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Assessment of Physical Fitness in Relation to Body Mass Index using Treadmill in Female Adults

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Abstract: ***Body Mass Index is the most appropriate simple indicator by which weight-for height can be related to health outcome. WHO therefore proposed the use of BMI to monitor both under nutrition and overweight in population. In the present study assessed the physical fitness in relation to body mass index by using treadmill and results shown that lowest activity time, energy expenditure was observed in obese and overweight people where as systolic B.P, BMR was highest in obese people and there is no statistical significance between the BMI and Hb level.***

Keywords: World Health Organization (WHO), Body Mass Index (BMI), Activity time (AT), Total energy expenditure (TEE), Basal metabolic Rate (BMR), Blood Pressure (B.P.),Haemoglobin (Hb)

1. Introduction

BMI is an indicator of total body fat and is therefore an indicator of health risk. BMI is used by healthcare professionals to screen for overweight and obese individuals.

This information can be used by healthcare professionals to assess a patient's health risk. A high BMI is a risk factor for disease and even death. People with BMI scores indicating that they are overweight or obese have a greater chance of developing high blood pressure, high blood cholesterol or other lipid disorders, type 2 diabetes, heart disease, stroke, and certain cancers. They are also at an increased risk for premature death, cardiovascular disease, gallbladder disease, sleep apnea, and osteoarthritis. As a person's BMI score increases so does his or her health risk.

BMI, which is calculated as weight (kg) divided by height squared (m2), was chosen as a simple measurement of body weight in relation to height. While increases in both body fat and lean tissue cause increments in BMI, relationships between body weight and health are conventionally expressed in terms of BMI rather than body fat **(Zimmet, 2006).**

Although the measurement and analysis of body weights and heights have been recognized as general indices of health for many years, it is only comparatively recently that the World Health Organization (WHO) has set out criteria for assessing underweight and overweight in both children and adults **(WHO 1995).** WHO Technical Consultations **(WHO 1995, 2000)** endorsed the use of a common BMI scheme for adults irrespective of sex or age. There are various causes of obesity such as environmental pollution, stress, and lack of exercise, overeating combined with lack of exercise is considered to be the main cause according to most scientists **(Na et al., 2001).**
Science of disease prevention and health improvement are crucial matters in our society and obesity is becoming a big issue for example, heart related diseases recently came up as a major cause of death. Research has shown that obesity can lead to health problems, including arthritis, heart disease and diabetes. One way to help to ensure that these problems do not arise is to improve people's physical fitness levels by taking regular exercise and awareness of physical fitness in the general population. A key concept in testing physical fitness is that of a person's pulse rate and, in particular, how quickly this returns to normal after excessive exercise. It is important that the pulse rate returns to normal after strenuous exercise, otherwise the heart is put under continuous stress. The purpose of this study was to examine the relationship between body mass index (BMI) and physical fitness.

2. Review of Literature

A study tested the hypothesis of body mass index (BMI) is representative of body fatness independent of age, sex, and ethnicity. Between 1986 and 1992, the authors studied a total of 202 black and 504 white men and women who resided in or near New York City, were ages 20-94 years, and had BMIs of 18-35 kg/m2. Total body fat, expressed as a percentage of body weight (BF%), was assessed using a four-compartment body composition model that does not rely on assumptions known to be age, sex, or ethnicity dependent. Statistically significant age dependencies were observed in the BF%-BMI relations in all four sex and ethnic groups (p values < 0.05-0.001) with older persons showing a higher BF% compared with younger persons with comparable BMIs. Statistically significant sex effects were also observed in BF%-BMI relations within each ethnic group (p values < 0.001) after controlling first for age. For an equivalent BMI, women have significantly greater amounts of total body fat than do men throughout the entire adult life span. Ethnicity did not significantly influence the BF%-BMI relation after controlling first for age and sex even though both black women and men had longer appendicular bone lengths relative to stature (p values < 0.001 and 0.02, respectively) compared with white women and men. Body mass index alone accounted for 25% of

between individual differences in body fat percentage for the 706 total subjects; adding age and sex as independent variables to the regression model increased the variance (r2) to 67%. These results suggest that BMI is age and sex dependent when used as an indicator of body fatness, but that it is ethnicity independent in black and white adults. **(Gallagher et al, 1996).** The present meta-analysis was conducted to assess the effect of overweight and obesity on ovarian cancer risk in the premenopausal and postmenopausal periods and find the results of both cohort and case-control studies showed being overweight and obesity increased the risk of ovarian cancer compared to women with normal weight during both premenopausal and postmenopausal periods: RR=1.08 (95%CI: 0.97, 1.19) and OR=1.26 (95%CI: 0.97, 1.63) for overweight and RR=1.27 (95%CI: 1.16, 1.38) and OR=1.26 (95%CI: 1.06, 1.50) for obesity. From this it can concluded that there is sufficient evidence that an increase in BMI can increase the risk of ovarian cancer regardless of the menopausal status, mimicking a dose-response relationship although the association is not very strong **(Poorolajal etal., 2014)**

A study conducted to assess the impact of Gestational Diabetes Mellitus (GDM) and obesity on neonatal and maternal pregnancy outcomes.The analysis showed that obesity and GDM were independent risk factors of perinatal complications. Only BMI had a dose-dependent effect on the risk of macrosomia and caesarean section. Both obesity (BMI > 30 kg/m2) and GDM were independent risk factors of neonatal morbidities. (**Vellinga et al, 2012)**

A study examined the relationship between elevated Body Mass Index (BMI) and selected physical fitness variables in male handball players. In addition, we investigated whether this relationship is age-dependent, i.e., whether a higher BMI has the same implications for physical fitness in adolescents as in adult players. Therefore, adolescent (n = 57, aged 14.9±1.4 yr) and adult (n = 39, 26.6±5.7 yr) participants performed a series of anthropometric and physical fitness measures. In adolescent players, BMI was inversely related with countermovement jump (r = -0.26), (**Nikolaids and Ingebrigtsen, 2013)**.

This study was investigated relationships between body mass index (BMI), physical fitness, and academic performance in elementary school students. Specifically, BMI and scores on the President's Challenge Physical Activity and Fitness Awards Program, a physical fitness test, were compared to reading and mathematics scores on the Florida Comprehensive Assessment Test (FCAT), a standardized normreferenced academic achievement measure. Participants included 132 4th and 5th grade students from a k-12 school located in North Central Florida. Results revealed that BMI and physical fitness were correlated with academic performance for 5th grade females. In addition, there was a significant and negative association found between BMI and physical fitness across grade level and sex **(Wingfield et al., 2011).**

The aim of the present study was to co-relate the incidence and relationship between the measures of efficiency physical fitness and the body mass index. And a A cross-sectional study was done to determine the correlation between the measures of efficiency fitness Index and body mass index. Subjects' physical fitness & body mass index was assessed using standardized protocols.. The study revealed high prevalence of low fitness among obese subjects and significant correlation between the selected indices of physical fitness (efficiency fitness index) and body mass index. From this it can be Conclued that the efficiency fitness index of the subjects differed significantly from one another in the various BMI categories, with the subjects of normal weight possessing a higher fitness than the overweight or obese subjects. Fitness capacity therefore decreased progressively as the BMI increased **(Srivastava1 et al., 2013)**

3. Methodology

In the present study 30 female postgraduate and Ph.D students selected from Acharya N.G.Ranga Agricultural University. And all the subjects were in the age group of 20 to 30years. In the present study, "Physical fitness was tested in lab conditions with the help of Graded maximal exercise test (GXT) under laboratory conditions using standard Bruce protocol on the treadmill. The heart rates were monitored on a online polar heart rate monitor throughout the exercise period and recovery time. Bioelectrical Impedance" named as "Body stat" was used to assess the Body composition of the subjects. The body composition such as total body fat (BF), lean body mass(LBM), and total body water(BW), and Body mass Index(BMI) Basal Metabolic Rate (BMR)were measured.

Method of Application of Body stat: The subjects were made in lie down in a relaxed state and out of the four electrodes two were attached at the back of the right palm while two electrodes were attached right leg upper side of the foot. Body stat also contains electrodes that have wires and these were attached with electrodes. The total detailed body composition was measured through Body stat. The gel electrodes were attached at the center of the third and fourth fingers of the palm and another one was attached below the electrode and near the wrist. For right leg, the gel electrodes were attached between third and fourth toes of right foot and another electrode were attached above to first electrode and towards right ankle. The electrodes are having two colors i.e. red and black wires and red wire electrode attached close to fingers and toes while black color electrodes was attached close to wrist and ankle joints. After completing the circuits, the data pertaining to subject number, age, height, weight, sex and activity (Sedentary / Moderate / Heavy) were entered. Body stat measures the total body composition such as total body fat (BF), lean body mass (LBM) and total body water (BW). BMI and Basal metabolic rate (BMR) were obtained according to subject, height, weight, body composition and also recommended range of each parameter that displayed in the monitor was recorded.

4. Results and Discussion

4.1 Family particulars of the subjects:

All the subjects were from nuclear family (100 per cent) and majority had four (33 per cent) or five (30 per cent) members in family with maximum two male (40 per cent)

and two female (37 per cent) members. Most of the subjects were unmarried (87 per cent) and doing post graduation (87 per cent). Family income of subjects ranged mostly (30 per cent) between one and half to two lakhs. This was followed by one to one and half lakh (20 per cent). The major reasons could be due to regular, private or government jobs of earning members in the respondent families.

4.2 Number of subjects as per BMI in Treadmill Test

The details pertaining to subjects grouping basing BMI were presented in Table 1.

Table 1: Number of Subjects according to BMI, and their mean

BMI classification	*No*	*Per cent*	*Mean ±SD*
Obese (≥30)	1	3	32.7 ± 0.00
Over weight (25-30)	1	3	25.6 ± 0.00
Normal (18 – 25)	23	77	17.8 ± 1.63
Mild (17 – 18.5)	5	17	17.8 ± 0.36

The subjects were grouped depending on the status with regard to BMI. The results indicated that majority (77 per cent) had normal BMI followed by mild under nutrition (17 per cent), over weight (3 per cent) and obese (3 per cent).

4.3 Changes in parameters of subjects during treadmill test, basing on BMI

Changes in various parameters basing on BMI in subjects during tread mill test was assessed and presented in Table 2

Table 2: Changes in parameters of subjects during Treadmill test, basing on BMI

Parameters	***Body mass index Ranges***				***Correlation***	***Regression***
	Obese (1)	*Over wt (1)*	*Normal (23)*	*Mild (5)*		
Heart rates during work loads (bpm)						
Rest	81	72	80 ± 7.30	78 ± 2.84	0.0051	-0.333
L1	118	109	125 ± 18.02	119 ± 7.55	-0.0652	0.009
L2	132	111	133 ± 11.19	130 ± 9.6	-0.1794	0.252
L3	158	135	151 ± 12.2	147 ± 5.4	-0.0404	-0.036
L4	175	159	174 ± 11.8	176 ± 1.33	-0.2968	-0.096
L5	-	172	188 ± 8.08	190 ± 1.00	0.0576	0.436
L6	-	-	196 ± 0.43	-	0.0432	0.709
AT	10	13	12.9 ± 1.83	11.2 ± 1.09	-0.0246	-
TEE	50	76	77 ± 18.5	65 ± 8.90	0.0144	-1.775
Heart rate (bpm) recovery time (mt)						
15	-	-	108 ± 5.67	109 ± 13.53	-0.3524	-0.563
20	110	96	108 ± 8.82	-	0.5087**	-0.042
25	-	-	109	165 ± 0.00	-0.1795	-0.646
Pulse rate (bpm)						
Before	75	71	84 ± 3.04	79 ± 11.24	0.118	1.644
After	130	104	126 ± 13.0	122 ± 15.13	0.0131	-0.429
B.P Systolic (mm Hg)						
Before	120	105	107 ± 6.48	106 ± 6.56	0.2849	1.24
After	141	120	128 ± 8.46	127 ±12.10	0.1547	-0.281
B.P Diastolic (mm Hg)						
Before	79	67	70 ± 4.47	71 ± 2.71	0.223	2.314*
After	79	69	75 ± 7.27	74 ± 11.24	-0.0134	0.07
BMR (K.cal/24Hr)	1459	1399	1308 ± 107.4	1259 ± 79.2	0.5032**	-
Body composition (Per cent)						
Fat	43	35	29 ± 3.48	29 ± 2.79	0.6262**	-
LBM	57	65	71 ± 10.09	71 ± 1.88	-0.4983**	-
Body water	40	47	52 ± 2.74	56 ± 2.21	-0.7428	-
Hb(g/dl)	10.4	10	11.3 ± 1.74	10.5 ± 2.79	0.0765	-
F = 0.92614 NS						

NS: Not significant
** Significance at 1%
* Significance at 5%

L1 to L6 are work loads with 3 mt increase (mt)
TEE : Total Energy expenditure (K.cal / AT)
AT : Activity time

- Negative correlation & regression
#Values in parenthesis indicate number of subjects

Heart rate of subjects belonging to four groups basing on BMI showed a higher heart rate (81 bpm) in obese and normal groups. While lower heart rate (72 bpm) was observed in over weight and mild groups. Subjects in mild group had moderately high heart rate and subjects who performed upto L5 work load had heart rate of 190 bpm in mild group. Normal subjects could continue upto L6 work load, while obese dropped at L4 work load. The details are presented table 2. Insignificant negative correlation was observed upto L4 level and regression for rest, L3 and L4 workloads. The AT of subjects was between 10 and 13 mt. Lowest AT was observed in obese (10 mt) group and highest in over weight (13 mt) and normal (12.9 mt) groups.

The total energy expenditure showed a similar trend to that of AT. Lowest energy expenditure was observed in obese (50 K.Cal / AT) group and highest in over weight (76 K.Cal / AT) and normal (77 K.Cal / AT) groups. Insignificant negative correlation was observed between energy expenditure and BMI

During recovery time, the heart rate of all the subjects ranged between 96 bpm (Over weight group) and 105 bpm (Normal BMI). Only subjects falling into normal and mild groups took 25 mt for recovery. The heart rates of subjects during recovery time of 20 mt showed significant correlation to BMI at 1 per cent level.

In the case of systolic B.P, minute variations were observed in overweight, normal and mild groups, while in obese group the systolic B.P was higher initially (120 mm Hg) among all. Physical exertion did not alter the diastolic B.P of all the subjects, irrespective of BMI range.

The initial pulse rate of subjects ranged between 71 bpm (Over weight group) and 84 bpm (Normal group) but following work load ,drastic increase was observed in the case of obese (130 bpm) while least increase was observed in over weight group. The rate of increase (42) in pulse rate was similar among normal and mild groups.

The BMR showed a perfect trend to BMI. When the BMI of obese group had highest BMR (1459 K.Cal / 24 Hr) and lowest BMR (1259 K.Cal / 24 Hr) was observed in mild under nourished group. But statistical analysis of correlation showed 1 per cent level significance between BMI and BMR.

The fat per cent showed decreased trend with decrease in BMI i.e. obese, mild groups with decreasing BMI and 1 per cent significant correlation was observed in between fat and BMI. Highest fat per cent was observed in obese (43 per cent) group and lowest fat per cent was observed in mild undernourished (29 per cent) group. The LBM showed contradicting trend to that of fat per cent and this was negatively correlated, with significance at 1 per cent level. Thus, lowest LBM was observed in obese (57 per cent) and highest in subjects having mild under nutrition (76 per cent). An increase in body water was observed with decrease in BMI. Body water ranged between 40 per cent (obese) and 56 per cent in mild under nourished group. But majority had 52 per cent body water. Negative correlation was observed between BMI and body water but was not significant.
The haemoglobin picture depicted normal level (11 g/dl) among subjects having normal BMI and followed by mild under nutrition (10.5 g/dl) and the rest of subjects were suffering from anaemia. But statistical significance was not observed between BMI and Hb level.

5. Conclusions

Physical inactivity is a major cause of morbidity and mortality. From this study in concluded that Physical fitness is negatively affected to a great degree by the subjects who are overweight and obese.

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