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Relationship between Body Composition, Smoking and Physical Fitness of Malaysian Armed Forces Naval Trainees

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Abstract

The aim of the study was to assess body composition and physical fitness level of the Royal Malaysian Navy (RMN) trainees who were training in the Training Centre based in RMN, Lumut, Perak. This study also determined the relationship between body composition and smoking with physical fitness among the RMN trainees. A total of 59 trainees aged 19-28 years from a training centre (TC) and on board the ship (BS) participated in this study. Anthropometric measurements included height and weight. Body composition was measured using the bio impedance method. Basic physical fitness (BFT) were assessed using 2.4 km run, push-up, sit-up, chin-up, standing broad jump and VO_2 max test. Group TC achieved higher scores in the chin-up test ($p<0.001$) and 2.4 km run ($p<0.001$), while group B achieved higher scores in other BFT test components, such as sit-ups ($p<0.001$), 4×10 m back and forth running ($p<0.001$). Group BS achieved higher overall BFT scores compared to that of group TC ($p<0.05$). There were no significant differences in VO_2 max value between group TC (37.33 ± 3.05 mL/kg/min) and BS (36.74 ± 3.94 mL/kg/min). There were also no significant differences for all the BFT components and the VO_2 max between the smoking and non-smoking subjects ($p>0.05$). It was found that there was correlation between body fat percentage and BMI with the 2.4 km run ($p<0.05$). A significant inverse correlation was found between VO_2 max and the body fat percentage ($r=-0.503$, $p<0.001$) and BMI ($r=-0.296$, $p<0.05$). These findings can be used as reference by MDF for any necessary implementation to improve the physical fitness of naval trainees.

Keywords: Armed forces; Body composition; Fitness; Smoking

Introduction

Physical fitness is defined as a set of characteristics or attributes in which a human body needs to perform his/her daily physical activities [1]. The main components of physical fitness include flexibility, muscle endurance, muscle strength, cardiorespiratory endurance and body compositions. Other components of physical fitness include aerobic capacity, physical strength, anaerobic capacity, muscle strength, body compositions and flexibility [2,3].

Physical activities are defined as any movements produced by the action of the muscle that consumes energy, while physical fitness is a set of attributes or components that enhance the individual's ability to perform their daily physical activities [3]. Physical activities and physical fitness are closely related because sufficient activity frequency, intensity and duration will ensure physical fitness [4]. Physical fitness is associated with certain lifestyle conditions such as physical activities, type of sports involved, smoking and drinking habits [5]. Low levels of physical activities and physical fitness is associated with the increase of all causes of mortality rate [6,2].

History suggests that the armed forces are stronger, healthier and more mentally resilient which enable them to perform their duties on optimal level of efficiency. Efficiency has been measured in several ways, including the quality of work, productivity, being successfully promoted and test scores [7]. However, excess nutrition may cause overweight and obesity among them, and increasing sedentary lifestyle has caused new concerns regarding the effect of body fat on health and the performance of the armed forces [8]. Due to the physical demands of many military tasks, each armed forces service has a physical fitness standard and also programs to ensure compliance with this standard [9].

Among the studies conducted to test the level of physical fitness of the foreign armed forces, who are involved with either intervention programs or extreme field trainings, it was found that it measures one or more of the following components, which normally are part or all of the components of physical fitness test for their services, which are body compositions, muscle strength and endurance (sit-up and push-up test), stamina and cardiorespiratory endurance (running/walking of 1.5 miles), flexibility (sit-reach test), aerobic capacity which estimates the maximum oxygen uptake (cycle ergometry/multiple levels test), hand grip strength and standing vertical jump [9,10-12]. Typically, researchers measure the physical performance by measuring the muscle strength, muscular power and/or anaerobic power and aerobic capacity. Some researchers also used the measuring test according to the aspects of physical performance which is considered correlated to the needs of a mission [13].

A research by Conway et al. [14], on the male navy personnel showed that the physical fitness is positively associated with the health behaviour, belief in the importance of physical fitness, desire to achieve or maintain an ideal weight, early age athletic participation and education, while physical fitness is negatively associated with tobacco use, age and excessive body weight. According to Conway and Cronan [15] smoking has a short-term effect on health and physiological function. The related physiological function that is affected by smoking, even among healthy young adults, is physical fitness. A research conducted by Conway and Cronan [16] suggests that the low level of physical fitness among smokers was not only due to the lack of exercise, but smoking cause detrimental effect on fitness. This research found that smoking is negatively associated with physical fitness. Habitual

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factors such as smoking have been found to affect the physical fitness of populations which carry out tasks actively [14,16-18].

Physical fitness is required for all navy personnel that carry out their duties actively and are evaluated through a physical fitness test program. The rational is for them to achieve a standard test, including combat readiness, work performance, uniform appearance, general health and fitness [19]. The armed forces are required to look after their health, fitness and appearance at all times to ensure that they are always prepared for all missions and ready for combat [20]. Since physical fitness is required for armed forces and is closely related to combat readiness and health, thus the study was conducted to assess the body composition and physical fitness level of the Royal Malaysian Navy (RMN) trainees who are training in the Training Centre. This study also determined the relationship between the body composition and smoking status with the physical fitness among the subjects.

Methodology

Research location and subject selection

This cross-sectional study was conducted on two groups of Royal Malaysian Navy (RMN) male trainees aged 18-25 years based in Lumut, Perak. The study utilised random sampling. They are members of the naval trainees undergoing training at the Training Centre (group TC) and undergoing on the job training and do more typically task. On board a ship (group BS). Subjects undergoing training on board a ship studied for comparison purposes in term of physical fitness with subjects at the Training Centre.

Approval for the study was obtained from the Research and Development Secretariat of the Science Technology Research Institute of Defence (STRIDE), Ministry of Defence, Malaysia. This study reports the results of subsampel of larger study on energy expenditure [21]. There were 36 and 23 subjects from group TC and BS respectively involved in this study. All subjects were within the normal body weight range, based on a body mass index (BMI) of 18.5–24.9 kg/m^2, and were healthy at the time of measurement. The trainees provided written, informed consent prior to their involvement in the study.

Questionnaires

Questionnaires were used to collect data regarding the subjects' age and years in the navy. Smoking measures included smoking status, which classified individuals as having never smoked or current smoker.

Anthropometric and body composition measurements

Anthropometric and body composition measurements were taken. Body weight was measured in light clothing and barefoot to the nearest 0.1 kg using the digital TANITA balance HD312 (Tanita Corp, Japan). Height without shoes was measured to the nearest 0.1 cm using the SECA body meter 208 (SECA, Germany). Body Mass index (BMI) was calculated using the weight and height (kg/m2) data. Body composition was measured by bioelectrical impedance analysis using the Bodystat® 1500 (Bodystat Ltd, Isle of Man). In order to obtain an accurate data set, the trainees were explained on the experimental protocol, which included fasting for 12–14 hours, not conducting any heavy physical activity the previous day, and ensuring they were in normal hydration status.

Physical and aerobic fitness test

Basic fitness test (BFT) was conducted to evaluate the physical fitness level of RMN members to ensure that it is compatible with their assignment requirements. BFT comprised of two components of fitness and is divided into 5 types of tests. The first component is the test of muscular strength, power and endurance. The first test is a sit-up test to measure the muscular endurance: number of bent-knee sit-ups done in 60 seconds period. The second test is a long-jump from the standing position test to measure the stretching power of the muscle. The third test is a chin-up test (30 seconds) to measure the muscle strength and power. The fourth test is a 4×10 m back and forth running test to measure the efficiency of the anaerobic system and the power of legs. The second component is the cardiovascular test, and the test involved a 2.4 km run to measure the ability of the cardiovascular system, stamina and lower-muscle endurance. The MAF also has age and sex-adjusted standards which were used to convert performance on each test into classification. Based on the BFT standard grading of the Malaysian Armed Forces (MAF) by age and gender, the actual BFT scores were converted to classification scores in order to calculate the overall score of each subject.

The VO_2 max test was carried out with a cassette which produces beep sound according to the fitness level. This cassette was provided by Brewer et al. [22], for University of Loughborough based on the research by Leger and Lambert [23]. This test involves continuous running between two lines which are 20 meters apart, in proportion to the *beep* sound and the time intervals. This test requires a site with flat surface and not slippery. Two lines at a distance of 20 m were marked with cones. All subjects were required to perform warm-up exercise for 10 minutes before the test begins. The subjects were then required to run according to the *beep* sound from the cassette at each time interval. Each distance of 20 m completed is a level up. The time given to complete the 20 meter runs decreases in proportion with the *beep* sound according to their fitness level. Usually, the initial velocity for the run (level 1) is 8.5km/h and will increase by 0.5 km/h at each level. Each subject must have their feet over the 20 meter lines at the end of each level. In order to avoid confusion, the cassette was played to all the subjects before the study begins. Trial runs for several sublevels were conducted before the actual until all subjects understand the concept. Each subject's performance was evaluated by the highest level achieved, in which the subject was no longer able to finish the run between the two lines of 20 meters in accordance to the *beep* sound. Based on the table of VO_2 max determination, an estimated value of VO_2 max, according to the levels and sublevels in which the subject stops, can be obtained.

Data analysis

The recorded data was analysed using the Statistical Package for the Social Sciences version 17.0 (SPSS Inc, Chicago, IL, USA). The results were expressed as the mean and standard deviation. The independent t-test was used to compare the mean BFT scores of Groups TC and BS and across the two smoking status groups: never smoked and current smoker. The relationship between each component of BFT score with body fat percentage and BMI were evaluated using Pearson's correlation coefficients. The results were considered to be significant at the 5% level.

Results and Discussions

Anthropometric characteristics and body composition

The physical characteristics of the subjects are shown in table 1. There were no significant differences in the body weight, height, BMI and lean body mass (LBM) (all $p>0.05$) except body fat percentage ($p<0.05$) between groups TC and BS. Based on the physical characteristics of the subjects, the study samples were considered to be homogenous.

Physical and aerobic fitness

Table 2 shows the BFT scores of subjects from groups TC and BS. The actual scores for each BFT component were converted to BFT

classification scores based on the MAF fitness-test level performance for male in the age group of 18-24 years old. The independent t-test results indicate that there were significant difference ($p<0.05$) for the overall BFT scores between both group in which the group BS subjects achieved higher overall scores compared to that of group TC ($p<0.05$). However, in the comparison of each and every scores in the BFT components showed that the subject from group TC achieved higher scores in the chin-up test ($p<0.001$) and 2.4 km run ($p<0.001$), while group BS subjects achieved higher scores in other BFT test components, such as sit-ups ($p<0.001$) and 4×10 m back and forth running ($p<0.001$). Only the long jump in standing position test showed no significant difference between the subjects of both groups TC and BS ($p>0.05$)

From these results, it can be concluded that the subjects from group BS has higher muscle endurance, anaerobic system efficiency and the leg power, while subjects from group A showed higher muscle strength and power as well as the cardiovascular system capacity, stamina and lower-muscle endurance. According to Sharkey [24], regular physical activities training increases the respiratory and cardiovascular system capacity and also increases the body muscle fiber strength. This is consistent with the higher scores for the 2.4 km run component, because the subjects from group TC has more opportunity for regular physical exercise activities compared to subjects of group BS.

The aerobic fitness level tested with 20 m beep test of various levels showed a slightly higher VO_2 max value from subjects of group TC (37.33 ± 3.05 mL/kg/min) compared to that of subjects from group BS (36.74 ± 3.94 mL/kg/min), but the difference of both groups are not significantly different (Table 2). This slight difference might be due to the fact that subjects from group A perform more exercise compared to the group BS subjects. Croteau [25] stated that the intensity of exercise is the main factor in improving aerobic fitness, in which the frequency and duration play an important role. The VO_2 max values obtained from the subjects in this study are much lower compared to the subjects from the study conducted by Booth [10] on the British Armed Forces who were on ecological trail assignment at the Ranjer Bukit Tawau Station, Sabah, which showed a VO_2 max value of 48.9 mL/kg/min. According to Cooper [26], the average VO_2 max value of the subjects in this study is in the moderate category. According to a research by Blair et al. [27], the VO_2 max value of 35 mL/kg/min for male is an adequate level for the purpose of promoting good health. Therefore, it can conclude that the subjects in this study have good level of health.

The relationship between smoking status and aerobic fitness

In this study, the subjects' smoking status is determined by the response of the subjects, either smoking or non-smoking. Overall, the percentage of subjects who smoke is quite high at 68%, where respectively, 57.9% and 75.7% of subjects from group TC and group BS smoke. The subjects studied (trainees) are young adults with a mean age of 22 years, which are in the age group that tends to adopt the smoking habit.

As shown in table 3, the results showed that there are no significant differences for all the BFT components and the VO_2 max between the smoking and non-smoking subjects ($p>0.05$). Although the percentage of these subjects who smoke are high, it was found that that this does not to give a high impact on their physical fitness. However, smoking among the RMN personnel should be given attention, because smokers are also generally found to contribute to higher expenditure of employers for their healthcare benefits compared to non-smokers. Furthermore, according to Ortlepp et al. [5], the physical fitness status has no influence on the impact of smoking on the increase in leukocyte count. This means that good fitness status does not prevent the adverse effects of smoking.

A study by Jensen [28] was conducted to determine the relationship between smoking and physical fitness among 54 members of the Army

Subjects	Mean ± SD (range)				
	Weight (kg)	Height (m)	BMI (kg/m²)	Fat (%)	LBM (g)
Group TC (n=36)	62.3 ± 4.5 (52.4-73.2)	1.68 ± 0.04 (1.61-1.77)	22.0 ± 1.1 (19.6-24.0)	12.3 ± 2.6 (7.6-17.1)	54.7 ± 4.8 (44.2-65.1)
Group BS (n=23)	63.6 ± 4.5 (52.4-76.6)	1.67 ± 0.05 (1.60-1.77)	22.9 ± 2.0 (19.42-26.55)	14.2 ± 3.1* (7.90-20.4)	54.5 ± 4.3 (47.4-64.5)
Total (n=59)	62.8 ± 4.9 (52.4-76.6)	1.68 ± 0.05 (1.60-1.77)	22.0 ± 1.6 (19.4-26.5)	13.3 ± 3.1 (7.60-20.4)	54.6 ± 4.5 (44.2-65.1)

*Signicantly different at $p<0.05$ within a column ($p<0.05$)

Table 1: The physical characteristics of the subjects.

Test	n	Group TC	n	Group BS
Actual Basic Fitness Test Scores				
Sit-up	36	42.27 ± 4.82 (33-53)	23	
Long-jump	36	224.73 ± 11.72 (190-240)	23	231.17 ± 16.20 (202-265)
4x10 m back and forth running test (second)	36	11.05 ± 0.54 (10.38-12.44)	23	10.36 ± 0.27*** (9.92-10.72)
Chin-up	36	8.11 ± 2.57 (4-15)	23	5.48 ± 2.79*** (1-10)
2.4 km run (min)	36	11.93 ± 13.91(10.19-14.5)	23	13.91 ± 1.34*** (11.27-16.25)
Classification Basic Fitness Scores				
Sit-up	36	4.56 ± 0.87 (2-5)	23	5.00 ± 0** (5-5)
Long-jump	36	2.75 ± 1.11 (1-4)	23	3.13 ± 1.42 (1-5)
4x10 m back and forth running test (second)	36	1.94 ± 0.98 (1-4)	23	4.17 ± 0.89*** (3-5)
Chin-up	36	3.25 ± 1.13 (1-5)	23	2.13 ± 1.18** (1-4)
2.4 km run (min)	36	2.03 ± 0.96 (1-5)	23	1.13 ± 0.46*** (1-3)
Overall score	36	14.51 ± 2.71 (8-20)	23	15.56 ± 2.66* (11-19)
Aerobic Fitness Test Scores VO_2 max (mL/kg/min)	37	37.33 ± 3.05 (31.4-43.7)	19	36.74 ±3.94 (30.2-43.9)

* Significant difference differences between two group of the subjects ($p < 0.05$)
** Significant difference differences between two group of the subjects ($p < 0.01$)
*** Significant difference differences between two group of the subjects ($p < 0.001$)

Table 2: Basic fitness test and aerobic fitness test of two group of the subjects.

found that non-smoking subjects have higher scores in 3 of the 4 physical fitness tests compared with the smoking subjects. Conway and Cronan [15] conducted a study on 1357 navy personnel who were on duty on board, and it was found that they perform more sit-ups, and their overall BFT scores were higher compared to smokers and ex-smokers. In this study, it was found that non-smoking subjects managed to get higher scores in 2 out of 5 tests, namely, 2.4 m run and chin-up, but the differences were not significant compared to those who smoke. The non-significant difference results in this study are probably due to the small sample size and it does not represent all smokers.

Daniels et al. [29], believed that smoking can contribute or encourage a lifestyle that reduces the aerobic capacity. However, in a group of young trainees from the US Army which undergo Basic Combat Training (BCT), with a mean age close to 22 years, it was found that there were no difference in VO_2 max between smokers and non-smokers. Other researchers who use the data from young members of the army with a mean age close to 21 years, also found that there were no effect of smoking on the VO_2 max (measured using maximal treadmill test). The results of previous research were consistent with the results obtained in this research, where the subjects with a mean age of 22 years showed non-significant difference in the VO_2 max between smokers and non-smokers. However, among the older military population, other studies showed that there were adverse effects of smoking on VO_2 max [29,30]. According to Bouchard et al. [31], among individuals who did not undergo training (sedentary), more than 50% of the variance of VO_2 max may be attributed to genetic factors.

The relationship between body composition with physical and aerobic fitness

Tables 4 and 5 shows the coefficient of correlation between the body fat percentage with physical fitness and between BMI with physical fitness of the subjects. The subjects' BFT scores obtained from this study cannot be analysed to determine the performance at high or different adiposity levels because the subjects in this study are trainees and are certain to have a healthy percentage range of body fat. The results showed that there was no correlation between body fat percentage and BMI with all the components in BFT, except for the 2.4 km run ($p<0.05$). A significant inverse correlation was found betweenVO_2 max and the body fat percentage ($r=-0.503$, $p<0.001$) and BMI ($r=-0.296$, $p<0.05$). According to Vogel [32], for young males, 20% of body fat is equal to the aerobic capacity level required, i.e. a mean of 50 mL/kg/min with rapid decrease occurred with increasing adiposity.

A study by Jones et al. [33] on military trainees found that there was significant positive correlation between the body fat percentage (measured using four skinfold measurement) with 1 or 2 miles runs, and an inverse correlation with the number of sit-ups and push-ups. It was also found that there was positive correlation between 1 or 2 miles runs with BMI ($p<0.05$). This study confirms the results obtained by Jones et al. [33], where there were significant positive correlations between body fat percentage and 2.4 km run and also between BMI and 2.4 km run ($p<0.05$).

According to Sharkey [24], the body fat percentage affects the VO2 max value and the body fat percentage is inversely proportionate to aerobic fitness. The higher the body fat percentage, the lower the aerobic fitness of an individual. This statement is consistent with the results obtained in this study. Daniels et al. [29] also believes that smoking contributes or encourages a lifestyle which leads to the drop in aerobic capacity. While aerobic fitness is inversely proportional to the body fat percentage, strength has a more important role in the task performance of military personnel and it is not associated with body fat percentage [32,34]. Performance in most of the military tasks requires more strength than aerobic fitness.

	Smoking status	
	No smoking n=19	**Smoking N=40**
Actual Basic Fitness Test Scores		
Sit-up	43.53 ± 5.62 (33-52)	45.55 ± 5.54 (33-57)
Long-jump	223.42± 3.24 (190-240)	229.42 ± 13.34 (202-265)
4x10 m back and forth running test (second)	10.79 ± 0.44 (9.92-12.11)	10.78 ± 0.62 (9.92-12.44)
Chin-up	8.10± 2.92 (3-15)	6.70± 2.86 (1-13)
2.4km run (min)	12.46 ± 1.58 (10.19-15.45)	12.82 ± 1.40 (10.21-16.25)
Classification Basic Fitness Test Scores		
Sit-up	4.63± 0.89 (2-5)	4.77 ± 0.62 (2-5)
Long-jump	2.58 ± 1.30 (1-4)	3.05 ± 1.20 (1-5)
4x10 m back and forth running test (second)	2.53 ± 1.35 (1-5)	2.95 ± 1.48 (1-5)
Chin-up	3.20 ± 1.27 (1-5)	2.65 ± 1.21 (1-5)
2.4km run (min)	2.00 ± 1.10 (10.19-15.45)	1.52 ± 0.78 (10.21-16.25)
Overall Scores	14.53 ± 2.82 (1-5)	14.75 ± 2.64 (1-4)
Aerbic Fitness Test Scores		
VO_2 max (mL/kg/min)	36.78 ± 3.23 (31-42.1)	36.81 ± 3.57 (30.2-43.9)

Table 3: Aerobic fitness test according smoking status.

Test	Fat percentage	P value
Sit-up	-0.035	0.795
Long-jump	-0.050	0.716
4x10 m back and forth running test	-0.210	0.120
Chin-up	-0.038	0.780
2.4 km run (min)	0.321	0.016*
VO_2 max (mL/kg/min)	-0.503	0.001*

* Value of $p<0.05$ are significant correlation.

Table 4: Coefficient of correlation between body fat percentage and physical and aerobic fitness (n=59).

Test	BMI	P value
Sit-up	0.089	0.502
Long-jump	-0.078	0.557
4x10 m back and forth running test	-0.114	0.390
Chinning	-0.081	0.543
2.4 km run (min)	0.373	0.004*
VO_2 max (mL/kg/min)	-0.296	0.027*

* Value of p<0.05 are significant correlation

Table 5: Coefficient of correlation between BMI with physical and aerobic fitness (n=59).

A limitation of the study is the use small sample size which did not represent all smokers in young naval trainees. In addition, more subjects are needed in future studies to confirm the association between BFT performance and smoking.

Conclusion

The BFT test performed on subjects from both groups showed that subjects who train in Training Centre (group TC) have higher scores in the chin-up test and 2.4 km run, while subjects who underwent training on board the ship (group BS) gives higher scores in sit-up tests and back and forth runs. There were no significant differences between the subjects in both groups in terms of VO_2 max values. The comparison of BFT test scores and VO_2 max between subjects who are smokers and non-smokers showed that there were no significant differences in physical and aerobic fitness in the subjects. All the scores in BFT components showed no significant correlation with the body composition, except for the 2.4 km run. This study also found that subjects with high BMI and body fat percentage were associated with low aerobic fitness.

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