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# Centenary Dynamics in Physical Development of Moscow School Girls

Natalia Aleksandrovna Skoblina , Olga Yurjevna Milushkina , Natalia Andreevna Bokareva , Olga Viktorovna Sazonova , Mikhail Yurievich Gavryushin * , Andrey Aleksandrovich Tatarinchik , Elena Vadimovna Skoblina

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Keywords: physical development, school girls, body mass, body length, muscle strength, menarche, centenary dynamics

*Article*

# Centenary Dynamics in Physical Development of Moscow School Girls

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**Abstract:** This article objective was to identify a centenary trend in the growth and development of girls in the metropolis of Moscow. *Material and methods* — The physical development (body length and weight, chest circumference, right hand muscle strength, and menstrual function development) of Moscow girls was studied during the period from 1920 to 2020. The amount of own observations was 4581 girls aged 8-17 years. *Results* – A comparative analysis of the physical development of Moscow school girls of different decades revealed a statistically significant increase in body length by 3-5 cm and a significant increase in chest circumference in all age groups of girls of the beginning of the XXI century, compared with their peers in the 1960s and 1980s, which indicates the completion of the gracialization processes that have been observed since the 1980s. However, in all age groups, a decrease in the muscle strength of the right hand is still being noticed. Earlier terms of menarshe onset in modern Moscow school girls (12 years 9 months) and a shift in growth jumps to earlier terms were established. It is shown that the age of menstruation depends on the level of family wealth. *Conclusions.* In Moscow girls in the centenary dynamics, a tendency to increase the total body size and shift the terms of biological maturation to earlier terms was revealed.

**Keywords:** physical development; school girls; body mass; body length; muscle strength; menarche; centenary dynamics

## 1. Introduction

The current situation in Russia and the world is characterized by a high prevalence of non-communicable diseases among children and adolescents, which is largely due to global lifestyle changes – the spread of unbalanced nutrition and sedentary lifestyle, uncontrolled use of electronic devices, reduction in medical activity, and many others [1,2]. Consequently, early diagnosis of premorbid conditions by indicators that are sensitive to the effects of risk factors for the development of diseases is of particular importance [3,4].

One of these indicators in the child population is the level of physical development, as a criterion of their health status, including the assessment of harmony and the level of biological development [4–6].

Healthy biological maturation also forms a woman's reproductive health in the future, depending on both genetic predisposition and the presence of somatic pathology, as well as on the impact of behavioral and other factors. Risk factors for violations of physical and biological development of girls are, for example, the level of family wealth, the quality of medical care and the development of the health system in the country, conditions and lifestyle, etc. [7–11]. In this regard, it is of special scientific interest to observe the physical development of Moscow girls in a centenary dynamics.

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*Aim.* Study of the centenary trend of physical development of school-age girls in Moscow.

## 2. Materials and Methods

### *2.1. Subjects and Instruments*

The retrospective study included an analysis of the results of their own research and archival data [12–15]. The total volume of own observations was 4581 school girls. Measurement of body length and weight, chest circumference, and muscle strength of the right arm was performed by means of standard certified medical instruments (anthropometer, medical scales, centimeter tape, hand dynamometer) according to the standard anthropometric method [16]. Additionally, the formation of menstrual function was studied in 893 female students born in the 1990s-2000s, studying at Moscow Universities.

To collect data on reproductive health, a standardized questionnaire was used to identify menstrual disorders in girls (Figure 1) [17]. The questionnaire allowed to determine the age of menstruation, the regularity of the menstrual cycle, the duration of the menstrual cycle and the presence of menstrual disorders.

To assess the socio-economic status of girls ' families, the family Affluence Scale was used according to the HBSC international questionnaire (Figure 2) [18].

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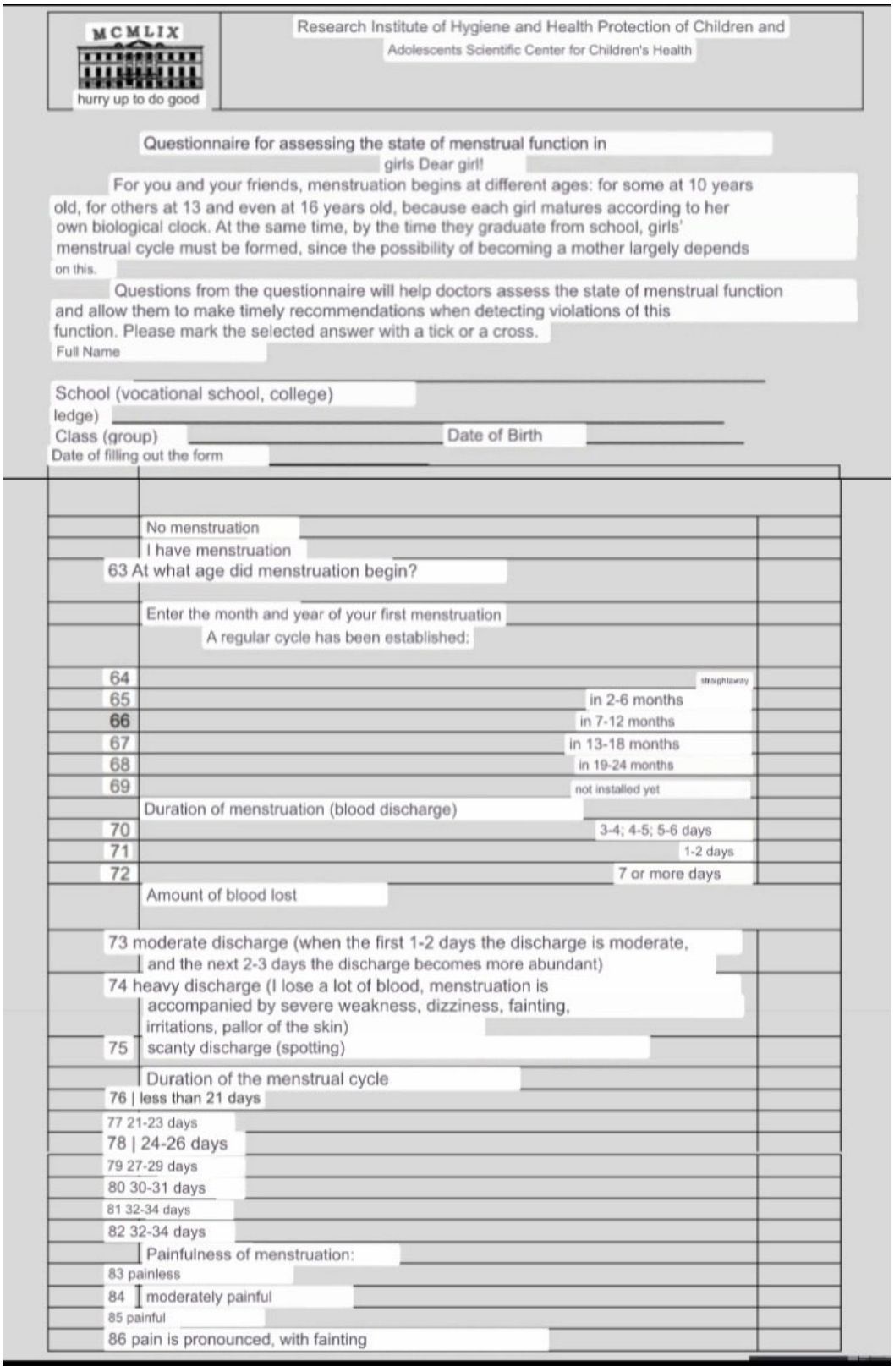
MCMLIX

hurry up to do good

Research Institute of Hygiene and Health Protection of Children and Adolescents Scientific Center for Children's Health

Questionnaire for assessing the state of menstrual function in girls Dear girl!

For you and your friends, menstruation begins at different ages: for some at 10 years old, for others at 13 and even at 16 years old, because each girl matures according to her own biological clock. At the same time, by the time they graduate from school, girls' menstrual cycle must be formed, since the possibility of becoming a mother largely depends on this.

Questions from the questionnaire will help doctors assess the state of menstrual function and allow them to make timely recommendations when detecting violations of this function. Please mark the selected answer with a tick or a cross.

Full Name

School (vocational school, college)

ledge)

Class (group) Date of Birth

Date of filling out the form

No menstruation

I have menstruation

63 At what age did menstruation begin?

Enter the month and year of your first menstruation

A regular cycle has been established:

64 straightaway

65 in 2-6 months

66 in 7-12 months

67 in 13-18 months

68 in 19-24 months

69 not installed yet

Duration of menstruation (blood discharge)

70 3-4; 4-5; 5-6 days

71 1-2 days

72 7 or more days

Amount of blood lost

73 moderate discharge (when the first 1-2 days the discharge is moderate, and the next 2-3 days the discharge becomes more abundant)

74 heavy discharge (I lose a lot of blood, menstruation is accompanied by severe weakness, dizziness, fainting, irritations, pallor of the skin)

75 scanty discharge (spotting)

Duration of the menstrual cycle

76 | less than 21 days

77 21-23 days

78 | 24-26 days

79 27-29 days

80 30-31 days

81 32-34 days

82 32-34 days

Painfulness of menstruation:

83 painless

84 moderately painful

85 painful

86 pain is pronounced, with fainting

**Figure 1.** The questionnaire to identify girls` menstrual disorders.

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The Family Affluence Scale (FAS) is used to analyze differences in socioeconomic status in HBSC studies.

This is due, firstly, to the fact that the socio-economic indicator cannot be used to make comparisons between countries, since this requires that occupational coding systems, labor market conditions and social security programs be comparable.

Secondly, socio-economic status is a composite criterion that combines economic status (income), social status (education) and work status (occupation). Therefore, this indicator is not applicable for children 11. 13. 15 years old.

Third, it is often difficult to obtain clear information from young people about the level of income of their parents and family.

To assess family wealth, use the questionnaire before the last survey in 2013-2014. Four questions were included: about the presence of a car and a computer in the family, own bedroom and family vacation.

1. Does your family have a car, minibus or truck?
Answer options: no (=0); yes, one (=1); yes, two or more (=2).

2. Do you have your own room?
Answer options: no (=0); yes (=1).

3. Over the past 12 months, how often have you left your country/locality for holidays/vacations with your family?
Answer options: did not travel at all (=0); once (=1); twice (=2); more than twice (=3).

4. How many computers does your family have?
Answer options: none (=0); one (=1); two (=2); more than two (=3).

The level of family wealth was determined by the sum of the answers. A low level of wealth is indicated by a score from 0 to 3, an average level by 4.5 points, and a high level by 6 points or more.

The table shows the wealth of families in the Russian Federation in studies from 2001-2010. The number of families with low income levels decreases from 2002 to 2010, due to an increase in the proportion of families with average and high income levels.

Family income level in the Russian Federation in 2001-2010, 9%

| Years | Short | Average | High |
|---|---|---|---|
| 2001-2002 | 58 | 35 | 7 |
| 2005-2006 | 48 | 41 | 12 |
| 2009-2010 | 33 | 45 | 21 |

**Figure 2.** HBSC international questionnaire.

Additionally, an observational single-center cross-sectional sample study of the physical development of Moscow schoolgirls, including their morphofunctional and biological development, was conducted. Among the participants were 343 girls aged 12-16 (12 years old – 78 girls; 13 y.o. – 65; 14 y.o. – 71; 15 y.o. – 63; 16 y.o. – 66). The analysis of the level of biological development was carried out in each gender and age group of the study participants, and the level of biological development was also assessed. The assessment of sexual development was carried out in accordance with the Tanner scale [19]. In the formula of biological development, sign “Ax” is indicated - the hair of the armpits, “P” – the hair of the pubic area, “Ma” – the development of the breast, “Me” – the menstruation. The numbers in the formula indicated the stage of development, as well as the sign "+" - the presence of a sign "-" - the absence of a sign. In girls, the degree of pubic hair loss and armpits was assessed, the degree of breast development and the age of menarche were also assessed.

The study was approved by the local ethics committee at the Samara State Medical University (protocol №196 dated November 7, 2018).

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*2.2. Statistics Analysis*

Statistical processing of the obtained data was performed using the statistical analysis package Statistica 10.0 (StatSoft, USA). Descriptive statistics were used: arithmetic mean values (Mean), squared errors of means (Std. err. of mean), and mean square deviations (Std. dev.) were calculated. To determine the normality of the distribution of indicators, a single-sample Kolmogorov-Smirnov normality test was used, and asymmetry, kurtosis, and their standard errors were analyzed. All quantitative indicators in the studied subgroups had a normal distribution. To assess the significance of differences in average values, the student's t-test was used. Differences are considered statistically significant when $t \geq 2.0$ – ($p<0.05$); $t \geq 2.6$ – ($p<0.01$); $t \geq 3.3$ – ($p<0.001$).

To describe the statistical relationship of qualitative indicators with a small number of discrete variants, we used the construction of conjugacy tables, the relationships between the indicators were described by the Pearson conjugacy coefficient, which is in the range from 0 to 1. An increase in the coefficient indicates an increase in the degree of connection.

To determine the probability of a certain outcome depending on a certain factor, the relative risk calculation was used.

**3. Results**

This study shows that at the beginning of the XXI century, a statistically significant increase in body length of Moscow school girls is observed in all age groups by an average of 3-5 cm compared to their peers in the 1960s, and in comparison with their peers in the 1980s, a significant increase in body length by an average of 2-3 cm is observed in the age groups of 9-15 years (Table 1).

At the beginning of the XXI century, Moscow school girls from 10 to 14 years old are significantly ahead by 2-4 kg of their peers in the 1960s and from 10 to 13 years old by 2-3. 5 kg of their peers in the 1980s.

The chest circumference of Moscow Schoolgirls in the 1980s was smaller than in the 1960s, indicating a gracilized physique. At the beginning of the XXI century, Moscow Schoolgirls in all age groups showed a significant increase in the chest circumference by 3-6 cm compared to their peers in the 1980s and by 2-4 cm compared to Schoolgirls in the 1960s.

However, there continues to be a decrease in the muscle strength of the right hand ($p<0.001$). The difference in values between the Moscow Schoolgirls of the early XXI century and contemporaries of the 1980s did not exceed 9 kg, and in comparison to peers of the 1960s, a significant difference was up to 11.4 kg by the age of 17.

In the 1920s, the maximum annual increases in Moscow girls were observed at 14-15 years (Figure 3), while at the beginning of the XXI century, the maximum annual increases shifted to earlier periods. The maximum increase in body length in Moscow Schoolgirls was recorded from 11 to 12 years old, and by 16 years old, growth processes in most girls are completed (the average value of weight gain from 16 to 17 years is less than 1 cm) (Table 2).

One of the main indicators of biological maturation is the formation of menstrual function. Based on archival data and the present study, the trend was shown to significantly reduce the age of menarche from 1920 to 2020 from 15.3 years old to 12.9 years old.

Not only the average values of the age of menarche onset in girls are of interest, but also their distribution by age of menarche onset (Figure 4).

In 1925, menarche in Moscow girls in 0.4% of cases began at 11 years old, in 2015-2020 in 0.7% of cases a year earlier - at 10 years, respectively. In 1925, 33.8% of menarche cases started at the age of 15 and another 33.5% of cases at the age of 16, and there were girls with a later onset of menarche (delayed biological development). In 2015-2020, there was a significant shift in the age of menarche onset to earlier periods: in 34.2% of cases, menarche began at the age of 12 and in another 30.8% at the age of 13.

Over the past century, the standard of living of families in the metropolis has undergone significant changes. Unfortunately, the authors do not have data in the historical aspect, but they have studied the standard of living of families of modern Moscow girls. The standard of living of a family reflects not only the amount of real income per capita, but also the degree to which the family

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is provided with spiritual and material goods. This indicator takes into account both economic and social factors that can influence the formation of menstrual function in girls. According to the analysis of the responses of girls to the international HBSC questionnaire, assessing socio-economic status of families surveyed Moscow girls showed that 22.2 % live in families with low income, 33,3% – in families with average income and 44.5% - in families with high income.

Only 20.9% of families do not have a car, the remaining families have one, two or more cars. Each family has two or more computers. Only 17.5% of girls in the last 12 months did not leave their country for holidays/vacations with their family. 38.1% of girls do not have their own room.

Let's compare the age of menstruation in Moscow girls from families with low income and from families with medium and high income. The average age of the onset of menstruation in girls from low-income families was 153.79±11.29 months, and girls from middle-and high-income families-146.95±9.26 months, which has no significant differences. However, the Student's t-test was 1.91 at p=0.689, which suggests a later onset of menstruation in girls from low-income families. Accordingly, girls from families with a low level of income should menstruate between 11 years 9 months and 13 years 8 months, and girls from families with a medium and high level of income-from 11 years 5 months to 13 years 0 months.

According to the results of the survey, 11.8% of the girls surveyed had a menstrual cycle disorder by the type of irregular menstrual cycle. Menstrual disorders of the proyomenorrhea type (the duration of the menstrual cycle is less than 21 days) were observed in 1.9% of girls.

Violation of the menstrual cycle by the type of opsomenorrhea (the duration of the menstrual cycle is more than 35 days) was observed in 6.7% of girls. The correlation between the presence of menstrual disorders in girls by the type of irregular menstrual cycle and the duration of the menstrual cycle was revealed (Pearson's conjugation coefficient was 0.52 at $p<0.001$). In General, various menstrual disorders were detected in 22.7% of girls. The relative risk values of 1.39 (DI=1.2-1.5) were obtained, indicating that the girl's living in a family with a low level of income increases the frequency of possible menstrual disorders in her.

Based on the conducted research, standards of biological development for schoolgirls in the Moscow region were developed. So, at the age of 12, the normal body length of girls should be in the range from 146.0 to 160.0 cm, biological development - $Ax_{1-2}$, $P_{2-3}$, $Ma_{2-3}$, Me ±. The norms increased under the age and at the age of 13, the normal body length of girls should be in the range from 153.0 to 165.0 cm, biological development – $Ax_{2-3}$, $P_{3-4}$, $Ma_3$, Me+; at age of 14, the normal body length of girls should be in the range from 157.0 to 169.0 cm, biological development - $Ax_3$, $P_4$, $Ma_{3-4}$, Me+; at age of 15, the normal body length of girls should be in the range from 158.0 to 170.0 cm, biological development - $Ax_{3-4}$, $P_{4-5}$, $Ma_4$, Me+; at age of 16, the normal body length of girls should be in the range from 158.0 to 170.0 cm, biological development - $Ax_{3-4}$, $P_{4-5}$, $Ma_{4-5}$, Me+;

**Table 1.** Indicators of physical development of Moscow Schoolgirls aged 8-17 years in different decades (1960-1969, 1982-1991, 2003-2012), M±m, t.

| Age | year of observation | n | body length (cm) | body weight (kg) | chest circumference (cm) | muscle strength of the right hand (kg) |
|---|---|---|---|---|---|---|
| 8 years old | 1960 | 288 | 125,66±0,32 | 25,54±0,28 | 60,50±0,22 | 10,4±0,2 |
| | 1982 | 125 | 127,78±0,51 | 26,23±0,41 | 58,27±0,33 | 13,3±0,2 |
| | 2003 | 143 | 129,12±0,47 | 25,48±0,46 | 62,34±0,44 | 5,5±0,2 |
| | p 1960-2003 | | <0,001 | =0,911 | =0,008 | <0,001 |
| | p 1982-2003 | | =0,054 | =0,225 | =0,003 | <0,001 |
| 9 years old | 1961 | 291 | 130,64±0,34 | 29,17±0,29 | 62,74±0,26 | 13,2±0,2 |
| | 1983 | 125 | 132,83±0,55 | 29,48±0,49 | 61,49±0,34 | 15,8±0,3 |
| | 2004 | 181 | 134,60±0,52 | 29,62±0,52 | 65,10±0,45 | 6,9±0,1 |
| | p 1961-2004 | | <0,001 | =0,451 | =0,004 | <0,001 |
| | p 1983-2004 | | =0,021 | =0,586 | <0,001 | <0,001 |
| | 1962 | 287 | 136,47±0,38 | 32,63±0,36 | 64,26±0,29 | 13,9±0,2 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| 10 years old | 1984 | 125 | 137,63±0,57 | 32,45±0,56 | 63,41±0,38 | 17,3±0,3 |
| | 2005 | 182 | 140,47±0,47 | 34,71±0,62 | 67,51±0,55 | 9,7±0,2 |
| | p 1962-2005 | | <0,001 | =0,004 | =0,003 | <0,001 |
| | p 1984-2005 | | =0,008 | =0,004 | <0,001 | <0,001 |
| 11 years old | 1963 | 248 | 142,88±0,45 | 36,38±0,44 | 67,80±0,33 | 17,0±0,3 |
| | 1985 | 125 | 144,10±0,65 | 36,67±0,65 | 64,65±0,47 | 18,1±0,3 |
| | 2006 | 167 | 146,59±0,56 | 39,87±0,78 | 70,28±0,60 | 13,4±0,2 |
| | p 1963-2006 | | <0,001 | =0,003 | =0,004 | =0,002 |
| | p 1985-2006 | | =0,003 | =0,003 | <0,001 | <0,001 |
| 12 years odl | 1964 | 148 | 147,20±0,60 | 41,30±0,60 | 70,80±0,40 | 21,2±0,3 |
| | 1986 | 125 | 150,20±0,60 | 41,90±0,70 | 68,80±0,50 | 20,4±0,4 |
| | 2007 | 118 | 153,20±0,64 | 44,40±0,97 | 74,60±0,79 | 14,7±0,3 |
| | p 1964-2007 | | <0,001 | =0,003 | <0,001 | <0,001 |
| | p 1986-2007 | | <0,001 | =0,004 | <0,001 | <0,001 |
| 13 years old | 1965 | 148 | 154,80±0,50 | 46,80±0,70 | 75,00±0,40 | 25,9±0,4 |
| | 1987 | 125 | 156,40±0,60 | 47,20±0,80 | 73,70±0,50 | 23,3±0,4 |
| | 2008 | 119 | 159,40±0,60 | 50,70±0,97 | 78,40±0,66 | 16,7±0,4 |
| | p 1965-2008 | | <0,001 | <0,001 | <0,001 | <0,001 |
| | p 1987-2008 | | <0,001 | =0,004 | <0,001 | <0,001 |
| 14 years old | 1966 | 148 | 158,00±0,50 | 50,60±0,60 | 76,70±0,40 | 29,4±0,5 |
| | 1988 | 125 | 160,00±0,50 | 52,20±0,80 | 76,40±0,50 | 24,8±0,4 |
| | 2009 | 86 | 162,60±0,64 | 53,20±1,09 | 80,40±0,67 | 20,9±0,5 |
| | p 1966-2009 | | <0,001 | =0,021 | <0,001 | <0,001 |
| | p 1988-2009 | | <0,001 | =0,069 | <0,001 | <0,001 |
| 15 years old | 1967 | 148 | 159,70±0,50 | 54,10±0,60 | 78,40±0,30 | 31,4±0,4 |
| | 1989 | 125 | 162,00±0,50 | 54,80±0,80 | 79,20±0,50 | 25,9±0,4 |
| | 2010 | 120 | 164,25±0,50 | 56,20±1,02 | 82,10±0,60 | 21,9±0,4 |
| | p 1967-2010 | | <0,001 | =0,065 | <0,001 | <0,001 |
| | p 1989-2010 | | =0,003 | =0,057 | <0,001 | <0,001 |
| 16 years old | 1968 | 148 | 160,20±0,50 | 56,30±0,60 | 79,5±0,40 | 31,4±0,4 |
| | 1990 | 125 | 163,10±0,50 | 56,90±0,70 | 80,0±0,40 | 26,2±0,4 |
| | 2011 | 118 | 164,63±0,53 | 57,41±0,99 | 82,71±0,61 | 21,4±0,4 |
| | p 1968-2011 | | <0,001 | =0,058 | <0,001 | <0,001 |
| | p 1990-2011 | | =0,061 | =0,073 | <0,001 | <0,001 |
| 17 years old | 1969 | 148 | 160,80±0,50 | 58,10±0,60 | 80,80±0,30 | 33,3±0,5 |
| | 1991 | 125 | 163,40±0,50 | 57,60±0,70 | 81,00±0,50 | 26,2±0,3 |
| | 2012 | 95 | 164,52±0,63 | 58,05±1,35 | 83,47±0,80 | 21,9±0,4 |
| | p 1969-2012 | | <0,001 | =0,097 | <0,001 | <0,001 |
| | p 1991-2012 | | =0,057 | =0,083 | =0,004 | <0,001 |

**Table 2.** Annual increase in body length in Moscow Schoolgirls at the beginning of the XXI century, m±m cited.

| Age | annual increase (cm) | |
|---|---|---|
| | n | M±m |
| from 8 to 9 years old | 111 | 5,51±0,12 |
| from 9 to 10 years old | 150 | 5,64±0,12 |
| from 10 to 11 years old | 135 | 5,96±0,16 |
| from 11 to 12 years old | 115 | 6,54±0,18 |
| from 12 to 13 years old | 94 | 4,84±0,23 |
| from 13 to 14 years old | 92 | 3,78±0,21 |

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| | | |
|---|---|---|
| from 14 to 15 years old | 84 | 2,15±0,19 |
| from 15 to 16 years old | 78 | 1,06±0,14 |
| from 16 to 17 years old | 58 | 0,60±0,13 |

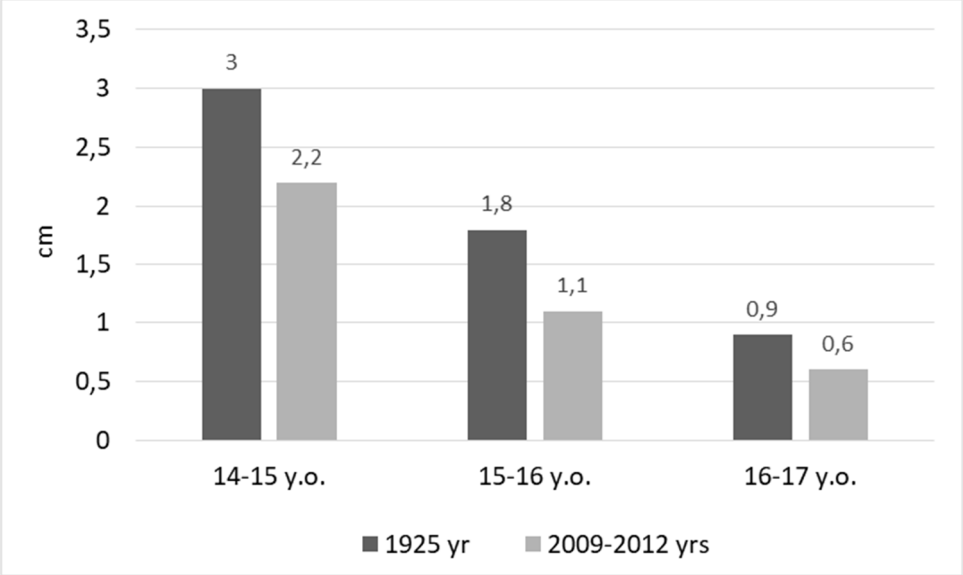


**Figure 3.** Annual increase in body length in Moscow girls in the 1920s and early XXI century, cm.

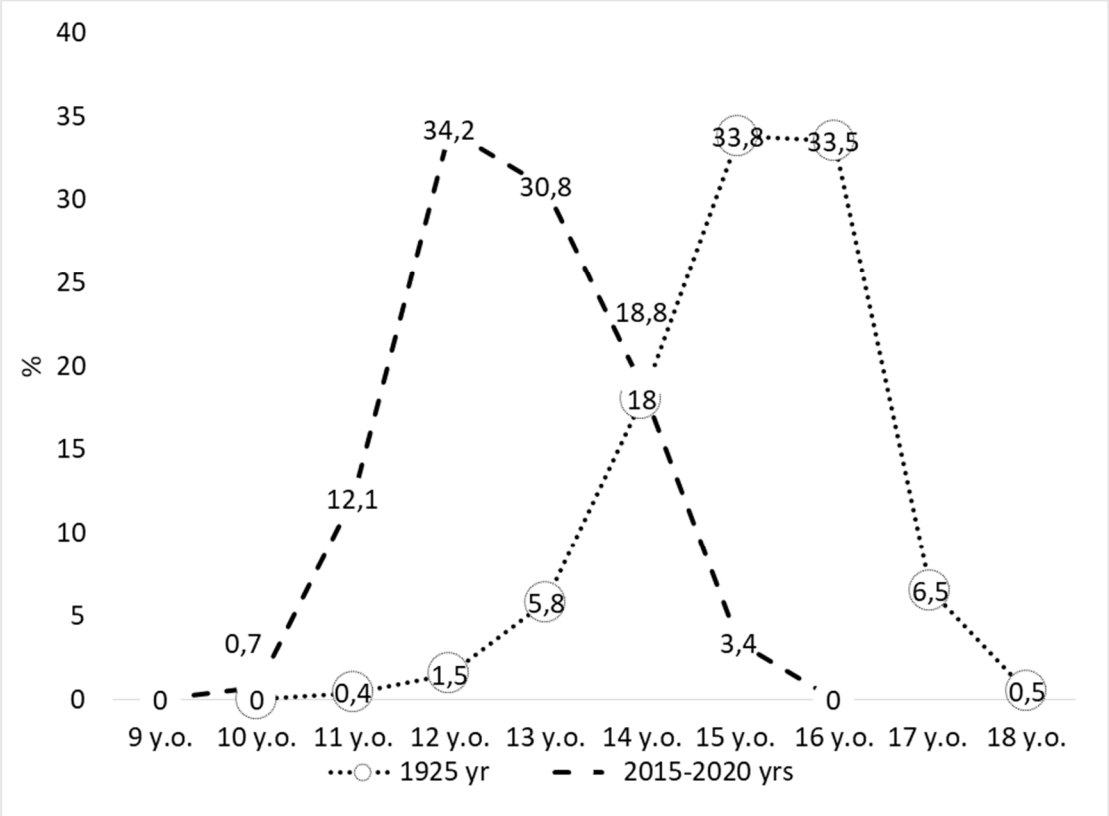


**Figure 4.** Distribution of Moscow girls by age of onset of menarche in the 1920s and early 21st century, %.

## 4. Discussion

The physical development of children and adolescents in Russia has been studied for more than 100 years and the authors have proved, that it depends on many factors [2,8,16]. The physical

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development of children, adolescents and youth in Moscow has been studied since the 1920s of the XX century, the results of the study were regularly published, in particular in the collection of P. I. Kurkin "Moscow working youth. Issue II", published in 1925 [12].

Furthe, data on the physical development of the child population were published in seven collections " Materials on the physical development of children and adolescents in cities and rural areas of the USSR (Russia)", published in 1962, 1965, 1977, 1986, 1998, 2013, 2019 years [13–15,20,21].

The cyclical nature of changes in the physical development of children in the twentieth century was shown: overcoming the post-war lag in physical development in the mid-1950s, acceleration of growth and development from the 1960s to the mid-1970s, deceleration of physical development from the late 1980s with the phenomena of gracilization of the physique until the early 2000s [22,23]. Gracilization was accompanied by a decrease in the muscle strength of the right hand [24,25].

The study showed the centenary dynamics, which is characterized by various trends in differences between anthropometric characteristics and indicators of biological development of school girls. Long-term trends of changes in physical development indicators were also noted by other authors [1,3,13,35–38]. In most European countries, at the end of the XX – beginning of the XXI centuries, was noted the stabilization of physiological and growth processes with a simultaneous increase in body weight. In recent years, several studies showed that weight gain is related to physical fitness. As body weight increased, so did BMI, which influenced this trend in China, Sweden, and New Zealand [39–41]. The process of weight gain was becoming so widespread among European countries that many researchers spoke of an "obesity epidemic". In the processes of puberty, there were trends similar to the Russian ones [4,5,20,34]. The role of endocrine-disrupting chemicals and obesogens, the impact of body mass index and obesity, genetic and biologic pathways, and the influence of lifestyle behaviors were identified [26,27]. Enrichment of cases can give good clues to the etiology of the problem. There have been some epidemics of precocious puberty, e.g., in Puerto Rico and in smaller scale in Italy. These have appeared to be peripheral and the real causes were not reliably identified [27]. In addition to epidemics of peripheral precocious puberty, there are some areas with a high incidence of central precocious puberty. One was reported in Northwest Tuscany, Viareggio, which differed from the neighbouring areas, but the cause remained unknown [28]. Pollution from greenhouses and several small navy yards in the Viareggio area were suspected to contribute to the problem. Even though the distance between Denmark and Finland is not very long, marked differences exist in the incidence of reproductive disorders between those two countries. Thus, coordinated epidemiological cohort studies in Denmark and Finland have suggested that components of the Testicular Dysgenesis Syndrome (TDS) are more frequent in Denmark than in Finland; testicular cancer is much more frequent, and semen quality is poorer in Denmark [29]. Also the incidence of genital malformations like cryptorchidism [30] and hypospadias [31] is much higher in Denmark compared to Finland. Exposure to endocrine disrupting chemicals like phthalates in breast milk was significantly associated with reproductive hormone levels in 3-month-old children [32]. In accordance, Danes are exposed to higher levels of a number of endocrine disrupting chemicals [33], supporting the hypothesis of environmental agents being associated with the regional differences. Data on regional differences in pubertal timing between the two countries are not available, as studies are ongoing.

Thus, comparing the incidence of selected endocrine disorders between the two closely located geographical regions is one way of studying the effect of environment on reproductive disorders. Causality cannot be proven by such epidemiological studies of geographical variations, but may certainly give hints towards possible associations.

However, the present study for the first time shows age-old changes in the dynamics of the physical development of girls, on the example of the city of Moscow, in connection with the main biological feature of girls and the influence of a social factor on it.

Systematic monitoring of the physical development and health status of children is included in the program of social and hygienic monitoring, contributes to the timely development and implementation of priority preventive and health measures [11]. At the same time, the analysis of

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centenary trend shows global changes in the development of girls, which is necessary for making decisions for the long term.

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## 5. Conclusions

Thus, the study showed that modern Moscow school girls have statistically significant differences in body length in all age groups in comparison with their peers in the 1960s. Moscow girls entered adulthood with almost the same body length in both the 1990s and 2010s.

At the same time, the leading indicator of the biological development of girls shows the opposite trend. In the centenary dynamics, the trend line shows a significant downward trend in the age of menarche onset. Analysis of the age of menarche showed that in 30% of cases, modern Moscow girls menstruate 3 years earlier than their peers in the 1920s. It is also shown that the age of menarche depends on the level of wealth of the family in which the girl lives.

Thus, in the dynamics of 100 years of observation in Moscow school girls, there is an increase in total body size, a decrease in functional indicators, and a shift in the terms of biological development to earlier terms.

The issues of the formation of the reproductive health of girls need to be paid attention already at the age of 10, since menarche may occur at this age. Growth processes in modern girls end by the age of 16, as evidenced by weight gain and body length and weight indicators. At the same time, there should be no delay in biological development and the correct menstrual cycle has been formed, which is a condition for reproductive health.

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**Conflicts of Interest:** All over authors declare that they have no conflicts of interest. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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