Abstract
The aim of this study was to define the actual model of body composition status of working age women in the territory of Belgrade. The sample comprised 109 women respondents, of an average age of 35.2±9.5 and the length of service = 9.6±9.3 years. All measurements were performed in the period from 2011–2012 in the Teaching-research laboratory of the Faculty of Sport and Physical Education of the University of Belgrade, by applying standardised procedure of electrical multichannel bioimpedance method. The researched encompassed twenty-two (22) variables – fourteen basic (14) and eight (8) derived (index) variables. Basic variables were: BH – body height, BM – body mass, ICF – intracellular fluid, ECW – extracellular fluid, TBW – total body fluids, Proteins, Minerals, BMC (Osseous) – bone mineral contents, BFM – total body fat mass, SMM – skeletal muscle mass, VFA – visceral fat area, BCM – body cell mass, BMR – basal metabolic rate, FIS – fitness score as assessment of body composition. The derived (index) variables were: BMI – body mass index, PBF% - percent of body fat, PBW - percent of body water, PFI - protein fat index, PSMM – percent of skeletal muscle mass, SMMMD – skeletal muscle mass density, OBMi – Osseous-body mass index, PBMI – protein body mass index. The results showed that the average body mass of the respondents was 67.66±13.39 kg, body height 167.04±6.62 cm, body mass index 24.27±4.66 kg/m2, muscle mass 26.55±4.46 kg, muscle mass percentage 29.09±8.47, body fat mass 20.52±9.74 kg, body fat percentage 29.09±8.47, visceral fat area was 77.92±40.23 cm² and fitness score 73.23±6.75 of index points. The obtained results led to the conclusion that the current morphological status of the studied women partially corresponds to a type of normal weight. BMI and the representation of body fat had nearly limiting values towards obesity. A very high percentage of women was recorded in the category of pre-obese and obese according to BMI (40%) and PSMM (36%). Based on the results of this study, it can be claimed that the four-dimensional model (4D model) of body composition of working-age women from the measured sample has the following characteristics: in women of average body mass of 67.66 kg – water content is 34.58 L or 51.11%, protein mass is 9.25 kg or 13.68%, mineral mass is 3.30 kg or 4.88% and fat mass is 20.25 kg or 30.32%.

Key words: BODY COMPOSITION / BIOIMPENDANCE / WOMEN / ADIPOSE TISSUE / BMI
INTRODUCTION

Body structure – composition implies the set of substances the human organism is made of (Heyward, & Stolarczyk, 1996). From the biological aspect, in relation to the macro level, human organism is composed of four main measurable segments of substances, namely: fluid – water, fat component, solid component – the basis of which are mineral substances, and protein – muscle component (the largest part). In addition to the mentioned basic elements of the body structure, morphological indices can also be defined, based on which one can determine the ratio between certain components or even segmentary ratio of the same components. That way the levels and proportion(s) of certain elements or segments can be determined more precisely (Macura, et al., 2010), which can be important in research or clinical work.

To determine quantitative indicators and the proportion of body composition, several methods have been developed (Heyward, & Stolarczyk, 1996), while comparing and validating is still performed of different techniques and measurement methods in relation to themselves, in relation to different characteristics of the population of people or in relation to different treatment of effects on modification of the same (Janković, et al., 2008; Gába, et al., 2009; Macura, et al., 2010; Stoiljković, Mandarić, Todorović, & Mitić, 2010; Ilić et al., 2012).

The method of body composition measuring by electrical multichannel bioimpedance is a technology of the latest generation which in a simple and non-invasive way provides valid data of body composition. InBody 720 (http://inbody.rs/), as a measuring instrument, allows the direct measurement of basic elements of body composition (Heyward & Stolarczyk, 1996; Gába et al., 2008; Macura et al., 2010).

Monitoring changes in body composition in different age groups is important for control of the current status, but also to determine the trend of changes of the total mass or individual parts of the given structure. Adipose tissue is the only component of body composition which shows the tendency to increase almost throughout the whole life (Abe et al., 1996; Mott et al., 1999). In addition to biological effects associated with aging (Cook, et al., 2009), the change of lifestyle of a modern man (reduced physical activity and increased energy intake), has determined that an enormous increase in representation of adipose tissue becomes one of the main determinants of health and diseases. As the authors Gába et al. (2009) noted, prevention of the excess gain in body mass-fat has become a public health priority in the developed countries of the world, as well as in Serbia (Jorga et al., 2007). On the other hand, aging is inevitably followed by reduction of muscle component of body composition, at which the weight either does not change, or increases at the expense of fat (Abe et al., 1996; Kyle, et al., 2006).

Cristou, et al. (2005), have concluded in their research that measurements of the total body and abdominal adiposity are consistently and independently associated with a wide variety of established risk factors for heart and blood vessel diseases in men and in women (Zamboni, et al., 1997). Determining the content of abdominal (visceral) adiposity is emphasized nowadays as the necessary information in the diagnosis and treatment of most chronic noninfectious diseases. Pelt et al. (2002) and Zamboni et al. (1997) have pointed out in their research that the regional (abdominal) fat is a strong independent predictor of insulin resistance and dyslipidemia in postmenopausal women. Determination of body mass index has been the basic, simplest and widely accepted indicator of the nutritional status of the population for several decades. It has been shown that higher values of this index were strongly and independently associated with harmful levels of inflammatory and lipid markers (cardiovascular biomarkers) in the research on a large female population (Mora, Lee, Min., Buring, & Ridker, 2006). According to indicators of the Institute of Public Health, adult population in Serbia is among the world top ranked in the number of diseased and dead from heart and blood vessels diseases, metabolic and malignant diseases and others. (Institute of Public Health of the Republic of Serbia, 2010; 2010a). Prevention of the above diseases implies defining reli-
able standards of all parameters that can indicate the risk of illness. In addition, it is necessary to develop a system with a unified methodology of assessing the current state of body weight and body structure in the population of interest for the research. This way it would also be possible to monitor the effects of the applied treatments (physical exercise, diet, etc.) (Jorga, et al., 2007; Janković, et al., 2008; Gába, et al., 2009; Dopsaj, et al., 2010; Stojilković, et al., 2010; Ilić, et al., 2012).

The main objective of this research was to define a descriptive model of the body structure of population of working-age women in Belgrade. The given population is hypothetically the most susceptible to the negative effects of working and living environment because of the conditions of life in the most urban environment of the Republic of Serbia. The secondary aim of the study was to initially describe the current status of monitored variables of a body structure, newly defined morphological indices included.

**METHOD**

**Sample of respondents**

The sample comprised 109 female respondents residing on the territory of the City of Belgrade. The basic descriptive data of the respondents were the following: age = 35.2±9.5 (Min – Max = 20 – 61) years of age, years of service = 9.6±9.3 (Min – Max = 1 – 35) years. As for the professional structure, 62 respondents (56.88 %) have been working in utility, police or military services (community police, firefighters, gendarmerie, police, and the army of the Republic of Serbia), while 47 (43.12 %) have been working in civil service (administrative jobs, physicians, economists, positions in management and education). In relation to the years of service, 49 (59.63 %) had up to 9.9 years, 22 (20.18 %) had from 10.0 to 19.9 years, 20 (18.35 %) had from 20.0 to 29.9 years and 2 (1.83 %) had over 30 years of service. In relation to age, 36 (33.03%) were in their twenties, 43 (39.45 %) were in their thirties, 20 (18.35 %) were in their forties, 9 (8.26 %) were in their fifties and 1 (0.92 %) was in her sixties. In relation to the frequency of physical activity or physical exercising (in a fitness centre or individually), 34 respondents (31.19%) did not exercise at all, while 46 (42.20%) were physically active or exercised 1 to 2 times a week, 20 (18.35%) were physically active or exercised 3 to 4 times a week, while 9 (8.26%) exercised 5 times a week. Compared to the respondents who were physically active or who exercised, the said individual activity lasted 34.6±28.4 minutes on average.

**Body structure measuring**

All measurements were performed in the period from 2011–2012 in Teaching-research laboratory (MIL) of the Faculty of Sport and Physical Education, University of Belgrade. Measurements were realized by standardized procedure, by applying the method of electrical multichannel bioimpedance with the help of body structure analyzer of the newest generation – InBody 720 (Gába, et al., 2008; Gába, et al., 2009; http://inbody.rs/).

**Variables**

This study comprised twenty-two (22) variables, namely fourteen primary (14) and eight (8) derived, i.e. index variables defined in the form of morphological indices, by which morphological body structure of the respondents was described.

Primary variables were the following:

1. BH – body height, expressed in cm,
2. BM – body mass, expressed in kg,
3. ICW – intracellular fluid (liquid contained inside the cell), expressed in L,
4. ECW – extracellular fluid (liquid contained outside the cell), expressed in L,
5. TBW – total body water, expressed in L,
6. Proteins – expressed in kg,
7. Minerals – expressed in kg,
8. BMC (Osseous) – bone mineral contents, expressed in u kg,
9. BFM – total body fat mass, expressed in kg,
10. SMM – skeletal muscle mass, expressed in kg,
11. VFA – visceral fat area of internal organs, expressed in cm²,
12. BCM – body cell mass in the organism, expressed in kg,
13. BMR – basal metabolic rate, expressed in Kcal,
14. FIS – fitness score as assessment of body composition, expressed in points.
Derived (index) variables were:

1. BMI – body mass index, expressed in kg/m²,
2. BFM% - percent of body fat, calculated as BFM/BM ratio, expressed in %,
3. PBW - percent of body water, calculated as TBW/BM ratio, expressed in %,
4. PFI – protein-fat relation index, index of protein (Proteins) and total body fat mass (BFM) ratio, calculated as Proteins/BFM ratio, expressed in %,
5. PSMM – percent of skeletal muscle mass – muscle index, index of the ratio of skeletal muscle mass (SMM) and body mass (BM), calculated as SMM/BM ratio, expressed in %,
6. SMMD - skeletal muscle mass density – index of the muscle density, index of the protein mass and skeletal muscle ratio, calculated as Proteins/SMM ratio, expressed in %,
7. OBM – Osseous-body mass index, index of the mineral bone mass (Osseous) and body mass (BM) ratio, calculated as Osseous/BM ratio, expressed in %,
8. PBmi – protein body mass index, index of the protein and body mass ratio, calculated as Proteins / BM, expressed in %.

Statistical data processing

All results were firstly analysed by applying descriptive statistical procedure to calculate fundamental measures of central tendency and dispersion of data (Mean, SD, cV%, Std. Error, Skewness, Kurtosis, Min and Max, and confidence interval at 95%). Regularity of distribution of variables was tested using the nonparametric Kolmogorov-Smirnov (K-S) test. In order to determine the dependencies be-
Table 1. Descriptive statistical indicators of the researched variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean±SD</th>
<th>cV%</th>
<th>Std. Error (Aps; rel%)</th>
<th>Min - Max</th>
<th>Skew</th>
<th>Kurt</th>
<th>K-SZ</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH (cm)</td>
<td>167.04±6.62</td>
<td>3.96</td>
<td>0.63; 0.38</td>
<td>154.5-182.7</td>
<td>-0.10</td>
<td>0.24</td>
<td>1.03</td>
<td>0.235</td>
</tr>
<tr>
<td>BM (kg)</td>
<td>67.66±13.39</td>
<td>19.79</td>
<td>1.28; 1.89</td>
<td>39.4-111.8</td>
<td>1.09</td>
<td>1.33</td>
<td>1.41</td>
<td>0.038</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.27±4.66</td>
<td>19.20</td>
<td>0.45; 1.85</td>
<td>14.90-38.18</td>
<td>0.89</td>
<td>0.34</td>
<td>1.70</td>
<td>0.006</td>
</tr>
<tr>
<td>ICW (L)</td>
<td>21.40±2.68</td>
<td>12.52</td>
<td>0.26; 1.21</td>
<td>14.3-30.3</td>
<td>0.34</td>
<td>0.63</td>
<td>0.48</td>
<td>0.974</td>
</tr>
<tr>
<td>ECW (L)</td>
<td>13.18±1.66</td>
<td>12.59</td>
<td>0.16; 1.21</td>
<td>9.6-18.8</td>
<td>0.54</td>
<td>0.53</td>
<td>0.69</td>
<td>0.722</td>
</tr>
<tr>
<td>TBW (L)</td>
<td>34.58±4.34</td>
<td>12.44</td>
<td>0.41; 1.19</td>
<td>23.9-49.1</td>
<td>0.45</td>
<td>0.68</td>
<td>0.61</td>
<td>0.857</td>
</tr>
<tr>
<td>Proteins (kg)</td>
<td>9.25±1.16</td>
<td>12.54</td>
<td>0.11; 1.19</td>
<td>6.2-13.1</td>
<td>0.36</td>
<td>0.62</td>
<td>0.51</td>
<td>0.956</td>
</tr>
<tr>
<td>Minerals (kg)</td>
<td>3.30±0.44</td>
<td>13.33</td>
<td>0.04; 1.21</td>
<td>2.38-4.90</td>
<td>0.54</td>
<td>0.74</td>
<td>0.68</td>
<td>0.750</td>
</tr>
<tr>
<td>BMC (Osseous) (kg)</td>
<td>2.75±0.36</td>
<td>13.09</td>
<td>0.04; 1.45</td>
<td>2.38-4.90</td>
<td>0.54</td>
<td>0.74</td>
<td>0.61</td>
<td>0.857</td>
</tr>
<tr>
<td>BFM (kg)</td>
<td>20.52±9.74</td>
<td>47.47</td>
<td>0.93; 4.53</td>
<td>5.7-51.6</td>
<td>1.10</td>
<td>1.02</td>
<td>1.48</td>
<td>0.025</td>
</tr>
<tr>
<td>SM (kg)</td>
<td>26.55±4.46</td>
<td>16.80</td>
<td>0.57; 2.15</td>
<td>16.6-42.2</td>
<td>0.63</td>
<td>1.78</td>
<td>0.62</td>
<td>0.833</td>
</tr>
<tr>
<td>VFA (cm²)</td>
<td>77.92±40.23</td>
<td>51.63</td>
<td>3.85; 4.94</td>
<td>8.2-184.3</td>
<td>0.53</td>
<td>-0.38</td>
<td>0.86</td>
<td>0.448</td>
</tr>
<tr>
<td>BCM (kg)</td>
<td>30.65±3.83</td>
<td>12.50</td>
<td>0.37; 1.21</td>
<td>20.5-43.4</td>
<td>0.35</td>
<td>0.64</td>
<td>0.46</td>
<td>0.985</td>
</tr>
<tr>
<td>BMR (Kcal)</td>
<td>1387.3±127.8</td>
<td>9.21</td>
<td>12.2; 0.88</td>
<td>1070-1819</td>
<td>0.43</td>
<td>0.57</td>
<td>1.85</td>
<td>0.002</td>
</tr>
<tr>
<td>FIS (point)</td>
<td>73.23±6.75</td>
<td>9.22</td>
<td>0.65; 0.89</td>
<td>51.0-84.0</td>
<td>-1.22</td>
<td>1.54</td>
<td>1.86</td>
<td>0.002</td>
</tr>
<tr>
<td>PBF (%)</td>
<td>29.09±8.47</td>
<td>29.12</td>
<td>0.81; 2.78</td>
<td>9.55-50.30</td>
<td>0.29</td>
<td>-0.39</td>
<td>0.86</td>
<td>0.455</td>
</tr>
<tr>
<td>PBW (%)</td>
<td>51.86±6.14</td>
<td>11.84</td>
<td>0.59; 1.14</td>
<td>36.48-66.67</td>
<td>-0.32</td>
<td>-0.41</td>
<td>0.89</td>
<td>0.400</td>
</tr>
<tr>
<td>PFI (%)</td>
<td>0.546±0.259</td>
<td>47.44</td>
<td>0.025; 4.58</td>
<td>0.194-1.859</td>
<td>2.01</td>
<td>7.10</td>
<td>1.01</td>
<td>0.256</td>
</tr>
<tr>
<td>PSMM (%)</td>
<td>38.10±5.71</td>
<td>14.99</td>
<td>0.73; 1.92</td>
<td>27.44-57.26</td>
<td>0.66</td>
<td>1.14</td>
<td>0.58</td>
<td>0.889</td>
</tr>
<tr>
<td>SMMD (%)</td>
<td>0.3549±0.0208</td>
<td>5.86</td>
<td>0.0027; 0.76</td>
<td>0.1991-0.3735</td>
<td>-7.26</td>
<td>55.33</td>
<td>3.11</td>
<td>0.000</td>
</tr>
<tr>
<td>OBM (%)</td>
<td>0.0413±0.0048</td>
<td>11.62</td>
<td>0.0005; 1.21</td>
<td>0.0279-0.0504</td>
<td>-0.41</td>
<td>-0.33</td>
<td>1.15</td>
<td>0.089</td>
</tr>
<tr>
<td>PBMi (%)</td>
<td>13.92±1.66</td>
<td>11.93</td>
<td>0.16; 1.15</td>
<td>9.76-17.76</td>
<td>-0.28</td>
<td>-0.33</td>
<td>0.80</td>
<td>0.549</td>
</tr>
</tbody>
</table>

Chart 1 displays the distribution of results (in %) of female respondents in the function of body mass index (BMI) class according to WHO standards (http://apps.who.int/bmi). The average age of the respondents is also shown with regard to the same class criterion. Based on the results, it can be claimed that more than 55.0% (51.38% + 4.59%) of female respondents is in the class of women of normal weight (ranging from 18.50 to 22.99, and from 23.00 to 24.99 kg/m²), that approximately 30.0% (+ 16.51% 13.76%) of the respondents is in the class of pre-obese (ranging from 25.00 to 27.49 and 29.99 kg/m²), and that about 10% (5.50% ± 4.59%) of the measured sample is categorized as obese (more than 30.00 kg/m²). In relation to the category of underweight (lean), it was found that only 3.67% of the respondents belong to that category (less than 18.49 kg/m²). Generally observed, if the BMI value of 25.00 kg/m² is taken as a general criterion for the limit between normal weight and obese, it can be claimed that in the studied sample of women, 40.36% of women are in some stage of obesity.
Chart 1. Results of distribution of the respondents in the function of body mass index class (BMI)

Generally observed, linear dependency between classes of body weight of the researched sample and age is on the level of the coefficient of determination of adj. R² = 0.151 and is not statistically significant (F = 2.06, p = 0.211). This means that for this sample of respondents, no statistically significant correlation of distribution of respondents divided by BMI classes and age was determined. In other words, in the case of the researched sample of women, no statistically significant proportional linearity was determined which would prove that the class of body weight increased with increasing age.

Chart 2 presents the results of distribution dependency (in %) of the respondents in the function of the body fat percentage class (PBF) (http://www.acefitness.org/) compared to the average age of respondents in classes. Based on the results, it can be claimed that more than 50.0% (24.77% +26.61%) of respondents had fat percentage in the class of persons with a normal level of body fat, 35.78% of respondents is in the class of obese based on the percentage of body fat, 10.09 % are in the class of athletes, while 1.83% has the percentage of body fat at the level of essential biological reserve, or at the level of body fat deficiency (0.92%).
Generally observed, linear dependency between classes of percentage of body fat in the body of the researched sample and the age is at the level of the coefficient of determination of $R^2 = 0.3636$, and is not statistically significant ($F = 3.86$, $p = 0.121$). That means that for this sample of respondents no statistically significant correlation of distribution of classes of women respondents divided with respect to the percentage of body fat in the body and age was determined.

Figures 1a. and 1b. show a 4D model of body composition in working-age women with the following characteristics: in relation to the body weight of the researched sample – 67.66 kg, water content is 34.58 L or 51.11%, protein content is 9.25 kg or 13.68%, mineral mass is 3.30 kg or 4.88%, and fat mass is 20.25 kg or 30.32%.

**Figure 1a.** 4D model of body composition of working-age women expressed in relative values

**Figure 1b.** 4D model of body composition of working-age women expressed in absolute values

Legend: BFM – Body Fat Mass; TBW – Total Body Water

### DISCUSSION

The primary objective of this pilot study was the initial definition of a descriptive model of the body structure of working-age women in urban Belgrade environment. Standards for most of the measured parameters do not exist. Analyzing the mean of only certain variables such as BMI – 24.27 kg/m², visceral fat area of 77.92 cm² (over 100 cm² is considered risky; Gába, et al., 2009), percentage of fat 29.09% (30% is the limit of the obesity; http://www.acefitness.org/), we can say that the descriptive model of our women fits to the one of normal weight, which tends towards a model with an excessive amount of fat, which also means a tendency towards a higher risk of developing a disease (Pelt, et al., 2002; Zamboni, et al., 1997).

If these values are observed in relation to the fact that these are relatively young persons, of an average age of 35, we can assume, based on the trend that fat increases with age, that they will enter the zone of risk of becoming ill relatively early, which will be especially manifested in the menopausal period (Pavlica et al., 2010; Toth, Tchernof, Sites, & Poehlman, 2000). Further analyzing the current state of body structure of the measured female respondents, based on body mass index, shows a very high percentage – 40% of pre-obese and obese, while only
55% of women of normal weight are observed. The results of the overall representation of fat also support the above data, and consequently it can be said that almost 36% of women are obese, and that nearly 60% of women have normal fat mass in total body composition (http://www.acefitness.org/). It is clear that in this sample of relatively young women high levels of body fat are already noted, which may explain the fact that for 5 variables (BW, BMI, BFM, BMR, FIS) the discrepancy from the hypothetically correct distribution of results was recorded. The amount of adipose tissue affects nearly all of the said variables. Adipose tissue is the one that tends to grow almost all the life, and it has the greatest variability, because it is most affected by environmental factors (physical activity and nutrition) (Ivković-Lazar, 2004). These features of fat reserves in the body, in the millennia long periods of human existence, were crucial for survival (Zheng, Lenard, Shin, & Berthoud, 2009). Unfortunately, in modern conditions of life characterized by hypokinesia and excessive energy intake, excessive fat content becomes a key factor in the pathogenesis of a disease.

One-third of our respondents said they had no organized physical activity, 40% of them exercised only 1-2 times a week, and a quarter of women was very active (3 or more times a week). Our results confirm the report of the Institute of Public Health of Serbia from 2010, which shows that nearly two-thirds of the female population did not have a minimum amount of physical activity of 30 minutes a day. Replies of our respondents about their physical activity may partly explain the high percentage of fat and almost threshold (towards obesity) BMI.

In this study, no statistically significant linear correlation of BMI and body fat distribution with age was recorded, which has been recorded in other studies (Kyle et al., 2006), but only a slight proportional tendency of these two parameters with the age of respondents. Such a result can be explained by the fact that this is a pilot study which involved only about a hundred women, with approximately 70% of women being up to the age of forty, while 27% were older female respondents.

Based on the obtained results, the defined 4D model of body composition of working-age women provides a profile of respondents who are on the verge of obesity due to the presence of total fat in the amount from 29.09% (Table 1, compared to the average value of individual variables PBF%) to 30.32% (Figure 1, Appendix 3, compared to the calculated 4D model), indicating the tendency and risk of becoming ill. Mineral component was represented with 3.30 kg (4.88%), and protein component with 9.25 kg (13.68%) in total body composition of the researched sample.

CONCLUSION

Descriptive model of the body structure of working age women in urban Belgrade environment is characterized by a normal body weight. Two main parameters, BMI and relative representation of adipose tissue, reached threshold towards obesity. There is a very high percentage of respondents in the category of pre-obese and obese, according to the percent of body fat and BMI (36% and 40% respectively). Additionally, this pilot study has not proven a statistically significant linear relationship of aging and the increase of values of body weight parameters, although a third of respondents did not have any organized or planned physical activity.

A very important result of this study is the presentation of a 4D model of body composition of working-age women in absolute and relative values. Model characteristics of body composition of the respondents are – compared to the average body mass of the sample – 67.66 kg, the water content is 34.58 L or 51.11%, quantity of proteins is 9.25 kg or 13.68%, the mass of minerals is 3.30 kg or 4.88%, and the mass of fat is 20.25 kg or 30.32%.

Limitations of the study

According to the type, this research is a cross sectional study, which is one of the important limitations. In addition, the age distribution of respondents is not consistent with the real distribution and the average age of the female population in Serbia, which affects the obtained results.
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