ORIGINAL ARTICLE

CARDIORESPIRATORY FITNESS, PHYSICAL ACTIVITY LEVEL, BODY MASS INDEX AND BLOOD PRESSURE AMONG UNIVERSITY STUDENTS IN NEGERI SEMBILAN

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ABSTRACT

Noncommunicable diseases are the number one killer globally and it could develop due to various risk factors. This cross-sectional study was aimed to identify these risk factors by assessing body mass index, waist circumference, waist to hip ratio and blood pressure and to find out the correlation between these risk factors, and cardiorespiratory fitness and physical activity level. The study samples were 103 students from two universities in Negeri Sembilan state selected by the convenience sampling method. After ethical clearance, International Physical Activity Questionnaire-short form in English was used to assess the physical activity level. The cardiorespiratory fitness was assessed by the Rockport one mile walk test and the other parameters were assessed following the standard protocols. The percentage of overweight (32.04%) and pre-hypertension (25.24%) were higher among students. 35.92% of students reported a low physical activity level and 46.6% having a lower fitness level (fair and poor). The physical activity level correlated with the cardiorespiratory fitness level (P<0.01). The body mass index (P<0.01) and systolic blood pressure (male P 0.05, female P<0.01) negatively correlated with the cardiorespiratory fitness level. Therefore, measures have to be taken to improve the physical activity level and cardiorespiratory fitness to lower the risk of overweight and high blood pressure among university students.

Keywords: Physical activity level, cardiorespiratory fitness, VO$_2$ max, Body mass index, waist circumference, Waist to hip ratio, blood pressure, university students.

INTRODUCTION

Globally 38 million people die each year due to noncommunicable diseases (NCDs) and cardiovascular disease is the number one cause among NCDs[1]. Physiological risk factors like high blood pressure (BP), overweight/obesity, raised blood glucose, raised cholesterol and behavioral risk factors like tobacco use, physical inactivity, unhealthy diet, and the harmful use of alcohol were the reasons for NCDs[2]. In Malaysia the cardiovascular disease accounts for 36% of deaths and this may be due to the high prevalence of cardiovascular risk factors in Malaysia[3-7]. Research studies reported high prevalence of cardiovascular risk factors among younger population like children and young college students[8-12]. Most of the cardiovascular events are preventable through healthy lifestyle interventions[13]. Hence the identification of these risk factors in younger generation (university students) are crucial to prevent the development of NCDs.

Among the risk factors, body mass index (BMI), waist circumference (WC), Waist to Hip ratio (WHR) and blood pressure (BP) can be assessed non-invasively which is practicable for community screening. The BMI is the commonly used measures to identify overweight/obesity in the community[14]. Along with BMI, WC and WHR, which can identify abdominal adiposity helps to better predict the cardiovascular disease and metabolic risk factors[15-20]. High BP is another important risk factor for cardiovascular disease and it can be assessed non-invasively by Mercury sphygmomanometer[21]. So the measurement of these risk factors among students will help to identify the NCD risk at an early stage.

Comparing to the above, physical activity (PA) and cardiorespiratory fitness(CRF) were inversely related to cardiovascular disease and metabolic disease risk factors[22-26]. As good CRF and PA have beneficial effect in reducing the risk of mortality, checking its status will help to plan the necessary steps for the prevention of NCD. It is reported in the previous studies that PA, CRF was related to BMI and BP[27-29]. If the student's PA level and CRF are assessed, and its relationship with risk factors, effective prevention program can be planned and promoted in the younger generation.

Therefore, this research study was designed to address that with the following objectives:

- To assess the CRF (VO_2 max), PA level, BMI, WC, WHR and BP of Malaysian students studying in two selecteduniversities around Negeri Sembilan.
- To find out the correlation between the CRF (VO_2 max), PA level and BMI, WC, WHR, BP of Malaysian students studying in two selected universities around Negeri Sembilan.

METHODOLOGY

Participants

This was a cross sectional study in which the CRF, PA level, BMI, WC, WHR and BPwere measured from all study samples for one time. The study period was from June 2015 to Dec 2015 and the ethical clearance was obtained fromINTI International University Research Ethics Committee. The study samples were fromtwo private universities recruited by the convenience sampling method. Before data collection,a brief description about the research and data collection procedure were given to the students and written informed consent was obtained.

The participants were recruited adopting the following inclusion criteria: students of Malaysian universities and university colleges from Negeri Sembilan, both male and female students aged 17 to 30 yearsirrespective of their race and religion. The students who do not speak and understand English, students with known Musculoskeletal,Cardiopulmonary or Neurological diseases which is severe enough to limit their physical activities, students taking regular medication for major illnesses, differently able students, students with known psychological problems and International students were excluded from the study.

Four experienced physiotherapists collected the data following the standard procedures. Before the data collection, practice sessions were conducted to follow the standard procedures without errors and inter-rater reliability was established. Each participant visited the laboratory once. The tests were completed in a single session atthe same time of the day as the fitness assessment needs to be conducted in the field (4pm to 7pm). Necessary precautions were taken to prevent the influence of environmental factors such as noiseand temperature. The students were requested not to attend any activity and to be in a resting condition on test days and avoid drinking or eating at least 4 hours before the measurements.

Procedures and measures

After obtaining the written consent from the participants, history collection and general physical examination were conducted to check the eligibilityto take part in the study. Then a personal information questionnaire was used to collect demographic and health information. The following variables were assessed from the students.

Physical activity level:Due to the cross sectional study design, the PA level of the samples wasassessed by subjective method using International Physical Activity Questionnaire (IPAQ)- short form (August 2002) in English[30] which is a quick, reliable and valid tool[31-33].Self administered questionnaire was given to all the samples and they have to provide the answer for 7 questions related to their time spent in physical activity for the last 7 days and return it to the investigator. The processing of the collected data was done based on the guidelines for data processing and analysis of the International Physical Activity Questionnaire-short and long forms[34]. From the data the total physical activity score for the last 7 days was calculated in MET-minutes/week as a continuous score and also categorised into low, moderate and high PA category following the same guidelines.

Body Mass Index:Standing height without shoes and body weight with light clothes as possible was measured using height and weight measuring scale RGZ-120. BMI was then calculated using Quetlet index[35,36]. The collected continuous data were then categorized into underweight, normal andoverweight (preobese, obese I,II and III) based on Ministry of Health, Malaysia guidelines[37].

Waist circumference and Waist to hip ratio: WC was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a tape following the report of a WHO expert consultation[38]. Hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the floor. Then the WHR was calculated by dividing hip circumference from WC values.For both measurements, the subject was standing with feet close together, arms at the side and body weight evenly distributed, and was wearing less clothing which was culturally acceptable. In a relaxed position, the measurements were taken at the end of a normal expiration. Each measurement was repeated twice; if the measurements were within 1 cm of one another, the average was calculated. If the difference between the two measurements exceeds 1 cm, the two measurements were repeated[38].Then the continuous data of WC were categorized into normal (Men < 90 cm and Women

< 80 cm) and risk category (Men ≥ 90 cm and Women ≥ 80 cm) based on Ministry of Health, Malaysia guidelines[39]. Similarly, the WHR was categorized into normal (Men ≤ 0.90 and Women ≤ 0.85) and risk category (Men > 0.90 and Women > 0.85) based on the same guidelines.

Blood pressure:The systolic and diastolic BP of each student was recorded from the first and the fifth phase of Korotkoff sounds respectively by standard procedure using Mercury Sphygmomanometer (Spirit CK-101C) and the Stethoscope[40,41].The BP was measured in the right and left arms in sitting and the arm with highest reading was assessed again and the average of 2 readings was recorded. Then the continuous data were categorized into hypotension, optimal, prehypertension and hypertension (stage I, II and III) categories based on the guidelines of the Ministry of Health, Malaysia[42].

Cardiorespiratory fitness(VO$_2$ max):The VO2 max was assessed by indirect method using Rockport one mile walk test which is a reliable and valid test to measure the CRF[43-46].The test was selected as it does not require any exercise testing equipment (treadmill) and easy to perform as walking is familiar to everyone. The subjects were asked to walk for 1 mile as fast as possible, without jogging or running with the electronic heart rate monitor sensor with chest strap (GARMIN, FORERUNNER 220) in their chest and heart rate monitor watch in their wrist. The test was administered outdoor on a track of 400 meters. The participants have to complete 4 rounds in the track. When finished, the time of the walk was recorded to the nearest minute and hundredth minute. The heart rate in beats per minute at the end of the last one-quarter mile was recorded by the electronic heart rate monitor.The test was conducted by following the guidelines for exercise testing by Greg M. Kline et al[44]. If the subject reported any discomfort during the procedure, the test was stopped immediately. The original equation by Greg M. Kline et al., 1987 was used to predict VO2 max with the body weight in Kg as given below:

VO2 max (mL•kg^{-1}•min^{-1}) = 132.853 - (0.1696 x BW) - (0.3877 x A) + (6.315 x G) - (3.2649 x T) - (0.1565 x HR 1-4)

where:
BW = body weight in kg, A = age in years, G = gender; 0 = female, 1 = male
T = time for the 1-mile track walk expressed as minutes and hundredths of a minute

HR 1-4 = Heart rate in b•min^{-1} at the end of the last one-quarter mile.

The continuous data were then categorized into superior, excellent, good, fair and poor based on the gender, using the reference from Heywood (2006) according to individual's age[47,48].

Statistical analysis
The continuous data were analysed by descriptive statistics to get the mean and standard deviation of CRF, BMI, WC, WHR and BP gender wise. The median value and interquartile ranges of total PA scores were reported due to unavilability of established thresholds for MET-minutes as per the guidelines for data processing and analysis of the International Physical Activity Questionnaire-short and long forms[34]. Then parametric correlation analysis (Pearson correlation) was executed using the overall and gender wise continuous variables to find out the relationship between CRF, PA level and BMI, WC, WHR, BP, as the literature reported gender wise variability in the values[49,50]. The correlation coefficient value of 0.00 to 0.25, 0.25 to 0.50, 0.50 to 0.75, and above 0.75 were considered as weak, fair, moderate and good relationship respectively[51]. The categories of the above mentioned data were presented as graphs in percentages. All the statistical analysis was run in SPSS version 13.0 and Microsoft Excel 2010.

RESULTS

Totally 106 students participated in the study. Out of this, one student discontinued the one mile walk test due to leg cramp and another two data were incomplete. The remaining 103 data were included for analysis out of which 70 (68%) were female students and 33 (32%) were male students.32.04% of students were overweight (8.74% of obese I and III, 23.3% preobese), 14.56% of students were underweight and 53.4% were normalbased on BMI. Pertaining toWC and WHR, 86.41% and 87.38% were normal, and13.59% and 12.62% were risk category respectively. 62.14% of students were in optimalBPcategory, whereas 25.24% and5.83% were inpre-hypertension and hypertensioncategories respectively. A small percentage (6.8%) were in hypotensive category. 53.4% students'fitness level was superior, excellent and good, while 46.6% in lower fitness level (fair and poor). 33.98%, 30.1% and 35.92% of students reported high, moderate and low physical activity level respectively. The graphical representation of gender wise data were given below.
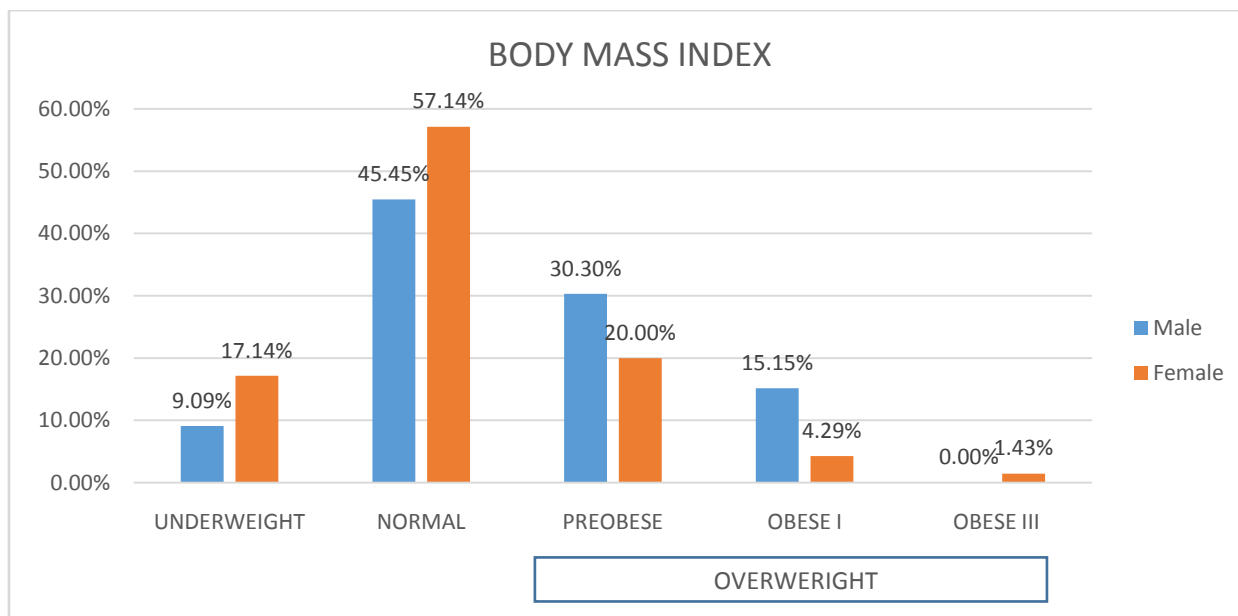
Figure 1: BODY MASS INDEX
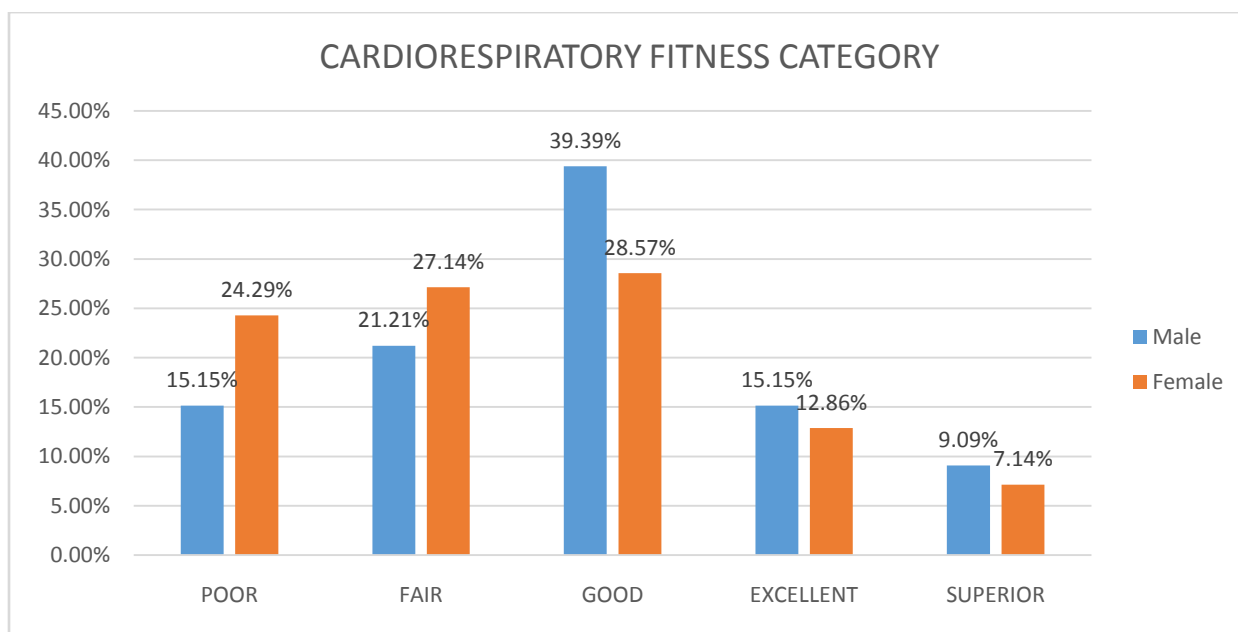
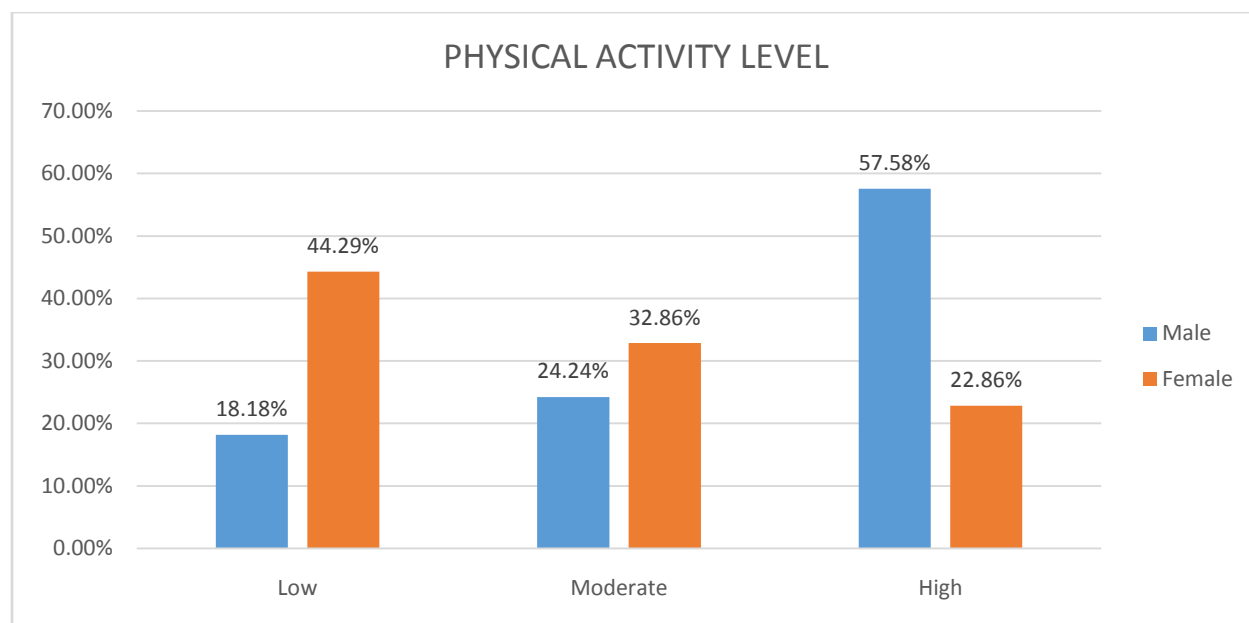**Figure 2: CARDIORESPIRATORY FITNESS CATEGORY**

Figure 2: PHYSICAL ACTIVITY LEVEL

Table 1: The descriptive statistics of the data

Variables	Male (N=33)		Female (N=70)		Total (103)	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Age (in years)	20.12	1.69	20.07	1.47	20.09	1.54
Body Mass Index	23.13	3.58	21.79	3.95	22.22	3.87
Waist circumference (cm)	75.94	9.54	71.66	10.43	73.03	10.30
Waist to hip ratio	.83	.14	.79	.15	.80	.15
Systolic Blood Pressure (mmHg)	117.09	8.76	108.74	10.50	111.41	10.67
Diastolic Blood Pressure (mmHg)	75.39	9.46	71.34	7.56	72.64	8.39
Cardiorespiratory fitness level (ml/Kg/min)	47.81	5.65	39.78	5.47	42.35	6.67
	Median	Inter quartile range	Median	Inter quartile range	Median	Inter quartile range
Physical activity level (MET-minutes/week)	4053	4909.00	1126.5000	2451.00	1542	3649.50

Table 2: The correlation of PA level with other variables.

Variables		Physical activity level (MET-minutes/week) Male (N=33)	Physical activity level (MET-minutes/week) Female (N=70)	Physical activity level (MET-minutes/week) Total (N=103)
Cardiorespiratory fitness level (ml/Kg/min)	Pearson Correlation	-.001	.113	.300(**)
	Sig. (2-tailed)	.997	.352	.002
Body Mass Index	Pearson Correlation	.230	-.046	.138
	Sig. (2-tailed)	.198	.706	.163
Waist circumference (cm)	Pearson Correlation	.128	-.107	.089
	Sig. (2-tailed)	.479	.380	.370
Waist to hip ratio	Pearson Correlation	.000	.020	.072
	Sig. (2-tailed)	.998	.872	.469
Systolic Blood Pressure (mmHg)	Pearson Correlation	.302	-.025	.257(**)
	Sig. (2-tailed)	.087	.835	.009
Diastolic Blood Pressure (mmHg)	Pearson Correlation	.002	-.191	.030
	Sig. (2-tailed)	.992	.114	.765

(* Significance at P<0.05, ** Significance at P<0.01)

Overall the PA level and CRF werepositively and fairly correlated significantly atP<0.01. The systolic BP shows fair positive significant correlation with the PA level. The overall values of BMI, WC, WHRand diastolic BP do not show any significant correlation with the PA level. Nevertheless, in male and female student population, we could not find any relationship.

Table 3: The correlation of CRF level with other variables.

Variables		Cardiorespiratory fitness level (ml/Kg/min) Male (N=33)	Cardiorespiratory fitness level (ml/Kg/min) Female (N=70)	Cardiorespiratory fitness level (ml/Kg/min) Total (N=103)
Body Mass Index	Pearson Correlation	-.524(**)	-.402(**)	-.265(**)
	Sig. (2-tailed)	.002	.001	.007
Waist circumference (cm)	Pearson Correlation	-.466(**)	-.198	-.116
	Sig. (2-tailed)	.006	.100	.242
Waist to hip ratio	Pearson Correlation	-.249	-.029	.000
	Sig. (2-tailed)	.162	.813	.999
Systolic Blood Pressure (mmHg)	Pearson Correlation	-.344(*)	-.412(**)	-.093
	Sig. (2-tailed)	.050	.000	.353
Diastolic Blood Pressure (mmHg)	Pearson Correlation	-.139	-.093	.040
	Sig. (2-tailed)	.440	.445	.688

(* Significance at P<0.05, ** Significance at P<0.01)

Overall, BMI has fair significant negative correlation with the CRF level at p<0.01. In females BMI and systolic BP displays significant (P<0.01) fair negative correlation with the CRF. In

case of males the negative correlation of CRF was moderate at P<0.01 with BMI, fair at P<0.01 with WC and fair at P0.05 with systolic BP.

DISCUSSION

The objective of this study was to find out the CRF, PA level, BMI, WC, WHR and BP of two Malaysian private university student population and to find the correlation between them. Largely the student population in the universities where the study was conducted was dominated by female population, which was reflected in the sample size (females 68%) as well. The mean of BMI, WC, WHR, BP, CRF level and PA level was reported to be higher in males than females, which was similar to the reports of other studies about Malaysian students[49,52].

On the whole 32.04% of students were overweight, which is lower than the reported result of 37.1% in a study conducted in Universiti Malaysia Sarawak students[53]. But, a study by Kuan et al., 2011 reported more or less similar percentages of BMI categories like this study results[50]. A study by Gan et al. reported lower percentage of overweight, but they followed WHO criteria of defining overweight, which is different than the Malaysian guideline[49]. The percentage ofobesity (15.15%) and preobese(30.3%) were higher in male students than female students. The reverse trend was true in case of underweight (17.1%) and normal BMI (57.1%) in female students. 45.45% of male students and 25.72% of female students were overweight.The trend of overweight and underweight in both genders were also similar to the result reported by previous studies[49,50]. From this result, it is clear that the prevalence of overweight is high in Malaysian student population and it may be due to the influence of race, religion, alcohol consumption and restrained eating in the students population[54].

The WC and WHR showed a similar trend of high percentage of normal category and low percentage of risk category in male and female student population. The percentage of males and females in a risk category based on WC, was comparatively in agreement with the result of previous study in Klang valley university students[49]. The mean WC values of males were slightly lower in this study when compared to the results of Choong et al., but in females it was closer[52]. However, the mean value of WHR was closerto the value reported by Choong et al., 2012 in both males and females.These reported differences may be due to different location (state) of the study and difference in ethnicity as this study included samples irrespective of their race, when compared to only chinese and Indians in the previous study[52].

The mean systolic BP and the mean diastolic BP in both genders and overall BP in this study were higher than reported by previous study among Malaysian university students[52,55]. The percentage of pre-hypertension reported in this study was less than previous reports[55]. The percentage of hypertension and pre-hypertension was more in male students, whereas the percentage of hypotension and optimal range BP was more in female students. In a study about the trends in the prevalence of hypertension from 1996 to 2006 showed a prevalence of 32.7% of those aged >18 years[56]. Whereas, the percentage of hypertension reported among Universiti Malaysia Sarawak students was 21.4 % in males and 9% in females[53]. In contrary the percentage of hypertension in this study was 9.1% in male students and 4.3% in female students. The electronic BP measurement apparatus was used in previous studies, whereas manual measurement of BP with mercurial sphygmomanometer was used in this study, as it is accepted as gold standard method of indirect BP measurement[42].The less number of samples andrace might have influenced the data as Malays are associated with a higher percentage of pre-hypertension[55], whereas the percentage of Malays (not reported here) in this study were less. Hence the percentage of hypertension and pre-hypertension reported in this study may be less than previous studies. Still the pre-hypertension percentage is a concern among students. Results from previous studies shown that prehypertension was related toage, gender, lack of physical exercise,less sleep, depression, overweight and obesity[55,57-59].

In this study, 33.98% reported high, 30.1% reported moderate and 35.92% reported low PA levels. A previous study conducted among Malaysian university students reported 58.3% of moderate, 41.4 % of low PA and only 0.3% of high PA[60]. A research study based on the reports of National Health and Morbidity Survey 2011 reported that nearly 65% of Malaysian adults were physically active, which is close to this study result of combined high and moderate PA level[61]. Males (57.6%) dominated in the high PA category, whereas more percentage of females (32.9%) reported moderate amount of PA in this study.A recent study reported similar trends of PA among male and female university students[62]. Nearly one third of students were not performing sufficient amount of PA. It may be due to various sociodemographic and health factors[63].

Overall, more than half of the participants' (53.4%) cardiorespiratory fitness level was satisfactory level of superior, excellent and good based on this study results. The mean value of VO2 max was slightly higher than reports of previous

studies[64,65]. When comparing genders, the more percentage of males were with good (39.4%), excellent (15.2%) and superior (9.1%) fitness category and high percentage of female students were in fair (27.1%) and poor (24.3%) fitness category. The difference may be due todifferent test used to assess the fitness level in the previous studies.

Generally, the PA level fairly, positively correlated withCRF(p<0.05), but gender wise the author cannot find a correlation. A research study among the normal population reported that the CRF was associated with calories spent in sports activities, but not with gender[66]. Similarly a study conducted among school children and adults in Europe established a positive correlation between CRF and moderate to vigorous, vigorous and very vigorous PA[67,68]. Hence it is clear that higher the PA level, better the fitness level. BMI, WC, WHR and diastolic BP do not show any significant correlation with the PA level. It is in accordance with the previous result that, BMI and PA does not correlate[67]. Correspondingly a study conducted among Malaysian students also did not establish any relationship between BMI, WC, WHR, systolic and diastolic BP with number of steps taken[69].The systolic BP shows a weak significant positive correlation with the PA level, which is not giving any important meaning for clinical application.But in female students the systolic and diastolic BP shows weak negative relation with the PA level.Contrarily, a study done in Jordan reported that the walking PA, moderate PA and total PA correlated negatively in a significant manner with the systolic and diastolic BP[27]. But in this study the numerical data of the METS min/week was used, whereas the previous study used categorial data for correlation analysis, which may be the reason for a different result.Another research in Malaysian adults also did not show any association between PA and diastolic BP, but positive association with systolic BP similar to this study results[70]. One of the possible reasons could be an overestimation of physical activity level as IPAQ-SF is the subjective recall of the PA[33].

BMIexhibited fair significant negative correlation with the CRF level at p<0.05 in both male and female students and overall score. Therefore, it is distinct that lower the BMI, higher the CRF level. It was in agreement with the results of previous studies[71,72].Likewise,WC also displayssignificant negative relationship with the fitness level in males.Previous research among the normal population also reported the same in males[66,71].In this study the WHR did not correlate significantly with CRF in both genders, but it was having negative relation. Then it differs from the result of a researchconducted among female students that

WHR is a significant predictor of CRF[73].It could be due to different test for assessing CRF as Rockport One mile walk test was used in this study, whereas Cooper 12-minute walk/run test was used in the previous study. In Asian Indians it was reported that WC better correlates with BMI than WHR[18]. It may be one of the reasons for lack of correlation between CRF and WHR, but it is positive between BMI and CRF.Both the systolic and diastolic BPdisplays negative relationship with CRF in both genders with significant fair negative correlation of systolic BP with CRF. Research done by Barlow CE et al., Klasson-Heggebø L et al., and Leon AS reported that higher the CRF, lower the incidence of hypertension, which is in accordance with this study result[74-76].

The results of this study cannot be generalised to all the Malaysian students due to small sample size, samples from only two universities, convenience sampling method, and usage of a questionnaire to assess the PA level. Shorter study duration and preliminary nature of the study were the reasons for limitations mentioned above. Hence, future studies should be planned considering the limitations of this study to get better insight into the problem.However, this study result gives an insight into the status of CRF, PA level, BP, BMI, WC, WHR and its relationships, which is a less researched area among Malaysian university students.

CONCLUSION

According to the results of this study, overweight was higher amongselected two Malaysian university students. The percentage of prehypertension also requires attention in this group. Eventhough the CRF of 53.4% of students were combinely in superior, excellent and good level, and PA level of 64.08 % of students were combinely in high and moderate level,more than one third of the students need to improve. The CRF positively correlates with PA level, whereas the BMI and systolic BPdisplays inverse relationship with the CRF. Hence it is important to raise the awareness of PA and fitness among Malaysian students to reduce the incident of overweight and prehypertension. The results of this study should be interpreted considering the limitations of this study.

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