# DIFFERENCES IN THE PHYSICAL DEVELOPMENT OF PRIMARY SCHOOL CHILDREN BY GENDER

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**ORIGINAL SCIENTIFIC ARTICLE**

**Abstract:** The primary aim of this study is to gain an insight into the "real situation" and to identify gender differences related to physical development among early primary school-aged children in order to reestablish and improve the monitoring system, and make the current school curriculums better. This research included the sample of 447 students (216 boys and 231 girls which was extracted from a population of pupils from five elementary schools, aged 7, 8, 9 and 10 years. Body weight and body height (standing height) was measured according to international standards for anthropometric assessment in a private setting while students were dressed in sports clothing, in the morning hours. Body mass index (BMI) was mathematically estimated according with the equation BMI=weight/height$^2$ (kg/m$^2$). At the level of the sample of respondents from 1$^{st}$ to 4$^{th}$ grade in relation to gender, except for the variables of body height and body weight in the 4$^{th}$ grade, the results of all investigated indicators show that higher values were measured in male respondents. Statistically significant differences were found for the following subspaces in relation to the observed subsample: in relation to gender and in relation to the 1$^{st}$ grade for body weight F=3.979, p=0.048 and for body mass index (BMI) F=6.315, p=0.013, while in relation to 2$^{nd}$ grade, the difference was found in body height F=4.324, p=0.040. There were no statistically significant differences in the observed characteristics of physical development among students of the 3$^{rd}$ and 4$^{th}$ grade. The obtained results on qualitative and quantitative gender differences in physical development in early school age, in addition to theoretical ones, can also have practical significance. Given that this is the age at which the formation of healthy lifestyle habits in children can be significantly influenced, the data of this research can significantly contribute to the adequate organization and implementation of both continuing physical education and extracurricular physical activities of children of the observed age.

**Keywords:** 7–10-year-old children, body height, body weight, body mass index, male, female

## INTRODUCTION

In recent years, hypokinesia is increasingly present in people worldwide, as a result of a highly urban lifestyle, reduced need for movement and the presence of the poor health and hygiene conditions (primarily unhealthy nutrition). Unfortunately, these negative tendencies have been noticed among younger population, and even in the population of school youth, as well as in Europe, America, and also in the Republic of Serbia (Gajević, 2009; Gajević, 2010; Dopsaj et al., 2010; Ivanović & Gajević, 2016; Ivanović, Gajević, & Parčina, 2020; Gajević, Ivanović, & Cicović, 2021). Based on results of previous research, it is not difficult to conclude that there have been significant constitutional changes in primary school children in the last decade. These results are not surprising because the data obtained by the study of Gajević (2009) unequivocally showed that primary school children are higher than in 1995 (for ages 7 to 14 body height in boys increased by an average of 3%, and in girls 2.5%). At the same time, for the same period, the body weight of primary school children increased by an average of 14% among boys, and 11% among girls. Body mass index (BMI) values increased on average by 7.3% in boys and 5.6% in girls. In addition, the results of the same research showed that compared to the results of primary school children from other European countries, primary school students in the Republic of Serbia recorded above average level of the results related to all three variables that mark physical development, in both genders. Similar results were published by Strel, Bizjak, Starc, & Kovač, (2009). Namely, the results of extensive research in Slovenia "Longitudinal comparison of the development of some physical characteristics and motor abilities of two generations of children and youth from 7 to 18 years of age in Slovenian primary and secondary schools in the periods 1990-2001. and 1997-2008." (Strel et al., 2009), showed that the body weight of students increased to 4% and the amount of subcutaneous adipose tissue to 13%. On the other side, in the United States, for example, 17% of youth aged 2 to19 years are obese, although the prevalence remained stable between 2003-2004 and 2009-2010 (Ogden, Flegal, Carroll, & Johnson, 2002; Ogden, Carroll, Kit, & Flegal, 2014). Rates are generally higher in girls than in boys (Cattaneo et al., 2010). Professional, scientific and public authorities' attention was increased in last years, so more and more experts were occupied around solving these problems - obesity, poor body posture and lack of physical activity. For the reason of all these facts is necessary to establish intensive physical fitness and body composition monitoring system (de Onis, Onyango, Borghi, Siyam, & Pinol 2006; Tambalis et al., 2015; Ivanović & Gajević, 2016; Bićanin, Milenković, Radovanović, Gajević, & Ivanović, 2018). Essential tool for child growth monitoring contains data of body height and weight. They are power „informational and monitoring tool", not only for children growth, but also for long-term health indication, especially in childhood and adolescent period (Cattaneo et al., 2010; Wijnhoven et al., 2013; Tambalis et al., 2015; Freedman & Berenson, 2017).

Precisely because of all that, systematic monitoring and evaluation of physical development with primary school children would provide timely evidence of many health problems – before any serious outcome. The elementary aim of this work is to

gain an insight into the “real situation” and to identify gender differences related to physical development among early primary school-aged children, in order to reestablish and improve the monitoring system, and make the current school curriculums better.

## MATERIALS AND METHODS

### Participants

This research included the sample which was extracted from a population of pupils from five elementary schools. The total sample of examinees was 447 students (216 boys and 231 girls). Thus defined, the sample was distributed among four subsamples, both in boys and girls. The criteria for the distribution of subsamples were years of age, with rounding to ±6 months, which provided the following subsamples in both genders: 7, 8, 9 and 10 years. Each subject parental was informed of the potential risks and discomfort associated with the investigation, and measurements were carried out with their parental willing consent in accordance with the requirements of the Declaration in Helsinki.

### Procedures

Body weight (BW, in kg) was measured to the nearest 0.1 kilogram with a calibrated scale over time (Seca, Germany), according to international standards for anthropometric assessment in a private setting while students were dressed in light clothing, in the morning hours. Body mass index (BMI) was mathematically estimated according with the equation $BMI=weight/height^2$ ($kg/m^2$). Standing height (BH, in cm) was measured in the standing position, with a portable stadiometer (Seca®, Hamburg, Germany).

### Statistical Analysis

Basic measures of central tendency and dispersion of results are shown using: Arithmetic Mean (Mean), Standard Deviation (SD), Coefficient of Variation (cV%), and limit value of the Total Range, i.e. range (Min and Max). From the statistical methods, in addition to the descriptive statistical model, the multivariate statistical method General Linear Model - multivariate procedure and post-hoc test (Bonferroni's test) was used to define the differences of the observed characteristics as a function of gender. All statistic methods were processed in the software SPSS package for Windows, Release 20.0 (Copyright © SPSS Inc., 1989-2011).

## RESULTS

The results of the measured values of the monitored characteristics of physical development of male subjects are shown in Table 1 and in Table 2 for girls. Based on the obtained descriptive statistical parameters of the tested sample, both male and female, we can claim that the results belong to a homogeneous group.

***Table 1.*** Basic descriptive indicators of the measured values of body height, body mass and body mass index in schoolboys

| | | Mean | SD | cV% | Min | Max |
|---|---|---|---|---|---|---|
| **BH (cm)** | 7 years | 130.39 | 6.02 | 4.62 | 117 | 145.3 |
| | 8 years | 137.5 | 6.02 | 4.37 | 121.5 | 150.5 |
| | 9 years | 141.95 | 6.45 | 4.54 | 129.2 | 157.5 |
| | 10 years | 146.5 | 5.63 | 3.85 | 135.5 | 159.6 |
| **BW (kg)** | 7 years | 30.37 | 7 | 23.04 | 21.1 | 51.7 |
| | 8 years | 33.83 | 8.06 | 23.82 | 20.2 | 59 |
| | 9 years | 36.36 | 8.13 | 22.34 | 26 | 63.3 |
| | 10 years | 41.25 | 10.74 | 26.05 | 28.8 | 82 |
| **BMI ($kg/m^2$)** | 7 years | 17.72 | 2.97 | 16.79 | 13.6 | 26.4 |
| | 8 years | 17.75 | 3.35 | 18.87 | 11.9 | 26.4 |
| | 9 years | 17.92 | 3.03 | 16.9 | 14.1 | 28 |
| | 10 years | 19.11 | 4.25 | 22.22 | 15 | 32.3 |

***Table 2.*** Basic descriptive indicators of the measured values of body height, body mass and body mass index in schoolgirls

| | | Mean | SD | cV% | Min | Max |
|---|---|---|---|---|---|---|
| **BH (cm)** | 7 years | 129.97 | 5.93 | 4.56 | 115.4 | 145.1 |
| | 8 years | 135.2 | 5.51 | 4.08 | 118.7 | 147.1 |
| | 9 years | 141.28 | 6.96 | 4.93 | 128 | 161 |
| | 10 years | 147.92 | 6.99 | 4.73 | 133.5 | 164.8 |
| **BW (kg)** | 7 years | 28.11 | 5.52 | 19.64 | 19.5 | 44.2 |
| | 8 years | 31.91 | 5.79 | 18.15 | 20.1 | 44.2 |
| | 9 years | 35.16 | 8.39 | 23.87 | 21.7 | 58.4 |
| | 10 years | 42.01 | 11 | 26.19 | 25.2 | 76 |
| **BMI ($kg/m^2$)** | 7 years | 16.54 | 2.38 | 14.36 | 12.2 | 23.7 |
| | 8 years | 17.37 | 2.52 | 14.49 | 13.2 | 22.7 |
| | 9 years | 17.47 | 3.27 | 18.7 | 12.3 | 28.2 |
| | 10 years | 19.01 | 3.89 | 20.48 | 11.8 | 30.8 |

Multivariate statistical analysis determined that at the level of the sample of subjects from $1^{st}$ to $4^{th}$ grade between the observed subsamples in relation to gender, there is no general statistically significant difference of all the examined characteristics.

However, the existence of statistically significant differences was determined for the following subspaces for the observed subsample in relation to gender: in relation to the $1^{st}$ grade for body weight $F=3.979$, $p=0.048$ and for body mass index (BMI)

F=6.315, p =0.013, while in relation to 2nd grade, the difference was found in body height F=4.324, p=0.040. There were no statistically significant differences in the observed characteristics of physical development among students of the 3rd and 4th grade.

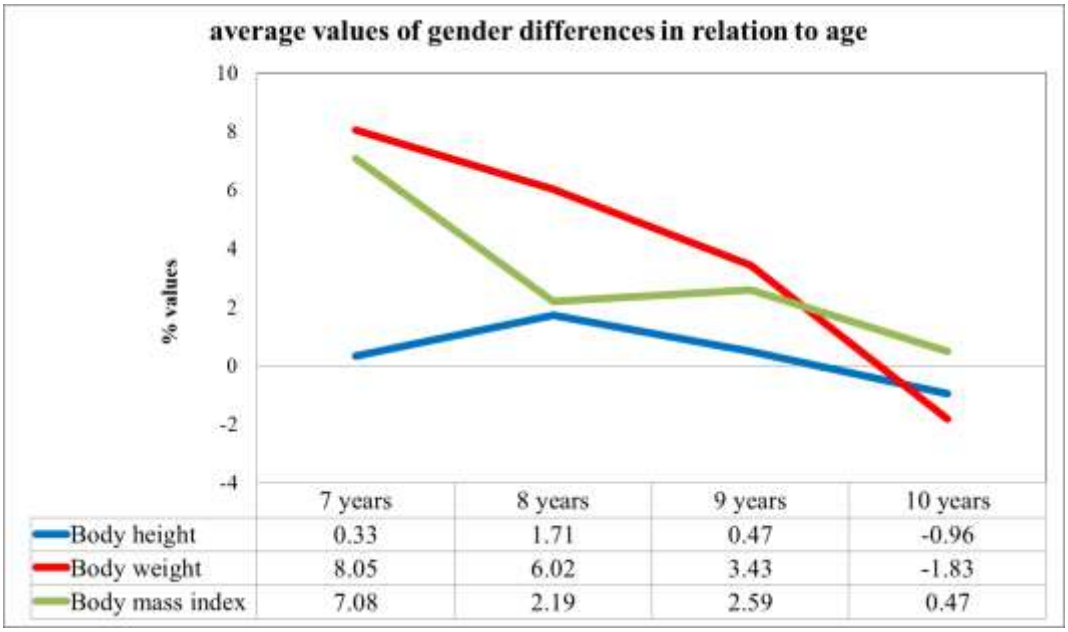
***Table3.*** Partial differences of the observed characteristics in relation to the gender

| characteristics | male | female | absolute differences | relative differences % | F values | p values |
|---|---|---|---|---|---|---|
| | | | 7 years | | | |
| **BH(cm)** | 130.39 | 129.97 | 0.42 | 0.33 | 0.064 | 0.801 |
| **BW(kg)** | 30.37 | 28.11 | 2.26 | 8.05 | 3.979 | 0.048 |
| **BMI (kg/m²)** | 17.72 | 16.54 | 1.17 | 7.08 | 6.315 | 0.013 |
| | | | 8 years | | | |
| **BH(cm)** | 137.50 | 135.20 | 2.31 | 1.71 | 4.324 | 0.040 |
| **BW(kg)** | 33.83 | 31.91 | 1.92 | 6.02 | 2.059 | 0.154 |
| **BMI (kg/m²)** | 17.75 | 17.37 | 0.38 | 2.19 | 0.454 | 0.502 |
| | | | 9 years | | | |
| **BH(cm)** | 141.95 | 141.28 | 0.67 | 0.47 | 0.370 | 0.544 |
| **BW(kg)** | 36.36 | 35.16 | 1.21 | 3.43 | 0.789 | 0.376 |
| **BMI (kg/m²)** | 17.92 | 17.47 | 0.45 | 2.59 | 0.747 | 0.389 |
| | | | 10 years | | | |
| **BH(cm)** | 146.50 | 147.92 | -1.43 | -0.96 | 1.290 | 0.259 |
| **BW(kg)** | 41.25 | 42.01 | -0.77 | -1.83 | 0.129 | 0.720 |
| **BMI (kg/m²)** | 19.11 | 19.02 | 0.09 | 0.47 | 0.015 | 0.902 |

At the level of the sample of respondents from the 1st to 4th grade in relation to gender, except for the variables of height and body height in the 4th grade, the results of all examined indicators shows that higher values were measured in male respondents (Table 3).

## DISCUSSION

Based on the conclusions from current research and also at the level of research by other authors (Kovacs et al., 2018; Milašinović, Bojanić, Čvorović, & Kukić, 2019; Gajević, 2009; Gajević et al., 2010; Gajević et al., 2021), the results speak in contribution to the fact that boys achieved better results in almost all monitored age categories (Table 3, Graph 1). The average values of gender differences in relation to body height are the highest in 2nd grade, and in relation to body weight and body mass index in the 1st grade (Graph 1). In girls, higher values of body height and body weight were measured in the 4th grade (Graph 1, Table 3).




**Graph 1.** Average gender differences in the physical development observed indicators

Despite the regularity of the linear increase of all three monitored characteristics of physical development in both gender with age (Table 3), it is noticeable that they are not absolute and they are significantly different in individuals, which indicates the difference between the biological and calendar age of the examined sample. These differences are much more noticeable in relation to the monitored percentage values of gender differences in relation to age (Graph 1). If we add to this the results of a comparative analysis (Table 4) in relation to different periods of measurement of the same characteristics on the population of younger elementary school children (Gajević, 2009), we can confidently claim that the average differences in function of gender are constantly changing.

***Table 4.*** Comparative analysis of the average differences in the observed indicators of physical development of the current research and research from 1995 and 2009 in the function of gender (Gajević, 2009)

| | 7 years | 8 years | 9 years | 10 years |
|---|---|---|---|---|
| **BH_1995** | 0.62 | 1.78 | 0.66 | 0.42 |
| **BH_2009** | 0.97 | 1.40 | 0.95 | 0.05 |
| **BH_2014** | 0.33 | 1.71 | 0.47 | -0.96 |
| **BW_1995** | -2.45 | 6.96 | 3.51 | 2.87 |
| **BW_2009** | 2.49 | 6.87 | 11.19 | 2.66 |
| **BW_2014** | 8.05 | 6.02 | 3.43 | -1.83 |
| **BMI_1995** | 2.91 | 3.24 | 2.41 | 2.36 |
| **BMI_2009** | 0.41 | 3.80 | 9.31 | 2.16 |
| **BMI_2014** | 7.08 | 2.19 | 2.59 | 0.47 |
| **AVG_1995** | 0.36 | 3.99 | 2.20 | 1.88 |

| | | | | |
|---|---|---|---|---|
| **AVG_2009** | 1.29 | 4.02 | 7.15 | 1.63 |
| **AVG_2014** | 5.15 | 3.31 | 2.16 | -0.77 |

Compared to 2009, the largest average gender differences were found in the 2nd grade, among eight-year-olds schoolchildren. The largest average differences during the measurement in 2009 were measured in 3rd grade and in the 1st grade in 2014 (Table 4). The reasons for the obtained results should certainly be sought in the fact that, on the one hand, the variability of body weight is far greater than the variability of body height (body weight is less genetically determined than body height), such results represent a realistic picture of the cross-section at each age. In addition, on the other hand, it must not be forgotten that the greatest increments of the monitored characteristics do not occur in the same periods of growth and development in relation to gender. In an indirect way, the research results confirm the fact that girls biologically mature earlier than boys. The results of this study confirm the results obtained by the previous research (Gajević et al., 2021) on a sample of 839 students (424 boys and 415 girls) from five elementary schools, especially from the aspect of the established differences of children in the 4th grade (Table 3, Graph 1).

It was founded that the analyzed sample is characterized by the developmental stages with the highest growth peak among girls at the age of 10 (4.49% change in TV, 16.32% change in TM and 8.06% change in BMI) (Gajević et al., 2021). Unlike girls, the results showed that the largest peak was the increasing in body height of boys at the age of 14 (4.78%), body weight in the 13th year (12.57%) and BMI in the 10th year (6.19%) (Gajević et al., 2021). Also, the results of previous study (Gajević et al., 2021) showed that the trend of change has a statistically significant increase in most of the monitored characteristics.

## CONCLUSION

This study provides current information on gender differences related to physical development among early primary school-aged children. The obtained results, in addition to theoretical ones, can also have practical significance. Given that this is the age at which the formation of healthy lifestyle habits in children can be significantly influenced, the data of this research can significantly contribute to the adequate organization and implementation of both continuing physical education and extracurricular physical activities of children of the observed age. Besides that, results evaluation which was analyzed in this study, give us possibility to obtain very informative data which can be used for the purpose of managing and monitoring school children anthropological status, but also for the Serbian National Measurement System improvement. All the results from this study can be assessed as a normative data on the national level, as well as model for the comparation in the field of morpho-functional characteristics with children from the other European countries.

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