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Assessment of Cardiorespiratory Endurance in Terms of Physical Fitness Index and VO2max among Young adult population of United Arab Emirates

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ABSTRACT— Cardiorespiratory endurance is an important aspect of health affecting the physical and mental activities of an individual. Little is known about the level of physical fitness among young adults in the UAE. The present study was undertaken to assess Cardiorespiratory Endurance in Terms of PFI and VO2max among Gulf Medical University Students, Correlate PFI with Vo2max, and Compare the cardiorespiratory endurances between male and female students and Arabs and non-Arabs. This experimental study was done on 78 healthy male and female students in the age group of 17 to 25 years from different nationalities and ethnicity. The cardiorespiratory endurance was assessed using HST. BMI, PFI (long form) and Vo2max (indirectly) were calculated and the Participants were categorized according to BMI, PFI, and Vo2max reference ranges. The data were presented as percentages and mean + SD. Student paired t-test was used to determine the difference in PFI and VO2max between Males and Females and Arabs and non-Arabs. Pearson correlation coefficient was used to determine the correlation between PFI and VO2max at $p < 0.05$. Over 60% of Arabs (45.7+5.07) and non-Arabs (46.3+4.42) and females (46.0+3.81) and males (45.6+6.07) were having poor PF. As for VO2max, most students of both genders (males; (55%, 42.0+4.26), females; (61%, 36.2+3.00)) and ethnicities (Arabs; (46%, 38.5+4.62), Non-Arabs; (79%, 39.6+4.74)) found having average VO2max. Students were predominantly in the poor PF category and have an average VO2max indicating poor to average Cardiorespiratory endurance. A significant positive correlation was found between PFI and VO2max.

KEYWORDS: Cardiorespiratory endurance, Physical Fitness, VO2max, Physical Fitness Index, Heart Rate

1. INTRODUCTION

The cardiorespiratory system is composed of a cardiovascular system and a respiratory system. One of the important functions of the cardiorespiratory system is delivering oxygen and removing the waste products of metabolic pathways such as Carbon Dioxide, Lactic Acid and Urea. Also, it performs a variety of functions in the human body including distribution of nutrients throughout the body during rest and exercise, control pH of blood, regulation of physiological and psychological functions via transporting hormones and enzymes and maintaining body temperature and fluid volume to prevent dehydration. [6] It is well known that individuals with regular physical activity have a lower risk of developing cardiovascular diseases, hypertension, type 2 diabetes, obesity and other chronic diseases. Therefore, performing regular cardiorespiratory exercise improves exercise capability which in turn increase cardiorespiratory fitness and results in short and long-term benefits on overall health like increased cardiovascular capacity, decreased Myocardial Oxygen Demand, increased Cardiac Output, lower Resting Heart Rate, and improved Metabolic Pathways and Digestion. [7] During physical activity, the human body will sense a need for more oxygen which results in an increase in the heart rate and activation of the sympathetic nervous system as well as an

increase in the respiration rate. However, after physical activity, the requirements of oxygen will go back to resting levels and parasympathetic system stimulation will be mediated by acetylcholine leading to responses opposite to those of sympathetic system including a decrease in cardiac output, blood pressure and respiration. [8,9] Cardiorespiratory endurance is an important aspect of health affecting the physical and mental activities of an individual. It is a process that measures the functioning of heart, lungs and muscles in a coordinated fashion. Physiologically, Heart and Lungs are capable to increase their capacity and use of oxygen. Cardiorespiratory endurance helps in indicating the physical fitness and health of an individual. It gives a sign of either: health and fitness or need for improvement. A regular aerobic exercise program is used to improve Cardiorespiratory Endurance. [10, 11] Physical fitness is the ability of an individual to perform different types of sports, occupations and activities without fatigue. It can be achieved via proper nutrition, moderate-vigorous physical exercise, and proper rest. [12] Physical fitness and capability of an individual are influenced by various factors and elements. Some of these factors encompass, gender, age, BMI, and health. Little is known about the influence of ethnicity on physical fitness, a determinant of cardiovascular and metabolic risk. Ethnicity is a group of individuals that can be recognized by each other by sharing similarities which include history, language, culture, ancestry, and society. Ethnicity is affected by both genetics and environmental factors. Genetics and inherited status are one of the core fundamentals of ethnicity. On the other hand, environmental factors include climate, geographical region, culture and traditions may influence ethnicity.

In this research, we will use Harvard step test which is a kind of cardiorespiratory endurance test that measures the fitness and an individual's ability to recover after a hard exercise developed by Brouha et al. in 1943. The faster the heart rate returns to resting, the better form the character is in. The Harvard step test consists of 3 to 5 mins of stepping up and down using a platform. The rate of 30 steps/min must be continued for 5 mins or until fatigue then the heart rate will be counted for 1 to 1.5, 2 to 2.5, and 3 to 3.5 mins. Other Step Tests include Chester step Test, Queens College Step Test, Balke Step Test, Home Step Test, Canadian Home Fitness Test and Forestry (Sharkey) Step test. Maximum Oxygen Consumption capacity is used to assess the cardiorespiratory endurance as it provides the maximum oxygen rate in the muscles that individual utilize during vigorous exercise. VO2Max is a respiratory parameter used to measure the fitness of an individual. There are various factors that influence the values of VO2 Max such as age, gender, physical activity, heart rate, and weight. Physical fitness and maximum oxygen consumption can be increased via regular physical activity and exercise. Improvement of overall fitness depends on the relationship between the cardiovascular system, respiratory system, and skeletal system. Thus, fitness is increased when these systems work together in an effective and dynamic fashion. VO2 Max is measured directly and indirectly; direct measurement is done in a sports performance lab using treadmill or stationary bicycle where the athlete will be asked to wear a face mask that is connected to a machine which will measure the respiratory rate and volume along with the concentration of oxygen and carbon dioxide during inhalation and exhalation. Heart rate is also measured using a heart strap that is worn around the chest. Due to the high cost and required equipment and space, in this research, we are using Harvard Step Test (HST) to measure VO2 Max indirectly using this formula: VO2 max = 15.3 x (MHR/RHR). [1,13,14,15,16]

2. Review of Literature:

Mitchell et al. (2008) conducted a study to assess changes in body mass index (BMI) and physical fitness parameters of medical students. The study has chosen a total of one hundred sixty-three medical military students aged 25 years. Bi-annual physical readiness test (PRT) was required to be performed by the students. Height and weight were measured, the number of push-ups performed within two minutes was recorded, the number of sit-ups performed in a 2-minute period, and 1.5-mile run was done. Height and

weight were obtained to measure the body compositions and sit-ups and push-ups were used to measure muscular endurance while Cardiorespiratory endurance was assessed using the result of the 1.5-mile run test. PRT test had to be completed by each student twice every year starting in 2004 and ending in 2006. An existing database was used to record PRT scores for all Navy personnel. The results were recorded and computed into SPSS software. The conducted study detected a 5% and 2% variance in body mass index and change in 1.5-mile run times respectively throughout the period of student's presence in medical school. The measurement of students BMI did not show significant change over the first three years. The average BMI was found to be 24.2 and the number of performed push-ups and sit-ups were constant among all students, whereas the number of push-ups that was completed by students was between 57 and 61 at each test (P = .11) and the average number of sit-ups in 2004 was 90 higher than the recorded number of sit-ups in 2006. The students showed a noted progression throughout their existence in medical school while the average run time showed a rise from 10:54 in 2004 to 11:31 in 2006 (P < .001). However, cardiorespiratory fitness of the students declined by 4%. It is important to note that, the significant decrease in cardiorespiratory fitness was unexpectedly greater than the predicted age-related sedentary change of 0.1% to 0.3% per year in young adults. [17] Das et al. (2010) done a research study titled: A Comparative Study of Physical Fitness Index (PFI) and Predicted Maximum Aerobic Capacity (VO2max) among the Different Groups of Female Students in West Bengal, India. The main objective of the study was to assess and compare the PF and cardiorespiratory fitness in terms of maximum aerobic capacity (VO2max) the urban and rural female students. The study was conducted on 40 female students from each urban and rural areas aged 16 to 20 years from the same socioeconomic background. HST was used to determine PFI while QCT was used to determine VO2max. The comparison between female students of both rural and urban sectors was done by performing an unpaired t-test to find out the significant differences between the 2 groups. In addition, the significant difference between PFI and age, weight and status of the sedentary female students of both sectors was assessed using correlation and regression. It was shown that the rural female students had high PFI and VO2max scores in comparison with urban female students. However, there was no significant correlation between age and PFI in both urban and rural female students. Nevertheless, body weight, BSA, BMI of urban female students and rural female students were found to have a significant negative correlation with PFI. In general, VO2max and PFI scores of both urban and rural female students were positively and highly correlated to each other. [18]

Abu Hanifah et al. (2013) assessed the connection between body composition measures and heart rate recovery (HRR). Parameters for body composition have been measured; body mass index z-score, body fat percentage, waist circumference, and waist peak ratio. The step test was performed using a modified Harvard step test. The first and the second minutes of heart rate recovery were both calculated via the difference between the resting pulse rate (respectively at 1 and 2 minutes) and the peak pulse rate during exercise. In results, it was found that HRR1min was inversely correlated with all body composition measures in both boys and girls. HRR2min was inversely correlated with all body composition measures in girls. However, all measures except for BMI z-score were associated with HRR2 min in boys. Only waist circumference in boys and body fat percentage in girls were inversely associated with HRR2min in multiple regression. Lastly, it was concluded that in apparently healthy adolescents HRR (1min and 2min) have an inverse relationship with body composition measurements. Thus, cardio-metabolic risk factors should be identified in apparently healthy adolescents to prevent adulthood morbidity. [19] Howard et al. (2013) made a study to find if there is any association between race or ethnicity and cardiorespiratory fitness in terms of higher socioeconomic status. 33,604 participants (589 AA and 33,015 C), who previously participated in the Cooper Center Longitudinal Study, were included and evaluated. Participants were excluded if found having any clinical history of diabetes, myocardial offences, cancer, or stroke. A maximum exercise test, physical

examination (blood pressure, anthropometric evaluations, and ECG), laboratory testing, self-report of relevant demographic information, and past medical history were all included in the examination. The results showed that there was an inverse relationship between cardiorespiratory fitness (CRF) and various health outcomes such as cardiovascular mortality, diabetes, and cardiovascular disease. Among African Americans, lower CRF has been documented in comparison with their Caucasian counterparts. After correcting for age, Race was predicted to be the reason of low fitness in African Americans. And after adjusting for the covariates of education, age, BMI, tobacco use, PA MET-minutes, haemoglobin, high blood pressure, it was found that the risk of having a low CRF is doubled in AA men in compared to C men. Although the same trend was found in AA women, the difference wasn't statistically significant. [20] Parmar and Vaghela (2015) conducted a study for assessing the physical fitness using a modified Harvard step test and its' association with body mass index among physiotherapy students in India. In general, it has been shown that physiotherapy students had poor PF and normal BMI students had greater PF of in compare to overweight students. One Hundred and five students of both genders aged 17-23 years from Ahmedabad Physiotherapy College were included in the study according to inclusion and exclusion criteria. Modified HST was used to assess PF of students and performed according to the standardized procedure and the heart rate was recorded at the 1st, 3rd and 5th min after exercise. PFI was calculated and statistical analysis was done using the Chi-square test. In conclusion, PF of students was found to poor as mentioned where it was said that it is probably due to sedentary lifestyle and inactivity. The students were recommended to increase their physical fitness by exercising more on daily bases and to eat healthier and avoid gaining weight. [21]

Lee et al. (2016) found out that simulator exercises such as, the ski simulator, has a higher PEI (physical efficiency index) levels than the HST and thus can be utilized effectively as exercise equipment, based on a study done on children in their growth phase in educational institutions in 2016. The purpose of the study was to evaluate the cardiorespiratory endurance by calculating the post-exercise recovery rate of children of both ski simulator exercise and HST. The children were categorized based on their body mass index (normal weight and overweight/obesity) and a physical efficiency index formula was used to calculate the cardiorespiratory endurance. [22] Bhatnagar et al. (2016) strongly suggested that there are certain types of activities that can contribute to the physical activity of South Asian ethnic groups. Thus, this study that study had been undertaken to identify these activities and how they vary between South Asian and White British ethnic groups, subdivided to sex and age. Data was collected and analysed (adjusted for the socioeconomic status) to determine the differences between ethnic groups. There was no significant difference in walking to total physical activity in women aged 16-34 years. Bangladeshi men were the highest in term of walking to total activity in the age group 35-54. In over 55 years old age group, sports to total activity was found the lowest among both genders in all South Asian ethnic groups. In the end, it was concluded that UK South Asian are more active in certain ways from White British which differ by gender and age. [23]

3. Material & Methods

3.1 Research design

This is an experimental study

3.2 Study population:

GMU Students from both genders between the age 17 to 25 years were included. Any participants under the age of 17 and above 25 were excluded. Females in their menses, pregnant females, or participants with known history of chronic diseases like, diabetes, asthma and hypertension.

3.3 Sample size
A total of 103 participants including both genders

3.4 Study settings
The study will be conducted in Gulf Medical University, with participants from within the university. With the participants' consents, the exercise will be done and a questionnaire after. The results will be given to the participants later.

3.5 Duration of study
The study took six months including data collection, data analysis, conclusion and publication.

3.6 Study instrument & validation procedure
Harvard Step Test (HST) [1] and IPAQ (Modified) [24] were used to assess the participants' physical fitness. Stool or Platform about 50cm or 20 inches in height, Digital Wrist Sphygmomanometer and Metronome were used to preform HST.

3.7 Ethical issues
A written and informed consent were obtained from participants. The names of the participants weren't mentioned. Results were communicated to participants with confidentiality. Only the students who were conducting the study and their supervisor had access to the data.

3.8 Methodology
Written informed consent and demographic information were obtained, followed by administration of a questionnaire to find age, ethnicity, history of any chronic diseases, and physical activity patterns among the participants. The HST, which is an internationally accepted test for assessing the physical fitness index, was employed for the proposed study. The maximum oxygen consumption capacity (VO2 max) was determined by the indirect method as follows: VO2 max = 15.3 x (MHR/RHR). [25] The cardiorespiratory endurance was assessed by correlating the PFI and maximum oxygen consumption capacity. The detail of the HST is as follows: This study was conducted on 103 healthy participants in the age group of 17-25 years. Students with a history of any chronic disease such as hypertension, asthma and others were excluded from the study. The procedure of Harvard step test was explained and demonstrated to the students. Both heights and weights were self-reported by the participants and used to calculate BMI. Participants were asked to sit quietly for 5 mins before the commencement of the test. The resting heart rate was recorded. After that, the stepping exercise was performed by the participants with sneakers or without shoes on a 50 cm (20 inches) high step. Each participant was asked to step up and down 30times/min. When the participant asked to start, the participant places one foot on the platform, steps up, places other foot on the platform, straightens both legs and the backbone and then steps down, bringing down the same foot that he/she placed up first. The instruction "UP" was given at 2sec intervals. The participants were directed to lead off with the same foot each time and not the alternate foot. The observer called the rhythm by adjusting the metronome. The participant performed this exercise if he/she could, but not more than 5 min. After the cessation of exercise, the participants were asked to sit quietly on a chair. After 15 seconds the first measurement of the heart rate was taken followed by another after exactly 1 min. It was recorded again in the second and third minutes. If the participant became dyspnoeic, felt fatigued or had pain in the chest area or lower extremities during the stepping exercise, he/she was asked to stop the exercise immediately. The participant performed the exercise for 5 min unless he/she stopped earlier due to exhaustion. If the participant could not maintain the stepping rate of 30 times/min for 20sec, he/she was exhausted, and the step-test will be discontinued. A stopwatch

was used to monitor the duration of the efforts to the nearest second. After completing 5 min exercise the participant was asked to stop. Subsequently, the PFI scores were calculated using the formula mentioned below. BMI and VO2max were also calculated and recorded. [1, 3, 26]

Calculations:

1. PFI: Physical Fitness Index:
   Long Form Equation - Fitness Index = (100 x test duration in seconds) divided by (2 x sum of heartbeats in the recovery periods). [1]
2. VO2max: Calculated (Indirect) Maximum Oxygen Consumption capacity
   VO2max = 15.3 x (MHR/RHR). [25]
3. BMI: Body Mass Index
   BMI = kg/m2 [4]

3.9 Feasibility of the research

The participants and the equipment were available. No invasive tests or chemicals were required. The experiment can be completed within the time limit. The test is easy to perform.

3.10 Details of data storage

All the data is stored in an excel format in storage device. Separate file is used to keep the records of the consent forms.

3.11 Data analysis

The data were analyzed using Excel and SPSS. The data are presented as percentages and mean + SD. Student paired t-test was used to compare PFI and VO2max between Male and Female and Arabs and non-Arabs. Pearson correlation coefficient was used to correlate PFI and VO2max. $p < 0.05$ was considered as significant.

4. Results

A total of one hundred and three (103) students of gulf medical university participated in the research. Healthy males and females of different ethnicities and nationalities were included aged 17 to 25 years. The 25 (24.3%) participants were removed from the analysis according to the exclusion criteria. Moreover, participants with missing information were also excluded.

4.1 Sample population

40 (51.3%, 19.5+1.8 years) participants were males of which 24 were Arabs (60.0%) and 16 non-Arabs (40.0%). 38 (48.7%, 20.2+1.5 years) female participants; out of were 26 Arabs (68.4%) and 12 non-Arabs (31.6%) (Table 1).

Table 1: Participants by gender and ethnicity

	Males	Females	Total
Arabs	24 (60.0%)	26 (68.4%)	50 (64.1%)
Non-Arabs	16 (40.0%)	12 (31.6%)	28 (35.9%)
Total	40 (51.3%)	38 (48.7%)	78

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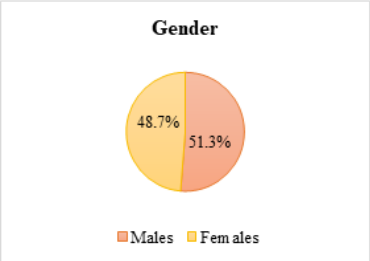


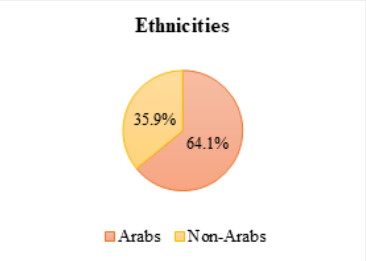


Figure 1.1: Participants by gender **Figure 1.2:** Participants by ethnicity

4.2 Body Mass Index

According to the ranges of BMI categories, the participants were categorized into underweight, Heathy weight, Overweight, and obese. Most students were found having healthy weight. (Table 2) shows that 8% of males were underweight (17.5+0.58) compared to females. None of females was found to be obese, unlike males, who counted for 13% (32.9+4.15) in the obese category. It is important to note that no one of non-Arabs was found to be obese while 10% (32.9+4.15) of Arabs were found in the same category. Males (28%, 26.4+1.18), who are overweight, were found to be higher than females by 7% in the same category (21%,27.0+1.42). Unlike non-Arabs, 10% of Arabs was found to be obese (32.9+4.15).

Table 2: BMI of participants in terms of gender and ethnicity

	Underweight Mean±SD (Kg/m2)		Healthy weight Mean+SD (Kg/m2)		Overweight Mean+SD (Kg/m2)		Obese Mean+SD (Kg/m2)	
Male	8%	17.5±0.58	53%	22.5±1.58	28%	26.4±1.18	13%	32.9±4.15
Female	11%	17.5±0.71	68%	21.5±1.93	21%	27.0±1.42	0%	0
Arab	4%	18.1±0.55	60%	21.6±1.86	26%	26.7±1.25	10%	32.9±4.15
Non-Arab	18%	17.3±0.53	61%	22.5±1.70	21%	26.5±1.47	0%	0

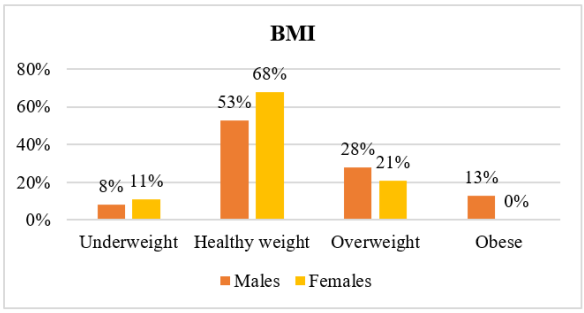


Figure 2.1: Gender wise distribution of BMI

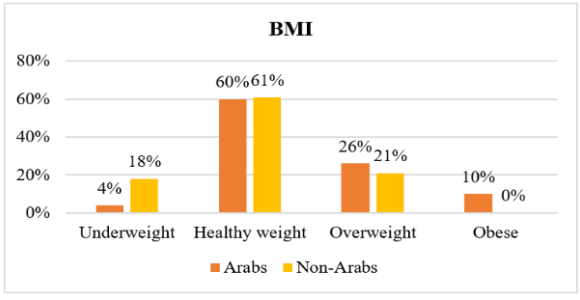


Figure 2.2: Ethnicity wise distribution of BMI

4.3 Physical Fitness Index

The Physical fitness index results are shown in (table 3); categorized into poor, low average, and high

average categories. Over 60% of Arabs (45.7+5.07) and non-Arabs (46.3+4.42) and females (46.0+3.81) and males (45.6+6.07) were predominantly in the poor PF category. Both Arabs and non-Arabs have the same proportion in high average category (4%, 68.5+0.00 and 77.0+0.00 respectively). However, no one from females was found to have to high PFI unlike males who counted for (8%, 68.5+0.00) in the same category. It is important to note that females had the lowest percentage of low average category of 5% and the highest percentage of poor category.

Data presented as mean+SD.

Table 3.1: PFI of participants in terms of gender and ethnicity

	Poor	Mean+SD (%)	Low Average	Mean+SD (%)	High Average	Mean+SD (%)	p Value
Male	68%	45.6+6.07	25%	57.4+2.72	8%	68.5+0.00	0.022
Female	95%	46.0+3.81*	5%	56.0+1.41	0%	-	
Arab	90%	45.7+5.07	6%	56.5+1.74	4%	68.5+0.00	0.04
Non-Arab	64%	46.3+4.42**	32%	57.4+2.83	4%	77.0+0.00	

Student t-test was used to determine the difference between male and female*
Student t-test was used to determine the difference between Arab and non-Arab. ** - indicates significant difference. P<0.05 was considered as significant.

Table 3.2: Comparison of PFI between male and female participants	**Mean±SD (%)**
Male	51±9.45
Female	47±6.49

Table 3.3: Comparison of PFI between Arab and non-Arab participants	**Mean±SD (%)**
Arabs	47±7.00
Non-Arabs	51±8.25

As shown in Table 3.2 and 3.3, Males had higher PF than females while Arabs had Lower PF in compare to non-Arabs.

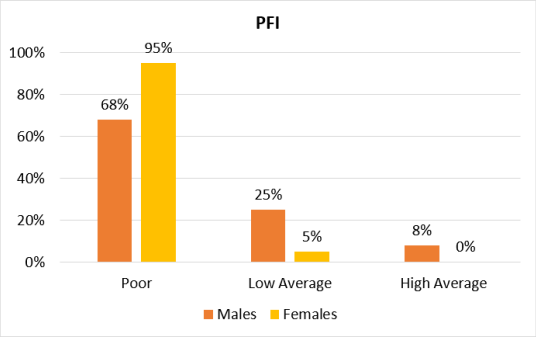


Figure 3.1: Gender wise distribution of PFI

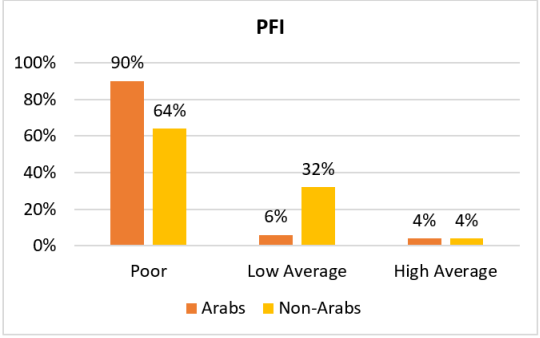


Figure 3.2: Ethnicity wise distribution of PF

4.4 VO2max

VO2max was indirectly calculated for both males and females. The participants were classified into four VO2max groups as very poor, poor, average, and good based on the reference table. [30] VO2max of both males and females shows the same percentage in the very poor VO2max category. According to table 4.1 that shows most students were found having average VO2max. On the other hand, the distribution of Arab students was mainly focused in both poor (50%, 31.7+2.06) and average (46%, 38.5+4.62) categories.

Data presented as mean+SD.

Table 4.1: VO_{2max} of participants in terms of gender and ethnicity

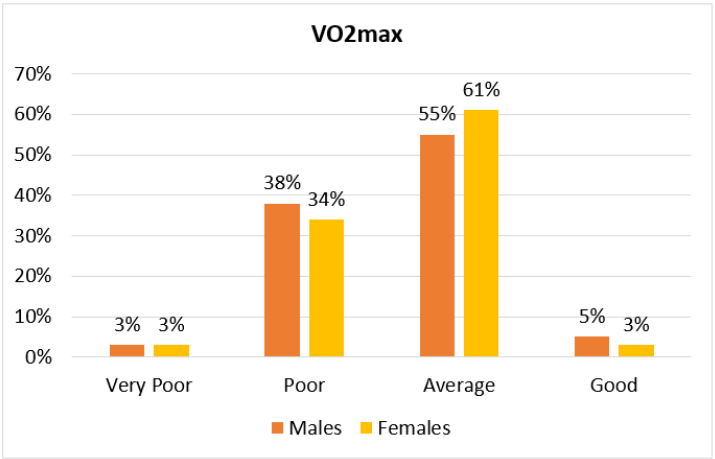
	Very Poor		Poor		Average		Good		p Value
		Mean±SD (ml/kg/min)		Mean±SD (ml/kg/min)		Mean+SD (ml/kg/min)		Mean±SD (ml/kg/min)	
Male	3%	28.0±0.00	38%	32.7±2.21	55%	42.0±4.26	5%	50.0±7.07	0.001
Female	3%	27.0±0.00*	34%	30.6±1.44	61%	36.2±3.00	3%	49.0±0.00	
Arab	2%	27.0±0.00	50%	31.7±2.06	46%	38.5±4.62	2%	55.0±0.00	0.007
Non-Arab	4%	28.0±0.00**	11%	31.5±3.38	79%	39.6±4.74	7%	47.0±2.83	

Student t-test was used to determine the difference between male and female*
Student t-test was used to determine the difference between Arab and non-Arab. ** - indicates significant difference. $p<0.05$ was considered as significant.

Table 4.2: Comparison of VO_{2max} between male and female participants	**Mean±SD (ml/kg/min)**
Male	39±6.49
Female	34±4.52

Table 4.3: Comparison of VO_{2max} between Arab and non-Arab participants	**Mean±SD (ml/kg/min)**
Arabs	35±5.68
Non-Arabs	39±5.85

As shown in Table 4.2 and 4.3, Males had higher VO2max than females while Arabs had Lower VO2max in compare to non-Arabs.



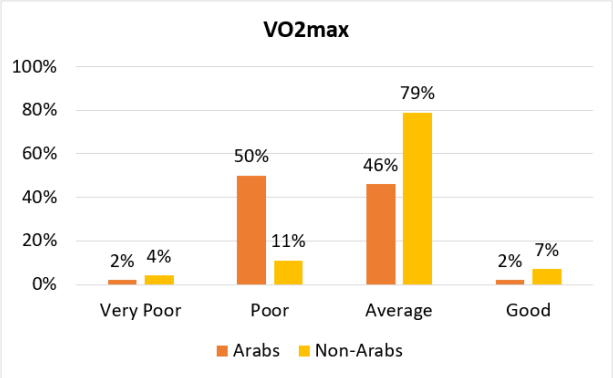


Figure 4.2: Ethnicity wise distribution of VO2max

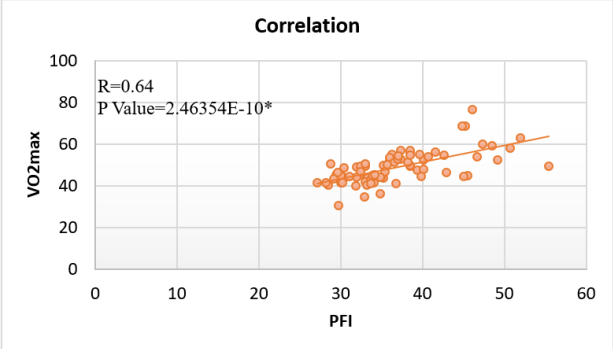


Figure 4.3: Correlation between PFI and VO2max of participants. Pearson correlation was used to determine the correlation between PFI and VO2max. $p<0.05$ was considered as significant.

4.5 Physical Activity

Physical activity of participants was categorized as low, moderate and high based on the IPAQ scoring protocol. The physical activity of an individual was concluded based on his/her walking, moderate physical activity and vigorous physical activity. Most students found having high physical activity; composed mostly of walking and moderate activity. Physical activity of males (68%) was found higher than the physical activity of females (55%). Unlike PFI and VO2max, non-Arab participants (57%) found lower in physical activity compared to Arab participants (64%).

Table 5: Physical activity of participants in terms of gender and ethnicity

	High	Moderate	Low
Male	68%	18%	15%
Female	55%	34%	11%
Arab	64%	22%	14%
Non-Arab	57%	32%	11%

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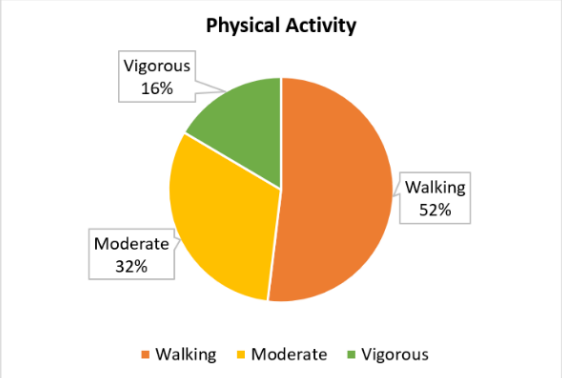

Figure 5: Distribution of physical activity

5. Discussion

This study provides evidence that most students have poor to average cardiorespiratory endurance. In general, PF was found to be poor and VO2max average among both genders and ethnicities. Less than 10% of males and females of both ethnicities were found to have high average PF. There was significant difference between males and females as well as between Arab and non-Arab students. VO2max was indirectly calculated for both males and females. Most non-Arabs had average VO2max while Arabs had from poor to average VO2max. Significant difference was found between males and females and Arabs and non-Arabs. For determining PFI, HST was used while, VO2max was indirectly calculated. Significant positive correlation was observed between PFI and VO2max. According to the ranges of BMI categories, most students were found having healthy weight. A previous study assessed PFI using modified HST among physiotherapy students aged 17 to 23 years where they found similar results to our present study; most physiotherapist students of both genders had poor PF. [21] Similarly, Low cardiorespiratory fitness has been shown in another previous published study among south African adolescent girls in low income communities. Although the study was done on girls only using different methodology such as 20 m shuttle run test, but it was found to have similar findings regarding cardiorespiratory fitness among overweight and obese female students. [28] VO2max was found average and physical fitness low and decreasing over the years in a study published in 2010. The aim of the study was to assess physical fitness using BMI and body mass of male and female students between 1996 and 2008 in Andrews university. [29] In addition, another study done by Nabi T et al, assessed the cardiovascular fitness via Queens college step test (QCT) among medical students. Results showed that VO2max was average in both males and females and students' cardiorespiratory fitness was categorized as fair. Unlike our study, cardiorespiratory fitness was assessed by calculating only VO2max indirectly and QCT was used instead of HST. [30]

Several studies shown that there is a significant positive correlation between PFI and VO2max. A study comparing between PFI and VO2max of female students from urban and rural areas in west Bengal concluded that, PFI score of these students was highly and positively correlated with VO2max. [20] Thus, supporting our finding. Rajshree Gupta found out that regular exercise training increases VO2max and PFI and decreasing heart rate and blood pressure. Hence, increasing the cardiorespiratory endurance and decreasing the occurrence of cardiovascular diseases. [31] Another study was done to find out the effect of nutrition and exercise on growing children. PFI and VO2max were used to assess physical fitness. It was concluded that both PFI and VO2max (Cardiorespiratory fitness parameters) increased by regular exercise and nutritious food. [32] In Nabi T study, a significant difference in physical fitness between male and female students was found. Female students had lower PF and VO2max compared to male students. [30] Consistent findings were found in another study done by Nightingale CM in 2016 to assess the physical

fitness in UK children of South Asian, black African-Caribbean and white European origin. Nightingale also found that children in the UK of South Asian origin had poor PF in compare to children of white Europeans and black African-Caribbeans origin. [33] PFI of males was found lower than females in a study done in china. The study was done medical students and used BMI, sidestep test, vital capacity index, and standing long jump in order to compare the two genders physical fitness indexes. Chi square and Wilcoxon rank sum test were used to analyze the data. [34] In 2004 a study was conducted in the US to find out whether there is any significant difference between black and white women in terms of aerobic fitness, and physical activity. White women found having significantly higher VO2max than that of black women, suggesting a possible influence of ethnicity on physical fitness. [35]

6. Conclusion

The present study showed that 95% of female students have poor PFI and 5% have low average PFI while 68%, 25%, 8% of male students have poor, low average and high average PFI respectively. It also showed that most of Arabs have poor PFI (90%) while non-Arabs represent 64% in the poor PFI category. Also, Arabs and non-Arabs were found to have the same percentage (4%) in the high average category of PFI. VO2max of both males and females shows the same percentage in the very poor VO2max category (3%) and higher percentages in both poor and average categories. Similarly, for Arabs and non-Arabs that have a small proportion in the very poor category (2%, 4%) and greater proportion in both poor and average categories of VO2max. From this study it can be concluded that, Arabs are having less physical fitness as compared to non-Arabs counter parts. The male students of GMU are having significantly ($p<0.05$) higher PFI than female. The result of this study revealed that more than 60% of students are having poor PF. Moreover, a significant correlation was found between PFI and Vo2max.

7. Limitations

The sample size was small compared with other similar studies and was limited to Gulf medical university students. No reports available regarding physical fitness in the gulf region to compare. Some participants refused to perform HST and some were unwilling to cooperate or provide the necessary data. Physical activity, weight, and height were self-reported thus results of BMI and physical activity may not be accurate.

8. Declaration

We hereby declare that the work incorporated in this research entitled “Assessment of Cardiorespiratory Endurance in Terms of Physical Fitness Index and VO2max among Gulf Medical University Students” is an original article with no potential conflicts of interest in respect of the authorship, research and/or publication.

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