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Relationship of Body Mass Index and Physical Activity with Hand Grip Status Among University Students: A Cross Sectional Analysis

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Abstract

The objective of this study is to determine the relationship between nutritional status and hand grip strength among university students in Kuala Nerus and assess the relationships between BMI and physical activity with hand grip among students. University students (N = 80, mean age 21.8 ± 1.4 years) that included 36 males and 44 females were recruited using a convenient sampling technique from two universities which is Universiti Sultan Zainal Abidin (UniSZA) and Universiti Malaysia Terengganu (UMT) in a cross sectional study in Kuala Nerus, Terengganu. Weight and height were measured and body mass index were calculated. Hand grip strength was measured too using Takei Digital Grip Strength Dynamometer. Furthermore, eating habits and level of physical activity were self-reported by the students using FFQ adopted from MANS and IPAQ questionnaire. The prevalence of underweight, normal weight, overweight and obesity were 7.4%, 66.3%, 17.5%, and 8.8% respectively. Male have slightly higher intake of calories, carbohydrates and fat with mean value of 2229 kcal, 295.3 g and 66.8 g respectively compared to female with calories of 2126 kcal, carbohydrates of 283 g and fat of 64.2 g. Meanwhile, most of the students involved in this study were classified as being moderately active (65%) followed by low physical activity (28.8%) and the least goes to the high physical activity category (6.2%). Furthermore, male subjects had a higher value of handgrip strength in both right (32.3 kg) and left hand (28.2 kg) as compared to female subjects that was 20.0 kg on the right hand while 17.6 kg on the left hand. The present study also showed that males had a higher percentage of overweight and obesity than females and there was a significant association between body mass index and gender as well as gender and hand grip strength ($p<0.05$). There were also significant association observed between BMI and physical activity with hand grip strength meanwhile, there is no association between dietary intakes (protein) with grip strength ($p<0.05$).

Keywords**:** eating habits, hand grip strength, BMI, physical activity

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Introduction

Recently, obesity has become a worldwide health glitch. The drastic increase in the number of individuals with overweight or obesity in developing countries is concerning [1]. According to the 1999-2002 National Health and Nutrition Examination Survey (NHANES) and World Health Organization (WHO), the prevalence of overweight for the Malaysian adults aged 18-59 years is 29.71% [2]. Besides, a previous study has reported that Malaysian university student also exhibit increase rate of obesity. This indicates that unhealthy food intake such as fast food and soft drinks, social media use and stress display the highest weightage contributing to overweight and obesity concerns for Malaysian university students [3]. Additionally, poor eating habits is said to be a major public health concern among young adults who undergo transition into university life, in which, they are exposed to stress and lack of time [4].

As young adults move from high school to an independent life in the university, they take full accountability of their eating habits and usually, they have not much or no guidance on the knowledge to make informed choices of the food they consume daily [1]. According to Niba et al., (2017), skipping meals especially breakfast was common among Malaysian and Italian university students. This entire behavior exhibit by the students is worrying as their nutritional status is often allied with academic performance. According to previous studies, undernourished children have been shown to have decrease attendance, attention and academic performance as well as experience more health problems compared to well nourish children [5]. Hence, a decent nutrition status would have lots of benefits.

Nutritional status adequacy often evaluated through anthropometry measurement by measuring weight and height. However, there is a lack of study on association between hand grip strength (HSG) with nutritional status and this has been looked at in this present study. The definition applied for hand grip strength was the one proposed by Cheng [6], which is a newfangled nutritional assessment parameter proposed by American Society for Parenteral and Enteral Nutrition (ASPEN) and the Academy of Nutrition and Dietetics (the Academy) for diagnosis of adult malnutrition associated to acute illnesses, chronic diseases or starvation. Full term of HGS insert here (HGS) is a rapid, cost effective and a user friendly tool that has high test and re-test reliability, as well as high inter-rater reliability and therefore could provide a number of benefits over existing nutrition assessment methods, which are more time consuming and require higher skill levels [7]. Despite the promising evidence and benefits of HGS as a nutrition assessment tool, to our knowledge there have been several or mostly no published articles exploring the potential of HGS to predict nutrition status of university students in Malaysia. Therefore, this study will highlight the relationship between three elements of nutritional status that had been mentioned above with the value of hand grip strength.

MATERIALS AND METHODS

Subject recruitment

The study design used was cross sectional study involving Malaysian students from Universiti Sultan Zainal Abidin (UniSZA) and Universiti Malaysia Terengganu (UMT). A total of 80 students age range between 19-29 years old, able to communicate in Malay or English, free from any psychological treatment and not pregnant were recruited for this study. Informed consent for subjects in the study was acquired for each subject. This study was conducted and approved by UniSZA Human Research and Ethics Committee (UHREC) (UniSZA/UHREC/2018/23). Subjects were cross-examined using a standardized questionnaire and measured for a number of parameters including age, ethnicity, and family history. The questionnaire consisted of information on socio-demographic, food frequency questionnaire (FFQ) and International Physical Activity Questionnaire (IPAQ). The sampling method used was convenient sampling.

Sample size calculation

Sample size was calculated using a comparing mean formula by Musa [8]. The standard deviation used for sample size calculation is according to hand grip strength in kilograms with age range of 20 to 29 years (Nicola et al. 2011) by considering 20% drop out data.

Assessment of dietary intake

Assessment of dietary intake was done using self-administered Food Frequency Questionnaire (FFQ). Frequency of meals, type of meal, vegetables and fruit consumption, daily water intake and consumption of food were taken to determine the eating habits among the subjects. The frequency of consumption for each food or beverage was converted into a daily equivalence. The nutrient value database were developed based on Nutrient Composition of Malaysia [9], Malaysia Food Atlas (4th edition) [10] and Singapore Food Composition website in Microsoft Excel 2010. Daily food intake (g/day) was computed by the formula: frequency of intake per day or daily equivalence × total number of serving × weight of food intake per serving (MANS, 2014).

Assessment of Physical Activity

The level of physical activity of participant was assessed by using the short form of the International Physical Activity Questionnaire (IPAQ). Participants were asked to answer the questionnaires that consist of seven questions. The questions asked about the time spent being physically active in the last 7 days. Generally, in the group with lower physical activity, the individuals took fewer than 600 MET-min/week; in those with sufficient (moderate) physical activity, 600–1500 MET-min/week; and in those with higher physical activity, more than 1500 MET-min/week [12].

Anthropometric measurements

The anthropometry measurements taken were weight and height and BMI was also calculated. Body weight of participants (to the nearest 0.1 kg) was measured using a portable digital scale (Tanita, Model: BC-587) in light clothing and without shoes. Standing height measurements (to the nearest 0.1 cm) was carried out with a portable stadiometer (Seca 213, Germany) without shoes. The height and weight measurements were used to compute BMI (in kg/m^2) as a measure of the weight status of subjects. The WHO criteria on BMI was used to categorize subjects as underweight (BMI $\leq$ 18.5 kg/m^2), healthy weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2) and obese (BMI $\geq$ 30.0 kg/m2) [13].

Hand grip strength measurement

Grip Strength Test Grip strength was measured using Takei Digital Grip Strength Dynamometer (Model: T.K.K.5401 Grip D, Takei Scientific Instruments Co., Ltd., Japan) on the dominant hand to assess upper body strength. The maximum grip reading (kg) was taken twice and recorded. The higher score was used in analysis.

Statistical Analysis

The statistical analysis of data was performed using Statistical Package for Social Science (SPSS) software for Windows, version 21.0. Statistical significance of all tests was set at the level of $p \leq 0.05$ and each test was done according to the objectives of the study.

RESULTS

Socio-demographic data and dietary assessment

The total number of respondents involved in this study was 80 students. The majority of respondents were females (55%) compared to males (45%) aged 20 to 25 years old. On the aspect of ethnicity, there were 85% of Malay respondents, followed by Chinese that was 13.8% and Indians of 1.3% (Table 1). Furthermore, large amount of the respondents having family history of diabetes mellitus (26.3%) and hypertension (22.5%) while 35% of them not having any.

Dietary Assessment

Table 2 summarized the dietary assessment of subjects acquired from the food frequency questionnaire (FFQ). Overall, male have slightly higher intake of calories, carbohydrates and fat with mean value of 2229 kcal, 295.3 g and 66.8 g respectively as compared to female with calories of 2126 kcal, carbohydrates of 283 g and fat of 64.2 g. However, females' subjects showed considerably higher intake of total protein that was 91.2 g compared to male subjects (88.5 g).

Anthropometric and hand grip strength assessment

A summary of mean weight (kg), height (m) and BMI is presented in Table 3. The mean BMI for the overall sample was 23.7 ± SD = 3.7 kg/m² where by the mean BMI of males (25.4 ± 4.4 kg/m²) were significantly higher than females (22.1 ± 3.7 kg/m²). In terms of BMI classification according to World Health Organization (WHO), most of the subjects were in a normal category which was 66.3%. Subjects with BMI category of overweight and obese was 17.5% and 8.8% respectively. Furthermore, male subjects had a significantly higher value of handgrip strength in both right (32.3 kg) and left hand (28.2 kg) compared to female subjects that was 20.0 kg on the right hand while 17.6 kg on the left hand.

Physical activity level

Generally, most of the students involved in this study were classified as being moderately active 65% followed by low physical activity 28.8% and the least goes to high physical activity category which was 6.2% (Table 4). Majority of females and males subjects were in moderate physical activity level 59.1% and 72.2% respectively. Meanwhile, in low physical activity level, female subjects with 38.6% were higher compared to male subjects with 16.7%.

Predicting factor for Hand Grip Strength

A summary of predicting factor for hand grip strength is presented in Table 5. There is a significant linear relationship between body mass index (BMI) and handgrip strength ($p<0.001$). It is observed that for every 1 kg/m2 increase in BMI, there will be 0.99 increased in handgrip strength. There is a significant linear relationship between carbohydrate intake and handgrip strength ($p<0.05$) meanwhile there is no significant linear relationship between protein and fat intake with handgrip strength. It is observed that for every 1 g increase in carbohydrate intake, there will be 0.044 increased in handgrip strength. Another predicting factor is IPAQ score where it showed significant linear relationship with handgrip strength. It is observed that for every 1

MET/week increase in IPAQ score there will be 0.003 increased in handgrip strength. Hence, this study showed that BMI, carbohydrate intake and IPAQ score are significant predicting factors for handgrip strength.

DISCUSSION

It is necessary to monitor and possibly correct dietary habits in young people, namely university students [14]. This is due to the changes of dietary habits including the nutrient intakes, dietary diversity, ways of food preparation and portion size. In this study, males showed higher intake of calorie, carbohydrate and fat compared to females meanwhile females has considerably higher intake of total protein compared to males. This is due to physiologically higher metabolic rate (BMR) in males that required males to have higher energy intake [15]. Results obtained from current study shows a higher intake of protein in both genders while intake of fat lies within the recommended value. Adult population are advised to consume 55 – 77% of carbohydrate per day [16]. The carbohydrate intake among subjects in this study had nearly met the recommendation in both genders where by males were 53% and females were 53.2%. Carbohydrate is essential in the diets as it is a main energy source for the body whereas fat is the second sources of energy and form higher energy compared to carbohydrates. Higher protein intake from recommended value was reported in this study, most probably due to under or over-reporting food intake as this research used FFQ to determine the dietary intake. The inconsistencies of misreporting dietary intake were also found to be due to several factors. First of all, it might be due to the nature of the FFQ which is likely to over-report the dietary intake. Moreover, FFQ requisite the respondents to report food intake in the past one month which involved a complex cognitive task where respondents need to rely on their long term memory to answer the questions [17]. Besides that, measurement errors from respondents often occurs when they answered the questionnaire as many studies shown that people have difficulty in guessing portion sizes of food due to lack of knowledge or information [18].

The percentage of overweight and obese was higher in male which were 25% and 13.9% compared to female with 11.4% and 4.5% respectively. According to a study done by Gan, Mohd Nasir, Zalilah, Hazizi [14], a similar result was attained where the prevalence of underweight was quite high (19.1%) among university students in their study. Similar findings were also reported by Niba et al.[1] where obesity estimates were higher among males (2.5%) than females (1.9%) while majority (69.9%) of the students had a healthy weight. Proportion of underweight female was higher than male which is 23.3% and 10% respectively. According to other studies, a low body weight was an unhealthy condition as it can increase the risk of clinical conditions such as anaemia [19] and lead to distortion of body image among young adults [20]. Generally, body image distortion can possibly lead to other mental illnesses such as depression. In fact, this may contribute to development of eating disorders [21]. The prevalence of normal weight was 68.5% which is similar to a study conducted by Khan et al,[22] in Universiti Teknologi MARA (UiTM), Puncak Alam Campus. A high prevalence of underweight among female university students might be due to their desire to lose weight and more likely than male students and mostly females preferred underweight as an ideal figure than overweight while males preferred overweight as their ideal figure than being underweight [23]. Another possible explanation for this might be due to the eating habits of university students of having less than three meals a day and frequent consumption of fried foods, sweets or chocolates, sugar sweetened beverages and cakes as a result of convenience and the availability of these items along the streets and in university cafeterias [24].

According to IPAQ classification, results obtained show that the evaluated university students are mainly more to moderate active lifestyle and more students were in the low category compared to high category. Most of female students exercise in order to lose weight meanwhile male students exercise to maintain physical condition. In this study, male was more physically active than female. These results support the idea of Cheah and Poh [25], who suggested that males are more likely to participate in moderate or high-intensity activity than females.

This study found that males have greater grip strength with mean value of 32.32 kg compared to female which is 20.03 kg. Similar result was reported by Montalcini et al.[26] which was a study done among Italian children aged 9 to 10 years, with males (15.2 ± 3.0 kg) having significantly greater maximal HGS than in females (13.8 ± 4.0 kg). Despite of having different age group of subjects, result showed a similar pattern where male tend to have greater grip compared to female [27]. According to Ng et al. [28], the most likely reason that might be the factors that leads to difference in HGS between gender was because of male subjects have higher proportion of muscle than fat compare to female and also surges in the female hormone estrogen and the male hormone testosterone are largely responsible for the discrepancies in body composition. It is well established in literature, when comparing men and women, that male, regardless of age, have a higher degree of muscle strength. Furthermore, force has a curvilinear relationship with age, peaking in the third decade of life and progressively decreasing after the fifth decade, a process explained by the decrease in the number and size of muscle fibers, especially type II muscle fibers, which are fast-twitch fibers and produce a large amount of force [27]. It has been debated that the rate of growth of the arm muscle tissues in males during adolescence is nearly twice than there are in females and that the gender difference in the growth of muscle tissue in the leg is much smaller.

Study displays that gender-related differences in muscular development contribute to differences in physical performance because muscle strength develops in proportion to the cross-sectional area of muscle, and growth curves for strength are essentially the same [29]. Another element that seems to intervene in the measurement of handgrip measurement is related to lateral dominance. Studies show that, in terms of peak maximum force, the dominant hand performs better, but fatigues faster, irrespective of gender.

This study also alike with the previous study where a positive relationship between body weight and handgrip strength was found [29]. However, this study was contradicted with previous study done by Alahmari et al. [30] which was inversely correlation between BMI and handgrip strength. The contrary results probably due to different variable used in regression analysis. The regression model in previous study selected only three variables, hand length, age and forearm circumference to be the significant predictors of hand grip strength. However this study did not include the measurement of hand length and forearm circumference as variables. This study found that there is no association between intake of protein and fat with HGS while there is positive relationship between carbohydrate and HGS. Additionally, similar results was established where there was no significant association between protein intake and muscle grip strength [31]. Protein intake has been associated to muscle mass and frailty where a long term insufficient protein intake would experience decreased in muscle mass. Moreover, results obtained from this study was also supported by the findings in Ten Haaf et al. [32] whereby there is no association of total protein intake with handgrip strength and quality of life.

Majority of the students in this study were classified in moderate level of physical activity followed by low and high category giving a fair positive correlation (r = 0.26). An active lifestyle can influence energy balance and body fat. Hence, active people will have higher proportion of lean muscle mass compare to fat. In contrast, results from this study found that only a small amount of improvement in handgrip strength was found (R2 = 0.069) when there is an increase in physical activity. The lack of association between self-reported physical activity and grip strength could suggest that the items used did not fully capture the types of activities affecting muscle strength or that the activities leading to greater muscle strength were not undertaken by participants of this study. The larger random measurement error expected in self-reported activity would also drive the associations towards the null [33].

Limitation and recommendation

The current study is insufficient to represent the whole population. Therefore, further studies should include a larger sample size. It is recommended to extend the study in larger population and more recruitment of other ethnicity. In addition to that, further studies can also collect the subject's diet record directly instead of self-reported to obtain exact nutrient intake which can increase the accuracy of the study. A face to face interview rather than spreading the questionnaire may reduce bias, under and over-report of university student's dietary intake. Moreover, the subjects will understand the question better by following instructions from the researcher.

Conclusion

In conclusion, this study found that there were significant association observed between BMI and physical activity with hand grip strength meanwhile there is no association between dietary intakes (protein) with hand grip strength. However despite its limitation, this is a novel study in determining dietary habits and for predicting factors for handgrip strength among university students.

Conflicts of interest

All authors declare no conflicts of interest.

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Table 1 Socio-demographic characteristics of subjects (n=80)

Socio-demographic Characteristics	Male (n = 36)	Female (n = 44)	Total (n = 80)
Age, n (%)			
20 years old	1 (2.8)	21 (47.7)	22 (27.5)
21 years old	3 (8.3)	2 (4.5)	5 (6.3)
22 years old	21 (58.3)	12 (27.3)	33 (41.3)
23 years old	6 (16.7)	6 (13.6)	12 (15)
24 years old	3 (8.3)	2 (4.5)	5 (6.3)
25 years old	2 (5.6)	1 (2.3)	3 (3.8)
Ethnicity, n (%)			
Malay	30 (83.3)	38 (86.4)	68 (85)
Chinese	5 (13.9)	6 (13.6)	11 (13.8)
Indian	1 (2.8)	-	1 (1.3)
University, n (%)			
UniSZA	20 (55.6)	26 (59.1)	46 (57.5)
UMT	16 (44.4)	18 (40.9)	34 (42.5)
Family history, n (%)			
Diabetes mellitus	8 (22.2)	13 (29.5)	21 (26.3)
Hypertension	8 (22.2)	10 (22.7)	18 (22.5)
Heart problems	5 (13.9)	2 (4.5)	7 (8.8)
Cancer	1 (2.8)	2 (4.5)	3 (3.8)
Others	3 (8.3)	-	3 (3.8)
None	11 (30.6)	17 (38.6)	28 (35)

Descriptive analysis

Table 2 Dietary assessment among university students (n = 80)

Dietary Intake	Mean (SD)	
	Male, n = 36	Female, n = 44
Energy (kcal)	2229 (223)	2126 (268)
Carbohydrate (g)	295.3 (59.6)	283.0 (48.5)
Protein (g)	88.5 (15.6)	91.2 (19.7)
Fat (g)	66.8 (8.9)	64.2 (12.7)

Table 3 Anthropometric and hand grip strength assessment

Assessment	Parameter	Mean (SD)		Total (mean ± SD)	Mean difference (95% CI)	df	p-value [a]
		Male, n = 36	Female, n = 44				
Anthropometric	Height (m)	1.63 (7.6)	1.56 (4.9)	1.59 ± 7.2	7.35 (4.4,10.3)	57.1	<0.001*
	Weight (kg)	67.4 (14.9)	53.8 (9.5)	59.9 ± 13.9	13.6 (8.2,19.1)	78	<0.001*
	BMI (kg/m²)	25.4 (4.4)	22.1 (3.7)	23.7 ± 4.3	3.0 (1.2, 4.8)	78	0.001*
Hand grip strength	Handgrip right (kg)	32.3 (7.3)	20.0 (4.4)	25.56 ± 8.47	12.28 (9.5,15.0)	54.8	<0.001*
	Handgrip left (kg)	28.2 (7.4)	28.2 (7.4)	28.2 (7.4)	28.2 (7.4)	28.2 (7.4)	<0.001*

[a]Independent t-test was applied.
*Significant difference between genders at P<0.05

Table 4 IPAQ score classification of students

IPAQ Score [a]		Male, n (%)	Female, n (%)	Total, n (%)
Classification	**Cut-off point** (MET- min/week)			
Low	<600	6 (16.7)	17 (38.6)	23 (28.8)
Moderate	600 – 1499	26 (72.2)	26 (59.1)	52 (65.0)
High	≥1500	4 (11.1)	1 (2.3)	5 (6.2)

[a] Source: Adapted from IPAQ Group, 2005

Table 5 Predicting factor of hand grip strength

Parameter	β(95% CI)	statistics	P value*	R^2
Body mass index (BMI)	0.99 (0.60,1.38)	5.09	< 0.001	0.249
Carbohydrate	0.044 (0.010,0.078)	2.566	0.012	0.078
Protein	0.013 (-0.093,0.119)	0.244	0.808	0.001
Fat	0.092 (-0.078,0.261)	1.077	0.285	0.015
IPAQ score	0.003 (0.001,0.006)	2.405	0.019	0.069

*Simple linear regression