ASSESSMENT OF DIETARY INTAKES USING DIGITAL PHOTOGRAPHY AND SMARTPHONE APPLICATION AMONG NORMAL AND OVERWEIGHT YOUNG ADULT FEMALES

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ABSTRACT

Introduction: Assessment of dietary intakes in the population continuously challenges the researchers due to various limitations. The emergence of numerous technologies in assessing dietary intakes provide potential advantages especially among young generation. Furthermore, dietary intakes among young adults raise great concern as they are not frequently involved in healthy eating. **Aims:** Therefore, this study explored the use of technology-based dietary records to assess the dietary intakes among normal and overweight young adult females. Smartphone food diary application (MyFitnessPal) was used to compare the dietary intakes between normal and overweight groups. MyFitnessPal was also used to compare the dietary intakes of participants to the Recommended Nutrient Intakes (RNI) 2017. Digital photography was used to compare the portion size intakes of the participants to the recommended portion size of Malaysian healthy plate. **Methods:** A total of 74 participants aged between 19 and 24 years old were recruited (n= 37 for normal weight group, n= 37 for overweight group). Participants were required to record their dietary intakes using a smartphone food diary application and capture photos of three main meals; breakfast, lunch and dinner using digital photography for two weekdays and one weekend. All dietary data and photos were sent to the researcher via Whatsapp for analysis. Data analysis was performed using SPSS Version 12.0. Statistically significant result was set at $p< 0.05$. **Results:** The findings demonstrated no significant difference in term of dietary intakes except for iron intake between normal and overweight young adult females ($p= 0.042$). Intake of energy and all nutrients were significantly lower than RNI except for polyunsaturated fatty acid (PUFA). It was also found that portion of carbohydrate intake among young adult females was significantly higher than recommendation by Malaysian healthy plate

"*suku suku separuh*" (p= 0.001); whereas portion of protein (p=0.001) as well as fruit and vegetables intake (p= 0.001) were significantly lower. **Conclusions:** This study indicates that positive outcomes in the dietary intakes among participants may be contributed by the self-monitoring abilities of technology devices. However, excessive and inadequate intakes of certain nutrients were identified.

Keywords: Digital Photography, Food Diary Application, Diet, Young adult, Females

INTRODUCTION

Eating behaviours among young adults raise a great concern as they are not frequently involved in healthy eating despite its advantages and benefits (Escoto, Laska, Larson, Neumark-Sztainer, & Hannan, 2012). The prevalence of overweight among Malaysian young adults showed an increasing trend as the age increased which were from 16.6 % (18-19 years), 19.6% (20-24 years), 22.2% (25-29 years) to 29.4% (30-34 years) (National Health and Morbitidy Survey (NHMS), 2015). In general, the probability of females to become overweight and obese is five times as compared to males (Baalwa et al., 2010). Overweight and obesity in young adulthood would increase risk of having chronic diseases such as cardiovascular diseases, hypertension and diabetes (Baalwa et al., 2010).

Therefore, precise dietary records that represent habitual intake of individuals are needed to monitor dietary intake of individuals. However, Thompson, Subar, Loria, Catherine, Reedy, and Barawnoski (2010) mentioned that there is an increased burden to further improve the conventional dietary intake assessment methods. Al-Hassan and Soondus (2016) emphasized the rising popularity of smartphones in the population which leads to the use of these smartphone technologies for developing more reliable measures of dietary intake to monitor individuals' intake of food and beverages. Daugherty et al. (2012) also stated that young generation shows more interest and high preference of assessing dietary intakes using technology as compared to the conventional methods.

Thus, with regards to the high interest of technology among the young adults and the need to monitor food and beverages consumption, it is necessary to introduce the use of current technology in assessing their dietary intake. This study explored the use of two technology-based dietary records which were digital photography and smartphone food diary application to assess the dietary intakes among normal and overweight young adult females. Smartphone food diary application (MyFitnessPal) was used to compare the dietary intakes between normal and overweight groups. MyFitnessPal was also used to compare the dietary intakes of participants to the (RNI) 2017. Digital photography was used to compare the

portion size intakes of the participants to the recommended portion size of Malaysian healthy plate.

MATERIALS AND METHODS

Subjects

In this cross-sectional study, a total of 74 female participants aged between 19 and 24 years old were recruited (n= 37 for normal weight group, n= 37 for overweight group) from International Islamic University Malaysia (IIUM) Kuantan campus. Participants who were currently on diet, on medications that may affect the taste, smell and salivation or with diseases that affect dietary intakes were excluded from this study. All of these conditions were excluded as they lead to the alteration of participants' patterns of food or fluid intake. (Douglass, & Heckman, 2010). This study had obtained ethics approval by IIUM Research Ethic Committee (2020-KAHS/NS14).

Anthropometry measurements

The weight was measured using Seca 813 electronic weighing scale and the height was measured using Seca 213 portable stadiometer (SECA, Hamburg, Germany). Body Mass Index (BMI) cut-off points for body weight classification was used to categorize participants into underweight (BMI<18.5), normal weight (BMI 18.5-24.9), overweight (25.0-29.9), obese class 1 (30.0-34.9), obese class II (35.0-39.9), and obese class III (≥40) (World Health Organization (WHO), 1998).

Socio-demographic questionnaire

The socio-demographic variables collected include BMI, age, year of study, and financial status.

Smartphone Food Diary Application

MyFitnessPal application was used to record dietary intakes of participants for 2 weekdays and 1 weekend. Four mealtimes were recorded in the app which include breakfast, lunch, dinner and snacks. Participants recorded their dietary intakes by either choosing their food from the database or scanning the barcode of food products. Intake of calories, macronutrients and micronutrients can be tracked after addition of each meal.

Digital Photography

Digital photography was used to capture image of main meals specifically portion size of the participants for 2 weekdays and 1 weekend. Participants were required to fill in their plate with portion size of food according to their preferences. A fiducial marker (2 inches by 1 inch printed on standard white paper) was placed beside the plate**.** The portion of food intakes was captured using digital photography before and after eating from two angles which were at 90 and 45 degrees as referred to the standard protocol of dietary reporting by Chen et al. (2017).

Procedure

Participants were recruited through WhatsApp or direct approach. They were required to fill in the informed consent form if they agreed to participate in the study. Their anthropometry measurements were measured. Eligible participants were required to fill in the participant socio-demographic information form. A meeting was arranged to provide participants with training to use both instruments; food diary application (MyFitnessPal) and digital photography. Participants were required to record their usual dietary intakes using the food diary application for 2 weekdays and 1 weekend. At the same time, they were also required to capture photos of their food intakes for three main meals; breakfast, lunch and dinner for 2 weekdays and 1 weekend. Standard operation procedure (SOP) was provided to guide the participants. Lastly, the nutritional information and the photos of their main meals were sent through Whatsapp to the researcher.

Statistical analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 12.0. Descriptive statistics for socio-demographic characteristics were analysed to describe the samples. The dietary intakes between normal and overweight young adults were compared using the independent sample t-test for normally distributed data and Mann Whitney U test for non-normally distributed data. The dietary intakes of the participants recorded in the food diary application were compared to the RNI 2017 using one sample t-test. The portion size intakes of the participants captured using digital photography were compared to the standard portion size of Malaysian Healthy Plate "*suku-suku separuh*" recommendation using one sample t-test. For all types of tests, the level of significance was set at $p < 0.05$.

RESULTS

Socio-Demographic Data of the Young Adult Females

The socio-demographic characteristics of the participants were presented in Table 1. Seventy–four samples were collected comprising 37 normal and 37 overweight participants. All participants were young adult females aged 19 until 24 years old. The mean age of the participants was 21.44 (±1.29) years. The frequency and percentage of Year 1 and Year 3 participants were among the highest and almost the same which were 30 (40.5%) and 34 (45.9%) respectively.

Table 1 Socio-demographic variables (n=74)

	Normal (n=37) n (%)	Overweight (n=37) n (%)	Total (n=74) n (%)
Age			
19-20 years old	12 (32.4)	14 (37.8)	26 (35.2)
21-22 years old	15 (40.5)	15 (40.5)	30 (40.5)
23-24 years old	10 (27.0)	8 (21.6)	18 (24.3)
Year of study			
Year 1	15 (40.5)	15 (40.5)	30 (40.5)
Year 2	1 (2.7)	6 (16.2)	7 (9.5)
Year 3	20 (54.1)	14 (37.8)	34 (45.9)
Year 4	1 (2.7)	2 (5.4)	3 (4.1)
Scholarship status			
PTPTN	10 (27.0)	14 (37.8)	24 (32.4)
JPA	6 (16.2)	9 (24.3)	15 (20.3)
State-funded	3 (8.1)	3 (8.1)	6 (8.1)
None	15 (40.5)	9 (24.3)	24 (32.4)
Others	3 (8.1)	2 (5.4)	5 (6.8)
Body mass index (BMI)			
18.5-24.9 kg/m^2	37 (100)	0 (0)	37 (50.0)
25 – 29.9 kg/m^2	0 (0)	37 (100)	37 (50.0)

Differences in Dietary Intakes between Normal and Overweight Young Adult Females

Based on Table 2.1, there was no significant difference between calorie intake of normal and overweight young adult females with p= 0.297. Furthermore, macronutrient intakes were not statistically different between normal and overweight young adult females with p= 0.857 for carbohydrate, p = 0.539 for protein and p = 0.591 for fat. Based on Tables 2.1 and 2.2, all fatty acids and micronutrient intakes depicted no significant differences between normal and overweight young adult females except for iron (p= 0.042). Iron intake of overweight group was significantly higher than normal group.

Table 2.1 Differences in dietary intakes between normal and overweight young adult females (n=74)

Variables	Normal (N=37) Mean (±SD)	Overweight (N=37) Mean (±SD)	*p*-value[a]
Total energy			
Kilocalorie (Kcal)	1231.92 (341.8)	1153.30 (300.1)	0.297
Total carbohydrate			
Percentage (%)	42.21 (9.8)	42.67 (11.7)	0.857
Total protein			
Gram (g)	36.10 (16.7)	40.72 (25.4)	0.539
Total fat			
Gram (g)	36.97 (18.2)	34.00 (13.3)	0.591
Saturated fat			
Percentage (%)	4.75 (3.1)	4.17 (2.6)	0.470
Sodium			
Milligram (mg)	857.86 (595.8)	685.86 (474.1)	0.235

[a]*Independent sample t-test*

Table 2.2 Differences in dietary intakes between normal and overweight young adult females (n=74)

	Normal, n = 37 Median (IQR)	Overweight, n = 37 Median (IQR)	*p*-value[a]
Monounsaturated fatty acid			
Percentage (%)	1.14 (0.4-1.7)	0.8 (0-1.6)	0.316
Polyunsaturated fatty acid			
Percentage (%)	0.56 (0.2-1.1)	0.41 (0-1.04)	0.529
Trans fat			
Percentage (%)	0 (0)	0 (0)	0.235
Potassium			
Milligram (mg)	79.00 (0-174.7)	136.67 (64.2-249.8)	0.097
Vitamin A			
Microgram (ug)	48.00 (9.0-198.0)	84.00 (6.0-231.0)	0.587
Vitamin C			
Milligram (mg)	4.00 (0-13.0)	4.00 (0-14.0)	0.802
Calcium			
Milligram (mg)	100.00 (30.0- 625.0)	250.00 (70.0-1060.0)	0.114
Iron			
Milligram (mg)	1.00 (0.7-3.0)	3.00 (0.8-5.0)	0.042*
Fiber			
Gram (g)	3.67 (1.6-5.0)	4.33 (2.5-6.3)	0.249

[a]*Mann-Whitney U-test,* **p*-value < 0.05

Nutrient Intakes of the Participants in Comparison to RNI 2017

Based on Table 3, all calories, macronutrient, fatty acid and micronutrient intakes among young adult females were statistically significant different as compared to RNI 2017 with *p*-value less than 0.001. Calorie and all nutrients intake

were significantly lower than RNI except for polyunsaturated fatty acid intake which was significantly higher than RNI (mean difference= +67.4, $p< 0.001$).

Table 3 Nutrients intake of the participants in comparison to RNI 2017 (n=74)

Nutrients	RNI	Mean (±SD)	% difference from RNI	*p*-value
Calorie, kcal	1610	1192.61 (321.9)	-25.92	0.001*
Carbohydrate, %	50	42.44 (10.7)	-15.12	0.001*
Protein, g	53	38.41 (21.4)	-27.52	0.001*
Fat, g	51	35.49 (15.9)	-30.41	0.001*
MUFA, %	12	1.26 (1.4)	-89.5	0.001*
PUFA, %	0.3	0.92 (1.3)	+67.4	0.001*
Saturated Fat, %	10	4.46 (2.9)	-55.4	0.001*
Trans Fat, %	1	0.08 (0.3)	-92.0	0.001*
Sodium, mg	1500	771.86 (541.7)	-48.5	0.001*
Potassium, mg	4700	144.82 (157.6)	-96.9	0.001*
Vitamin A, ug	600	183.09 (357.5)	-69.5	0.001*
Vitamin C, mg	70	8.11 (10.1)	-88.4	0.001*
Calcium, mg	1000	553.88 (985.9)	-44.6	0.001*
Iron, mg	20	2.61 (2.6)	-87.0	0.001*
Fiber, g	20	4.89 (6.3)	-75.6	0.001*

*p-value < 0.05

Estimated Portion Size Intakes of the Participants In Comparison To Recommended Portion Size in Malaysian Healthy Plate

Based on Table 4, the portion intakes of carbohydrate, protein and fruit and vegetable among the participants were significantly different from the recommended portion of Malaysian healthy plate. Portion of carbohydrate intake was significantly higher than the recommendation (% difference= +35.9, $p< 0.001$) whereas portion of protein (% difference= -36.0, $p< 0.001$) as well as fruit and vegetable intakes (% difference= -72.0, $p< 0.001$) were lower than the recommendation.

Table 4 Estimated portion size intakes of the participants in comparison to recommended portion size in Malaysian healthy plate (n=74)

Portion intake	Standard Portion	Mean (±SD)	% difference from RNI	*p*-value
Carbohydrate	0.25	0.39 (0.1)	+35.9	0.001*
Protein	0.25	0.16 (0.06)	-36.0	0.001*
Fruit & Vegetables	0.5	0.07 (0.04)	-72.0	0.001*

*p-value < 0.05

DISCUSSION

This study investigated the use of technology-based dietary records to assess the dietary intakes among normal and overweight young adult females. It should be noted that no previous studies had been conducted using food diary application to specifically compare the dietary intakes between normal and overweight groups particularly among young adult females.

Differences in Dietary Intakes between Normal and Overweight Young Adult Females

In this study, no significant differences in energy intake was found between normal and overweight young adults, which is similar to the study by Farhat et.al. (2019). Regarding macronutrients intake, no significant differences in carbohydrate, protein and fat intakes between normal and overweight females were demonstrated from previous study which was similar to this study (Spiroski et al., 2020). In contrast, Yap et al. (2019) reported significant differences of all carbohydrate, protein, and fat between both groups which differed from the results of this present study. As for micronutrients intake, the results of this study were parallel with a study by Farhat et al. (2019) among university students, in which all micronutrient intakes except iron showed no significant difference between normal weight and overweight female participants.

No significant differences were detected in most of the dietary intakes between normal and overweight groups in this study may be due to the self-monitoring effect of the food diary application used; as both groups may intend to eat within the recommendation set by the app. According to a study by Hutchesson, Rollo, Callister, and Collins (2015), through automated feedback of food diary application, many of the young adult participants revealed that they had altered their eating habits including the types of foods eaten and the frequency of the snacking. Kerr et al. (2016) also stated the primary outcomes using mobile food record that gives dietary feedback were a significant reduction of energy-dense nutrient-poor (EDNP) foods and sugar sweetened beverages (SSB) among young adult participants together with reduction in body weight.

Nutrient Intakes of the Participants In Comparison To RNI 2017

According to Gan et al. (2011), energy intakes of young adults female recorded were lower than RNI recommendation which showed the same result to this study. In regards to macronutrients intake, Spiroski et al. (2020) reported the contradicting results from this study as the protein and fat intakes were higher than recommendation whereas the carbohydrate intake met the recommendation. Nonetheless, Ruiz et al. (2016) presented the same results to this study as the macronutrient intakes were all far from nutritional goals. In regards to

micronutrients intake, the results of previous studies were in line with this study as they reported lower intakes of most micronutrients among young adults in comparison to the recommended values (Farhat et al., 2019; Koo, Hadirah, Airina, Amrina, & Faziela, 2019).

Calorie and macronutrients intake among participants showed positive outcomes as they were taken within recommendation. Various studies reported a significant decrease in calorie intakes from baseline among participants using mobile devices to track and monitor dietary intakes (Turner-McGrievy et al., 2017). Study using PDA with the same monitoring ability as food diary application reported significantly lower fat intakes among participants (Burke al., 2011). However, all micronutrients intake among participants in this study were far lower than recommendation which may be due to the lower intake of fruits and vegetables, milk and dairy product among young adults as reported by Koo et al. (2019) and Farhat et al. (2019). In spite of that, out of all the nutrients, it is a good outcome for the sodium as the intake was within recommendation. Ipjian and Johnson (2015) also reported the significant decrease in sodium intake with the use of MyFitnessPal as a food diary application in dietary assessment.

Estimated Portion Size Intakes of the Participants in Comparison to Recommended Portion Size in Malaysian Healthy Plate

Previous study showed that majority of the participants had low daily consumption of fruit and vegetable as compared to the recommended daily intakes which were similar to the results of this study (Ahmad Sirfan, Hamirudin, & Sidek, 2020). In regards to cereal consumption, Campos-Pérez et al. (2016) stated that general cereal intake exceeded the recommended values which were the same to this study. With regards to protein consumption, a study by El Ansari et al. (2015) showed that meat or sausage products and fish or seafood products recorded the lowest adherence to recommendation among participants which exhibited similarity to this study.

Based on the results of this study, regardless of the use of digital photography in the dietary assessment among young adult females, their portion of carbohydrate, protein as well as fruit and vegetable intake were not adhered to the recommendation. This result was the same to a study by Lassen et al. (2010) that showed no differences in their eating habits to any great extent when using digital photography even though they were aware of their food intakes evaluation by other people. There are various barriers that limit the intake of fruit and vegetables among female young adults such as non-availability and not delicious (Ahmad Sirfan et al., 2020). The possible reasons of higher carbohydrate-based food intakes among female young adults were due to an increased number of fast food restaurants and cereal and grain intakes were maintained as the most frequently consumed foods by young

adults (Mogre, Nyaba, Aleyira, & Sam, 2015). The restriction of protein-based food intakes among young adult females was due to increasing consumption of energy-densed extra food and due to their effort in losing weight (Fayet et al., 2014; Wardle et al., 2004).

Strengths and Limitations of Study

Some limitations of this study were misreporting issues and some participants tend to forget capturing after meal photos. Other limitation was dietary records may be affected as they were not able to complete the dietary records in the university and need to continue doing it at home. The strengths of this study were the combination of digital photography and food diary application in assessing the dietary intakes which had not been done yet in Kuantan. Other strengths were the inclusion of overall calorie, macronutrient and micronutrient intakes data encouraging overall dietary improvement. Lastly, this study also included data on portion intakes per meal among the participants instead of overall portion intakes per day or serving size intakes per day which has been widely studied in other research.

CONCLUSION

This study used two types of technology approaches which were smartphone food diary application and digital photography to assess the dietary intakes among normal and overweight young adult females. In short, food diary applications may be effective to monitor the dietary intakes of participants as in this study, they tend to control their intakes within RNI. However, excessive and inadequate intakes of certain nutrients were identified. Regardless of the self-monitoring on dietary intakes, participants were still did not comply to the recommended portions of Malaysian Healthy Plate "*suku suku separuh*" when their portion food of main meals were captured using digital photography. Thus, lower overall dietary intakes of the participants may not be due to the adherence of the recommended portion of food intakes but may be driven by the changes in other parts of dietary behaviours. Future study is needed to identify the aspects of technology which are specifically beneficial in improving the accuracy of dietary assessment and future work is required to find the association between the self-monitoring abilities of the technologies and the improvement of nutritional outcomes and dietary behaviours among participants.

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