*Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)*
*An Open Access, Online International Journal Available at www.cibtech.org/sp.ed/jls/2015/03/jls.htm*
*2015 Vol. 5 (S3), pp. 769-772/Babaali et al.*
***Research Article***

# COMPARE THE MAIN BIOMECHANICAL AND PHYSIOLOGICAL CHARACTERISTICS OF 10-12-YEAR-OLD GIRLS

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## ABSTRACT
Engaging in sports from childhood can be critical to physical and mental health of children. The purpose of this research was to compare the main biomechanical and physiological characteristics of 10-12-year-old girls. 148 female students were selected using cluster sampling. Normal distribution of the data was examined using the Kolmogorov-Smirnov test. Mean, standard deviation, and percentile rank were used to describe the data. The results showed significant differences in the biomechanical characteristics of the subjects at the 0.05 significance level except in Sargent jump test, but no significant differences were observed in their physiological characteristics. Implications for research are provided.

***Keywords:*** *Biomechanical, Physiological*

## INTRODUCTION
Inactivity is one of the major problems in the modern age and is directly related to technological advances. Inactivity can cause cardiovascular diseases, obesity, and skeletal disorders that can lead to early mortality. Thus a large number of studies have been conducted to address the problem of inactivity (de Onis and Habicht, 1996).
Physical fitness in girls is an important issue that ensures the health and wellbeing of a major portion of the society. Physical performance capacity can be improved through physical activity, which must be incorporated in the curricula (Ya, 2005).
The main benefits of physical activity for girls are improved functioning of the organs and the digestive system, lower daily energy expenditure, improved breathing, and increased muscular strength (Gholamian, 2011).
Many factors can directly affect an individual's health and wellbeing, such as biomechanical and physiological factors which must be studied in relation to age and gender. There is an extensive body of research on the relationship between body composition, health, and physical activity (Bloomfield *et al.*, 1994).
Creeley (2012) found that growth caused significant differences in the anthropometric, biomechanical, and physiological parameters in 9-11-year-old girls.
Rahmati (2012) identified static balance as the main biomechanical parameter in 16-year-old girls. Mehraban (2013) found no significant differences in the biomechanical parameters (flexibility, power, agility, speed, and balance) of 9-11-year-old girls.
Bayati (2013) showed that maturity can cause significant differences in the biomechanical and physiological parameters of 11-13-year-old girls.
However, Sheikh (2013) found significant differences in muscular endurance and strength, agility, static and dynamic balance, and posture of non-athlete women. A variety of factors can affect biomechanical and physiological parameters, such as quality of life, nutrition, and geographical conditions (Hadavi, 2008).
Understanding biomechanical and physiological parameters, posture, and musculoskeletal symptoms is essential to preventing diseases associated with inactivity (Pheasant and Haslegrave, 2005). The purpose of the present research is to examine and compare biomechanical and physiological parameters in 10-12-year-old girls. The findings can have implications for physical education teachers and health researchers.

## MATERIALS AND METHODS

### *Methods*

The present research is descriptive-comparative. The population consists of all the 10-12-year-old girls of Shahrud City in Semnan Province, Iran. Using cluster sampling, 148 female students were selected as the sample. The instruments for measuring biomechanical parameters were a box 30.5 cm high and tape measure with an accuracy of 0.1 cm for measuring forward bend, mat, chronometer, and paper for recording push-ups and sit-ups, 4 pieces of wood, chronometer, and paper for recording agility scores (4×9 run), a flat surface and tape measure for recording double-leg long jump scores, chalk, flat surface, and wall for recording Sargent vertical jump scores, dynamometer (Yagami, Japan) for measuring wrist strength, and chronometer, recording paper, chair, a plastic cone, and tape measure for recording Stork test and sit-to-stand test results. Also physiological parameters were recorded using a medical history questionnaire (developed by the researcher), chronometer, and paper for recording 540m run scores and heart rate in 15 seconds before and after exercise.

## RESULTS AND DISCUSSION

### *Results*

*Biomechanical Parameters*

The highest standard deviation (SD = 22.93) and dispersion occurred in double-leg long jump in 12-year-old girls, while the lowest standard deviation (SD = 0.32) and dispersion occurred in sit-to-stand time in 10-year-old girls. The highest and lowest mean occurred in double-leg long jump in 12-year-old girls and Stork test in 12-year-old girls respectively.

The results showed significant differences in the biomechanical parameters of the 10-12-year-old girls except in Sargent Jump scores. Given the normality of data distribution, one-way analysis of variance was used to test the hypothesis. Because of the significance of the test, Fisher's least significant difference (LSD) was used as post-hoc test. The results indicated that there were significant differences in all the biomechanical parameters (i.e. power, static balance, speed, and muscular endurance) except Sargent vertical jump test.

**Table 1: The results of ANOVA of the biomechanical parameters**

| Parameters | Variance | Sum of Squares | df | Mean Squares | F | Sig. |
|---|---|---|---|---|---|---|
| **Sargent jump (cm)** | Between-Group | 10.37 | 2.00 | 5.18 | 0.42 | 0.66 |
| | Within-Group | 1781.15 | 145.00 | 12.28 | | |
| | Total | 1791.52 | 147.00 | - | | |
| **Double-leg long jump (cm)** | Between-Group | 6710.02 | 2.00 | 3355.01 | 10.05 | 0.00 |
| | Within-Group | 48423.13 | 145.00 | 333.95 | | |
| | Total | 55133.15 | 147.00 | - | | |
| **Stork test (s)** | Between-Group | 7.10 | 2.00 | 3.55 | 6.17 | 0.00 |
| | Within-Group | 83.40 | 145.00 | 0.58 | | |
| | Total | 90.50 | 147.00 | - | | |
| **40m run (s)** | Between-Group | 1255.46 | 2.00 | 627.73 | 20.73 | 0.00 |
| | Within-Group | 4391.34 | 145.00 | 30.29 | | |
| | Total | 5646.80 | 147.00 | - | | |
| **Push-ups (per minute)** | Between-Group | 1281.0 | 2.00 | 640.52 | 17.10 | 0.00 |
| | Within-Group | 5430.96 | 145.00 | 37.46 | | |
| | Total | 6711.99 | 147.00 | - | | |
| **Wrist strength (kg)** | Between-Group | 22.53 | 2.00 | 11.27 | 23.36 | 0.00 |
| | Within-Group | 69.95 | 145.00 | 0.8 | | |
| | Total | 92.48 | 147.00 | - | | |

**Table 2: The results of LSD post-hoc test based on mean difference**

| Dependent Variable | Age (I) B | (J) B | Mean Difference (I – J) | Std. Error | df | 95% CI Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|---|
| **Double-leg long jump (cm)** | 10 | 11 | -11.19 | 3.63 | 0.00 | -18.36 | -4.03 |
| | | 12 | -16.47 | 3.77 | 0.00 | -23.93 | -9.02 |
| | 11 | 10 | 11.19 | 3.63 | 0.00 | 4.03 | 18.36 |
| | | 12 | -5.28 | 3.67 | 0.15 | -12.53 | 1.97 |
| | 12 | 10 | 16.47 | 3.77 | 0.00 | 9.02 | 23.93 |
| | | 11 | 5.28 | 3.67 | 0.15 | -1.97 | 12.53 |
| **Stork test (s)** | 10 | 11 | -0.10 | 0.15 | 0.50 | -0.40 | 0.19 |
| | | 12 | -0.52 | 0.16 | 0.00 | -0.83 | -0.21 |
| | 11 | 10 | 0.10 | 0.15 | 0.50 | -0.19 | 0.40 |
| | | 12 | -0.42 | 0.15 | 0.01 | -0.72 | -0.12 |
| | 12 | 10 | 0.52 | 0.16 | 0.00 | 0.21 | 0.83 |
| | | 11 | 0.42 | 0.15 | 0.01 | 0.12 | 0.72 |
| **40m run (s)** | 10 | 11 | 0.02 | 1.09 | 0.99 | -2.14 | 2.18 |
| | | 12 | -6.28 | 1.14 | 0.00 | -8.53 | -4.04 |
| | 11 | 10 | -0.02 | 1.09 | 0.99 | -2.18 | 2.14 |
| | | 12 | -6.30 | 1.10 | 0.00 | -8.48 | -4.12 |
| | 12 | 10 | 6.28 | 1.14 | 0.00 | 4.04 | 8.53 |
| | | 11 | 6.30 | 1.10 | 0.00 | 4.12 | 8.48 |
| **Push-ups (per minute)** | 10 | 11 | 0.23 | 1.21 | 0.85 | -2.17 | 2.62 |
| | | 12 | 6.47 | 1.26 | 0.00 | 3.98 | 8.97 |
| | 11 | 10 | -0.23 | 1.21 | 0.85 | -2.62 | 2.17 |
| | | 12 | 6.25 | 1.23 | 0.00 | 3.82 | 8.67 |
| | 12 | 10 | -6.47 | 1.26 | 0.00 | -8.97 | -3.98 |
| | | 11 | -6.25 | 1.23 | 0.00 | -8.67 | -3.82 |
| **Wrist strength (kg)** | 10 | 11 | -0.21 | 0.14 | 0.13 | -0.48 | 0.06 |
| | | 12 | -0.93 | 0.14 | 0.00 | -1.22 | -0.65 |
| | 11 | 10 | 0.21 | 0.14 | 0.13 | -0.06 | 0.48 |
| | | 12 | -0.72 | 0.14 | 0.00 | -1.00 | -0.45 |
| | 12 | 10 | 0.93 | 0.14 | 0.00 | 0.65 | 1.22 |
| | | 11 | 0.72 | 0.14 | 0.00 | 0.45 | 1.00 |

*Physiological Parameters*

The highest standard deviation (SD = 25.71) and dispersion occurred in post-exercise heart rate in 12-year-old girls, while the lowest standard deviation (SD = 0.33) and dispersion occurred in 540m run time in 10-year-old girls.

**Table 3: The results of ANOVA of the physiological parameters**

| Parameters | Variance | Sum of Squares | df | Mean Squares | F | Sig. |
|---|---|---|---|---|---|---|
| **Pre-exercise heart rate (per minute)** | Between-Group | 45.61 | 2.00 | 22.81 | 0.54 | 0.58 |
| | Within-Group | 6117.93 | 145.00 | 42.19 | | |
| | Total | 6163.54 | 147.00 | - | | |
| **540m run (s)** | Between-Group | 0.64 | 2.00 | 0.32 | 2.23 | 0.11 |
| | Within-Group | 20.78 | 145.00 | 0.14 | | |
| | Total | 21.42 | 147.00 | - | | |
| **Post-exercise heart rate (per minute)** | Between-Group | 1540.43 | 2.00 | 770.21 | 1.70 | 0.19 |
| | Within-Group | 65901.90 | 145.00 | 454.50 | | |
| | Total | 67442.32 | 147.00 | - | | |

The highest and lowest mean occurred in post-exercise heart rate in 10-year-old girls and 540m run time in 11-year-old girls respectively.

The results of one-way ANOVA showed no significant differences between the physiological parameters (i.e. pre- and post-exercise heart rate and 540m run time) of 10-12-year-old girls.

***Discussion and Conclusion***

The present findings showed that there were significant differences between the biomechanical parameters of 10-12-year-old girls at the 0.05 significance level except in Sargent vertical jump scores. Agility, muscular endurance (push-ups), and speed were higher in 10-year-old girls, balance and muscular endurance (sit-ups) was higher in 11-year-old girls, and double-leg long jump, sit-to-stand time, flexibility, and strength were higher in 12-year-old girls. This suggests that except for agility and speed which were higher in 10-year-old girls, other parameters such as power, balance, muscular endurance, flexibility, and strength increase with age. These findings are consistent with the results of Creeley (2012), Sheikh (2014), Mehraban (2013), and Bayati (2013). However, the present findings were inconsistent with the results of Rahmati (2012) who found no significant differences in the biomechanical parameters of 16-18-year-old girls. In the age group 10-12 years, girls approach their puberty and their physical capabilities significantly develop due to growth in bones, connective tissues, and muscle size. Their muscular strength and endurance gradually increases, thus increasing their overall motor skills and physical fitness. However, there is no significant growth in bones, connective tissues, and muscle size after puberty, which may be one reason for the inconsistency of the present findings with the results of Rahmati (2012). Moreover, our results showed no significant differences in the physiological parameters of the 10-12-year-old girls at the 0.05 significance level. This is in line with the results of Mehraban (2012) and Rahmati (2012). Comparing mean values of physiological parameters indicated that pre- and post-exercise heart rate and running speed gradually increase with age, but this change was not statistically significant. The lack of a significant difference between age groups can be attributed to small differences in physiological maturity of the subjects. Future research can compare physiological and biomechanical parameters in other age groups.

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