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Influence of Body Mass Index over the Youngsters' Motion

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Abstract

Motion can be defined as a voluntary motor activity, becoming, through exercise, an involuntary, automatic and stereotyped motor activity. By motion, body continuously adapts to the supporting surface and the surrounding environment. Motion is a physical activity that slightly affects the respiratory and circulatory functions, produces a general body relaxation and contributes to keeping a correct posture. Any weight excess (overweight, obesity or physical load) impacts adversely the motion mechanism, generating the occurrence a deficient body posture, with effects over the spine. The work subject is to underline the BMI (body mass index) impact over the motion to youngsters. The research methods are the following: the bibliographic documentation, the observation method, the experimental method, the statistical and mathematical method, the graphic method. The research subjects (n=7) are students of the "Polytechnic" University of Bucharest, with the average age of 19.85 years old. The variables on which this research relied are: the anthropometric measurements (weight, height, BMI), the motion indicators (contact area, plantar pressure, maximum force), as obtained through computerized analysis, using the PedarX System. The results obtained show an inverse correlation between BMI and the contact area (-0.629), as well as strong correlations between the contact area and the maximum force on the right leg (0.853), respectively on the left leg (0.981), between the

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plantar pressure and the maximum force on the right leg (0.973), respectively on the left leg (0.873), and between the plantar pressure and the left foot contact area (0.876), respectively the right foot contact area (0.778). Data show that BMI can be considered a co-variable of the health condition, any changes in the body weight affecting adversely the osteomuscular and ligamental apparatus.

Keywords: Body Mass Index, motion, youngsters, computerized techniques.

1. Introduction

The human body locomotion is usually ensured through motion. Motion consists of constant imbalances and rebalancing of the body and continuous adjustment of the body to the supporting surface and the surrounding environment. [1]

The motion mechanism implies the movement of the whole body: head, shoulders, trunk, upper limbs, pelvis, lower limbs.

Obesity is one of the greatest public health challenges of the 21st century. Its prevalence has tripled in many countries of the WHO European Region since the 1980s, and the numbers of those affected continue to rise at an alarming rate. In addition to causing various physical disabilities and psychological problems, excess weight drastically increases a person's risk of developing a number of noncommunicable diseases (NCDs), including cardiovascular disease, cancer and diabetes. [2]

The worldwide prevalence of obesity nearly doubled between 1980 and 2008.

Based on the latest estimates in European Union countries, overweight affects 30-70% and obesity affects 10-30% of adults. The forecasts are alarming for the UK, with 33% of obese women in 2030, compared with 26% in 2010 and 36% of men versus 26% in 2010. In Greece, for example, the proportion of men and women who suffer from obesity would double from 20% in 2010 to 40% in 2030, while in Spain, the proportion of obese men to rise From 19% to 36% over the same period.

In Romania, 21.3% of romanians aged over 18 years suffer from obesity, according to the ORO epidemiological study of the prevalence of obesity and obesity risk factors. The same study showed that 23% of Romanian men are obese, compared to 20.3% of women, and 41.6% of males and 24.7% of women are overweight.[3]

Over 60% of children who are overweight before puberty will be overweight in early adulthood. If current trends continue to be maintained, the WHO indicates that 70 million children will be affected globally by 2025.

Childhood obesity is strongly associated with risk factors for cardiovascular disease, type 2 diabetes, orthopaedic problems, mental disorders, underachievement in school and lower self-esteem.

2. Problem Statement

The Body Mass Index is a variable in the process to determine the health condition of youngsters. Any changes in BMI, as the increase of the body weight, may have negative impacts over the motion mechanism [4], leading to the increase of the muscular – skeletal disease and posture attitude deficiency rates. [5, 6]

According to other specialist studies, the BMI increase is directly proportional with the decrease of the motion speed and the maximum knee extension. BMI increased also affects directly the loading rate and the braking force during the motion. [7, 8]

This study aims to objectify the BMI influence over the motion by using the PEDAR X System.

3. Aims of the research

Research Purpose – The purpose of this study is to establish the BMI influence over the motion parameters (plantar pressure and maximum force) to youngsters by using the Pedar X System and to point out the changes that occur.

Working Hypothesis – Using the stepping analysis, we can point out the parametric changes occurring during the motion, correlated with the BMI. We consider that an increased BMI affects the main motion parameters (plantar pressure and maximum force).

4. Research Methods

Description of ascertaining experiment

To point out the BMI influence over the motion to youngsters, we used the Pedar X System. The measurements are performed in the Laboratory of the Fine Mechanics and Mechatronics Chair within CCDM Department of the "Polytechnic" University of Bucharest.

The PedarX equipment, in the version with data acquiring by Bluetooth, was used according to the needs, being connected to a PC (Fig. 1).



Figure 1. Pedar X System

The following are used:

- Instrumentalized insoles of different sizes;
- Pedar X Unit that ensures the data acquiring and the communication with the data acquiring, processing and storing device;
- The Data Acquiring, Processing and Storing Device: one PC (Core2, 3GHz, RAM of 2 GB).
- Accessories: the cables providing the connection between the Pedar X System and accumulators, as well as between insoles and the PedarX Unit, the belts for fixing the cables to the leg, the hardware key and the Bluetooth adapter to be installed on PC USB ports.

The Data Acquiring Unit communicates bidirectional with the computer through Bluetooth technology, enabling a higher freedom of movement for the subject examined.

To carry out the measurements, the working procedure was the following:

- The Pedar X equipment, made of the Data Acquiring and Control Device, was connected to the Data Acquiring Unit represented by a PC (for laboratory measurements) or a laptop, along with the Bluetooth device for remote acquiring of data;
- The equipment connected to the Data Storing Unit (namely the relevant PC or laptop) is checked in terms of its ability to transmit data from the data acquiring unit, namely the Pedar X System, to the computer, via Bluetooth device;
- The subject is prepared, being installed the insoles in the shoes usually used and attached the portable Pedar X data acquiring unit to the subject's body (Fig. 2).



Figure 2. Pedar X System for stepping appraisal (front plan)

- We carried out a number of minimum 4 sets of measurements under the following circumstances: stepping with common speed, as naturally as possible, on a distance of about 16 m, for about 20 seconds minimum;
- The results displayed are: the plantar footprint, the distribution of pressures on the insole sensors, the 3D pressure distribution, the 2D pressure distribution, the step analysis, the maximum pressure, maximum force, time and contact area values.

To complete the research, we used anthropometric measurements that aimed: the longitudinal dimension (height), the somatic mass dimension (weight) and the proportionality relation between weight and height, expressed by the Body Mass Index, as resulted from the formula: body weight (kg)/ height (m^2). The values obtained qualified the subject as follows:

- Hypo-weighted – less than 20;
- Normal – between 20 and 25;
- Hyper-weighted – more than 25;
- Obese – more than 30.

To establish the BMI influence over the motion parameters, the Pearson correlation that show the force of the variable association was used, where r (Pearson coefficient) = ±1.

Subjects – The experimental group was made of 10 students (4 girls and 6 boys) of the "Polytechnic" University of Bucharest, who offered as volunteers for this study and follows the Kinetotherapy course. (Table 1).

The sample is randomized by using the random selection technique. In the psycho-pedagogical / methodically research, where they cannot select subjects without taking the risk of spoiling the flocks groups, there shall be taken as experiment and control groups, the parallel ones, considering that the "random" factor has acted in the initial establishment of the groups.

The students were asked for the verbal and written agreement to use the data obtained on the research. They had the opportunity to refuse or to withdraw from the experiment without any consequence from the examiners. Each subject was individually tested and asked that the sample and data provided by them to be very accurate for the authenticity of the study.

The research is an ascertaining one, being carried out during the period of time between October 2016 and February 2017.

Table 1 Subjects participating in the research

Subject	Name	Weight (kg)	Height (cm)	BMI
1 (S1)	B.M.	58	172	19.61
2 (S2)	B.T.	58	158	23.24
3 (S3)	C.D.	80	163	30.19
4 (S4)	C.A.	47	168	16.67
5 (S5)	D.A.	86	185	25.15
6 (S6)	D.C.	74	172	25.02
7 (S7)	O.S.	73	176	23.57
8 (S8)	C.M.	69	165	25.36
9(S9)	F.L.	73	168	25.88
10(S10)	P.C.	56	160	21.87

5. Findings

The calculation of the Body Mass Index (BMI) enable us to qualify the subjects as follows: 2 hypo-weighted subjects, 5 normally weighted subjects, 2 hyper-weighted subjects and 1 obese subject.

Pursuant the statistical processing, the results showed in Table 2 are obtained, which show the linear link across the variables of the research (BMI, contact area, plantar pressure and maximum force):

Table 2 Correlation across research variables

	BMI – Contact Area	BMI – Plantar Pressure	BMI – Maximum Force
Pearson Correlation	-0.629	0.063	0.445

The results obtained show an inverse correlation between BMI and the contact area (r = -0.629), which enable us to point out that a subject with an increased BMI will influence the contact area towards its lowering. An increase of the maximum force established during stepping will also lead to a decrease of the plantar pressure.

Strong correlations are obtained between the contact area and the maximum force (r = 0,853), between the plantar pressure and the maximum force (r = 0.973) and between the plantar pressure and the contact area (r = 0.778).

To illustrate, we submit hereinafter the results for a subject (namely S3) that qualify within the weighing area of obesity (BMI = 30.19).

Table 3 Average values obtained through Pedar X System (S3) - Obesity

Contact area (L) cm^2	Contact area (R)	Contact time (L) ms	Contact time (R) ms	Max force (L) N	Max force (R) N	Peak pressure (L) kPa	Peak pressure (R) Kpa
71.95	16.98	320	320	412.69	51.60	110	50.0

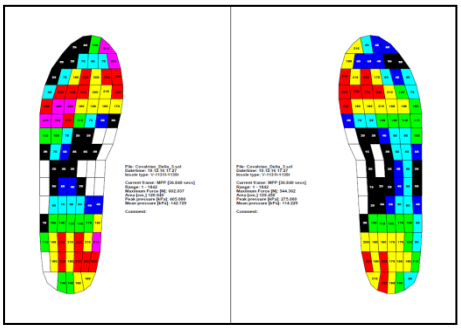


Figure 3 – Baropodographic view (S3)

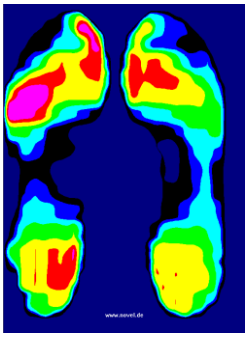


Figure 4 – 3D view (S3)

The baropodographic views obtained by using Pedar X System highlight an unequal weight distribution in bipodal support (fig. 3, 4), a contact area on the right leg (71.95 cm^2) larger than on the left leg (16, 98

cm^2), and a plantar pressure on the right leg (110 kPa) higher than on the left leg (50 kPa) in case of a subject having a higher BMI.

6. Discussions

The assessment of the motion based on computerized techniques, by using the Pedar X System, pointed out the impact of BMI over the motion.

The computerized analysis of stepping enlarges the range of the information related to the main stepping parameters to the correlation of those parameters with the Body Mass Index.

Data show that BMI can be considered a co-variable of the health condition, any changes in the body weight having a negative impact over the osteomuscular and ligamental apparatus.

7. Conclusions

This study provides data that support the negative impact of increased BMI over stepping. Subjects having an increased BMI (hyper-weighted or obese subjects) show unequal values of the time and space parameters (contact area, plantar pressure, maximum force). The statistical data show a positive correlation across BMI, plantar pressure and maximum force as well as an inverse correlation (negative) between BMI and contact area. Those data confirm the research hypothesis according to which an increased BMI affects the main motion parameters (plantar pressure and maximum force).

The regular physical activity, along with a healthy lifestyle, significantly reduces the risk to develop diseases associated to an increased Body Mass Index.

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