DIETARY FAT INTAKE AMONG NORMAL AND OVERWEIGHT YOUNG ADULT FEMALES IN KUANTAN: A COMPARATIVE STUDY

FATIMAH MASRI
DEPARTMENT OF NUTRITION SCIENCES, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JALAN SULTAN AHMAD SHAH, BANDAR INDERA MAHKOTA 25200 KUANTAN, PAHANG, MALAYSIA
fatimah.bt.masri@gmail.com

ALIZA HASLINDA HAMIRUDIN, PhD (CORRESPONDING AUTHOR)
DEPARTMENT OF NUTRITION SCIENCES, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JLN SULTAN AHMAD SHAH BANDAR INDERA MAHKOTA 25200 KUANTAN, PAHANG, MALAYSIA
aliza@iium.edu.my

ABSTRACT

Introduction: Malaysian young adult females are highly vulnerable to become overweight because of many factors that can lead to high intake of dietary fat in their daily lives. However, insufficient researches in Malaysia have indicated a strong link of dietary fat with body weight as much as carbohydrate does. **Aim:** The main objective is to assess the differences on dietary fat intake between normal and overweight young adult females in Kuantan, Pahang. **Methods:** A total of 60 participants aged between 18 and 35-year-old were recruited (n = 30 for normal weight group, n = 30 for overweight group). The dietary intake data was collected by using diet history method. Diet analysis was conducted using Nutritionist Pro™. Statistically significant result was set at $p < 0.05$. **Results:** There were no significant differences between overweight and normal young adult females regarding their energy, total fat, saturated fat, polyunsaturated fat and monounsaturated fat intakes. No significant associations were detected between dietary fat intake and BMI of the young adult. **Conclusions:** Dietary fat is not the main contributor of body weight status in this population. However, strategies to inculcate healthy dietary intake in this population need to be planned accordingly.

KEYWORDS: Fat intake, Normal young adults, Overweight young adults

INTRODUCTION

As one of the developing countries, the quality of diet among people in Malaysia, especially young adults remains poor (Bhargava, 2001). It was reported that this country has surprisingly become the fattest country in Asia, with almost half of its adult population are overweight or obese (Fuller, O'Connor and Richtel, 2017). The contributing factors that lead to this phenomenon is primarily due to sedentary lifestyle and unhealthy dietary habits. The young adult females nowadays have greater resources and easy access to various dine-out places and most of them are unhealthy such as fast food, junk foods and ready-to-eat food that mainly low in nutrients and high in carbohydrates and fats. With the decreasing uptake of physical activity among young adult females, the condition could be worsening, and it is

not surprising to see that there is an increment of young adult females who are overweight (Hallal et al., 2012).

According to Devaraj et al. (2008), fat is among the nutrients which is highly found in energy-dense fast-food. Some of the previous Western studies have shown the association between dietary fat intake and its effect on body mass index. Of which, a decline in fat consumption will cut down the gap between total energy intake and total energy expenditure and hence is an efficient approach in reducing the current epidemic of overweight and obesity (Shai et al., 2009, Bray and Popkin, 1998). However, in a study conducted by Willett and Leibel (2002), the consumption of fat and prevalence of overweight and obesity were not positively correlated within population of similar economic status. They argued that diets high in dietary fat do not seem to be the main factor contributing to the excess body fat. Thus, reduction in fat will not be the key determinant in decreasing current overweight and obesity epidemic.

Therefore, in this study, the main aim is to examine the difference between dietary fat consumption among young adult females of different body mass index (BMI) categories specifically normal weight and overweight in Kuantan, Pahang, Malaysia. The rationale is to address the gap in the knowledge of the previous studies, which is, whether fat can contribute to the prevalence of overweight. This is also emphasized by Bray and Popkin (1998) and Bray et al. (2016) whereby they found out that a positive relation between intakes of dietary fat; specifically, the percentage of energy in fat and body mass index have been reported in some studies, but not in others.

METHODS

Subjects

A cross sectional study was conducted to recruit a total of 60 young adult females (n=30 normal weight, n= 30 overweight) who live in Kuantan, Pahang, Malaysia. Informed consent was obtained from the respondents. The protocol of the study was approved by Kulliyyah Post Graduate Research Committee (KPGRC) and International Islamic University Malaysia Research Ethical Committee (IREC) with reference number IREC 2019-110.

For inclusion criteria, any available young adult females (normal and overweight) in Kuantan between 18 to 35 years old were chosen as the subjects, regardless of their housing area, employment status, marital status and socioeconomic factors.

Meanwhile, individuals who had the following characteristics were excluded from this study: underweight or obese and those who have differ in term of recommended fat intake than healthy population, which are:

i) Those who have any diseases such as hyperlipidaemia.
ii) Individuals who are on antiretroviral therapy and NNRTI-based therapy which can alter lipid metabolism.
iii) Individuals who are on lipid-lowering medications.
iv) Those who are on dieting or have any diet restriction.
v) Those who have eating disorder.

Sociodemographic questionnaire

The subjects who are eligible to be recruited in this study were required to fill in a socio-demographic information form.

Anthropometric measurements

This was done by measuring their weight using Seca 813 electronic weighing scale and measuring their height using Seca 213 portable stadiometer made in Hamburg, Germany. When measuring weight, the subjects were required to remove anything that can affect the measurement such as hand watches, jewelleries, wallets, hats and shoes (Suzana et al., 2015). For measuring height, the subjects were required to remove their shoes, stand straight forward, feet together, and arms by the sides (Li et al., 2015).

After weight and height measurement have been performed, the BMI of the subjects were calculated to make sure that only normal and overweight subjects were chosen to participate in this study. The BMI category is based on World Health Organization cut-off value: BMI <18.5 kg/m^2 (underweight), BMI 18.5- 24.9 kg/m^2 (Normal), BMI 25- 29.9 kg/m^2 (overweight) and BMI ≥ 30 kg/m^2 (obese).

Dietary intake

The participants were required to have about a 30-minutes session with the researcher to assess their dietary fat intake using diet history method. This session was used to gain all the information about the data of food intake and typical diet of the subjects. The subjects need to report all foods and beverages as well as dietary supplements intake. Among the important things that have been asked during this session were the frequency of the food consumed, preparation method, type or brand of the food and beverages, the portion size and the time of the meals consumed. To improve accuracy, the researcher brought along visual aids, standard 240-ml glass, standard cup, tablespoon, standard ladle and matchbox in order to help the subjects identify and state the portion size (Suzana et al., 2015). All the information that were given by the subjects were recorded and keyed-in onto the diet analysis application which is Nutritionist Pro™.

Statistical analysis

The statistical analysis of results included descriptive statistics, independent *t*-test (to assess differences of total energy as well as percentage and gram of fat intake) and Pearson Correlation (to identify association between total dietary fat intake and BMI) using the Statistical Package for the Social Sciences (SPSS) version 12.0.1 for Windows. P value was set at $p<0.05$ as statistically significant.

RESULTS

Socio-Demographic Characteristics of The Young Adult Females

The results for socio-demographic characteristics of the young adult females' participants (n=60) is shown in the Table 1. There are equal number of respondents in each

group of BMI categories, which account for 30 (50%) respectively. Out of the total of 60 respondents, 75% (n=45) which is majority of them aged between 21 to 25 years old.

Table 1. Socio-demographic characteristics of the young adult females

Socio-demographic variables	Frequency	Percentage (%)
BMI		
Normal	30	50.0
Overweight	30	50.0
Age		
18-20	10	16.7
21-25	45	75.0
26-30	3	5.0
31-35	2	3.3
Marital status		
Single	59	98.3
Married	1	1.7
Divorced	0	0
Prefer not to say	0	0
Current employment status		
Full-time employment	10	16.7
Part-time employment	0	0
Self-employed	0	0
Unemployed	1	1.6
Student	49	81.7
Others	0	0
Monthly household income		
≤ RM1,000/month	14	23.3
RM1,001 to RM5,000/month	22	36.7
RM5,001 to RM10,000/month	17	28.3
≥ RM10,000/month	7	11.7
Highest education status		
High school	3	5.0
College	4	6.7
University	48	80.0
Others	5	8.3

Differences of Total Energy and Total Fat Intake Between Normal and Overweight Young Adult Females

The differences of total energy as well as percentage and gram of total fat intake between normal and overweight young adult females that have been obtained from the diet history were analyzed by using the independent t-test and the results are tabulated in the Table 2. Based on Table 2, there was no significant differences between normal weight young adult females' total energy intake compared to overweight young adult females ($p = 0.378$). Besides, there was also no significant differences between normal weight young adult females' total fat intake compared to overweight young adult females in term of both percentage ($p = 0.202$) and gram, ($p = 0.684$). Hence, there was no differences of total energy and total fat intake between normal and overweight young adult females.

Table 2. Differences of Total Fat Intake between Normal and Overweight Young Adult Females

	Normal (n = 30) Mean ± SD	Overweight (n = 30) Mean ± SD	*p*-value
Total energy			
Kilocalorie (kcal)	1413.2 ± 453.3	1688.0 ± 683.1	0.378
Total fat intake			
Percentage (%)	30.72 ± 9.55	31.76 ± 7.06	0.202
Gram (g)	50.07 ± 27.96	60.96 ± 30.55	0.684

Differences of Saturated Fat Intake Between Normal and Overweight Young Adult Females

The percentage and gram differences of saturated fat intake between normal and overweight young adult females were analyzed by using the independent t-test and the results are tabulated in the Table 3. Based on Table 3, there was no significant differences between normal weight young adult females' saturated fat intake compared to overweight young adult females in term of both percentage and gram (p = 0.433 and p = 0.107 respectively).

Table 3. Differences of Saturated Fat Intake between Normal and Overweight Young Adult Females

	Normal (n = 30) Mean ± SD	Overweight (n = 30) Mean ± SD	*p*-value
SFA intake			
Percentage (%)	6.75 ± 4.10	7.54 ± 3.68	0.433
Gram (g)	10.58 ± 7.66	14.43 ± 10.36	0.107

Differences of Polyunsaturated Fat Intake between Normal and Overweight Young Adult Females

Based on Table 4, there was no significant differences between normal weight young adult females' polyunsaturated fat intake compared to overweight young adult females in term of both percentage and gram (p = 0.942 and p = 0.384 respectively).

Table 4. Differences of Polyunsaturated Fat Intake between Normal and Overweight Young Adult Females

	Normal (n = 30) Mean ± SD	**Overweight (n = 30) Mean ± SD**	***p*-value**
PUFA intake			
Percentage (%)	4.24 ± 2.80	4.19 ± 2.63	0.942
Gram (g)	6.52 ± 4.53	7.58 ± 4.79	0.384

Differences of Monounsaturated Fat Intake between Normal and Overweight Young Adult Females

Based on Table 5, there are no significant differences between normal weight young adult females' monounsaturated fat intake compared to overweight young adult females in term of both percentage and gram (p = 0.852 and p = 0.217 respectively).

Table 5. Differences of Polyunsaturated Fat Intake between Normal and Overweight Young Adult Females

	Normal (n = 30) Mean ± SD	**Overweight (n = 30) Mean ± SD**	***p*-value**
MUFA intake			
Percentage (%)	4.57 ± 2.09	4.47 ± 1.76	0.852
Gram (g)	7.02 ± 3.68	8.26 ± 4.01	0.217

Association between Dietary Fat Intake and BMI

The association between total dietary fat intake (in percentage and gram) and BMI of young adult females were analyzed by using Pearson Correlation and the results was tabulated in the Table 6.

Based on Table 6, it was shown that there is no significant correlation between dietary fat intake and BMI for both percentage and gram (r = 0.062, p = 0.635 and r = 0.186, p = 0.155 respectively). Therefore, there is no association between dietary fat intake and BMI in young adult females in Kuantan.

Table 6. Association between Dietary Fat Intake and BMI of Young Adult Females

	Mean ± SD (n = 60)	**r**	***p*-value**
Total Dietary Fat Intake			
Percentage (%)	31.24 ± 8.34	0.062	0.635
Gram (g)	55.51 ± 29.55	0.186	0.155

DISCUSSION

This study demonstrated no significant difference of total energy intake between normal weight and overweight groups, which is in line with other studies (Davis, Hodges, and Gillham, 2006, Haerens et al., 2007). Although the finding was not statistically significant, it is good to found out that both normal and overweight young adult females do not have excessive energy intake (TEI = 1413.2 ± 453.3kcal and 1688.0 ± 683.1 respectively). Based on RNI 2017, the energy intake for general young adult females population should be around 1840 kcal/day. However, there is limited research about the total energy intake of normal and overweight young adult populations. For the finding of total fat intake, which is also no differences between those two BMI groups, it is in contrast with several findings which suggested that overweight adults consume more total fat compared to normal weight adults

(Zelman, 2007, Surh and Dong, 2009). While for the young adult populations, there are no such information revealed. It is worth to note that the young adult females in both BMI groups have slightly higher percentage of total fat intake than RNI 2017 and WHO recommendation of 25% to 30%.

The finding of saturated fat intake is parallel with several studies that highlighted about no significant differences of saturated fat intake between normal weight and overweight adult populations (Davis, Hodges, and Gillham, 2006, Haerens et al., 2007, Perez et al., 2016). However, this finding is opposed to another several studies which suggested that overweight individuals have higher intake of saturated fat compared to normal weight individuals (Chu et al., 2001, Rosqvist et al., 2014, Raatz et al., 2017).

The findings of PUFA intake is inconsistent with several studies that mentioned about higher polyunsaturated fat intake in overweight subjects when compared to normal weight subjects (Alfieri, Pomerleau, and Grace, 1997, St-Onge et al., 2004, Doonweerd et al., 2016). This also contradicted to some findings in which suggested that normal young adult females consume more percentage of polyunsaturated fat compared to overweight young adult females. Micallef et al. (2009) and Albert et al. (2014) in their study also revealed that healthier BMI individuals has higher intake of polyunsaturated fat compared to overweight individuals ($p = 0·002$).

Since the result is not statistically significant, other studies done by Raatz et al. (2017) and Diaf, Khaled, and Sellam (2015) also reported that the intake of dietary PUFA does not show any significant difference between those two BMI groups. Meanwhile, Little et al. (2016) has reported that overweight individuals have higher omega-6 PUFA consumption and lower omega-3 PUFA consumption compared to normal weight individuals, which means that overweight have more intake of pro-inflammatory types of PUFA (omega-6) as compared to their normal counterparts who have more intake of anti-inflammatory types of PUFA (omega-3).

The result of monounsaturated fat intake is inconsistent with most of the research which depicted that overweight individuals have higher monounsaturated fat intake compared to normal weight individuals (Carey et al., 1996, St-Onge et al., 2004, Doonweerd et al., 2016). Raatz et al. (2017) and Klein-Platat (2015) had reported that there was significant difference in intake of MUFA between normal and overweight individuals, as they used larger sample size compared to this present study. A study done by Coelho et al. (2006) in female adults populations also found out that there is significant difference of MUFA intake between normal and overweight BMI groups. However, there is limited evidence about the young adult females populations with regards to MUFA intake.

Our finding is also in line with several studies which demonstrated no association between dietary fat intake and BMI. According to Aeberli, Kaspar, and Zimmermann (2007), dietary fat intake was not significantly correlated with BMI after controlling for age, gender and total energy in their subjects. Apart from that, a study that had been done more than two decades ago by Willett (1998) had proved that the relationship between dietary fat intake and weight gain is not consistent. Although cross-sectional studies generally reveal a positive

association between fat intake and obesity, long-term trials of high-fat as well as low-fat diets do not show strong effects on weight gain (Chu et al., 2001). Furthermore, a recent study done by Pinheiro and Wilson (2017) suggested only a weak association between dietary fat and excess weight gain. Nevertheless, there are also several studies which claimed that BMI was strongly positively correlated with total fat intake (Zelman, 2007, Surh and Dong, 2009). However, there was no previous research specifically about the association of dietary fat intake with BMI in young adult females population.

Limitation of this study is some of the respondents tend to misreport during the diet history interview. As mentioned in other studies, many overweight individuals have tendency to under-report their food intake. According to McManus, Antinoro, and Sacks, (2001), women under-reported their energy intake by −2206 kJ/day±1841 (527 kcal ± 440). Nevertheless, there are several strengths pertaining to this study. Firstly, this study used diet history which is a reliable method in determining the dietary fat intake of the normal weight and overweight young adult females (Lo Siou et al., 2017). Furthermore, there is only one researcher who had done the data collection and data analysis, which can minimize the possible error and bias in this study.

CONCLUSIONS

Dietary fat intake had been an issue whether it contributes to the weight of an individual. From the findings in this study, there was no significant differences between overweight young adult females' energy, total fat, saturated fat, polyunsaturated fat, and monounsaturated fat intake compared to normal weight young adult females. There was no correlation between dietary fat intake and BMI for both percentage and gram respectively. Therefore, dietary fat is not the main contributor of body weight in this population of study. Further studies are warranted to clarify findings of this study.

This study had drawn a new insight of dietary fat intake among young adult females, in which this macronutrient is not the main contributor of body weight in this population of study. Strategies to inculcate healthy dietary intake in this group of population can be planned accordingly to increase awareness on appropriate dietary fat intake among the young adults. Thus, actions and legislation by the government especially in the Health Division can be further enforced to cater this serious issue of weight gain among young adults in Malaysia nowadays.

ACKNOWLEDGEMENT

We would like to express our deepest gratitude to the research participants.

REFERENCES

Aeberli, I., Kaspar, M., Zimmermann, M.B. (2007). Dietary intake and physical activity of normal weight and overweight 6 to 14 year old Swiss children. Swiss medical weekly 137 (2007). - ISSN 1424-7860 - p. 424 - 430.

Albert, B., Derraik, G., B., Brennan, M., Biggs, B., Smith, C., Garg, L., Cameron-Smith, D., Hofman, L., Cutfield, S. (2014). Higher omega-3 index is associated with increased insulin

sensitivity and more favourable metabolic profile in middle-aged overweight men. https://doi.org/10.1038/srep06697

Alfieri, M., Pomerleau, J., & Grace, D. M. (1997). A Comparison of Fat Intake of Normal Weight, Moderately Obese and Severely Obese Subjects. Obesity Surgery, 7(1), 9–15. doi:10.1381/096089297765556150

Bhargava. (2001). *Nutrition, health, and economic development: Some policy priorities*. Retrieved from http://journals.sagepub.com/doi/pdf/10.1177/156482650102200208

Bray, G. A., Frühbeck, G., Ryan, D. H., & Wilding, J. P. H. (2016). Management of obesity. The Lancet, 387(10031), 1947–1956. doi:10.1016/s0140-6736(16)00271-3

Bray & Popkin. (1998). *Dietary fat intake does affect obesity | The American Journal of Clinical Nutrition | Oxford Academic*. Volume 68, Issue 6, 1 December 1998, Pages 1157–1173, https://doi.org/10.1093/ajcn/68.6.1157

Carey, D. G., Jenkins, A. B., Campbell, L. V., Freund, J., & Chisholm, D. J. (1996). Abdominal Fat and Insulin Resistance in Normal and Overweight Women: Direct Measurements Reveal a Strong Relationship in Subjects at Both Low and High Risk of NIDDM. Diabetes, 45(5), 633–638. doi:10.2337/diab.45.5.633

Chu, N.F., Stampfer, M.J., Spiegelman, D., Rifai, N., Hotamisligil, G. S., Rimm, E. B. (2001). Dietary and lifestyle factors in relation to plasma leptin concentrations among normal weight and overweight men. International Journal of Obesity. Macmillan Publishers Limited. https://doi.org/10.1038/sj.ijo.0801468

Coelho, S. B., de Sales, R. L., Iyer, S. S., Bressan, J., Costa, N. M. B., Lokko, P., & Mattes, R. (2006). Effects of peanut oil load on energy expenditure, body composition, lipid profile, and appetite in lean and overweight adults. Nutrition, 22(6), 585–592. doi:10.1016/j.nut.2006.03.012

Davis, J. N., Hodges, V. A., & Gillham, M. B. (2006). Normal-Weight Adults Consume More Fiber and Fruit than Their Age- and Height-Matched Overweight/Obese Counterparts. Journal of the American Dietetic Association, 106(6), 833–840. doi:10.1016/j.jada.2006.03.013

Devaraj, S., Polagruto, J., Keen, C. L., & Jialal, I. (2008). *High-fat, energy-dense, fast-food'style breakfast results in an increase in oxidative stress in metabolic syndrome*. Retrieved from https://www.sciencedirect.com/science/article/pii/S0026049508000875. Volume 57, Issue 6, June 2008, Pages 867-870

Diaf, M., Khaled, M. B., & Sellam, F. (2015). Correlation Between Dietary Fat Intake and Atherogenic Indices in Normal, Overweight and Obese Adults with or Without Type 2 Diabetes. Romanian Journal of Diabetes Nutrition and Metabolic Diseases, 22(4). doi:10.1515/rjdnmd-2015-0041

Doornweerd, S., IJzerman, R. G., van der Eijk, L., Neter, J. E., van Dongen, J., van der Ploeg, H. P., & de Geus, E. J. (2016). Physical activity and dietary intake in BMI discordant identical twins. Retrieved from sci-hub.tw/https://onlinelibrary.wiley.com/doi/abs/10.1002/oby.21475

Fuller, O'Connor & Richtel (2017). In Asia's Fattest Country, Nutritionists Take Money from Food Giants. *The New York Times* [Kuala Lumpur], p. A1. Retrieved on 20th September 2018 from https://www.nytimes.com/2017/12/23/health/obesity-malaysia-nestle.html

Haerens, L; Deforche, B; Maes, L; Cardon, G; Bourdeaudhuij, I. (2007). Physical activity and endurance in normal weight versus overweight boys and girls. De. Journal of Sports Medicine and Physical Fitness; Turin Vol. 47, Iss. 3, (Sep 2007): 344-50.

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., & Ekelund, U. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. https://doi.org/10.1016/S0140-6736(12)60646-1. Volume 380, Issue 9838, 21–27 July 2012, Pages 247-257

Klein-Platat, C., Drai, J., Oujaa, M., Schlienger, J.-L., & Simon, C. (2005). Plasma fatty acid composition is associated with the metabolic syndrome and low-grade inflammation in overweight adolescents. The American Journal of Clinical Nutrition, 82(6), 1178–1184. doi:10.1093/ajcn/82.6.1178

Li, F., Wilkens, L. R., Novotny, R., Fialkowski, M. K., Paulino, Y. C., Nelson, R., … Boushey, C. J. (2015). Anthropometric measurement standardization in the US-affiliated pacific: Report from the Children's Healthy Living Program. American Journal of Human Biology, 28(3), 364–371. doi:10.1002/ajhb.22796

Little, M., Humphries, S., Patel, K., & Dewey, C. (2016). Factors associated with BMI, underweight, overweight, and obesity among adults in a population of rural south India: a cross-sectional study. Retrieved on 26th September 2018 from https://bmcobes.biomedcentral.com/articles/10.1186/s40608-016-0091-7

Lo Siou, G., Csizmadi, I., Boucher, B., Akawung, A., Whelan, H., Sharma, M., … Robson, P. (2017). The Comparative Reliability and Feasibility of the Past-Year Canadian Diet History Questionnaire II: Comparison of the Paper and Web Versions. Nutrients, 9(2), 133. doi:10.3390/nu9020133

McManus, K., Antinoro, L., Sacks, F. (2001). A randomized controlled trial of a moderate-fat, low-energy diet compared with a low fat, low-energy diet for weight loss in overweight adults. International Journal of Obesity. Macmillan Publishers Limited. https://doi.org/10.1038/sj.ijo.0801796

Micallef, M., Munro, I., Phang, M., & Garg, M. (2009). Plasma n-3 polyunsaturated fatty acids are negatively associated with obesity. British Journal of Nutrition, 102(09), 1370. doi:10.1017/s0007114509382173

Pérez, W. C, Becerra, K. G., López, O. R., Gómez, J. A. S., Cabrera, E. B, Roman, S., Panduro, A., López, E. M (2016). Same Dietary but Different Physical Activity Pattern in Normal-weight and Overweight Mexican Subjects. Journal of Food and Nutrition Research, 2016, Vol. 4, No. 11, 729-735. DOI:10.12691/jfnr-4-11-5

Pinheiro, M. M., & Wilson, T. (2017). Dietary Fat: The Good, the Bad, and the Ugly. Nutrition Guide for Physicians and Related Healthcare Professionals, 241–247. doi:10.1007/978-3-319-49929-1_24

Raatz, S., Conrad, Z., Johnson, L., Picklo, M., & Jahns, L. (2017). Relationship of the Reported Intakes of Fat and Fatty Acids to Body Weight in US Adults. Retrieved from https://www.mdpi.com/2072-6643/9/5/438/htm Nutrients 2017, 9(5), 438; doi:10.3390/nu9050438

Rosqvist, F., Iggman, D., Kullberg, J., Cedernaes, J., Johansson, H. E., Larsson, A., & Riserus, U. (2014). Overfeeding polyunsaturated and saturated fat causes distinct effects on liver and visceral fat accumulation in humans. Retrieved from http://diabetes.diabetesjournals.org/content/early/2014/02/11/db13-1622.short

Shai, I., Schwarzfuchs, D., Henkin, Y., Shahar, D. R., Witkow, S., Greenberg, I., Stampfer, M. J. (2009). Weight Loss with a Low-Carbohydrate, Mediterranean, or Low-Fat Diet. Retrieved on 22nd September 2018 from https://www.nejm.org/doi/full/10.1056/NEJMoa0708681. N Engl J Med 2008; 359:229-241 DOI: 10.1056/NEJMoa070868

St-Onge, M.-P., Janssen, I., & Heymsfield, S. B. (2004). Metabolic Syndrome in Normal-Weight Americans: New definition of the metabolically obese, normal-weight individual. Diabetes Care, 27(9), 2222–2228. doi:10.2337/diacare.27.9.2222

Surh & Dong, Z. (2009). High-fat-diet induced modulation of adipogenic transcriptional cascades. In Dietary modulation of cell signaling pathways (p. 393).

Suzana, S., Shanita, S., Zahara, A. M., & Hasnah, H. (2015). Atlas of food exchanges & portion sizes (3rd ed.). Kuala Lumpur: MDC Publishers Sdn Bhd.

Willett & Leibel. (2002). *Dietary fat is not a major determinant of body fat*. Volume 113, Issue 9, Supplement 2, 30 December 2002, Pages 47-59. https://doi.org/10.1016/S0002-9343(01)00992-5

Zelman. (2007). Good fats vs. bad Fats: get the skinny on fat. Retrieved on 25th September 2018 from https://www.webmd.com/diet/obesity/features/skinny-fat-good-fats-bad-fats#1