (when estimation of mean age was 10.88 years).

In a study comparing the pubertal maturation of internationally adopted girls and girls born in Denmark at (Teilmann et al., 2009) Teilmann et al., 2009, it was found that 16% of adopted girls reached stage B2 before the age of 8. The mean age at B2 breast development was 9.5 years, and the mean age of menarche was 12.1 years in adopted girls. These values were significantly lower compared to girls born in Denmark.

In a cross-sectional study by (Russo et al., 2012) Russo et al., 2012 of the Lombardy region of Italy, the mean age of B2 was 9.75 years while the prevalence of B2 stage at 7 years was 5.9%.

In the literature review, one of the more recent studies on puberty stages is Bergen's two-stage study of Norwegian children. According to the data from the study, puberty in Norway starts earlier than 10-15 years ago with the average age of stage B2 at 10.4 years.

A cross-sectional study by (Ma et al., 2009) Ma et al., 2009 conducted in China, 19.57% of girls had B2 breast development at the age of 8 years with the mean age 9.20 years.

It follows from the studies of (Hur et al., 2021) Hur et al., 2021 observed in parts of Bangladesh that in less than 3% of the studied population B2 stage is observed before 8 years of age while the average age is 11.02 years.

According to the systematic review and meta-analysis conducted by (Eckert-Lind et al., 2020), where literature was searched for a total of 3062 studies on the age of breast development in girls. According to Eckert, the average age of Tanner B2 breast development in a worldwide comparison ranged from 9.8 to 10.8 years in Europe, from 9.7 to 10.3 years in the Middle East, from 8.9 to 11.5 years in Asia, 8.8 to 10.3 years in the United States, and 10.1 to 13.2 years in Africa. The lowest average age was recorded in the United States, while the highest in Africa. According to the study, it observes a worldwide secular trend of decreasing the age of breast development by an average of almost 3 months per decade from 1977 to 2013, ie 0.24 years per decade .

We have managed to find only one previous study from our country about puberty that was conducted by (Krstevska-Konstantinova et al., 2009) in 928 girls in order to evaluate the prevalence of overweight and puberty stage in different ethnicities. The study shows the presence of puberty signs B2 with 4.3% of girls from Macedonian ethnicity in the first grade, 23% in the third grade and 51.7% in the fifth grade. While among the Albanian ethnicity B2 it is present with 2.7% in the first, 5.2% in the third and 46.9% in the fifth grade.

## Conclusion

Thelarche is a natural part of female puberty, marking the beginning of breast development. At our study the prevalence of stage B2 breast development at 6 and 7 years, is worth emphasizing because the occurrence of secondary sexual characteristics before the age of 8 may indicate a possible sign of early onset of puberty. Early thelarche, occurring before the age of 8, has become a topic of interest due to its potential psychological, social, and long-term health implications. The main contribution of our study is that sheds light on the significance of early thelarche as an indicator of potential early onset puberty for children in our country, underscoring the importance of further research to unravel the underlying factors and devise appropriate intervention strategies.

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