

EFFECTS OF PHYSICAL ACTIVITY ON BODY COMPOSITION IN ADULT WOMEN

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Abstract: Data published by the World Health Organization (WHO) and the International Association for the Study of Obesity (IASO) suggests that the number of obese people in Europe has tripled in the last 20 years and resulted in a prevalence of 130 million obese and 400 million people overweight (Sassi et al., 2009). Body composition is the relative percentage of fat and fat-free mass (bones, muscles, organs, water, blood) of total body weight. After Wilmore, Buskirk, DiGirolamo and Lohman (1986) the optimal level for health of body fat is 16-25% (18-30%) for women. The objective of our study was to assess body composition of adult women, identifying the effect of intervention program on body fat and lean mass, and uncover cases of obesity and overweight. The study involved 95 adult women from Fit4U Fitness Center in Oradea. Period of the study: February 2015 - June 2016. Anthropometric measurements were made: height, weight, circumference, subcutaneous folds. It was calculated the body mass index (BMI), body composition and optimal body weight (estimation based on the five skinfolds measures). The physical activity program consisted of Step - aerobics, Pilates and strength training in the gym, 3 times a week for 60-90 minutes, for 12 months. Results: mean body mass, BMI, BF%, real BF decreased significantly. Mean body fat percentage from 25,63% ($\pm 6,53$) decreased to 22,95% ($\pm 5,56$). In the studied group overweight and obesity is more frequent in the age group between 35-44 years, but it can be seen the prevalence in all age groups. Conclusions: the physical activity program had a beneficial effect on body composition - by reducing body fat. We found cases of overweight and obesity (21% of the study group).

Keywords: body composition, obesity, adult women, physical activity.

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INTRODUCTION

Exercise, recreation, movement in an "accelerated" world, when women are directed towards career too, are absolutely necessary, studies showing high levels of physical inactivity since childhood (Atkin, 2013; Blair, 2009; Ruiz et al. , 2011).

For health maintenance it should be understood and applied a healthy lifestyle. Many women "who think they are healthy" are fighting with overweight or inadequate body

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composition. Promoting a healthy lifestyle is the most effective way of preventing illness and maintaining health (Woolf et. A., 1996 cited. Courtenay, 2000).

Body weight depends on many factors, the most significant being those related to individual attributes such as: height, age, sex, body constitution, body composition. It also depends on hereditary, environmental, economic, geographic factors. Recommended optimal body weight is the weight at which a person feels good, is healthy and is satisfied with his physical appearance (Șerbescu, 2007).

Body composition is the relative percentage of fat and fat-free mass (bones, muscles, organs, water, blood) of total body weight. Adipose tissue is made up of essential body fat (is present in the nervous tissue, bone marrow and organs) and non-essential or storage fat (represented by subcutaneous adipose tissue, over the muscle fascia, around the kidneys, liver and heart). Essential body fat is approximately 3% of body mass for men and 12% of body mass for women. In general, the total body fat percentage (essential plus storage fat) is between 12% and 15% for young men and between 25% and 28% for young women. Fat percentage varies according to age: in women up to 30 years in the range of 14-21%, between 30-50 years is 15-23%, respectively 16-25% over 50 years (Jeukendrup & Gleeson, 2010). After Wilmore, Buskirk, DiGirolamo and Lohman (1986) the optimal level for health of body fat is 12-18% (10-25%) for men and 16-25% (18-30%) for women.

People are considered obese when the body mass index (BMI) exceeds 30 kg/m² (WHO, 2000). Data published by the World Health Organization (WHO) and the International Association for the Study of Obesity (IASO) suggests that the number of obese people in Europe has tripled in the last 20 years and resulted in a prevalence of 130 million obese and 400 million people overweight (Sassi et al., 2009).

The lifespan of an obese person with a BMI between 30 and 35 is two to four years shorter than that of a person of normal weight. The gap increases to eight to ten years for those who are severely obese (BMI of 40-45), mirroring the loss of life expectancy suffered by smokers. An overweight person of average height will increase their risk of death by approximately 30% for every 15 additional kilograms of weight (Sassi, 2010). However, a growing body of research shows that the impact of obesity on disability is far larger than its impact on mortality (Gregg and Guralnik, 2007).

According to WHO (2009), 6% of deaths worldwide are caused by physical inactivity, being considered as an important risk factor. Overweight and obesity are responsible for 5% of global mortality (WHO, 2009).

It has been shown that participation in regular physical activity reduces the risk of coronary heart disease and stroke, diabetes, hypertension, colon cancer, breast cancer and depression. Additionally, physical activity is a key determinant of energy expenditure, and thus is fundamental to energy balance and weight control (WHO, 2002-2009).

Physically active adults are likely to have less risk of a hip or vertebral fracture. Increases in exercise training can minimize the decrease in spine and hip bone mineral density. Increases in exercise training enhance skeletal muscle mass, strength, power, and intrinsic neuromuscular activation (Bauman, A. et al., 2005; Warburton, D. et al., 2006).

Levels of physical activity tend to decrease with increasing age (Hawkins et al., 2009; Jones, Ainsworth, Croft, Macera, Lloyd, & Yusuf, 1998) and women tend to be less active than men (Jones et al.; Marshall, Jones, Ainsworth, Reis, Levy, & Macera, 2007).

The prevalence of obesity in adults is relatively low in Romania (~8%) is now the lowest in the EU27, more than 2 times below European highs (over 18% in Hungary and the UK). Instead, prevalence of overweight in Romania (35.9%) is the highest in the EU27 and the general trend is one of a worsening situation (Eurostat, 2011).

The Non-communicable Diseases Risk Factor Collaboration in their pooled analysis of 1698 population-based studies, with more than 19 million participants representing most countries found that between 1975 and 2014 the mean age-corrected BMI increased from 21,7 kg/m² to 24,2 kg/m² in men and from 22,1 kg/m² to 24,4 kg/m² in women. The prevalence of obesity also increased from 3,2%, in 1975 to 10,8% in 2014 in men and from 6,4% to 14,9% in women (NCD Risk Factor Collaboration, 2016).

OBJECTIV OF THE STUDY

The objective of our study was to assess body composition of adult women, identifying the effect of intervention program on body fat and lean mass, and uncover cases of obesity and overweight.

MATERIALS AND METHODS

Subjects

This study involved 95 adult women (originally 119) who attended two gyms of Fit4U Fitness Center in Oradea.

Period of the study: February 2015 - June 2016. Baseline assessment were conducted in February-March 2015. The subjects attended the gym for 12 months, and during May-June 2016 were carried out the follow-up evaluations. At the follow-up evaluation participated 95 women of 119, others abandoned/quitted along the way (for various reasons: maternity leave, over 2 weeks of physical inactivity).

The research included only those women who showed interest, accepted the measurements and gave permission that their data to be used in research. So it was non-random sampling, from non probabilistic sample category we used the convenience (Sandor, 2013).

Methods

Anthropometric measurements were performed after the standards described by ISAK - International Society for the Advancement of Kinanthropometry:

- stature (in centimeters, with stadiometer);
- body mass/weight (in kg using a calibrated weighing scale);
- ghirts (in cm, antropometry tape) in the following areas: neck, chest, arm relaxed, waist, hips, thigh, calf;
- skinfolds (in mm, with Slim Guide caliper): only at the right side of the body, 3 times each region and using the average value in the following 5 regions: biceps, subscapular, abdominal, supraspinal (or wing), thigh .

Calculation of body composition and optimal body weight was made after formulas by the National Center for Sports Medicine from Romania (Dragan, I. 2002. Iliescu, A. 2013; Șerbescu, C. 2007) based on the measurement of five skinfolds: biceps, subscapular, abdominal, supraspinal and thigh in mm.

Then, after assessing body fat percentage (BF%), actual body mass (BM kg), actual fat-free mass (FFM kg), was calculated the optimal body fat in kilograms (BF kg), optimal fat-free mass, and the optimal body mass/weight:

$$\text{Body fat percentage (BF\%)} = (5 \text{ skinfolds sum(mm)} \times 0.15) + 5.8 + (\text{BSA})\text{m}^2$$

$$\text{BSA} = \text{Body Surface Area, was estimated using Du Bois formula (Du Bois, 1916)}$$

$$\text{Actual BF (kg)} = \text{Actual body mass(kg)} \times \text{BF\%}$$

$$\text{Actual FFM (kg)} = \text{Actual BM (kg)} - \text{BF(kg)}$$

$$\text{Optimum FFM (kg)} = \text{Actual BM(kg)} \times 75\%$$

$$\text{Optimum BF} = \text{Optimum FFM} \times 25\%$$

$$\text{Optimal Body mass (kg)} = \text{Optimum FFM (kg)} + \text{Optimum BF}$$

Data were statistically analyzed with SPSS, version 15.0 (descriptive analysis and comparison of means).

Physical activity program

The physical activity program consisted in combined training of Step - aerobics, Pilates and strength training in the gym, 3 times a week for 60-90 minutes, for 12 months.

Depending on individual objectives (weight loss, decrease body fat - at overweight and obese subjects/weight gain - at underweight subjects) was different the number of repetitions, different load and intensity of training used.

There were used: dynamic, repetitive exercises, with large muscles groups; hard resistive exercises; functional exercises; high intensity interval training; balance exercises (Pilates); circuit training; stretching exercises.

Muscle strengthening was conducted mainly in the following muscle groups: upper limb muscles, back muscles, abdominal muscles, lower limb muscles.

RESULTS

They were assessed 95 adult women, aged between 18 and 52 years. For objective analysis of the measurements, subjects were distributed on age categories shown in Table 1.

Table 1. Subject distribution by age categories

	18 – 24 years	25 – 34 years	35 – 44 years	45 – 52 years
Nr. of subjects	41	31	14	9
Percentage	43,2%	32,6%	14,7%	9,5%

Baseline and follow-up means of evaluated somatic parameters for the whole group are presented in Table 2.

Table 2. Descriptive analysis of anthropometric measurements

Anthropometric characteristics					
		Mean (\pm SD)	Min	Max	p \leq 0,05
Age (years)		28,45 (\pm 8,74)	18	52	
Weight (kg)	Baseline	63,67 (\pm 11,69)	43	103	0,000
	Follow-up	62,39 (\pm 10,63)	43	98	
	Optimal	59,69 (\pm 10,96)	40,31	96,56	
Height (cm)		166,88 (\pm 6,36)	150	190	
BMI (kg/m ²) Baseline		22,86 (\pm 3,76)	16,61	36,49	0,000
BMI (kg/m ²) Follow-up		22,40 (\pm 3,60)	16,96	34,72	
Sum of 5 skinfolds (biceps, subscapular, abdominal, supraspinal, thigh) mm Baseline		120,83 (\pm 42,90)	58	247	0,000
Sum of 5 skinfolds (biceps, subscapular, abdominal, supraspinal, thigh) mm Follow-up		103,04 (\pm 36,48)	40	208	
BF % Baseline		25,63 (\pm 6,53)	16,22	45	0,000
BF % Follow-up		22,95 (\pm 5,56)	13,37	39,11	
BF (kg)	Baseline	16,95 (\pm 7,61)	8,33	45,90	0,000
	Follow-up	14,79 (\pm 6,26)	7,09	38,33	
	Optimal	11,94 (\pm 2,19)	8,06	19,31	
Fat-free mass (kg)	Baseline	46,71 (\pm 5,20)	34,58	64,57	0,850
	Follow-up	47,66 (\pm 5,51)	34,58	64,57	
	Optimal	47,75 (\pm 8,77)	32,25	77,25	
	Neck Baseline	31,89 (\pm 2,13)	28	41	0,000
	Neck Follow-up	31,27 (\pm 1,92)	28	40	
	Arm (right) Baseline	28,41 (\pm 3,81)	22,5	43	0,000

Effects of physical activity on body composition in adult women

Girth (cm)	Arm (right) Follow-up	27,66 (\pm 3,65)	23	41	0,000
	Arm (left) Baseline	28,32 (\pm 3,68)	23	42	
	Arm (left) Follow-up	27,57 (\pm 3,57)	23	41	0,000
	Chest Baseline	76,71 (\pm 8,17)	60	101	
	Chest Follow-up	76,03 (\pm 7,86)	60	98	0,000
	Waist Baseline	73,15 (\pm 9,62)	58,5	103,5	
	Waist Follow-up	72,15 (\pm 8,94)	59	99	0,000
	Hip Baseline	98,97 (\pm 8,68)	85	130	
	Hip Follow-up	97,36 (\pm 7,21)	84	120	0,000
	Thigh (right) Baseline	56,42 (\pm 5,95)	31,5	75	
	Thigh (right) Follow-up	55,73 (\pm 5,58)	31	72	0,000
	Thigh (left) Baseline	56,13 (\pm 5,86)	31	72	
	Thigh (left) Follow-up	55,57 (\pm 5,54)	31	71	0,000
	Calf (right) Baseline	36,80 (\pm 3,96)	31	59	
	Calf (right) Follow-up	36,47 (\pm 3,83)	31	58	0,000
	Calf (left) Baseline	36,83 (\pm 3,97)	31	59	
Calf (left) Follow-up	36,47 (\pm 3,76)	31	58		

The results of the baseline and follow-up means of evaluated somatic parameters on age groups can follow in Table 3.

Tabel 3. Baseline and follow-up means of evaluated parameters on age categories

Age category	Nr. of subjects	Evaluated parameters	Mean (\pm SD)		P - value ($p \leq 0,05$)
			Baseline	Follow-up	
18 – 24 years	41	Weight (kg)	59,05 (\pm 8,57)	58,44 (\pm 7,89)	0,003
		BMI	20,90 (\pm 2,71)	20,68 (\pm 2,46)	0,002
		Sum of skinfolds (mm)	103,51 (\pm 33,58)	91,22 (\pm 27,27)	0,000
		BF %	22,99 (\pm 5,11)	21,14 (\pm 4,16)	0,000
		Real BF (kg)	13,92 (\pm 5,27)	12,62 (\pm 4,30)	0,000
		FFM (kg)	45,12 (\pm 4,12)	45,91 (\pm 4,38)	0,000
25 – 34 years	31	Weight (kg)	66,35 (\pm 13,47)	64,42 (\pm 12,07)	0,002
		BMI	24,13 (\pm 4,51)	23,45 (\pm 4,14)	0,001
		Sum of skinfolds	130,26 (\pm 45,75)	108,16 (\pm 41,20)	0,000
		BF %	27,06 (\pm 6,99)	23,73 (\pm 6,27)	0,000
		Real BF (kg)	18,75 (\pm 8,95)	15,86 (\pm 7,43)	0,000
		FFM (kg)	47,59 (\pm 5,48)	48,55 (\pm 5,88)	0,000
35 – 44 years	14	Weight (kg)	68,36 (\pm 12,95)	66,93 (\pm 12,01)	0,045
		BMI	24,68 (\pm 3,87)	24,11 (\pm 3,54)	0,023
		Sum of skinfolds	140,29 (\pm 43,57)	118,43 (\pm 36,85)	0,000
		BF %	28,60 (\pm 6,65)	25,31 (\pm 5,64)	0,000
		Real BF (kg)	20,19 (\pm 8,24)	17,51 (\pm 6,94)	0,002
		FFM (kg)	48,16 (\pm 6,24)	49,62 (\pm 6,41)	0,011
45 – 52 years	9	Weight (kg)	68,22 (\pm 9,35)	66,33 (\pm 9,34)	0,005
		BMI	24,64 (\pm 3,26)	23,96 (\pm 3,26)	0,005
		Sum of skinfolds	137,00 (\pm 47,05)	115,33 (\pm 44,06)	0,000
		BF %	28,11 (\pm 7,09)	24,84 (\pm 6,64)	0,000
		Real BF (kg)	19,52 (\pm 6,74)	16,79 (\pm 6,11)	0,001
		FFM (kg)	48,69 (\pm 5,72)	49,54 (\pm 5,90)	0,125

Calculating BMI of the subjects included in the study shows that 71% had normal weight, 16% were overweight, 8% underweight and 4% had obesity class I, 1% class II obesity. At the

final assessment 74% were normal weight, 13% were overweight, 9% underweight, 4% obese class I and no one had class II obesity (figure 1).

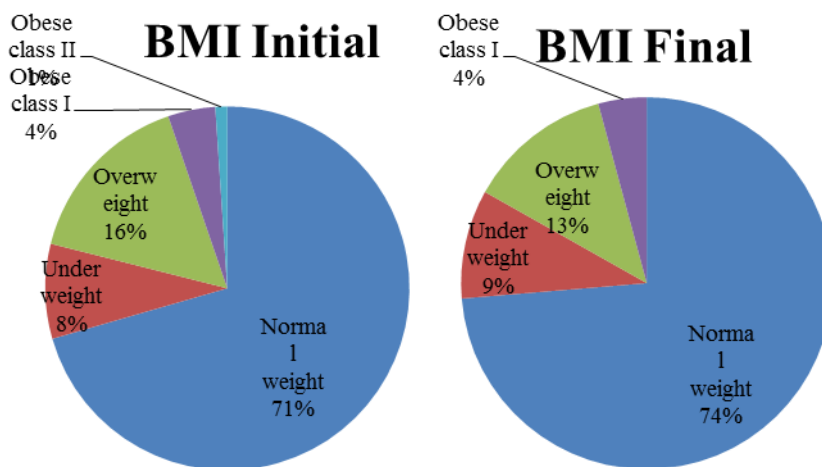


Figure 1: Percentage of body weight based on BMI

In Table. 4. you can follow the numerical and percentage prevalence of overweight and obesity subjects, by age groups, at the baseline and follow-up evaluation.

Table 4. The prevalence of overweight and obesity on age categories

	18 – 24 years (41 subjects)		25 – 34 years (31 subjects)		35 – 44 years (14 subiecți)		45 – 52 years (9 subjects)		Total 18 – 52 years (95 subjects)	
	B*	F**	B	F	B	F	B	F	B	F
Nr. of overweight and obese subjects	5	3	8	7	5	4	2	2	20	16
Percentage	12,2%	7,3%	25,8%	22,6%	35,7%	28,6%	22,2%	22,2%	21,1%	16,8%

*B=Baseline; **F=Follow-up

DISCUSSIONS

The mean weight of the group at baseline was 63.67 (\pm 11.69) kg and at follow-up was 62.46 (\pm 10.71) kg, 1,21 kg less than the baseline mean. Although, according to statistical analysis the loss is significant ($p = 0.000$), we consider this weight loss after 12 months training program is low. But we have to take into account that 8% of subjects were underweight, they wanted to gain weight, and 16% of overweight subject lost on average 2,73 kg, respectively 4% obese lost 3,25 kg.

Baseline mean of body fat percentage (BF%) was 25,63% (\pm 6,53), which is at normal range, but 26 women had BF% higher than the threshold, above 28%. Above this threshold are considered a risk for health (Jeukendrup & Gleeson, 2010). Follow-up mean of BF% was 22,95% (\pm 5,56) and exceed the threshold of 28% only 18 subjects.

Baseline mean of real body fat (BF kg) decreased with 2,16 kg from 16,95 ($\pm 7,61$) kg to 14,79 ($\pm 6,26$) kg. Paired sample T test shows that the loss is significant ($p = 0.000$), and the age category at which the loss is the highest is 25-34 years: 2,89 kg (Table 3.).

There are studies indicating the same tendencies in weight loss, BF%, real BF loss, like in our study, after a similar physical activity training programme (Skrypnik et. al, 2015; Willis et. al, 2012).

The mean of fat-free mass increased from 46,71 ($\pm 5,20$) to 47,66 kg ($\pm 5,51$) kg.

Baseline mean of the sum of 5 skinfolds (biceps, subscapular, abdominal, supraspinal, thigh) was 120,83 mm, which is above the general average, normally the sum of these skinfolds is between 80-100 mm (Ionescu & Gurău, 2006; Șerbescu, 2007). At the follow-up the sum of 5 skinfolds approached this threshold: 103,04 mm.

Baseline mean of waist girth was 73,15 ($\pm 9,62$) cm, which is considered normal, but we must mark that 20 of the 95 subjects were over 80 cm, which is the maximum recommended by the World Health Organization. Above this threshold there is an increased risk of developing heart disease, diabetes etc. (WHO, 2008). Follow-up mean of waist girth was 72,15 (± 8.94) cm and 18 subjects were over 80 cm.

The prevalence of obesity in adults is relatively low in Romania (~8%), whereas the prevalence of overweight is the highest in the EU27: 35,9% (Eurostat, 2011).

At the group studied by us the trend is the same: 5% are obese and 16% are overweight.

According to the study of Prospective Studies Collaboration from 2009, unhealthy diets, sedentary lifestyles and obesity are responsible for a considerable proportion of the burden of ill health and mortality. The largest existing study of the link between obesity and mortality, covering close to one million adults in Europe and North America, came to the conclusion that mortality increases steeply with BMI once individuals cross the 25 kg/m² threshold (the lower limit of the overweight category) (Prospective Studies Collaboration, 2009). **At the group studied by us 21% cross this threshold.**

In our study can be seen overweight and obesity in all age groups and highest percentage can be observed in the age group between 35-44 years (Table 4.).

CONCLUSIONS

Implementation of the physical activity program for 12 months showed significant changes in body composition. It should be noted that subject's diet and nutrition has not changed. The intervention program on body composition had a beneficial effect – by reducing body fat percentage with 2,68% and actual BF with 2,16 kg, increased of fat-free mass (FFM) with 0.95 kg. We probably had a greater impact on body composition with daily frequency of training program and if we could monitor and influence nutrition. Also at the training programme we haven't the possibility to differentiate the subjects by age group or by level of physical condition.

We found cases of overweight and obesity: 21% of the study group.

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Submitted:
July 28 , 2016

Revised:
March 10, 2017

Accepted and published online
June 08, 2017