Lower Body Mass Index, Waist Circumference and Body Fat Percentage for Reduction of Cardiovascular Risk Among Malaysian Male Security Personnel

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ABSTRACT

Background: Appropriate body composition is a critical element positively influencing security personnel's physical performance, health, and force readiness. **Objective:** A cross sectional study was conducted to determine the appropriate body mass index (BMI), waist circumference (WC), and body fatness cut-off values for the prediction of cardiovascular risk among Malaysian male security personnel. **Methods:** A total of 913 respondents, aged between 18 to 50 years were recruited using a two-stage proportionate stratified sampling design. Their anthropometric measurements, physical fitness status, blood pressure, lipid profile, fasting glucose, and 2-hour post prandial glucose were obtained. A receiver operating characteristic (ROC) curve was employed to determine the optimal cut-offs of BMI, WC, and body fatness with optimum sensitivity and specificity. **Results:** More than 38% of the respondents were overweight (BMI 25.0-29.9 kg/m2), 18% were obese (BMI > 30.0 kg/m2), and 44% were classified with abdominal obesity (WC > 90 cm). Almost 60% of respondents have at least one cardiovascular risk factor. A WC of 80.0 cm gave the largest area under the ROC curve (AUC=0.808, 95% CI 0.775-0.840), followed by a BMI of 23.5 kg/m2 (AUC=0.802, 95% CI 0.769-0.834), and body fatness of 20.0% (AUC=0.794, 95% CI 0.761-0.826). The sensitivity and specificity of these cut-offs ranged between 89.8% to 90.2% and 83.0% to 84.1% respectively. **Conclusion:** Optimal cut-offs of BMI 23.5 kg/m2, WC 80.0 cm, and total body fatness of 20.0% were suggested for reduction of cardiovascular risk among Malaysian male security personnel.

KEYWORDS: BMI, Waist Circumference, Cardiovascular Risk Factor.

INTRODUCTION

Defining body composition standards among security personnel has been challenging, as such definition has to consider the relationship between health, adiposity, and physical performance outcomes. Setting a standard too high and idealistic may encourage disordered eating and other health habits that impair, rather than promote physical and medical readiness [1]. On the other hand, any adjustment would cause deliberate acceptance of lower fitness and health standards [2]. Current guidelines for retention, awards, and promotions in the national security service, which adopts body mass index (BMI) as the sole anthropometric measurement, is rather biased. BMI is widely accepted as a gross indication of fatness, of which the contribution of percentage body fat and muscle are not well differentiated [3]. This clearly neglects the fact that personnel with larger BMI may have higher muscle mass and not necessarily body fat.

The World Health Organization (WHO) recommended the use of BMI 25.0 to 29.9 kg/m2 for the definition of overweight and BMI ≥ 30.0 kg/m2 as obesity [4]. However, there has been awareness that the progression in the prevalence of cardiovascular disease with increasing BMI and waist circumference (WC) were seen in all parts of Asia; far below the recommended cut-off points [4-13]. Subsequently, this has led to many efforts to recommend a new definition of obesity for the Asian population [12]. The 3rd National Health and Morbidity Survey (NHMS III) conducted in 2006 indicated that the optimal BMI cut-off for predicting diabetes, hypertension, hypercholesterolemia, or at least one cardiovascular risk factor for Malaysian adults ranged from 23.3 to 24.1 kg/m^2 for men and from 23.9 to 25.4 kg/m^2 for women while WC cut-off points to identify obesity in Malaysian adults (BMI ≥ 30 kg/m^2) was 93.2 cm for men and 85.2 cm for women [13,14].

Obesity has been an epidemic worldwide, and the national security population was not spared. There was an increasing trend of overweight and obese in the military forces everywhere in the world and this directly affected the state of combat readiness [15-17] and incurred obesity-related costs [18,19]. Despite the rise in the prevalence of obesity worldwide, epidemiological data and evidence on obesity among Malaysian national security personnel is scarce as compared to the civilian counterparts. Thus, there is a lack of understanding and any effort to intervene obesity problem for this specific population could not be carried out systematically. It is crucial, for reasons stated, that the anthropometric measures be properly defined so that security personnel with larger and heavier builds of muscle mass will be acknowledged while necessary intervention on those with excess fat is instituted. Therefore, this study was conducted to examine the relationship between BMI, WC, total body fatness and cardiovascular risk factors among national security personnel. We also evaluated the sensitivity and specificity of various cut-off values of the anthropometric indices and further recommend optimal cut-offs of BMI, WC and body fatness for the prediction of cardiovascular risk factors.

Materials and Methods

This cross-sectional study was conducted between June to November 2013, of which two-stage proportionate stratified sampling design were employed. Sample size calculated using Sample Size Calculator for Sensitivity and Specificity Studies [20]. A region, consisting of 70 units was categorized into three primary security task groups, whereby 1 200 male security personnel were selected proportionately, based on the latest updated size measures. Eligibility for participation includes male security personnel, aged between 18 to 50 years. Respondents were excluded if they had increased abdominal girth not related to increased adiposity (e.g. abdominal ascites, hypothyroidism and other debilitating illness), bedridden, physical disability or mental illness. After data cleaning, a final total of 913 respondents were included in the analyses. A pilot study was carried out to test questionnaires and field logistics. Ethical approval was obtained from the Research Ethics Committee, Universiti Kebangsaan Malaysia (NN-100-2013) and all respondents gave written informed consent prior to involvement in the study.

A self-administered questionnaire was used to collect information on educational level, smoking habits, alcohol consumption, medical history, family medical history, and physical activity. Body height was measured using mobile stadiometer SECA 217 (Seca, Hamburg, Germany) with the Frankfurt plane horizontal, to the nearest 0.1 cm without shoes [21]. Weight, total body fatness, and skeletal muscle mass (SMM) was measured in light indoor clothes without shoes using a calibrated body composition analyzer InBody model 230 (Biospace Co., Korea) with an accuracy of 0.1 kg. BMI (weight/height^2) was then calculated. Respondents were given instructions to undertake the measurement in a state of normal hydration (no exercise or alcohol / caffeine consumption in the preceding 12 hours) and after urination or excretion. WC was measured using Lufkin tape (Apex Tool Group, UK) to the nearest 0.1 cm, midway between the lowest rib margin and the top of the hipbone (iliac crest) at the end of a gentle expiration [21]. Two measurements were taken for each respondent and in the event that there was a difference of five units between the two measurements, a third measurement was taken. The two measurements that were close to each other were selected and the mean of the selected measurement was calculated during the analyses.

A total of 5 ml of overnight fasting venous blood samples were taken to determine low-density lipoprotein cholesterol (LDL), high-density lipoprotein cholesterol (HDL), triglyceride (TG) and fasting blood glucose. Those who claimed to be non-diabetic then consumed 75 g of glucose and had 2.5 ml of their venous blood samples taken for 2 hours post prandial (2HPP) glucose. All biochemical analyses were done using a clinical chemistry analyzer Cobas 6000 C501 module (Roche Diagnostics, Mannheim, Germany). Blood pressure was measured using a calibrated digital blood pressure device model HM-7203 (Omron Healthcare, Kyoto, Japan) on the right arm after an adequate rest period of at least 15 minutes. Two measurements were taken for each respondent with a 30 seconds interval between measurements. The average reading was used.

The cut-off value for hypertension was defined as systolic blood pressure $\geq$ 140 mmHg and/or diastolic blood pressure $\geq$ 90 mmHg, elevated LDL as LDL $\geq$ 4.1 mmol/l, decreased HDL as HDL < 1.0 mmol/l, elevated TG as TG $\geq$ 1.7 mmol/l, and diabetes mellitus as 2HPP $\geq$ 11.1 mmol/l [22-24]. 'At risk' was defined as having at least one of the above risk factors.

A modified 3-event physical fitness test with a sequence of 60 seconds push-ups, 60 seconds sit-ups and 2.4 km run were executed to assess physical fitness [25]. Respondents were then categorized into passed or failed. Passed was defined as passing all three physical fitness events while failed was defined as failing at least one physical fitness event. Respondents were also classified into full assignment or limited assignment according to the national security medical classification system [26]. Full assignment was defined as the personnel being healthy and having no restrictions to the location of deployment and level of employment, while limited assignment was defined as the personnel having either physical ailments or disease that might restrict their location for deployment and level of employment.

Respondents were assigned to categories of BMI and WC using pre-set border values for given parameters as recommended by WHO (1995) and WHO/IASO/IOTF (2000), respectively [4,11]. Total body fatness was classified according to the Malaysian Clinical Practice Guidelines on Management of Obesity [27]. Statistical analyses were performed using Statistical Package for the Social Sciences, SPSS® for Windows™ applications (Version 22; SPSS Inc., Chicago, USA) whereby the significant level was pre-set at $P < 0.05$. A logistic regression model, adjusted for age and smoking habits, was employed to determine the relationship between BMI, WC and body fatness with the presence of at least one cardiovascular risk factor (hypertension, dyslipidemia, or diabetes mellitus). The odds ratio of having these cardiovascular risk factors were calculated at a different cut-off of BMI, WC, and body fatness as compared to the lowest cut-off in each of the categories. Receiver operating characteristic (ROC) curves were employed to determine the optimal cut-off values of BMI, WC, and body fatness with optimum sensitivity and specificity for the prediction of cardiovascular risk factors. Sensitivity was defined as the probability of correctly identifying those with hypertension, dyslipidemia, diabetes mellitus, or at least one of the risk factors for a given BMI, WC, and body fatness cut-off points, while specificity was defined as the probability of correctly identifying those without the cardiovascular risk factors for a given BMI, WC, and body fatness cut-off point. Area under the ROC curve (AUC) with 95% confidence interval was generated to indicate the diagnostic performance of BMI, WC, and body fatness for identification of those having cardiovascular risk factors.

RESULTS

The sample consisted of 913 male respondents aged between 18 and 50 years, with an overall positive response rate of approximately 99%. Malays made up 81.4% of the respondents, while 17.6% were Sabah/Sarawak Bumiputera. Of those, 68.3% were married. Majority of the respondents (79.1%) had attained secondary education, while 20.3% had their tertiary education.

Smokers comprised 71.9% and 12.0% admitted to consuming alcoholic beverages. The BMI ranged between 16.7 to 39.8 kg/m^2. Most of the respondents (96.8%) were classified as full assignment, while the remaining had either physical ailments or disease. Upon blood investigation, 55.9% were dyslipidemic, and 2.1% were found to have diabetes mellitus. Almost 20% were diagnosed with hypertension while 60% of the respondents were found to have at least one cardiovascular risk factor. Previously, only 6.4% were known to be hypertensive, 5.2% were known to have dyslipidemia, while 2.0% were known to be diabetic. Only 7.9% passed all 3-event physical fitness tests.

It was noted that those respondents in the younger age group (18-39 years) had lower BMI, WC, blood pressure, and LDL as compared to their older counterparts (40-50 years) (Table 1). It was also worth noting that disease or physical ailments occurred at the mean (SD) age of 32.8 (5.5) years (Table 2).

Table 1: Characteristics of Anthropometric Indices and Cardiovascular Risk Factors According to Age Group

	Total		Age group (years)			
			18 – 39		40 – 50	
Variables	n	mean (SD)	n	mean (SD)	n	mean (SD)
Height (cm)	913	168.3 (5.7)	856	168.3 (5.7)	57	167.5 (6.1)
Weight (kg)	913	73.6 (13.0)	856	73.4 (13.0)	57	76.1 (11.2)
BMI (kg/m^2)	913	26 (4.4)	856	25.9 (4.4)*	57	27.1 (3.8)*
WC (cm)	913	86.8 (13.0)	856	86.6 (12.7)*	57	90.4 (16.0)*
Body fat (%)	913	23.9 (8.4)	856	23.9 (8.5)	57	25 (7.3)
SMM (kg)	913	30.9 (3.7)	856	30.9 (3.7)	57	31.7 (3.8)
SBP (mmHg)	913	120.8 (15.3)	856	120.4 (15.0)**	57	126 (17.4)**
DBP (mmHg)	913	73.4 (12.4)	856	73.1 (12.2)*	57	78.8 (14.4)**
LDL (mmol/l)	892	3.5 (1.0)	836	3.5 (1.0)*	56	3.8 (1.0)*
HDL (mmol/l)	913	1.3 (0.5)	856	1.3 (0.5)	57	1.2 (0.3)
TG (mmol/l)	912	1.7 (1.4)	856	1.7 (1.4)	56	1.9 (1.5)
Fasting glucose (mmol/l)	909	4.8 (1.1)	856	4.8 (1.1)	53	4.8 (1.0)
2HPP (mmol/l)	907	5.6 (1.3)	851	5.5 (1.2)	56	6.0 (2.3)
60 s push-ups (no)	913	29.7 (10.3)	856	29.9 (10.4)*	57	25.5 (7.8)*
60 s sit-ups (no)	913	35.2 (8.1)	856	35.4 (8.0)**	57	31.8 (7.5)**
2.4 km run (min)	913	13.9 (3.2)	856	13.8 (3.2)	57	14.5 (3.1)

**P value < 0.01; *P value < 0.05; significant differences in means between age groups
BMI: body mass index; WC: waist circumference; SMM: skeletal muscle mass; SBP: systolic blood pressure; DBP: diastolic blood pressure; LDL: low-density lipoprotein cholesterol; HDL: high-density lipoprotein cholesterol; TG: triglyceride; 2HPP: 2 hours post prandial glucose.

It was found that those respondents who were categorized as full assignment were younger, had lower BMI, WC, and body fatness with good blood pressure readings and biochemical profiles. Those who passed all 3-event physical fitness tests were found to have significantly lower BMI, WC, and body fatness. The mean for BMI, WC, body fat, blood pressure, and LDL increased significantly with age. Meanwhile, assignment status deteriorated significantly as age increased. There was no significant mean difference of SMM in either age group or assignment status (Table 2).

Upon adopting the WHO (1995) recommendation of BMI, 38.0% of the respondents were found to be overweight (BMI 25.0 – 29.9 kg/m^2) and 18.6% were obese (BMI ≥ 30.0 kg/m^2). According to the WHO/IASO/IOTF (2000) recommendation, 43.8% were classified as having abdominal obesity (WC ≥ 90 cm). There were strong significant associations between BMI, WC, and body fatness with the presence of hypertension, dyslipidemia, or diabetes. The odds ratio for the presence of at least one cardiovascular risk factor, which was adjusted to age and smoking, increased with increasing BMI, WC, and body fatness (Table 3).

Table 2: Characteristics of Anthropometric Indices and Cardiovascular Risk Factors According to Assignment and Physical Fitness Status

	Assignment status				Physical fitness status			
	Full assignment		Limited assignment		Passed		Failed	
Variables	n	mean (SD)	n	mean (SD)	n	mean (SD)	n	mean (SD)
Age (years)	884	29.4 (5.7)**	29	32.8 (5.5)**	72	29.6 (6.6)	841	29.5 (5.7)
Height (cm)	884	168.3 (5.7)	29	166.5 (6.2)	72	168.4 (5.5)	841	168.3 (5.7)
Weight (kg)	884	73.4 (12.9)	29	78 (15.1)	72	68.5 (11.5)**	841	74.0 (13.0)**
BMI (kg/m^2)	884	25.9 (4.3)**	29	28 (4.6)**	72	24.2 (4.1)**	841	26.1 (4.4)**
WC (cm)	884	86.6 (12.9)**	29	93 (12.8)**	72	82.6 (11.5)*	841	87.1 (13.0)*
Body fat (%)	884	23.8 (8.4)*	29	27.4 (7.8)*	72	20.7 (8.6)**	841	24.2 (8.4)**
SMM (kg)	884	30.9 (3.6)	21	31.4 (4.8)	72	29.8 (3.2)*	841	31.0 (3.7)*
SBP (mmHg)	884	120.6 (15.1)	29	124.4 (19.3)	72	121.8 (15.7)	841	120.7 (15.2)
DBP (mmHg)	884	73.3 (12.3)	29	76.7 (14.5)	72	74.7 (12.3)	841	73.3 (12.4)
LDL (mmol/l)	864	3.5 (1.0)**	28	4.1 (1.0)**	72	3.3 (0.9)	820	3.6 (1.0)
HDL (mmol/l)	884	1.3 (0.5)	29	1.1 (0.2)	72	1.2 (0.3)	841	1.3 (0.5)
TG (mmol/l)	883	1.7 (1.4)	29	1.9 (1.4)	72	1.8 (1.4)	840	1.7 (1.4)
Fasting glucose (mmol/l)	881	4.8 (1.1)	28	4.9 (0.7)	72	4.6 (0.7)	837	4.8 (1.1)
2HPP (mmol/l)	878	5.6 (1.3)	29	5.8 (1.8)	71	5.5 (1.2)	836	5.6 (1.3)
60 s push-ups (no)	884	29.8 (10.1)	29	25.9 (14.9)	72	41.4 (5.8)**	841	28.6 (10.0)**
60 s sit-ups (no)	884	35.2 (8.0)	29	32.7 (9.3)	72	48.2 (6.8)**	841	34.0 (7.1)**
2.4 km run (min)	884	13.8 (3.1)**	29	16.4 (4.9)**	72	11.9 (1.2)**	841	14.0 (3.3)**

**P value < 0.01; *P value < 0.05; significant differences in means between assignment status or physical fitness status, where applicable
BMI: body mass index; WC: waist circumference; SMM: skeletal muscle mass; SBP: systolic blood pressure; DBP: diastolic blood pressure; LDL: low-density lipoprotein cholesterol; HDL: high-density lipoprotein cholesterol; TG: triglyceride; 2HPP: 2 hours post prandial glucose.

Table 3: Associations between BMI, WC and Body Fatness with the Cardiovascular Risk Factor among Male Malaysian Security Personnel

Cardiovascular risk factor, n (%) At risk, 561 (61.4)		**OR**	**(95% CI)**	**P value**
BMI (kg/m^2)	< 23.0	1.00		
	23.0 – 24.9	2.19	(1.39, 3.44)	< 0.001
	25.0 – 26.9	4.52	(2.78, 7.36)	< 0.001
	27.0 – 29.9	5.46	(3.56, 8.37)	< 0.001
	≥ 30.0	5.84	(3.59, 9.51)	< 0.001
WC (cm)	< 80.0	1.00		
	80.0 – 82.9	2.56	(1.44, 4.54)	< 0.001
	83.0 – 85.9	3.56	(1.92, 6.59)	< 0.001
	86.0 – 89.9	3.08	(1.86, 5.08)	< 0.001
	≥ 90.0	5.46	(3.78, 7.91)	< 0.001
	< 20.0	1.00		
Body fat (%)	20.0 – 22.4	2.07	(1.26, 3.40)	< 0.01
	22.5 – 24.9	3.68	(2.10, 6.45)	<0.001
	≥ 25.0	5.01	(3.53, 7.12)	<0.001

OR, odds ratio adjusted for age and smoking;
At risk, the presence of hypertension/dyslidemia/diabetes mellitus

The optimal BMI cut-off value for predicting the presence of hypertension, dyslipidemia, or at least one cardiovascular risk factor varied from 23.0 to 23.5 kg/m^2 with a sensitivity of 75.0 to 90.2% and a specificity of 84.1 to 97.6% (Table 4). The optimal WC cut-off value varied from 80.0 to 89.0 cm with a sensitivity of 76.2 to 89.8% and specificity between 83.0 to 97.6%. The optimal body fatness cut-off value varied from 18.0 to 20.0% with sensitivity between 76.2 to 90.2% and specificity between 83.0 to 97.8% (Table 4). As for diabetics, the sample was relatively very small and was excluded from this calculation.

Table 4: AUC, Sensitivities and Specificities of BMI, WC and Body Fatness Cut-offs Predictive of Cardiovascular Risk Factor

		Cut-off	AUC (95% CI)	Sensitivity (%)	Specificity (%)
BMI (kg/m^2)	At risk	23.5[a]	0.802 (0.769, 0.834)	90.2	84.1
		23.0[b]	0.797 (0.763, 0.831)	89.8	83.8
		25.0[c]	0.776 (0.745, 0.807)	89.4	83.8
	Hypertension	23.5[a]	0.766 (0.733, 0.798)	75.0	97.6
		23.0[b]	0.752 (0.718, 0.787)	75.0	97.6
		25.0[c]	0.726 (0.693, 0.759)	75.0	97.8
	Dyslipidemia	23.0[a,b]	0.795 (0.760, 0.829)	89.0	87.1
		25.0[c]	0.766 (0.734, 0.798)	88.4	87.1
WC (cm)	At risk	80.0[a]	0.808 (0.775, 0.840)	89.8	83.0
		90.0[b]	0.743 (0.711, 0.775)	89.6	83.0
	Hypertension	89.0[a]	0.773 (0.742, 0.803)	76.2	97.6
		90.0[b]	0.769 (0.738, 0.800)	75.6	97.8
	Dyslipidemia	80.0[a]	0.799 (0.765, 0.833)	89.0	86.8
		90.0[b]	0.723 (0.690, 0.756)	87.8	87.3
Body fat (%)	At risk	20.0[a]	0.794 (0.761, 0.826)	90.2	83.0
		25.0[d]	0.752 (0.720, 0.784)	89.6	84.4
	Hypertension	18.0[a]	0.822 (0.792, 0.852)	76.2	97.8
		25.0[d]	0.724 (0.692, 0.757)	77.9	97.9
	Dyslipidemia	20.0[a]	0.779 (0.745, 0.812)	89.0	86.6
		25.0[d]	0.747 (0.715, 0.779)	89.0	86.8

[a]optimal cut-off by the present study
[b]WHO/IOTF/IASO (2000) recommendation[10]
[c]WHO (1995) recommendation[3]
[d]Ministry of Health Malaysia (2004) classification[22]
AUC: area under the ROC curve; ROC: receiver operating characteristic; BMI: body mass index; WC:waist circumference

DISCUSSION

Body fatness was related to some aspects of health risks [28]. It was worth noting that excess adiposity and not excess body weight was the real culprit of obesity-associated complications [29]. BMI was considered the most useful, population-level measure of obesity. However, BMI does not distinguish between weight associated with muscle or fat. Hence, many studies recommended a consideration of a second-tier evaluation that provided an improved resolution on health risk prediction as a complement to BMI when evaluating individual and population adiposity [15,30].

The diagnostic performance of a BMI, WC, and body fatness cut-off value in the present study was assessed by calculating its sensitivity and specificity for predicting the cardiovascular risk factors. Our findings showed that the optimal BMI of 23.5 kg/m^2, WC of 80.0 cm, and body fatness of 20.0% correctly identified more than 89% of those with at least one cardiovascular risk factor and correctly identified more than 83% of those without. The optimal cut-off of BMI 23.5 kg/m^2 was comparable to the national survey [13] which recommended BMI 23.3 to 24.1 kg/m^2 for Malaysian adult men and was comparable to previous findings from other Asian countries [5-10]. However, optimal cut-off values of WC 80.0 cm found in the present study apparently were much lower than the national study [14] of WC 93.2 cm for Malaysian adult men. Nevertheless, similar findings were reported by population-based studies conducted in Taiwan (80.5 cm) [6] and Hong Kong (78.2 cm) [10]. The variations were most probably due to differences in sample size, health risk factors, or methods used in determining the optimal cut-offs. As for total body fatness, it was not comparable to other studies as the methods used in each study differ.

Adoption of a BMI, WC, and body fatness cut-offs with higher sensitivity, which also means a higher false-positive rate, while minimizing the false-negative rate, was accepted in clinical and public health practice. There was relative harm and cost in recommending the false-positive group for weight management and cardiovascular risk factor screening as compared to those with medical cost incurred for treatment of those with obesity-related diseases [18,19]. Furthermore, it would promote awareness about the potential risks of further weight gain among those classified as overweight but not having any cardiovascular risks as yet [9].

According to the NHMS in 2019, the prevalence of overweight, obesity and abdominal obesity in the general Malaysian adult men population was 30.8%, 15.3% and 41.4% respectively [36]. These parameters were found to be higher among the national security personnel (38.0%, 18.6% and 43.8% respectively) when compared to the general population. The cause of this situation has remained unexplained and warrants further investigation. As highlighted by Bae et al, a previous study conducted on a group with a similar vocation in Korea found that security personnel were exposed to a high risk of obesity [15]. This was due to living apart from their families, which leads to irregular meals and infrequent dinner arrangements related to their duties and work shifts that last from morning to night. Early discharge of those with disease and obesity may contribute to a decreased number of personnel with obesity in the service. The present study also found that disease or physical ailments occurred at the mean (SD) age of 32.8 (5.5) years. This also meant that these personnel, who were categorized as limited assignment, would be restricted on their location for deployment and level of employment. This situation may jeopardize the national security state of readiness as majority of the security personnel were made up of this age group. Therefore, factors that contributed to this matter need to be further determined.

It was worth noting that the military performance not only involved tasks of muscular strength and endurance but far beyond to load carrying ability and lifting. Previous studies demonstrated that fatness was associated with longer load carrying time to cover a given distance and lean body mass was associated with faster load carriage time [28]. The present study found that regardless of age, those who passed all 3-event physical fitness tests had lower BMI, WC, and body fatness. This is consistent with previous study which reported that soldiers with body fat less than 18% performed significantly better on 7 of the 10 fitness tests [31]. They also found that soldiers with similar amounts of fat free mass, those with less body fat had improved aerobic and anaerobic capacity and increased muscular strength. A higher Army Physical Fitness Test (APFT) score was associated with a healthier cardiovascular risk factor profile, diastolic blood pressure, and BMI, and was a predictor of better pre-deployment cardiovascular health [32]. In the Malaysian national security population, this warrants further investigation. Standpoint for determining body composition standards for the national security population remains controversial. Fat and fitness standards have had different purposes and cannot be easily combined, even though they were both ultimately intended to ensure individual readiness [1]. However, health endpoints have been heavily relied on to set body fat standards in the national security population as these criteria were better defined than physical performance or appearance outcomes [37].

The present study was the first of its kind to determine the optimal BMI, WC, and total body fatness cut-off points for predicting cardiovascular risk factors among the Malaysian male national security population. Being a cross-sectional study design, the causal inference could not be drawn from the present study as the associations of BMI, WC, and body fatness with cardiovascular risk factors are probably not stable over time. However, numerous prospective studies have documented that cardiovascular risk, cancer and all-cause mortality were attributed to overweight and obesity [33-35]. Given the limitation, this study showed that there were strong significant associations between BMI, WC, and body fatness with the presence of hypertension, dyslipidemia, or diabetes. The optimal BMI cut-offs recommended for the national security population was comparable with the Malaysian male general population. Current outcomes served as a crucial preliminary finding that require further investigations and later, revision of current national security health policies and implementation of new interventional strategies for the specific group.

CONCLUSIONS

Anthropometric measures should be properly defined so that security personnel with differing builds of muscle mass will be acknowledged while providing necessary guidelines for those with excess body fat. This study indicated that the optimal cut-offs for predicting the presence of hypertension, dyslipidemia or diabetes among Malaysian male national security personnel were BMI of 23.5 kg/m^2, WC of 80.0 cm and total body fatness of 20.0%. Appropriate cut-off values were necessary for the identification of high-risk individuals for further screening and intervention. These recommended cut-offs are intended to motivate fitness and good nutrition habits that promote individual physical readiness.

Conflicts of Interest

The authors declares that there is no conflict of interest regarding the publication of this paper.

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