ORIGINAL ARTICLE

EVALUATION OF PHYSICAL FITNESS BY POST-EXERCISE HEART RATE RECOVERY IN RELATION TO BODY MASS INDEX

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Background: The rising prevalence of physical inactivity among youth is resulting in a decrease in their physical fitness. The aim of this study was to evaluate the physical fitness (PF) status of undergraduate medical students of Services Institute of Medical Sciences (SIMS), Lahore by assessing the heart rate recovery (HRR) after the exercise challenge in relation to their body mass index (BMI). **Methods:** This cross-sectional study was conducted in the Department of Physiology, SIMS from May to December 2019. Ninety-three (93) healthy students of first and second-year MBBS were recruited through nonprobability convenient sampling. Demographics and lifestyle components were gathered using a questionnaire. Height, weight, and resting heart rate were recorded before exercise. All participants underwent an exercise challenge on a treadmill. Post-exercise HRR was determined by taking multiple recordings (zero, 2, and 5 minutes after exercise cessation). **Results:** Mean age of the participants was 20±1 years, 63.4% were male and 36.6% were female; 16.1% were underweight, 54.8% were of healthy weight, 25.8% were overweight, and 3.2% were obese according to WHO criteria of BMI. Majority (93.5%) of participants were physically inactive, only 6.5% were physically active. The HRR at 5 min post-exercise was statistically significant (p<0.00) in underweight, healthy weight and overweight groups while it was statistically non-significant (p=0.142) in obese participants. The percentage of participants having good PF in underweight, healthy weight, overweight and obese was 66.7%, 82.4%, 70.8%, 33.3% respectively. **Conclusion:** Participants having a healthy weight had greater PF as compared to other BMI groups.

Keywords: Physical fitness, exercise, heart rate recovery, body mass index, medical students

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INTRODUCTION

A healthy lifestyle enhances lifelong health, This is possible with balanced nutrition and physical exercise (PE). Substantial research links the effects of PE to positive physiological and psychological health outcomes.[1] The World Health Organization's (WHO) global recommendations on physical activity for health for adults is 150 minutes of moderate-intensity activity (or equivalent) per week to achieve and maintain these health and wellness benefits.[2]

Despite the well-known health benefits, globally, 81% of adolescents and 23% of adults fail to meet the recommendations by WHO on PE.[3] Owing to the advancement of technology and social media hype, physical inactivity has become a global pandemic. In Pakistan alone, 26% of university students are physically inactive. The majority of the youngsters prefer to stay indoors leading a sedentary lifestyle as the consequence of their physical fitness, predisposing themselves to related co-morbidities in the long run.[4]

Physical fitness (PF) encompasses a set of capacities and functions that allows individuals to perform physical and sport-based exercises with vigour and effectiveness in their daily life. It is a measure of cardio-respiratory endurance, muscular strength and endurance, body composition, and flexibility.[5] Various factors have shown to affect PF like genetics, gender, socio-economic status, lifestyle, type of work, exercise training, body composition (BMI) and nutritional status.[6] PF was found to have a positive correlation with young people's cognitive ability, self-control, executive function, and memory. For students, these abilities are critical for good academic performance.[7]

Heart rate (HR) is one of the key cardiovascular parameters for PF evaluation. The heart rate is the most direct response to physiological indicators during resting state, exercise and post-exercise recovery. Heart rate recovery is the speed at which the HR reverts to normal levels post-exercise. Subjects with better PF tend to have lower heart rates during peak exercise and return to their resting heart rate more quickly after physical exercise.[8] Treadmill as exercise testing equipment is superior to cycle ergometer since locomotion on treadmill involve greater muscle mass utilization.[9]

Medical education is a demanding field requiring students to undertake lengthy sitting study sessions. Medical students of today are the doctors of tomorrow and the future of our nation. Thus, medical students are a potential target population for promoting physical activity (PA), considering the evidence of negative health effects of low PF.[10]

Numerous previous studies done upon students have highlighted the relationship of PF with academic performance. These studies have used sprint run test, handgrip strength test, push-up and chin-ups test, and jump test as parameters to evaluate PF.[11] In this study, the treadmill was used as an exercise test equipment tool to assess the pre and post-exercise HR as a cardiovascular parameter to evaluate PF.

Study was to evaluate the physical fitness (PF) status of undergraduate medical students of Services Institute of Medical Sciences (SIMS), Lahore by assessing the heart rate recovery (HRR) after the exercise challenge in relation to their body mass index (BMI).

MATERIAL AND METHODS

Approval to conduct the study was granted by the Institutional Review Board (IRB) SIMS, Lahore. This cross-sectional study was performed at the research lab in the department of Physiology, SIMS between May to December 2019. The subject population was healthy young male and female first and second-year MBBS students. The participants were recruited through nonprobability convenient sampling.

The study participants included healthy male and female students between the age group of 18-23 years who qualified through the Physical Activity Readiness Questionnaire (PAR-Q+).[12] Any participant with a history of smoking, known cardiovascular, metabolic, neurological, pulmonary, orthopaedic disorders, or taking drugs (beta-blockers and anxiolytics) that could limit exercise performance was excluded. The participants were instructed not to indulge in any vigorous physical activity 24 hours prior to the test and not to consume heavy meals, tea, coffee at least 2 hours before the exercise test.

Informed consent was taken from the participants. Additionally, the participants completed a questionnaire stating demographic information related to age, gender, academic year, and an average amount of time spent in planned exercise. The lifestyle of the participants were categorized into physically active and physically inactive as per the WHO recommended guidelines.[13] The sample size was calculated by WHO calculator version 12.2.6 to be 80 samples, with 90% power of the study.[14] For better statistical results we decided to recruit an additional 13 subjects.

Weight (kg) was measured by using a Certeza electronic scale (precision, 0.1 kg). Height (cm) was measured using a wall-mounted tape (precision 0.1 Cm) of participants standing bare feet against the wall. Body mass index (BMI) [weight (Kg)/height (m^2)] was categorized into four groups: underweight (BMI<18.5 Kg/m^2), normal weight (18.5≤BMI≤24.9), overweight (25≤BMI≤29.9), and obese (BMI≥30).[15]

Before the commencement of the test, the subjects were asked to rest for 5 minutes. Resting heart rate (RHR) was measured using the digital pulse oximeter (made in China) placed over the tip of the right index finger for 5 seconds and recording the most reoccurring value. The participant was then asked to mount the treadmill (Revo-Fitness made in China) and wear the safety stop belt. Each participant started with a warming up session of 3 minutes at 3 miles per hour (mph) and 0-degree incline. After 3 minutes, the participant underwent an exercise challenge in which the speed of the treadmill was increased to 4 mph with a 0-degree incline for the next 8 minutes.[16] All the students were tested under similar laboratory conditions in a comfortable environment at 20–25 °C room temperature. After completion of exercise, the HR was measured using the same pulse oximeter at intervals of 0 minutes (HR-0) (immediately post-exercise), 2 minutes (HR-2) and 5 minutes (HR-5) after exercise.

The data was analysed by SPSS version 20. For a descriptive analysis of the quantitative variables, the mean and standard deviation were calculated; for categorical variables, count (*n*) and percentages (%) were used. Pre- and post-exercise HR recordings were compared using a paired *t*-test, and $p<0.05$ was taken as statistically significant.

RESULTS

The anthropometric baseline data of the participants represented as mean and standard deviation are given in Table-1.

Out of the 93 students that participated in the study, 59 (63.4%) were male and 34 (36.6%) were female with a mean age of 20±1 years. As per BMI classification, 15 (16.1%) were underweight, 51 (54.8%) were healthy weight, 24 (25.8%) were overweight and 3 (3.2%) were obese. As per WHO guidelines, most of the participants 87 (93.5%) were physically inactive, while 6 (6.5%) were physically active. Among gender groups, all the physically active subjects were male and the majority in the healthy weight group as shown in Table-2.

In this study, it was noted that the underweight participants had the lowest mean resting HR as compared to healthy weight and overweight participants. In obese participants, there was a greater rise in HR immediately after exercise and a greater difference between mean RHR and mean HR-5 minutes. Healthy weight and overweight participants had an almost similar HR response pre and 5 minutes post-exercise challenge as shown in Table-3.

By applying the paired t-test, it was noted that obese participants showed a non-significant ($p>0.05$) difference between mean peak HR (immediately after exercise) and HRR 5 minutes post-exercise. There was a significant ($p<0.05$) mean peak HR and HRR post-exercise in underweight, healthy weight and overweight categories as shown in Table-4.

Generally, the faster the HRR, the better is the physical fitness. Physical fitness of the participants was calculated by noting the difference between the subjects' HR at five minutes and the minimum value of the mean HR immediately after exercise in their respective BMI groups. The participant attaining the HR-5 equal to or less than the minimum value of the mean HR-0 was considered to have good PF, whereas, those who did not attain these values are labelled as having poor PF. The percentage of participants having good PF in underweight, healthy weight, overweight and obese were 66.7%, 82.4%, 70.8%, 33.3% respectively as shown in Figure-1.

Table-1: Baseline characteristics of participants

Characteristic	Mean±SD
Age (Years)	20.0±1.0
Height (m)	1.72±1.1
Weight (Kg)	68.5±14.0
Resting Heart Rate (bpm)	77.84±7.5

Table-2: Lifestyle among different BMI and gender groups represented as frequency and percentages (n=93)

BMI Groups	Gender	Lifestyle	
		Physically Active	Physically Inactive
Underweight n=15	Male (n=12)	Zero	12 (12.9%)
	Female (n=3)	Zero	3 (3.2%)
Healthy weight n=51	Male (n=30)	4 (4.3%)	26 (27.9%)
	Female (n=21)	Zero	21 (22.6%)
Overweight n=24	Male (n=16)	2 (2.2%)	14 (15.1%)
	Female (n=8)	Zero	8 (8.6%)
Obese n=3	Male (n=1)	Zero	1 (1.1%)
	Female (n=2)	Zero	2 (2.2%)

Table-3: Comparison of BMI with pre and post-exercise heart rate represented as mean and standard deviation (n=93)

Groups	Heart Rate (bpm) (Mean±SD)			
	Before Exercise	Post Exercise HR recovery		
		Zero immediately post exercise	2 minutes post exercise	5 minutes post exercise
Underweight (n=15)	72.6±6.6	98.6±11.5	85.7±9.9	77.7±8.9
Healthy Weight (n=51)	78.6±6.6	109.8±15.5	93.1±12.8	84.3±10.2
Overweight (n=24)	79.7±8.7	108.0±19.5	92.5±14.2	84.2±10.1
Obese (n=3)	77.0±4.6	117.7±27.6	101.3±15.0	89.7±7.7

Table-4: Heart rate recovery at 5 minutes post-exercise among BMI groups

Groups	n	HRR at 5 min post exercise (Mean±SD)	*p*
Underweight	15	20.93±12.3	0.000*
Healthy Weight	51	25.47±11.8	0.000*
Overweight	24	23.75±16.2	0.000*
Obese	3	28.00±20.5	0.142

*Highly significant

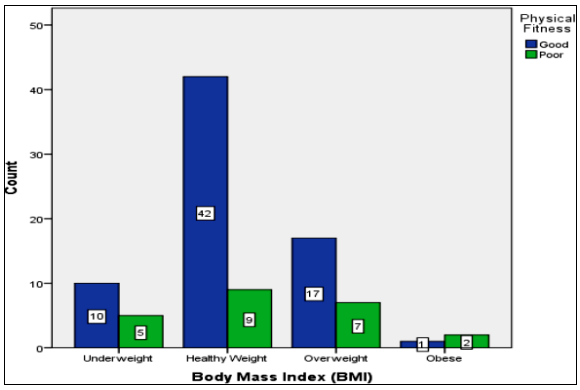

Figure-1: Comparison of fitness levels among different BMI groups represented as frequency

DISCUSSION

This study analyzed the relationship between physical fitness and body composition (BMI). The fitness of the participants was assessed using HRR post-exercise test in healthy medical students of SIMS, Lahore.

A physically active lifestyle has an established positive association with physical fitness. In this study, a majority (93.5%) of the participants were physically inactive, and 6.5% were physically active according to the WHO guidelines. These results are in agreement with Thanamee *et al*[17] who reported a far greater proportion of participants as physically inactive.

Obesity is known to cause autonomic dysfunction and resting heart rate (RHR) is dependent on the autonomic system. In the present study, underweight participants had a lower mean resting HR as compared to healthy weight and overweight participants. Our results are consistent with the findings of Upadhyay *et al*[18] stating that RHR is lower in underweight individuals as compared to healthy and overweight.

Altered post-exercise HRR has been investigated in various studies with diverse results. In this study, significant recovery of HR at 5-minute post-exercise was seen in underweight, healthy weight and overweight participants. These results are different from the studies done by Azam *et al*[19] and Fan *et al*[14]. The results of those studies reported a delayed HRR in overweight (BMI>25 Kg/m^2) participants as compared to healthy individuals (BMI<25 Kg/m^2). The difference in our results can be explained by the presence of a greater proportion of physically active males in the overweight category.

In this study, 82.4% of participants in the healthy weight group were assessed to have good PF. Similar results are presented by Nikolaidis *et al*[20] who reported that healthy-weight individuals are more physically fit as compared to individuals with higher BMI. Above 70% of the overweight participants also possessed good PF. The reason for good PF in

overweight can be explained by the presence of a more physically active male in this category. Another study by Rosa-Guillamón *et al*[11] supports our results reporting that a person can be overweight and have a good PF status if there is an optimal PA level.

CONCLUSION

Participants with healthy weight had greater physical fitness as compared to other BMI groups.

RECOMMENDATIONS

Larger studies should be conducted to assess the PF considering other parameters like the lifestyle, physical activity, nutritional status other than the BMI. The PF assessment of medical students should be conducted yearly to monitor their physical fitness and to create awareness regarding necessity of physical fitness.

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