

The effect of physical training program on body composition and body mass index

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ABSTRACT

Objectives: To evaluate the effect of physical training program on body composition and body mass index, and to evaluate the body mass index as predictor of body fat in young adults.

Material and methods: Prospective was done at the College of Physical Education – University of Mosul, first year students (100) male and (22) female were participated in this study. A physical training program of 2 hours (aerobic exercise) daily for 4 days per week for 4 months. Medical height and weight scales (Detector) and bio-electrical impedance analysis measurements device(Quantum Π) were used for measurements.

Results: Physical training program has significant effect on body weight, BMI and free fat mass, but has no significant effect on fat mass.

Conclusions: Physical training program increase BMI and free fat mass but has no significant effect on fat mass. BMI is a specific test for overweight and obesity but it is not a sensitive test.

Keywords: BMI, physical training program, body composition.

الخلاصة

الأهداف: تقييم تأثير برنامج التدريب الجسدي على تركيبة الجسم ومؤشر كتلة الجسم وتقييم كفاءة مؤشر كتلة الجسم كدالة على نسبة الدهون لدى الشباب.

طريقة العمل: دراسة استباقية أجريت في جامعة الموصل كلية التربية الرياضية على طلبة السنة الأولى كلية التربية الرياضية (100) من الذكور (22) من الإناث. تم تطبيق برنامج التدريب الجسدي لمدة ساعتين يومياً وعلى مدى أربعة أيام في الأسبوع ولأربعة أشهر وتم استخدام جهاز قياس الطول والوزن وجهاز تحليل المقاومة الكهربائية الحيوية. **النتائج:** لبرنامج التدريب الجسدي تأثير معنوي على وزن الجسم ومؤشر كتلة الجسم والكتلة الخالية من الدهون ولم يظهر له تأثير على كتلة الدهون.

الاستنتاجات: برنامج التدريب الجسدي له تأثير معنوي على مؤشر كتلة الجسم والكتلة الخالية من الشحوم وليس له تأثير معنوي على كتلة الشحوم. مؤشر كتلة الجسم هو فحص خاص لزيادة الوزن ولكن غير حساس.

الكلمات المفتاحية: مؤشر كتلة الجسم، تركيبة الجسم، برنامج التدريب الجسدي.

Obesity is a world wide public health problem, and its great increase is mainly due to the increases in energy consumption owing to availability of food of high caloric density and to the reduction of energy expenditure by regular physical activities¹⁻⁶. Observational and experimental

studies have shown beyond doubt the growing prevalence of obesity. Obesity occurs in an individual when body fat is very high relative to the lean body mass and is defined as a body mass index (BMI) $\geq (30 \text{ Kg} / \text{m}^2)^{(7,8)}$.

Absolute prevalence has been observed across the globe over the past few decades⁽⁹⁾.

The WHO estimates that over a billion adults are over-weight and over 30· millions are obese world wide. We are facing a global obesity crisis^(10,11).

Obesity means having too much body fat. It is different from being over weight which means weighing too much, the weight comes from muscle, bone, fat and / or body water. Both terms mean that a person's weight is greater than what's considered healthy for his or her height^(12,13).

The national Health and Nutrition Examination Survey (NHANES) reports that the prevalence of obesity has doubled over the last 25 years, based on direct height and body – weight measurements^(14,15).

Obesity is a cause of major morbidity and mortality^(16,17); it is associated with numerous co-morbidities such as cardiovascular disease, type 2 diabetes, hypertension, certain cancers, sleep apnea, osteoarthritis and reduced life expectancy⁽¹⁸⁻²¹⁾.

BMI is a calculation based on height, weight and gender specific in adults. It does not directly measure the percentage of body fat, but it is a more accurate indicator of over weight and obesity that relying on weight alone⁽²²⁾.

Bioelectrical impedance analysis is another method of assessing body fat percentage. There is a variety of body composition and body fat analyzer and scales available that provide more than just total weight measurements. It determines total weight measurements, the percent and amount of body fat, muscle mass, water and even bone mass⁽²³⁾.

Eating disorder clinics and fitness centers use more sophisticated tests such as bioelectrical impedance analysis that calculate lean body mass, body fat, and total body water based on changes in conduction of all applied electrical current⁽²⁴⁾.

When weight is lost too rapidly or by significant reductions in energy intake, lean muscle mass will be lost, which can affect performance negatively^(25,26).

The National Institute of Health recommends, that a healthy adult male's body should have

between 13-17% fat , a healthy female's body should be composed of 25% fat⁽²⁷⁾.

Objectives: To evaluate the effect of physical training program on body composition and body mass index, and to evaluate the body mass index as predictor of body fat in young adults.

Methods

The data were collected prospectively using experimental design. A simple stratified sample consists of 122 students (100 males and 22 females) from first year of the College of Physical Education– University of Mosul.

The pre test started at 1st Dec. 2008 for one month, standard scale (medical Decto scale, USA origin) is used for measuring the height and weight of adults, was used in order to identify the BMI levels. The weight was measured in kilograms and the height was measured in meters.

Using the following formula to calculate the BMI:

$$BMI = \frac{\text{Weight in kilogram}}{(\text{Height in meters})^2}$$

Body composition was examined by using of Bio – electrical impedance analysis device (Quantum Π – USA origin); available at Nursing College and College of Physical Education– University of Mosul. The following circumferences in the body were measured, neck, chest, abdomen, hip, right arm, right thigh, right calf circumferences.

Body composition measurements

- a. Fat percentage.
- b. Fat weight (kg).
- c. Free fat percentage.
- d. Free fat weight.
- e. BMI.

The results of Segal study 1998 confirms the validity of BIA and indicate that the precision of predicting LBM and FFM from impedance, can be enhanced by sex and fatness-specific equations⁽²⁸⁾.

The following guideline were applied before Bio–electrical impedance analysis measurement:

- 1- No eating or drinking within 4 hours of the test.
- 2- No exercise within 12 hours of the test.
- 3- Urinate within 30 minutes of the test.
- 4- No alcohol consumption within 48 hours.
- 5- No Diuretic within 7 days.

The BIA test starts by lying the student on testing table, and electrodes are connected to the hands and feet, electrolyte gel is applied, then a current of 50 KH2 is introduced. Selecting the appropriate equation to determine the quality of the results and minimize variables. Average time for conducting this test is about 10 minutes BIA is used to determine body weight, BF%, free fat mass.

According to the College of Physical Education curriculum; a physical training program of 2 hours of aerobic exercise with strength training (moderate practice at the beginning and increased gradually) for 4 days a week for 4 months is practiced. The post test started on the 1st April 2009, BMI and BIA was also examined in the same manner for one month.

Results

Table (1) shows significant difference of physical training program on mean body weight, BMI and free fat but no significant difference on fat mass.

Table (2) shows anthropometric measurements in male pre and post physical training program by using BMI, and bio electrical impedance analysis to determine BF%.

Table (1): The effect of physical training program.

Categories	Physical training program	No.	X	SD	t.cal	P. Value
Body weight	Pre	122	64.94	9.6	2.9	0.05
	Post	122	65.81	9.9		Sig
BMI	Pre	122	22	9	3.6	0.05
	Post	122	23	10.4		Sig
Fat mass	Pre	122	12.3	5.6	1.5	0.05
	Post	122	11.35	5.8		N.S
Fat free mass	Pre	122	80.2	11.9	3.5	0.05
	Post	122	83.6	7.4		Sig

df= 121, t. critical = 2.6, X= mean weight in kilograms

BMI classify 82% of students within normal range, while actually 42% of them are within normal range by using BIA for estimating of body fat . After physical training program (post test) there is an increase of the over weight and obese students, while there in decrease in the number of over weight and obese students by using BIA for estimating body fat. The mean BMI is (22) and mean body fat is (21) in pre physical training program while the mean BMI is (23) and mean body fat is (16) in post physical training program.

Table (3) shows the anthropometric measurements in female pre and post physical training program BMI, BF%.

It shows that 68% of females are within normal range of weight by using of BMI, while 28% only are within normal range by using of BIA, in contrast to 18% are overweight by using BMI and 45% are over weight by using BIA.

No great difference is seen in post training program by the use of BMI and BIA, and the mean BMI is (22) in pre and post physical training program.

The mean body fat is (47) in pre physical training program while it is (38) in post physical training program by using of bio electrical impedance analysis.

Table (4) shows the sensitivity and specificity of BMI.

It represent the sensitivity and specificity of BMI in males and females according to WHO criteria. The mean specificity is 87.5% in males compared with 84.9% in females, while mean sensitivity is 30.2% in males and 32% in females, it indicate that BMI is a specific test but it is not a sensitive test for overweight and obesity.

Table (2): Male anthropometric measurements in pre and post physical training program.

Pre physical training program	BMI		Body fat	
	no	%	no	%
underweight	1	1	4	4
normal	82	82	42	42
overweight	13	13	32	32
obese	4	4	22	22
X- SD	22-7.5	2-3.6	21-3.8	13-0.6

Post physical training program.	BMI		Body fat	
	no	%	no	%
underweight	4	4	2	2
normal	73	73	57	57
overweight	15	15	24	24
obese	8	8	17	17
X-SD	23-1.55	2-3	16-6.5	9-0.7

Table (3): Female anthropometric measurements in pre and post physical training program.

Pre physical training program.	BMI		Body fat	
	no	%	no	%
underweight	1	4	0	0
normal	15	68	6	28
overweight	4	18	10	45
obese	2	10	6	27
X-SD	22-4.4	3-2.9	47-5.2	18-0.6

Post physical training program.	BMI		Body fat	
	no	%	no	%
underweight	2	10	0	0
normal	13	59	6	28
overweight	4	18	11	49
obese	3	13	5	22
X-SD	22-5.2	3-12	38-5.9	15-3.6

Table (4): The sensitivity and specificity of BMI in male and female.

BMI	Male		Female	
	Specificity	Sensitivity	Specificity	Sensitivity
<18.5	96%	3%	90.5%	9.5%
18.5 – 24.9	77.5%	100%	68.5%	100%
25.0 – 29.9	84%	13.3%	96%	4%
>30.0	92.5%	4.3%	84.5%	15%
Mean	87.5%	30.2%	84.9 %	32.1%

Discussion

Obesity is a cause of major morbidity and mortality. It is a chronic condition associated with increased cardio metabolic risk as well as number of obesity – related co morbidities. Achieving and maintaining weight reduction can have numerous positive effects , on overall health ⁽²⁹⁾.

There is universal support for the use of physical activity to decrease overweight and promote improved health ^(30,31). An increase in physical activity is an important part of weight management program. Most weight loss occurs because of decreased caloric intake. Sustained physical activity is most helpful in preventing weight regain⁽³²⁾.

There are reasons to become more informed about body composition:

- To develop complete physical fitness profile for clients.
- To monitor body fat loss and muscle growth resulting from exercise.
- To provide baseline data for nutritional counseling and treatment of obesity.
- To describe changes due to growth, development, maturation and aging.
- To maximize the performance of athletes⁽³³⁾.

Table (1) shows significant difference of physical training program on body weight , BMI and free fat mass, but no significant difference on fat mass.

Physical activity has been shown to be inversely associated with BMI in numerous cross-sectional studies, and obese subjects have been observed to be physically less active than non-obese. However, in some studies No association between physical activity and BMI has been found or an inverse association has been observed only in women^(34,35).

Table (2) shows anthropometric measurements in males pre and post physical training program by using BMI, and bio electrical impedance analysis to determine BF%.

The athlete's weight should typically fall between the 25th and 75th percentile of weight for height for age (by National center for health statistics guidelines), although some athletes weigh more because of increase muscles mass, the use of BMI in athletes is not recommended^(36,37).

BMI demonstrates low or no correlation with other methods for assessing overweight and obesity, BMI identifies fewer obese subjects than other methods⁽³⁸⁾.

WHO suggest the use of BMI as a method of choice to determine over weight, it is an adequate method, its index ranges from malnutrition to grade III obesity, However, fat content, which is the most important factor in terms of associated chronic disease may oscillate widely within the same BMI value⁽³⁹⁾.

Table (3) shows the female anthropometric measurements in pre and post physical training program. Significantly higher associations exist in each gender between BMI and BF% in the upper BMI textile than in the lower BMI textile. In the lower BMI textile, the correlations between BMI and FFM were approximately twice as large as those between BMI and BF%, the BMI correctly identified 44% of obese men and 52% of obese women, when obesity was determined from BF%, BMI is an uncertain diagnostic index of obesity⁽⁴⁰⁾.

Average men have more skeletal muscles than average women and average women have more fat than average men^(41,42).

Jackson 2002 study show there is an average BMI gap of 2.3 kg/m² between men and woman, body fat 25% for men, 33% for

woman⁽⁴³⁾, while Deureberg 2001 study shows overweight women tend to have higher BMI values than over weight men⁽⁴⁴⁾.

The mean BMI in men is not necessarily that different from BMI in women; body composition does vary by gender, men have more skeletal muscle than women – both in absolute terms and relative to body mass. The differences have been found to be greater in the upper body⁽⁴⁵⁾.

Table (4) represents the sensitivity and specificity of BMI in males and females according to WHO criteria. It indicates that BMI is a specific test but it is not a sensitive test for overweight and obesity. This result is in agreement with Dietiz study 1998 which show that the BMI has a poor sensitivity to screen for overweight⁽⁴⁶⁾.

Sensitivity is given more importance than specificity since false positive overweight is not considered as serious as a false negative overweight⁽⁴⁷⁾.

The use of BMI to screen for overweight / obesity can generate a high percentage of false positive male and even higher percentage of false negative female, a more universal approach to using anthropometric measure to screen for overweight / obesity should be developed⁽⁴⁰⁾.

BMI a number tested a formula for calculating weight for height is significantly associated with total body fat content and should be used to monitor changes in body weight or to assess overweight or obesity, the calculated BMI is a common clinical Index of obesity or altered body fat distribution. A well accepted scale has been developed to calculate by gender using weight-to-height ratios⁽⁴⁸⁾.

BMI continues to serve well for many purposes, but the time is now right to initiate a gradual evolution beyond BMI toward standards, based on actual measurement of body fat mass⁽⁴⁹⁾.

Conclusions

Increased physical activity has significant effect on body weight, so sustained physical activity is most helpful in the prevention of weight regain.

Anthropometry has the advantage of being a measuring tool involving less time and

operational costs than other more complex methods, However, BMI fails to distinguish between lean body mass and fat, thus the relationship between BMI and body fatness varies according to body composition properties.

BIA is a method of choice to determine body fat . One draw back of using BIA method is the equipment is relatively expensive (\$3,500).

Recommendations

- Physicians should understand body composition measurement, and be willing to educate athletes, about nutritional consultation and physical training programs.
- Results are consistent with published data showing the need to consider the age and sex as an open defining the prevalence of obesity with BMI.
- BIA should be considered as a method of choice to determine overweight and obese people according to fat mass.

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