

## **DEVELOPMENT CHANGES AND COMPARATIVE RELATIONSHIPS OF FLEXIBILITY AT PUPILS FROM TWO SEXES AGES 6 TO 14**

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(Original scientific paper)

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### **Abstract**

*The performance level of young people is often used to define the well-being. Indeed, several studies and correlations with health conditions (e.g. obesity and growth) are combined. In North Macedonia there is a lack of investigation in order to define the physical level of children and adolescents. Over than 4013 subjects (6–14) grouped according to ages were tested during the Physical Education (PE) lessons by experts from the area of kinesiology and medicine, previously trained to perform tests and to take anthropometric measures. All instructions about testing phases were selected within Eurofit battery test. In particular Sit and Reach (SAR) were assessed to evaluate flexibility of the lower back. The results are processed by appropriate statistical parameters. On the basis of the results obtained, it can be concluded that flexibility shows oscillatory changes with an increase in age in both sexes. Among boys and girls in all adult categories, there are statistically significant differences in the "forward bend" motor test. Boys in all age categories show worse results in the motor test "forward bend", and these differences are most evident in the 13th and 14th years.*

**Key words:** Eurofit battery test, Flexibility

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### **Introduction**

The physical fitness is a powerful marker of the health condition during the childhood and adolescence (Myers J, et.al. 2002; Andersen LB, et.al 2006). Even among the children and adolescents the fitness is inversely associated with cardiovascular risk factors for chronic disease, such as high blood pressure (Sallis JF, et. al. 1998; Ruiz JR, et. al. 2006), total fatness (Ruiz JR, et. al. 2006), hyperinsulinemia (Gutin B, et. al. 2004), abdominal adiposity (Brunet M, et.al. 2006), atherogenic lipid profile (Mesa, J.L, et. al. 2006), insulin resistance (Gulati M, et. al. 2003), and clustering of metabolic risk factors (Brage S., et. al. 2004; Ruiz J.R, et. 2007).

Several studies have correlated the performance level with different lifespan condition leading researchers to assess a shared protocol for testing physical performance. Indeed, since 1988 within the Council of Europe (CE) the Eurofit battery test (EBT) was accepted by numerous European countries as a uniform procedure for the assessment of health-related, functional and motor status of people.

Differences within gender and manhood (Saygin 2007, Freitas 2002), intellectual disability (Van de Vliet 2006), living areas influence (urban or rural; Ozdirenc 2005, Tsimeas 2005) or sport practice (Serbescu 2006, Verstraete 2007) have been investigated in different countries (not only in Europe, Huang & Malina 2002). In North Macedonia this kind of investigation is lacking (at least for wide subjects samples): status favors the spread of a general thought on a decrease in physical performance.

Flexibility is a complex factor that determines the degree of joint mobility, and at the same time amplitude of the movement. As synonyms of flexibility in the literature, the following terms are used: mobility, gypsum, articular amplitude, volume of movement, joint-muscular mobility, elasticity, flexibility, extensibility, but flexibility as a term in our country is widely accepted.

In biological term, the boundary flexibility factor is the size and shape of the adherent surfaces, the length and elasticity of the muscles, the joints, the fascia and the tendons, the muscle tone, the mass of interlaced muscles, the skin, and so on. Accordingly, the expression of flexibility affects the sex, age, previous physical activity, outside temperature, period of the day, the character of warming and emotions.

Numerous researches on the relation between gender and flexibility as well as experience suggests that women have a much greater degree of flexibility than men, and the same effect in increasing flexibility is achieved by women for 10-15% with a less working effort. When it's about the age, it should be emphasized that with age, muscle or tendon tissue tend to reduce elasticity.

The main objective of the research is to determine the condition, developing changes and comparative flexibility relationships among students of both sexes aged 6 to 14 years.

### Methods of Work

The research was realized on a sample of 4013 subjects, the population of students from the primary and secondary schools of the R. N. Macedonia. The sample is divided into two subsamples by gender, out of which 2025 male and 1988 female respondents. Each of the subsamples is also divided according to the chronological age in xxx age groups in the span of one calendar year. The sample is proportionally defined on state allocation of students in urban and rural environments.

The chronological age has been defined on the basis of decimal years (difference between the measurement date and date of birth, which are transformed into an appropriate sized division of the year into ten instead of twelve months). Accordingly, there are 9 male age groups and 9 female age groups established in span of one calendar year, as follows: 6 (6 - 6.9), 7 (7 - 7.9), 8 (8 - 8.9) 9 (9 - 9.9), 10 (10 - 10.9), 11 (11 - 11.9), 12 (12 - 12.9), 13 (13 - 13.9) and 14 (14 - 14.9) years.

The study included students for whom their parents had given consent to take part in the research, who were psychically and physically healthy and who regularly attended the classes of physical and health education. The respondents were treated in accordance with the Helsinki Declaration. Measurements were realized in March, April and May 2012, in standard school conditions at regular classes of physical and health education. The measurement was realized by experts from the area of kinesiology and medicine, previously trained to perform tests and to take anthropometric measures.

### Evaluation of Physical Fitness

Prior to starting the study, the researchers involved in the project undertook training sessions in order to guarantee the standardization, validation, and reliability of the measurements (Moreno LA, et. al. 2003).

Sit and Reach test. With the subject seated on the floor and using a standardized support, the maximum distance reached with the tip of the fingers by forward flexion of the trunk is measured. Test indicative of amplitude of movement or flexibility.

### Statistical Analysis

In all age categories of estimation of flexibility are calculated: basic statistical parameters: arithmetic mean (X), standard deviation (SD), coefficient of variability (KV%), minimum score (MIN), maximum score (MAX); Kolmogorov-Smirnov's method for testing the normal distribution result (KS); and they are graphically represented.

Differences between age categories and sex in the flexibility assessment test were determined by multivariate and univariate variance analysis (MANOVA and ANOVA).

In order to determine which subparts are statistically different, the LSD test is applied to the variable where there is a statistically significant difference. The data are processed with the statistical packages SPSS for Windows Version 15.0

### Results

Tables 1 and 2 show the basic descriptive statistical parameters (Mean - arithmetic mean, SD - standard deviation, Min - minimum score, Max - maximum score, Std. Err - standard error of the artistic environment, KV% - coefficient of variability, F - univariate F test, Q - statistical significance of the univariate F test) for all age groups.

Charts 1 and 2 show the results that characterize motor capability flexibility in the hip joint and the lower part of the spinal column, which is represented by the "forward bend" motor test. From the curve trend (Chart 1), it can be seen that flexibility shows oscillatory changes with age increasing in both sexes. At girls age 6 to 9, there is a slight decrease in the flexibility in the hip joint and the lower part of the spine, ranging from 0.21 to 0.55 cm, followed by mild acceleration (mild improvement) of the results in the test up to 11 years, in 12 years to decelerate (decrease) of the test result, then to resume acceleration up to 14 years.

Table 1. Basic statistical parameters and statistically significant differences between the age categories of the motor test forward bend in sitting at boys age 6 to 14

| Age | Min  | Max   | Mean  | Std. Err | SD   | KV%   | F    | Q          |
|-----|------|-------|-------|----------|------|-------|------|------------|
| 6   | 0,00 | 23,50 | 14,09 | 0,50     | 4,99 | 35,41 | 4,45 | <b>,00</b> |
| 7   | 0,00 | 27,50 | 14,52 | 0,32     | 4,77 | 32,85 |      |            |
| 8   | 0,00 | 27,00 | 13,69 | 0,32     | 5,07 | 37,07 |      |            |
| 9   | 0,00 | 26,00 | 12,95 | 0,34     | 5,27 | 40,69 |      |            |
| 10  | 0,00 | 37,50 | 12,52 | 0,36     | 5,75 | 45,94 |      |            |
| 11  | 0,00 | 27,50 | 12,45 | 0,36     | 5,59 | 44,92 |      |            |
| 12  | 0,00 | 30,50 | 12,38 | 0,43     | 6,34 | 51,19 |      |            |
| 13  | 0,00 | 32,50 | 12,25 | 0,44     | 6,53 | 53,28 |      |            |
| 14  | 0,00 | 31,50 | 13,40 | 0,48     | 6,84 | 51,00 |      |            |

Table 2. Statistically significant differences between age categories (Post-hoc LSD test)

| Age | 6          | 7          | 8          | 9   | 10  | 11  | 12  | 13         | 14  |
|-----|------------|------------|------------|-----|-----|-----|-----|------------|-----|
| 6   |            | ,53        | ,56        | ,10 | ,02 | ,02 | ,01 | ,01        | ,33 |
| 7   | ,53        |            | ,12        | ,00 | ,00 | ,00 | ,00 | ,00        | ,05 |
| 8   | ,56        | ,12        |            | ,15 | ,02 | ,02 | ,01 | ,01        | ,60 |
| 9   | ,10        | <b>,00</b> | ,15        |     | ,40 | ,35 | ,29 | ,19        | ,40 |
| 10  | <b>,02</b> | ,00        | <b>,02</b> | ,40 |     | ,90 | ,80 | ,61        | ,10 |
| 11  | ,02        | ,00        | ,02        | ,35 | ,90 |     | ,89 | ,70        | ,08 |
| 12  | ,01        | ,00        | ,01        | ,29 | ,80 | ,89 |     | ,81        | ,07 |
| 13  | ,01        | ,00        | ,01        | ,19 | ,61 | ,70 | ,81 |            | ,04 |
| 14  | ,33        | ,05        | ,60        | ,40 | ,10 | ,08 | ,07 | <b>,04</b> |     |

Table 3. Basic statistical parameters and statistically significant differences between the age categories of the motor test forward bend in sitting at girls age 6 to 14

| Age | Min  | Max   | Mean  | Std. Err | SD   | KV%   | F    | Q          |
|-----|------|-------|-------|----------|------|-------|------|------------|
| 6   | 5,50 | 26,00 | 15,99 | 0,36     | 3,75 | 23,48 | 3,74 | <b>,00</b> |
| 7   | 0,00 | 25,75 | 15,78 | 0,29     | 4,51 | 28,56 |      |            |
| 8   | 0,00 | 27,00 | 15,36 | 0,31     | 4,82 | 31,39 |      |            |
| 9   | 0,00 | 30,05 | 14,81 | 0,34     | 5,07 | 34,26 |      |            |
| 10  | 0,00 | 32,50 | 15,05 | 0,34     | 5,26 | 34,92 |      |            |
| 11  | 0,00 | 28,20 | 15,41 | 0,35     | 5,50 | 35,71 |      |            |
| 12  | 3,00 | 34,00 | 14,87 | 0,41     | 5,78 | 38,88 |      |            |
| 13  | 2,00 | 32,50 | 16,01 | 0,40     | 6,09 | 38,03 |      |            |
| 14  | 0,00 | 33,50 | 17,24 | 0,49     | 6,73 | 39,03 |      |            |

At boys between the ages of 6 and 7, an improvement in the flexibility assessment test is observed, resulting in a stagnation or a threshold reduction of the capability to 13 years, from 13 to 14, a slight improvement in the test results in the forward bend test in sitting, when male examinees improve the test score by about 1.15 cm.

The biggest variability among boys is the motor test of forward bend test shown among 13 year olds, while among girls is among 12 year olds.

From the values of the LSD test (Tables 2 and 4) for determination of the differences between the arithmetic environments of the coexisting age groups, it can be seen that there are statistically significant

differences in the motor test of a forward bend test in sitting, the values were obtained between groups of 13 and 14 and 12 and 13 year aged boys, and 13 and 14 year age girls.

Table 4. Statistically significant differences between age categories (Post-hoc LSD test)

| Age | 6          | 7          | 8          | 9          | 10         | 11         | 12         | 13         | 14  |
|-----|------------|------------|------------|------------|------------|------------|------------|------------|-----|
| 6   |            | ,74        | ,31        | ,06        | ,13        | ,35        | ,08        | ,97        | ,05 |
| 7   | ,74        |            | ,39        | ,05        | ,13        | ,44        | ,07        | ,64        | ,01 |
| 8   | ,31        | ,39        |            | ,26        | ,53        | ,92        | ,34        | ,19        | ,00 |
| 9   | ,06        | <b>,05</b> | ,26        |            | ,63        | ,22        | ,90        | ,02        | ,00 |
| 10  | ,13        | ,13        | ,53        | ,63        |            | ,47        | ,73        | ,05        | ,00 |
| 11  | ,35        | ,44        | ,92        | ,22        | ,47        |            | ,29        | ,22        | ,00 |
| 12  | ,08        | ,07        | ,34        | ,90        | ,73        | ,29        |            | ,03        | ,00 |
| 13  | ,97        | ,64        | ,19        | ,02        | <b>,05</b> | ,22        | <b>,03</b> |            | ,02 |
| 14  | <b>,05</b> | ,01        | <b>,00</b> | <b>,00</b> | <b>,00</b> | <b>,00</b> | <b>,00</b> | <b>,02</b> |     |

Chart 1. Development trend of a forward bend test at students from 6 to 14

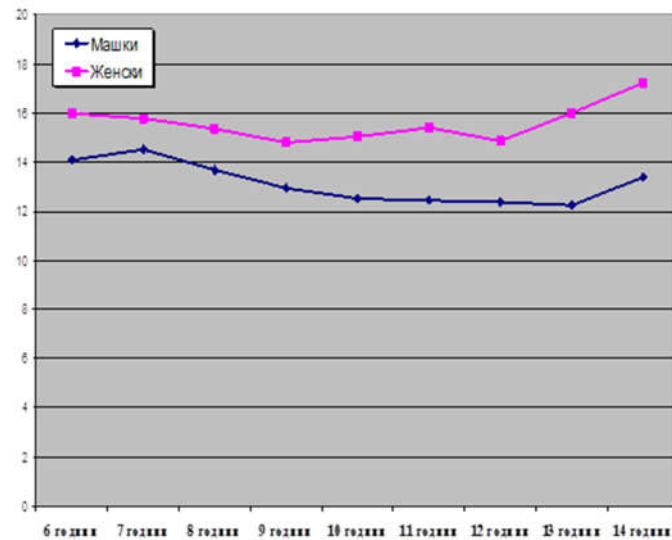
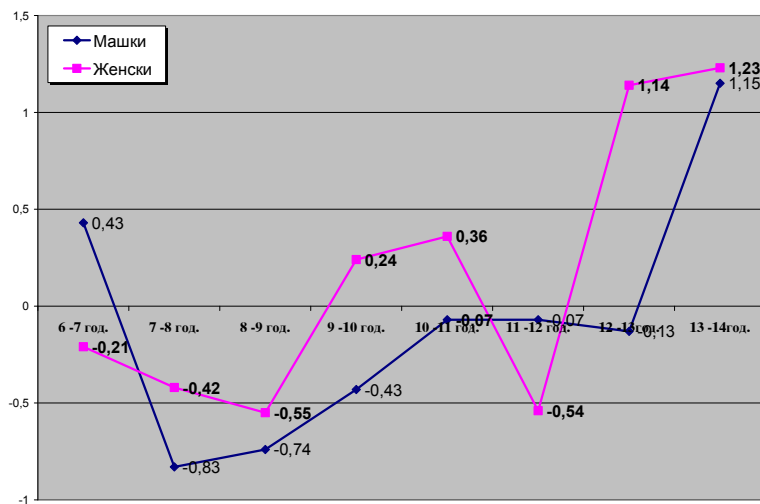


Chart 2. Changes in the test forward bend in pupils at an annual level



The significance of the differences in the motor test of forward bend between boys and girls in each age category was checked by analysis of the variance. The results of the analysis are shown in Table 5, and all significant elements are distinguished with tinted characters (bolded).

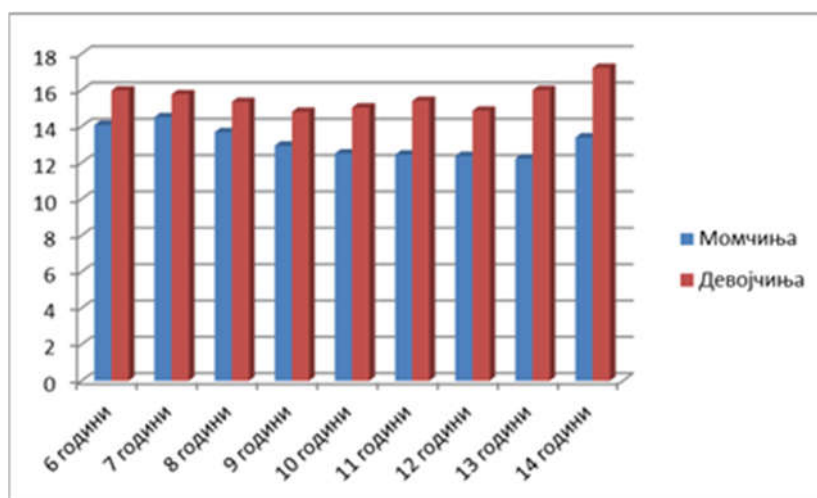
From the overview of Table 5 and the graphs showing the values of arithmetic environments and the level of statistical significance, it can be seen that there are statistically significant differences between female and male participants of all tested groups.

From the overview of the obtained results, we can conclude that boys, unlike girls in all adult categories, show worse results in the motor test for assessing the forward bend flexibility, and these differences are increased with increasing age. The differences are more evident on the age of 13 and 14. The smallest differences are noted on the age of 7 and 8.

Table 5. Differences in sex within each age category in the test forward bend in sitting position

| Age | Male  | Female | F     | p           |
|-----|-------|--------|-------|-------------|
| 6   | 14,09 | 15,99  | 6,74  | <b>0,01</b> |
| 7   | 14,52 | 15,78  | 8,20  | <b>0,00</b> |
| 8   | 13,69 | 15,36  | 15,19 | <b>0,00</b> |
| 9   | 12,95 | 14,81  | 16,68 | <b>0,00</b> |
| 10  | 12,52 | 15,05  | 25,36 | <b>0,00</b> |
| 11  | 12,45 | 15,41  | 41,86 | <b>0,00</b> |
| 12  | 12,38 | 14,87  | 16,11 | <b>0,00</b> |
| 13  | 12,25 | 16,01  | 34,16 | <b>0,00</b> |
| 14  | 13,40 | 17,24  | 33,67 | <b>0,00</b> |

Chart 3. Differences in gender in each age category in the motor test forward bend in sitting



## Conclusions

Based on the performed research with the basic goal of defining the situation and the developmental changes in the flexibility of students of both sexes, aged 6 to 14 years, and in accordance with the set individual goals that check the defined hypotheses, the following conclusions are obtained:

Flexibility shows oscillatory changes with increasing age in both sexes. At girls from 6 to 9 years, there is a slight decrease in the flexibility in the hip joint and the lower part of the spine, ranging from 0.21 to 0.55 cm, followed by mild acceleration (mild improvement) of the results in the test up to 11 years, in 12 years to decelerate (decrease) of the test result, then to resume acceleration up to 14 years. At boys between the ages of 6 and 7, an improvement in the flexibility assessment test is observed, resulting in a stagnation or mild reduction of the capability to 13 years, from 13 to 14, a slight improvement in the test results in the forward bend test in sitting position, when male examinees improve the test score by about 1.15 cm. Among

boys and girls in all adult categories, there are statistically significant differences in the "forward bend" motor test.

Boys in all age categories show worse results in the motor test forward bend, and these differences are more evident in the 13<sup>th</sup> and 14<sup>th</sup> years of age.

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