UNIVERSITI PUTRA MALAYSIA

DIET QUALITY AND ITS CONTRIBUTING FACTORS AMONG ADULTS IN THREE DISTRICTS OF SELANGOR, MALAYSIA

IBNTEESAM PONDOR

FPSK(M) 2017 49

DIET QUALITY AND ITS CONTRIBUTING FACTORS AMONG ADULTS IN THREE DISTRICTS OF SELANGOR, MALAYSIA

By

IBNTEESAM PONDOR

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

August 2017

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Master of Science

DIET QUALITY AND ITS CONTRIBUTING FACTORS AMONG ADULTS IN THREE DISTRICTS OF SELANGOR, MALAYSIA

By

IBNTEESAM PONDOR

August 2017

Chairman : Geeta Appannah, PhD
Faculty : Medicine and Health Sciences

Food price forms a major part of the food environment and is an important influence on food choices. Research on daily dietary cost (DDC) and diet quality (DQ) has been hindered by a lack of data in Malaysia. This cross-sectional study aimed to examine associations between socio-economic characteristics, dietary intake, BMI and DDC with DQ among adults in Selangor. A total of 450 adults were recruited from housing areas in Bangi, Selayang and Bandar Petaling Jaya. Recruitment involved one adult from odd-numbered houses in selected streets who voluntarily participated. Socio-economic characteristics and anthropometric measurements were obtained during face-to-face interviews. Dietary data was collected using a validated Food Frequency Questionnaire and Nutritionist Pro^{TM} software was used to analyze nutrient intakes, thus evaluating DQ using a Healthy Eating Index (HEI). DDC (RM/ 2000Kcal) was calculated using food prices from the Ministry of Trade, Cooperatives and Consumerism. SPSS version 22.0 was used for all statistical analyses.

There were 35.8% of males and 64.2% of females. Majority of them were working adults (66.0%) with mean age 37.55± 11.0, had at least secondary school education (97.2%) and reported median personal income of RM3000 (2400) and household income of RM4000 (3000) and a majority of them (59.3%) lived in low cost housing. Respondents with normal BMI counted 38.9% while 22.0% were obese and 36.7% were overweight. There was 50.6% (N= 228) of respondents with energy misreporting and therefore analysis was carried out for both total respondents and plausible reporters. The mean HEI score of plausible reporters (N= 222) was 60.96 ±10.22. Respondents achieved more than 55% of the Malaysian Dietary Guidelines for most HEI components except for milk products (46.8%) and total sodium (12.4%). There were no statistically significant difference (p> 0.05) between HEI

scores and socio-economic characteristics except for age groups (p= 0.041) for total respondents and personal income (p= 0.029) for plausible reporters. There was also no significant difference in mean HEI scores with regards to BMI (p> 0.05). There were significant weak positive correlations between energy adjusted carbohydrate (r= 0.189, p= 0.009) and protein (r= 0.141, p= 0.014) and HEI scores (N= 222). The median crude DDC was RM16.73 (12.50) while energy adjusted DDC was RM10.81 (4.45)/ 2000kcal for plausible reporters. The highest contributors to total DDC were cereal products (20.1%), non-alcoholic beverages (18.0%) and confectionaries (13.4%). The multiple linear regression model concluded that energy adjusted fat (β= -0.183) and DDC (β= 0.244) were significant contributors to diet quality (N= 222; p= 0.013). Results from this study suggests that higher diet quality was more expensive than less healthy choice. It not only serves as a stepping stone for more research into examining DDC and DQ in a Malaysian setting but also as a basis for policy makers in gearing subsidies towards more healthful food choices. This study comes at a timely moment especially when there is a need for everybody especially those of low socio-economic background to get access to healthy foods so as to improve health and prevent non-communicable diseases.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

KUALITI DIET DAN FAKTOR SUMBANGAN DALAM KALANGAN ORANG DEWASA DI TIGA DAERAH NEGERI SELANGOR, MALAYSIA

Oleh

IBNTEESAM PONDOR

Ogos 2017

Pengerusi : Geeta Appannah, PhD
Fakulti : Perubatan dan Sains Kesihatan

Harga makanan merupakan satu bahagian utama dalam persekitaran makanan dan mempunyai pengaruh penting terhadap pilihan makanan. Kajian ke atas kos harian pemakanan (KHP) dan kualiti pemakanan (KP) tidak dapat dijalankan dengan baik disebabkan oleh kekurangan data di Malaysia. Kajian keratan rentas ini bertujuan untuk mengkaji hubungan di antara ciri-ciri sosio-ekonomi, pengambilan makanan, IJB dan KHP dengan KP di kalangan orang dewasa di Selangor. Seramai 450 orang dewasa telah dipilih dari tiga kawasan perumahan yang bertempat di Bandar Baru Bangi, Bandar Baru Selayang dan Bandar Petaling Jaya. Pemilihan melibatkan seorang dewasa secara sukarela dimana pemilihannya adalah melalui rumah yang bernombor ganjil di sepanjang jalan yang terpilih. Ciri-ciri socio-ekonomi dan ukuran antropometri telah diperoleh melalui temuduga bersemuka.. Data dikumpulkan dengan menggunakan borang soal selidik kekerapan makanan (FFQ) yang telah disahkan kesesuaian pengunaanya dan perisian "Nutritionist Pro^{TM}" telah digunakan untuk menganalisis pengambilan nutrien, dengan itu KP telah dinilai dengan menggunakan Indeks Pemakanan Sihat (IPS). KHP (RM/2000Kcal) telah dikira dengan menggunakan senarai harga dari Kementerian Perdagangan, Koperasi dan Kepenggunaan. Perisian SPSS versi 22.0 telah digunakan untuk semua analisis statistik. Daripada jumlah keseluruhan responden, 35.% adalah lelaki dan 64.2% adalah wanita. Kebanyakan mereka terdiri daripada orang dewasa yang sedang bekerja (66.0%) dengan umur purata sebanyak 37.5±11.0, mempunyai sekurang-kurangnya pendidikan sekolah menengah (97.2%) dan berpendapatan median peribadi sebanyak RM3000 (2400) dan pendapatan isi rumah sebanyak RM4000 (3000). Sejumlah 38.9% responden mempunyai indeks jisim badan (IJB) yang normal manakala 22.0% adalah gemuk dan 36.7% mempunyai berat badan berlebihan. Terdapat seramai 50.6% (N = 228) responden yang telah melaporkan tenaga kilo kalori yang kurang tepat. Oleh itu, analisis hanya melibatkan jumlah responden dan pelapor yang munasabah sahaja. Purata skor IPS yang dilaporkan

oleh pelapor munasabah (N = 222) adalah 60.96 ±10.22. Responden mencapai lebih daripada 55% Garis Panduan Pemakanan Malaysia untuk kebanyakan komponen IPS kecuali untuk produk susu (46.8%) dan jumlah natrium (12.4%). Tidak terdapat perbezaan statistik yang signifikan (p> 0.05) di antara skor IPS dan ciri-ciri sosio-ekonomi melainkan untuk kumpulan umur (p = 0.041) bagi keseluruhan responden dan pendapatan peribadi (p = 0.029) bagi pelapor munasabah. Terdapat juga perbezaan yang tidak signifikan dalam skor purata IPS yang berkaitan dengan IJB (p> 0.05). Sementara itu, terdapat korelasi positif yang lemah antara pengambilan karbohidrat yang diselaraskan tenaga (r = 0.189, p = 0.009) dan pengmabilan protein (r = 0.141, p = 0.014) dan skor IPS (N = 222). Median KHP kasar adalah RM16.73 (12.50) manakala KHP yang diselaraskan tenaga adalah RM10.81(4.45) / 2000kkal. Penyumbang tertinggi kepada KHP ialah bahan bijirin (20.1%), minuman (18.0%) dan manisan (13.4%). Model regresi linear berganda menyimpulkan bahawa lemak yang telah diselaraskan tenaga (β = -0.183) dan KHP (β = 0.244) adalah penyumbang signifikan kepada kualiti pemakanan(N = 222). Hasil kajian ini menunjukkan bahawa kualiti pemakanan yang tinggi adalah lebih mahal harganya jika dibandingkan dengan pilihan makanan yang kurang sihat.. Hasil kajian ini bukan sahaja akan menyumbang pada kajian KHP dan KP di Malaysia, tetapi juga akan membantu kerajaan untuk menggubal polisi berkaitan susbidi makanan yang sihat. Selain itu, hasil kajian ini turut menyumbang kepada keperluan ramai khususnya golongan sosio-ekonomi yang rendah untuk mendapatkan akses kepada makanan yang sihat untuk menambahbaik kesihatan secara umum serta mengelak penyakit-penyakit yang kronik.

ACKNOWLEDGEMENTS

In the name of the Almighty God, the most Merciful and Generous…

I am truly grateful to God for making me see this day and be able to stand through this Master's journey with no major difficulties.

I would like to dedicate this thesis to my father, Mr. Mohammad Imraan Pondor. My strongest pillar in all sense. His open mind and resilience have always driven me to pursue my own ambitions.

My deepest gratitude goes to my main supervisor, Dr. Geeta Appannah for her unfailing support, positivity and guidance throughout this study. She has effectively steered me while at the same time given me freedom over my research study. I am thankful to my co-supervisor Dr. Gan Wan Ying who has meticulously revised my work and given me valuable instructions.

I would like to acknowledge all the respondents who voluntarily participated in this project. Thanks to Nor Aishah Binti Emi, the main enumerator to this study who also drove us to all data collection sites. I would like to equally thank my friends Chan Suk Huei and Ivy Cheah Hsiaoyong for their great help in data collection. I would also like to acknowledge Universiti Putra Malaysia grant in financially supporting this study. Also this degree would not have been possible without the Islamic Development Bank-Ministry of Higher Education Malaysia joint scholarship.

To my aunties Marie Paule, Rooafzah and Atoufa, I am thankful for your relentless support and love. I would like to recognize Mr. Bashir Ahmad Bin Mohd Ibrahim and family. Thank you for opening your doors to me and treating me like family in this foreign country. My appreciation and sincere thanks goes to all my friends at UPM especially Abubakar Sadiq Tanko, Mihade Joyub, Sarah Nouman, Sadaf Shakoor and Isatou Hydara.

Thank you to my mother, Mohezamah Pondor and brother, Yaceer Pondor for being there unconditionally.

I certify that a Thesis Examination Committee has met on 17 August 2017 to conduct the final examination of Ibnteesam Pondor on her thesis entitled "Diet Quality and its Contributing Factors among Adults in Three Districts of Selangor, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Norhasmah binti Sulaiman, PhD
Associate Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Chairman)

Chin Yit Siew, PhD
Senior Lecturer
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Internal Examiner)

Norimah A. Karim, PhD
Professor
Universiti Kebangsaan Malaysia
Malaysia
(External Examiner)

NOR AINI AB. SHUKOR, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 30 November 2017

The thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirements for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Geeta Appannah, PhD
Senior Lecturer
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Chairman)

Gan Wan Ying, PhD
Senior Lecturer
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

_____
ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- There is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature:  Date: _____

Name and Matric No.: Ibnteesam Pondor (GS43027)

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- Supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____
Name of
Chairman
Supervisory
Committee: Dr. Geeta Appannah

Signature: _____
Name of
Member
Supervisory
Committee: Dr. Gan Wan Ying

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

BMI	Body Mass Index
BMR	Basal Metabolic Rate
CPI	Consumer Price Index
DDC	Daily Dietary Cost
DQ	Diet Quality
DQI	Diet Quality Indicator
FAFH	Food Away From Home
FAO	Food and Agricultural Organization
FFQ	Food Frequency Questionnaire
HEI	Healthy Eating Index
IPH	Institute of Public Health
DOSM	Department of Statistics Malaysia
KPDNKK	Ministry of Trade, Cooperatives and Consumerism Malaysia
MANS	Malaysian Adult Nutrition Survey
MASCO	Malaysian Standard Classification of Occupations
NCD	Non Communicable Diseases
NHMS	National Health and Morbidity Survey
SEP	Socio-economic Position
SES	Socio-economic Status
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background

Dietary consumption is an assortment of behaviors which takes place as a result of one's decision-making. When faced with several options of what, where, when and how much to eat, behavioral economics proposes that individuals will choose combinations which best serve their own utility. However, utility is restricted by lack of time, financial constraints, social norms, preferences or health concerns (Sloman & Wride, 2009). Individual food choice on the other hand is more specifically dictated by factors which include taste, cost, and convenience and to a far less significance, health especially among lower socio-economic groups (Kamphuis, Bekker-Grob & Lenthe, 2015). Consuming a balanced diet is important to prevent and reduce chronic diseases, particularly for populations who are socio-economically disadvantaged and have increased disease risk as compared to people of higher socio-economic status (Rao, Afshin, Singh & Mozaffarian, 2013).

While the latest economic development in Malaysia has brought about a major improvement in lifestyle and eating patterns, it has alongside brought about an increase in the occurrence of nutrition related disorders. The recent National Health and Morbidity Survey (NHMS) in 2015 revealed that the prevalence of overweight and obesity among Malaysian adults were 32.4% and 18.5% respectively. Obesity being higher in women (22.9%) compared to men (14.5%) and in adults aged 30-39 years (21.2%) compared to other adult age groups. Those of Indian ethnicity had a higher proportion of obesity (28.1%) compared to Malays (22.0%), Bumiputra Sarawak (17.0%), Bumiputra Sabah (14.1%) and Chinese (10.8%). There has been a significant increase in obesity from 15.4% as noted in the NHMS 2011 compared to 18.5% in the NHMS of 2015. Obesity plays a significant role in the etiology of non-communicable diseases and the consequences are at increased risk of premature mortality and poorer quality of life. The obesity burden has undoubtedly contributed to increasing medical treatment costs and decreased productivity in the Malaysian population (IPH, 2015).

Locally, the Malaysian Dietary Guidelines (2010) has been driven to encourage Malaysians to consume less calories, be more physically active and make better food choices. It is unfortunate that the NHMS (2011) revealed that 92.5% of the local adult population consumed less than five servings of fruits and/ or vegetables per day which is a measure of healthfulness of an individual's diet. The latest NHMS (IPH, 2015) has demonstrated that adults have a mean serving size of 1.40 for fruits compared to the recommended two, while for vegetables, Malaysians consume 1.51 servings compared to the recommended three daily servings. In the ethnically diverse population, factors such as sex, socio-economic position race and culture may influence the food habits of Malaysians (Wan Abdul Manan et al., 2012). On

the other hand, factors such as availability and cultural acceptability of healthier alternatives hinder the promotion of healthy diets. The universally designated barrier is indeed cost as it is commonly accepted that those alternatives are more expensive than less healthy foods (Rao et al., 2013).

Darmon and Drewnowski (2008) have conducted a review based on multiple European countries, Canada, Australia and United States. They concluded that generally better educated and more affluent people would consume the higher-quality diets. The opposite was also true and thus they inferred that if higher socio-economic status is a determining factor in diet quality, all the epidemiologic studies linking diet quality and better health have inadvertently been confounded by overlooked socio-economic characteristics. The same authors have in a more recent review come to the conclusion that higher cost of healthy diets definitely account for socioeconomic disparities in diet quality. Food patterns that are reasonably priced, nutrient dense and appealing at the same time should be identified and prioritized to combat this inequality (Darmon & Drewnowski, 2015). Earlier studies have demonstrated that high adherence to diet quality indicators were associated with higher diet cost (Darmon & Drewnowski, 2008). Shroder et al. (2006) also concluded an inverse association between high adherence to diet quality indicators and BMI and obesity. Therefore, it is evident that economic constraints, and their effects on food choices, have to be taken into account for the development of dietary tools for weight gain prevention.

Cassady, Jetter and Culp (2007) stated that one of the ways to reduce the risk of diet-related chronic disease among low-income consumers is to increase the consumption of fruits and vegetables. Bernstein et al. (2010) also concluded that foods from plant origin provide the best investment for health. Furthermore, a recent systematic review by Xia et al. (2014) has provided further evidence to confirm these findings. It was noted that the average reduction in mortality from cardiovascular risk was 4% for each additional serving of fruit and vegetables combined (hazard ratio 0.96, 95% confidence interval 0.92 to 0.99; $p = 0.02$). As for fruits only, the percentage was 5% (0.95, 0.91 to 1.00; $p = 0.03$) and lastly for each additional serving per day of vegetables, it was 4% (0.96, 0.93 to 0.99; $p = 0.01$) (Xia et al., 2014). One British researcher has stated that nutrition should be consistent with people's reality and that high cost foods cannot be promoted to low-income people without taking costs into consideration (Lang, 2005).

1.2 Problem statement

Local researchers such as Karupaiah, Chee, Ying, Koon and Chinna (2013) have put forward the fact that indicators of diet quality and the understanding of factors affecting food choice should be used to evaluate the health of the population. Diet quality is assessed by assigning scores to dietary patterns as to what extent they adhere with national dietary guidelines and how the diversity of healthy choices meet core food groups or equivalent international groupings (Wirt & Collins, 2009).

Karupaiah et al. (2013) have hypothesized that food accessibility by urban communities and consequently the ability to meet healthy eating practices should greatly be affected by the built environment such as food markets as well as other factors unique to that particular environment. Food price and consequently the dietary cost of individuals form a fundamental part of the food environment and is the leading influence on food choices (Darmon, Briend & Drewnowski, 2004). It is therefore necessary to study the relationship between food expenditure and the healthfulness of food choices made by the Malaysian population. Engel's law of expenditures for food states that the quantity of food purchased will increase as an individual's income increases. Nevertheless, the percentage of income spent on food will in fact decrease as total income increases (Kindleberger, 1990). This is relevant when considering the social inequalities of access to a healthy and nutritious diet. The lower income earners would face important challenges with regard to increasing food price since food expenditure already constitutes a main portion of their income. The salaries and wages survey report revealed that the mean salary of Malaysians was RM2312 while those from urban regions had a mean of RM2514 (JPM, 2015). Mean monthly household income for Malaysian has increased from RM5000 in 2012 to RM6141 in 2014. The household income and basic amenities survey thus reported an increase of 10.3% per annum (JPM, 2014).

Findings from the household expenditure survey (JPM, 2014) revealed that Selangor had a mean monthly household consumption expenditure of RM 4,646 after Wilayah Persekutuan Putrajaya (RM 5,627) and Wilayah Persekutuan Kuala Lumpur (RM 5,559). All Malaysian states recorded an increase in mean monthly household consumption expenditure compared to 2009. In 2009, Malaysians spent 20.3% of the household consumption expenditure on food and non-alcoholic beverages, while in 2014, the percentage decreased to 18.9%.

Malaysian statistics regarding the decrease in percentage of household consumption expenditure on food from year 2009 to 2014 fit Engel's theory adequately. However, the Consumer Price Index, [a measure of the average change over time in the price paid by urban consumers for a market of goods and services (US Bureau of Labour Statistics, 2017)] with regards to the rise in food away from home index (+3.4%) (JPM, 2016) is a paradox and tend to fit the definition of dietary consumption (Sloman & Wride, 2009) whereby individuals would choose combinations of food that maximize their convenience, which are nevertheless curbed by several constraints. The following numbers show how the consumer price index for food and non-alcoholic beverages rose by 3.8% in November 2016 compared to the same month of the previous year. Food items which are majorly responsible for this rise are cooking oil (+ 45.6%), chicken (+ 10%), fish and seafood (+ 4.5%) and vegetables (+3.6%) (JPM, 2016). With the rise in food commodities, it is therefore important to examine the daily dietary cost of the Malaysian population. In this study's context, daily dietary cost refers to the sum of cost of foods consumed on a daily basis (Cade et al., 1999).

Asma, Nawalyah, Rokiah and Mohd Nasir (2010) assessed the diet quality of married couples in a selected urban area in Selangor, Malaysia. A 2-day 24-hour dietary recall and a Food Frequency Questionnaire (FFQ) were used to assess the quality of diet among the respondents using the Diet Quality Index Revised (DQI-R). The diet quality of the population was not found to be adequate and in general the male respondents had better diet quality than their female counterparts. However, no pricing or expenses pertaining to food was investigated. Higher DQI-R scores in this study were characterized by reduced intake of fat, saturated fat and dietary cholesterol, along with higher intakes of fruits, vegetables, calcium and iron intake.

Karupaiah et al. (2013) investigated the dietary health behaviors of women living in high rise dwellings in an urban community in Malaysia. A healthy eating index (HEI) scale was used to evaluate the respondents' diet quality. The HEI score was significantly different ($p < 0.05$) among the 3 main ethnicities (Malay, Chinese & Indian). It was also noted that eating out frequency was associated with poor HEI score, more specifically a decreased vegetable intake ($\rho = -0.320$; $p < 0.001$) and sodium excess ($\rho = -0.135$; $p = 0.065$). The study suggested that health promotion for diet related non-communicable diseases should be done at the community level. With the previously mentioned obesity rates in Malaysia, the investigation of body mass index is warranted especially to determine any differences in diet quality with regards to body mass index.

According to the review by Rao et al., (2013), several studies across other countries have evaluated whether healthier foods or diets cost more, however, not much is known about the potential diversity of this relationship. For instance, some studies compared healthier and less healthy models of the same food while others focused on dietary patterns, both containing different types of foods. Moreover, the healthfulness of food may be based on single nutrients (sugar or fat content) or on more elaborate dietary patterns and consequently impacting the price difference (Rao et al., 2013). Thus, there is a need to investigate the relationships between nutrient intakes and diet quality.

To conclude, with the ever increasing of food prices and the notorious statistics of obesity and chronic diseases in Malaysia, it is mandatory to investigate about daily dietary cost, BMI, socio-economic characteristics in particular income levels and the diet quality of Malaysian adults. Thus, the present study aims to determine associations between socio-economic characteristics, BMI, daily dietary cost and diet quality in adults in Selangor.

1.3 Research Questions

- What is the diet quality, daily dietary cost and body weight status of adults in Selangor?
- What is the difference in diet quality with regards to socio-economic characteristics and BMI?
- What is the association between daily dietary cost and diet quality?
- What is the relationship between dietary intake and diet quality?
- What are the factors influencing with diet quality?

1.4 Significance of the study

While the healthfulness of food choices has been examined in all the age groups of the Malaysian population, there is a tangible absence of study that links daily dietary cost of Malaysians to their diet quality. Food price is undoubtedly one of the most important factors and commonly accepted motivator that drive people especially income earners and household heads to their food choices. Additionally it is noted that dietary cost is an important determinant of diet quality. Previous studies keep on demonstrating the need for improvement in diet quality for all segments of the population. However, no efforts have been made in understanding the importance of food expenditure in relation to diet quality. With a lack of published studies simultaneously assessing socio-economic characteristics, BMI, daily dietary cost and diet quality in Malaysia, it is a research area that needs to be urgently tackled. This is because being able to enjoy good health is a basic human right and if the socio-economic status of an individual has a direct effect on his health, then it is indeed a matter of public health concern.

The present study will bring to light any existing associations between dietary cost, socio-economic status and BMI with regards to diet quality. This will be a groundbreaking insight and enable the society at large to be informed about their relative dietary cost as well as the influence of socio-economic status and BMI with regards to diet quality. Along with being informative, the hypothesized associations might be used as a baseline to investigate more about daily dietary cost of the population in Malaysia especially among people of lower socio-economic groups. This would consequently be a means to identify solutions to enable low-income earners to afford and make healthful food choices. Overall, it can also contribute in helping policy makers to develop strategies aimed at tackling the problem of socio-economic disparities in nutrition on a national level in Malaysia.

1.5 Conceptual Framework and operational definition of variables

Figure 1.1 demonstrates the conceptual framework relating all the variables in this study whereby diet quality is the dependent variable and socio-economic characteristics, dietary intake, daily dietary cost and anthropometric measurements are the independent variables. It has been stipulated that normally a healthy diet

should consists of 55-75% from carbohydrates, 10-15% from proteins and 15-30% from lipids (WHO, 2003).

The literature has counted a well-established link between dietary cost and diet quality such that healthier diets tend to be more expensive than less healthier ones (Darmon & Drewnowski, 2015). It is also known that socio-economic inequalities contribute to this equation as low-income earners are unable to afford high diet quality and often expensive food items. Ryden and Hagfors (2011) have reported that children whose parents were the least educated and had blue-collared occupations, consumed the cheapest and most unhealthy diets. In general, lower socio-economic groups have been described to have lower quality diets and higher rates of non-communicable diseases (Darmon & Drewnowski, 2008). Additionally, it is also understood that high diet quality is inversely associated with BMI (Schroder, Marrugat and Covas, 2006).

1.5.1 Diet Quality

a) Diet quality is measured by scoring food patterns in terms of how closely they align with national dietary guidelines and how diverse the variety of healthy choices is within core food groups or equivalent international groupings (Wirt & Collins, 2009).
b) Dietary Quality Indices or Indicators (DQIs) are algorithms aiming to evaluate the overall diet and categorize individuals according to the extent to which their eating behaviour is healthy (Gil, Martinez de Victoria & Olza, 2015).
c) Diet quality refers to both the amount of nutrients and the uptake of specific nutrients from foods to support body maintenance, growth, physiological status (for instance pregnancy and lactation), physical activity and protection against infection. Diet quality is also reflected in the variety (diversity) of food groups consumed (International Atomic Energy Agency, 2017).

From the above definitions, diet quality can be summed up as an optimal measure of nutrients for the overall well-being such as body maintenance, growth, physiological status and physical activity and it is a way to measure how an individual's diet adhere with national dietary guidelines or to the extent to which their eating behaviour is healthy.

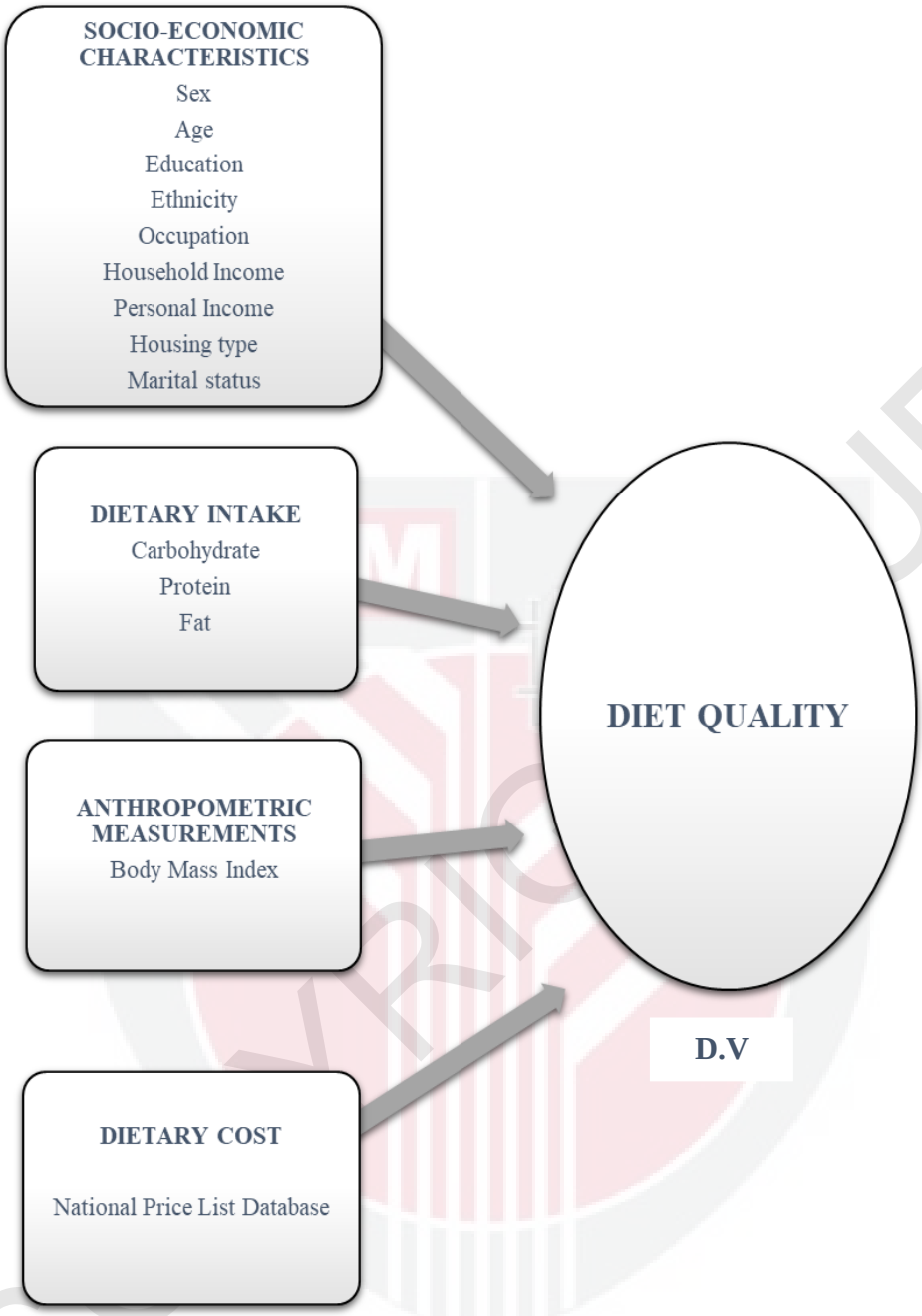

Figure 1.1 : Conceptual Framework showing the dependent and independent variables being assessed

1.5.2 Socio-economic characteristics

Socio-economic status is often measured as a combination of education, income and occupation. It is commonly conceptualized as the social standing or class of an individual or group (APA, 2017).

1.5.3 Body Mass Index

Body Mass Index (BMI) is a person's weight in kilograms divided by the square of height in meters (CDC, 2015).

1.5.4 Daily Dietary Cost

Daily dietary cost is referred to the sum of cost of foods consumed per day (Cade et al. 1999).

1.6 Objectives

General objective: To determine associations between socio-economic characteristics, dietary intake, BMI, daily dietary cost and diet quality among adults in Selangor.

1. Specific objectives:
2. To determine socio-economic characteristics: sex, age, education, ethnicity, occupation, personal and household incomes, housing types and marital status; diet quality; body weight status and daily dietary cost of adults.
3. To examine differences in diet quality with regards to socio-economic characteristics and BMI of adults.
4. To determine association between daily dietary cost and diet quality of adults.
5. To examine relationship between dietary intake and diet quality of adults.
6. To determine factors influencing diet quality of adults.

1.7 Hypotheses

H_{01}: There is no difference in diet quality with regards to socio-economic characteristics and BMI of adults.

H_{02}: There is no relationship between daily dietary cost and diet quality of respondents.

H_{03}: There is no relationship between dietary intake and diet quality of respondents.

H_{04}: There is no significant factors influencing diet quality of respondents

REFERENCES

Abdull Hakim, N. H., Muniandy, N. D., & Danish, A. (2012). Nutritional status and eating practices among university students in selected universities in Selangor, Malaysia. *Asian Journal of Clinical Nutrition, 4*(3), 77-87, doi: 10.3923/ajcn.2012.7.

Aggarwal, A., Monsivais, P., Cook, A. J., & Drewnowski, A. (2011). Does diet cost mediate the relation between socioeconomic position and diet quality? *European Journal of Clinical Nutrition, 65* (9), 1059-1066.

Aggarwal, A., Monsivais, P., Cook, A. J., & Drewnowski, A. (2014). Positive attitude toward healthy eating predicts higher diet quality at all cost levels of supermarkets. *Journal of Academy of Nutrition and Diet, 114*(2), 266-272. doi: 10.1016/j.jand.2013.06.006.

Aggarwal, A., Rehm, C. D., Monsivais, P., & Drewnowski, A. (2016). Importance of taste, nutrition, cost and convenience in relation to diet quality: Evidence of nutrition resilience among US adults using National Health and Nutrition Examination Survey 2007-2010. *Preventive Medicine, 90*, 184-192. doi: 10.1016/j.ypmed.2016.06.030.

Alamir, N. F., & Preedy, V. R. (2013). Diet quality: Setting the scene. In V. R. Preedy, L. A. Hunter, & V. B. Patel (Eds.), *Diet quality: an evidence based approach* (pp. 3-9). New York: Springer Science and Business Media.

Alkerwi, A. (2014). Diet quality concept. *Nutrition, 30*(6), 613-618. doi: 10.1016/j.nut.2013.10.001.

Alkerwi, A., Vernier, C., Sauvageot, N., Crichton, G. E., & Elias, M. F. (2015). Demographic and socioeconomic disparity in nutrition: application of a novel Correlated Component Regression approach. *BMJ Open, 5*(5), e006814. doi: 10.1136/bmjopen-2014-006814.

American Psychological Association (2017). Education and socioeconomic status fact sheet. Available online at: http://www.apa.org/pi/ses/resources/publications/factsheet-education.pdf.

Andrieu, E., Darmon, N., & Drewnowski, A. (2006). Low- cost diets: more energy, fewer nutrients. *European Journal of Clinical Nutrition, 60*, 434-436.

Arvaniti, F., & Panagiotakos, D. B. (2008). Healthy indexes in public health practice and research: A review. *Critical Reviews in Food Science and Nutrition 48*, 317–27.

Asma, A. (2014). *An Exploration of Dietary Patterns and the Relationship with Obesity in the Malaysian Population.* Unpublished PhD thesis, University of Southampton. Available at: https://eprints.soton.ac.uk/382976/1/FULL%2520THESIS%2520_%2520CD.pdf.

Asma, A., Nawalyah, A. G., Rokiah, M. Y., & Nasir, M. T. (2010). Assessment of diet quality among married couples in a selected urban area in Selangor. *Journal of Community Health, 16*(2), 17-28.

Atwater, W.O. (1984). Foods: nutritive value and cost. *USDA Farmers Bulletin*, 23.Washington, DC: Government Printing Office. Available online at: https://www.ars.usda.gov/ARSUserFiles/80400530/pdf/hist/oes_1894_farm_bul_23.pdf.

Backholer, K., Spencer, E., Gearon, E., Magliano, D. J., McNaughton, S. A., Shaw, J. E., & Peeters, A. (2016). The association between socio-economic position and diet quality in Australian adults. *Public Health Nutrition, 19*(3), 477-485. doi: 10.1017/S1368980015001470.

Bernstein, A. M., Bloom, D. E., Rosner, B. A., Franz, M., & Willett, W. C. (2010). Relation of food cost to healthfulness of diet among US women. *American Journal of Clinical Nutrition, 92*(5), 1197-1203. doi: 10.3945/ajcn.2010.29854.

Black, A. E. (2000). Critical evaluation of energy intake using the Goldberg cut-off for energy intake: basal metabolic rate. A practical guide to its calculation, use and limitations. *International Journal of Obesity, 24*(9), 1119-1130.

Brooks, R. C., Simpson, S. J., & Raubenheimer, D. (2010). The price of protein: combining evolutionary and economic analysis to understand excessive energy consumption. *Obesity Reviews, 11*, 887-894, doi: 10.1111/j.1467-789X.2010.007.

Cade, J. E., Burley, V. J., Warm, D. L., Thompson, R. L., & Margetts, B. M. (2004). Food-frequency questionnaires: a review of their design, validation and utilisation. *Nutrition Research Reviews, 17*, 5-22.

Cade, J., Upmeier, H., Calvert, C., & Greenwood, D. (1999). Costs of a healthy diet: analysis from the UK Women's Cohort Study. *Public Health Nutrition, 2*(04). doi: 10.1017/s1368980099000683.

Carlson, A., & Frazao, E. (2014). Food costs, diet quality and energy balance in the United States. *Physiology Behaviour, 134*, 20-31. doi: 10.1016/j.physbeh.2014.03.001.

Carlson, A., Lino, M., Juan, W. Y., Hanson, K., & Basiotis, P. P. (2007). *Thrifty Food Plan, 2006. (CNPP-19).* U.S. Department of Agriculture, Center for Nutrition Policy and Promotion.

Carvalho, K. M. B., Dutra, E. S., Pizato, N., Gruezo, N. D., & Ito, M. K. (2014). Diet quality assessment indexes. *Revista de Nutrição, 27*(5), 605-617. doi: 10.1590/1415-52732014000500009.

Cassady, D., Jetter, K. M., & Culp, J. (2007). Is price a barrier to eating more fruits and vegetables for low-income families? *Journal of American Dietetics Association, 107*(11), 1909-1915. doi: 10.1016/j.jada.2007.08.015.

Cavicchia, P. P., Steck, S. E., Hurley, T. G., Hussey, J. R., Ma, Y., & Ockene, I. S. (2009). A new dietary inflammatory index predicts interval changes in serum highsensitivity C-reactive protein. *Journal of Nutrition, 139*, 2365–72.

Centers for Disease Control and Prevention. (2015). *Body Mass Index.* Available online at: https://www.cdc.gov/healthyweight/assessing/bmi/index.html

Chamhuri, N., & Batt, P. J. (2013). Exploring the factors influencing consumers' choice of retail store when purchasing fresh meat in Malaysia. *International Food and Agribusiness Management Review, 16*(3), 99-122.

Clerfeuille, E., Maillot, M., Verger, E. O., Lluch, A., Darmon, N., & Rolf-Pedersen, N. (2013). Dairy products: how they fit in nutritionally adequate diets. *Journal of Academy of Nutrition and Diet, 113*(7), 950-956. doi: 10.1016/j.jand.2013.04.002.

Conklin, A. I., Monsivais, P., Khaw, K. T., Wareham, N. J., & Forouhi, N. G. (2016). Dietary Diversity, Diet Cost, and Incidence of Type 2 Diabetes in the United Kingdom: A Prospective Cohort Study. *PLoS Medicine, 13*(7), e1002085. doi: 10.1371/journal.pmed.1002085.

Darmon, A. D. N. (2005). Food Choices and Diet Costs: an Economic Analysis. *American Society for Nutritional Sciences, 135*, 900-904.

Darmon, N., & Drewnowski A. (2008). Does social class predict diet quality*? American Journal of Clinical Nutrition, 87*, 1107-1117.

Darmon, N., & Drewnowski, A. (2015). Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: a systematic review and analysis. *Nutrition Reviews, 73*(10), 643-660. doi: 10.1093/nutrit/nuv027.

Darmon, N., Briend, A., & Drewnowski, A. (2004). Energy-dense diets are associated with lower diet costs: a community study of French adults. *Public Health Nutrition, 7*(1). doi: 10.1079/phn2003512.

Darmon, N., Lacroix, A., Muller, L., & Ruffieux, B. (2014). Food price policies improve diet quality while increasing socioeconomic inequalities in nutrition. *Internation Journal of Behavioural Nutrition and Physical Activity, 11*, 66. doi: 10.1186/1479-5868-11-66.

Davis, G. C., & Carlson, A. (2014). The inverse relationship between food price and energy density: is it spurious? *Public Health Nutrition, 18*(6), 1091-1097. doi: 10.1017/S1368980014001098.

Department of Statistics Malaysia (2010). *Malaysia at a glance: Selangor*. Available online at https://www.statistics.gov.my/index.php?r=column/cone&menu_id=eGUyTm9RcEVZSllmYW45dmpnZHh4dz09.

Department of Statistics Malaysia, population and demographics statistics division. (2016). *Population Quick Info*. Putrajaya, Malaysia. Available online at: https://www.dosm.gov.my/v1/index.php?r=column/cone&menu_id=Nk1JZnJBMm1TdmRFS0xaTXZnanIrQT09.

Department of Statistics Malaysia. *Consumer Price Index Press Release.* Department of Statistics, Putrajaya, Malaysia. 2016.

Department of Statistics Malaysia. *Report of household income and basic amenities survey.* Department of Statistics, Putrajaya, Malaysia. 2014.

Department of Statistics Malaysia. *Report on Characteristics of Household, Population and Housing census of Malaysia, 2010*. Department of Statistics, Putrajaya, Malaysia. 2010.

Department of Statistics Malaysia. *Report on Education and Social Characteristics of the population, 2010*. Department of Statistics Malaysia, Putrajaya, Malaysia. 2010.

Department of Statistics Malaysia. *Report on the household expenditure survey, Malaysia (2009/2010).* Department of Statistics Malaysia, Putrajaya, Malaysia. 2011.

Department of Statistics Malaysia. *Salaries and wages report*. Department of Statistics, Putrajaya, Malaysia. 2015.

Drenowatz, C., Shook, R. P., Hand, G. A., Hebert, J. R., & Blair, S. N. (2014). The independent association between diet quality and body composition. *Scientific Reports, 4*, 4928. doi: 10.1038/srep04928.

Drewnowski, A. (2005). Concept of a nutritious food: Toward a nutrient density score. *American Journal of Clinical Nutrition, 82*, 721–32.

Drewnowski, A. (2010a). The cost of US foods as related to their nutritive value. *Americal Journal of Clinical Nutrition, 92*(5), 1181-1188. doi: 10.3945/ajcn.2010.29300.

Drewnowski, A. (2010b). The Nutrient Rich Foods Index helps to identify healthy, affordable foods. *Americal Journal of Clinical Nutrition,* 91(4), 1095S-1101S. doi: 10.3945/ajcn.2010.28450D.

Drewnowski, A. (2013). New metrics of affordable nutrition: which vegetables provide most nutrients for least cost? *Journal of the Academy of Nutrition and Dietetics*, *113*(9), 1182-1187. http://dx.doi.org/10.1016/j.jand.2013.03.015.

Drewnowski, A., & Darmon, N. (2005). The economics of obesity: dietary energy density and energy cost. *Americal Journal of Clinical Nutrition,* 82(Supp), 265S–273S.

Drewnowski, A., & Eichelsdoerfer, N. D. (2010). Can Low-Income Americans Afford a Healthy Diet? *Nutrition Today, 44(6),* 246-249.

Drewnowski, A., & Eichelsdoerfer, P. (2009). The Mediterranean diet: does it have to cost more? *Public Health Nutrition, 12*(9A), 1621-1628. doi: 10.1017/S1368980009990462.

Drewnowski, A., & Specter, S. E. (2004). Poverty and obesity: the role of energy density and energy costs. *Americal Journal of Clinical Nutrition, 79*, 6-16.

Drewnowski, A., Henderson, S. A., Shore, A. B., Fischler, C., Preziosi. P., & Hercberg, S. (1996). Diet quality and dietary diversity in France: Implications for the French paradox. *Journal of the American Dietetic Association, 96*, 663–9.

Drewnowski, A., Rehm, C. D., Maillot, M., & Monsivais, P. (2015). The relation of potassium and sodium intakes to diet cost among U.S. adults. *Journal of Human Hypertension, 29*(1), 14-21. doi: 10.1038/jhh.2014.38.

Dubois, L., Girard, M. & Bergeron, N. (2000). The choice of a diet quality indicator to evaluate the nutritional health of populations. *Public Health Nutrition, 3*(3), 357-365.

Duncan, G. J., Daly, M. C., McDonough, P., Williams, D. R. (2002). Optimal Indicators of Socioeconomic Status for Health Research. *Research and Practice, 92*(7), 1151-1157.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. *Behaviour Research Methods, 41*(4), 1149-1160. doi: 10.3758/BRM.41.4.1149.

Food and Agricultural Organization. (1985). *FAO/WHO/UNU expert consultation: Energy requirements of adults*. Available online at: http://www.fao.org/docrep/007/y5686e/y5686e07.htm.

Food and Agriculture Organization (1996). *Rome Declaration on World Food Security*. Available online at: http://www.fao.org/docrep/003/w3613e/w3613e00.HTM.

Ford, E. S., & Dietz, W. H. (2013) Trends in energy intake among adults in the United States: findings from NHANES. *American Journal of Clinical Nutrition, 97*, 848-853.

Frazao, E., Carlson, A., & Stewart, H. (2011). Energy-adjusted food costs make little economic sense. *American Journal of Clinical Nutrition, 93*(4), 861. doi: 10.3945/ajcn.110.009639.

Galobardes, B., Morabia, A., & Bernstein, M. (2001). Diet and socioeconomic position: does the use of different indicators matter? *International Journal of Epidemiology, 30:* 334–40.

Gil, A., Martinez de Victoria, E., & Olza, J. (2015). Indicators for the evaluation of diet quality. *Nutricion Hospitalaria Journal, 31*(3), 128-144. doi: 10.3305/nh.2015.31.sup3.8761.

Goldberg, G. R., Black, A. E., Jebb, S. A., Cole, T. J., Murgatroyd, P. R., Coward, W. A., & Prentice, A. M. (1991). Critical evaluation of energy intake data using fundamental principles of energy physiology: Derivation of cut-off limits to identify under-recording. *European Journal of Clinical Nutrition, 45*(12), 569-81.

Grech, A., Sui, Z., Siu, H. Y., Zheng, M., Allman-Farinelli, M., & Rangan, A. (2017). Socio-Demographic Determinants of Diet Quality in Australian Adults Using the Validated Healthy Eating Index for Australian Adults (HEIFA-2013). *Healthcare, 5*(1). doi: 10.3390/healthcare5010007.

Guenther, P. M., Reedy, J., Krebs-Smith, S. M., & Reeve, B. B. (2008). Evaluation of the Healthy Eating Index-2005. *Journal of American Dietetic Association, 108*(11), 1854-1864. doi: 10.1016/j.jada.2008.08.011.

Hakansson, A., Andersson, H. S., & Granfeldt, Y. (2015). Diet inequality prevails among consumers interested and knowledgeable in nutrition. *Food and Nutrition Research, 59*, 27601. doi: 10.3402/fnr.v59.27601.

Hann, C. S., Rock, C. L., King, I., & Drewnowski, A. (2001). Validation of the healthy eating index with use of plasma biomarkers in a clinical sample of women. *American Journal of Clinical Nutrition, 74*, 479- 486.

Harrington, J., Fitzgerald, A. P., Layte, R., Lutomski, J., Molcho, M., & Perry, I. J. (2011). Sociodemographic, health and lifestyle predictors of poor diets. *Public Health Nutrition, 14*(12), 2166-2175. doi: 10.1017/S136898001100098X.

Hsiao, P. Y., Mitchell, D. C., Coffman, D. L., Allman, R. M., Locher, J. L., Sawyer, P., Jensen, G. L., & Hartman, T. J. (2013). Dietary patterns and diet quality among diverse older adults: the University of Alabama at Birmingham study of aging. *Journal of Nutrition Health Aging*, 17(1), 19–25.

Institute for Public Health. *Food Portion Sizes of Malaysian Foods Album 2002/2003, Malaysian Adult Nutrition Survey*. Technical Committee for Malaysian Adult Nutrition Survey. Institute for Public Health, Ministry of Health Malaysia: Putrajaya, Malaysia. 2003

Institute for Public Health. *Malaysian Adult Nutrition Survey.* Institute for Public Health, Ministry of Health Malaysia: Putrajaya, Malaysia. 2003.

Institute for Public Health. *National Health and Morbidity Survey 2011 (NHMS 2011) Volume II: Non-Communicable Diseases*; Institute for Public Health, Ministry of Health Malaysia: Putrajaya, Malaysia. 2011.

Institute for Public Health. *National Health and Morbidity Survey 2014*: *Malaysian Adult Nutrition Survey (MANS). Volume II: Survey Findings.* Institute of Public Health, Ministry of Health Malaysia, Putrajaya, Malaysia. 2014.

Institute for Public Health. *National Health and Morbidity Survey 2015 (NHMS 2015). Volume II: Non-Communicable Diseases, Risk Factors and Other*

Health Problems; Institute for Public Health, Ministry of Health Malaysia, Putrajaya, Malaysia. 2015.

International Atomic Energy Agency. (2017). *Diet Quality*. IAEA. Available online at: https://www.iaea.org/topics/diet-quality

Ismail, M. N., Chee, S. S., Nawawi, H., Yusoff, K., Lim, T. O., & James, W.P.T. (2002). Obesity in Malaysia. *Obesity reviews, 3,* 203-208.

Ismail, M. N., Ng, K. K., Chee, S. S., Roslee, R., & Zawiah. H. (1998). Predictive equations for the estimation of basal metabolic rate in Malaysian adults. *Malaysian Journal of Nutrition, 4,* 481-90.

Ivanovitch, K., Klaewkla, J., Chongsuwat, R., Viwatwongkasem, C., & Kitvorapat, W. (2014). The intake of energy and selected nutrients by thai urban sedentary workers: an evaluation of adherence to dietary recommendations. *Journal of Nutrition Metabolism, 2014*, 145182. doi: 10.1155/2014/145182.

Jones, N. R., & Monsivais, P. (2016). Comparing Prices for Food and Diet Research: The Metric Matters. *Journal of Hunger Environmental Nutrition, 11*(3), 370-381. doi: 10.1080/19320248.2015.1095144.

Jones, N. R., Conklin, A. I., Suhrcke, M., & Monsivais, P. (2014). The growing price gap between more and less healthy foods: analysis of a novel longitudinal UK dataset. *PLoS One, 9*(10), e109343. doi: 10.1371/journal.pone.0109343.

Kamphuis, C. B. M., Bekker-Grob, E. W., & Lenthe, F. J. (2015). Factors affecting food choices of older adults from high and low socioeconomic groups: a discrete choice experiment. *American Journal of Clinical Nutrition*, 101:768–74.

Kant, A. K. (2004). Dietary patterns and health outcomes. *Journal of the American Dietetic Association, 104,* 615-635, doi: 10.1016/j.jada.2004.01.010.

Kant, A. K., & Graubard, B. I. (2005). Energy density of diets reported by American adults: association with food group intake, nutrient intake, and body weight. *International Journal of Obesity (London), 29*(8), 950-956. doi: 10.1038/sj.ijo.0802980.

Karlsen, M., Troy, L., Rogers, G., Dwyer, J., McKeown, N., & Jacques, P. (2015). Protein sources, nutrient adequacy and diet quality. *The Journal of Federation of American Societies for Experimental Biology*, *29*(1). 599.5. DOI: 10.1096/fj.1530-6860.

Karupaiah, T., Swee, W. C., Liew, S. Y., Ng, B. K., & Chinna, K. (2013). Dietary health behaviors of women living in high rise dwellings: a case study of an urban community in Malaysia. *Journal of Community Health, 38*(1), 163-171. doi: 10.1007/s10900-012-9597-1.

Kennedy, E., Bowman S. A., Lino, M., Gerrior, S. A., & Basiotis, P. P. (1999). *Diet quality of Americans: Healthy Eating Index* (pp. 97-109). In E. Frazao (Ed.),

America's eating habits: Changes and consequences, Vol. 740 Agriculture Information Bulletin.

Kim, S., Haines, P. S., Siega-Riz, A. M., & Popkin, B. M. (2003). The diet quality index- international (DQI-I) provides an effective tool for cross-national comparison of diet quality as illustrated by China and the United States. *Journal of Nutrition, 133,* 3476- 3484.

Kindleberger, C. P. (1990). *Engel's Law. In Economic Laws and Economic History:* (pp. 3–20). Retrieved from https://www.cambridge.org/core/books/economic-laws-and-economic-history/engels-law/40B672A9990B226B04559A37EE46170D.

Kourlaba, G., & Panagiotakos, D. B. (2009). Dietary quality indices and human health: a review. *Maturitas, 62*(1), 1-8. doi: 10.1016/j.maturitas.2008.11.021.

Lasheras, C., Fernandez, S., & Patterson, A. M. (2000). Mediterranean diet and age with respect to overall survival in institutionalized, non-smoking elderly people. *American Journal of Clinical Nutrition, 71,* 987- 992.

Ledikwe, J. H., Blanck, H. M., Kettel Khan, L., Serdula, M. K., Seymour, J. D., Tohill, B. C., & Rolls, B. J. (2005). Dietary energy density determined by eight calculation methods in a nationally representative United States population. *Journal of Nutrition, 135,* 273-278.

Lee, H., & Tan, A. (2006, August). *Determinants of Malaysian household expenditures of food-away-from-home.* Paper presented at the International Association of Agricultural Economists Conference, Gold Coast, Australia.

Lee, J. H., Ralston, R. A., & Truby, H. (2011). Influence of food cost on diet quality and risk factors for chronic disease: A systematic review. *Nutrition & Dietetics, 68*(4), 248-261. doi: 10.1111/j.1747-0080.2011.01554.x.

Lee, K. W., Oh, J. E., & Cho, M. S. (2012). The Application of the Korean Dietary Pattern Score; KNHANES (Korean National Health and Nutrition Examination Survey) 2007. *Food and Nutrition Sciences, 3*(12), 1688-1696. doi: 10.4236/fns.2012.312221.

Lee, T.T., Norimah, A.K., & Safiah, M.Y. (2011, March). *Development of Healthy Eating Index for Malaysian adults.* Symposium conducted at 26th Scientific Conference and Annual General Meeting of the Nutrition Society of Malaysia, Kuala Lumpur, Malaysia. Available online at: http://www.nutriweb.org.my/downloads/NSM.

Lipoeto, N. I., Khor, G. L., & Angeles-Agdeppa, I. (2012). Food consumption patterns and nutrition transition in South-East Asia. *Public Health Nutrition, 16*(9), 1637-1643. doi: 10.1017/S1368980012004569.

Lipsky, L., M. (2009). Are energy-dense foods really cheaper? Reexamining the relation between food price and energy density. *American Journal of Clinical Nutrition, 90,* 1397-1401.

Lo, Y. T., Chang Y. H., Wahlqvist, M. L., Huang, H. B., & Lee, M. S. (2012). Spending on vegetable and fruit consumption could reduce all-cause mortality among older adults. *Nutrition Journal,11*(1):113.

Lo, Y.T., Chang, Y. H., Lee, M. S., & Wahlqvist, M. L. (2009). Health and nutrition economics: diet costs are associated with diet quality. *Asia Pacific Journal of Clinical Nutrition*, *18*(4):598–604.

Loureiro A.S., Da Silva, R. M., Rodrigues, P. R. M., Pereira, R., A., Wendpap, L., L., & Ferreira, M. G. (2013). Diet quality in a sample of adults from Cuiabá (MT), Brazil: Association with socio-demographic factors. *Revista de Nutrição*, *26*(4), 431-441.

Mackenbach, J. D., Brage, S., Forouhi, N. G., Griffin, S. J., Wareham, N. J., & Monsivais, P. (2015). Does the importance of dietary costs for fruit and vegetable intake vary by socioeconomic position? *British Journal of Nutrition, 114*(9), 1464-1470. doi: 10.1017/S0007114515003025.

Maillot, M., Darmon, N., & Drewnowski, A. (2010). Are the lowest-cost healthful food plans culturally and socially acceptable? *Public Health Nutrition, 13*(8), 1178-1185. doi: 10.1017/S1368980009993028.

Maillot, M., Darmon, N., Vieux, F., & Drewnowski, A. (2007). Low energy density and high nutritional quality are each associated with higher diet costs in French adults. *American Journal of Clinical Nutrition*, *86*, 690-6.

Margetts, B. M., & Nelson, M. (1997). *Design concepts in nutritional epidemiology.* 2nd edition, Oxford: Oxford University Press.

Mariscal-Arcas, M., Romaguera, D., Rivas, A., Feriche, B., Pons, A., Tur, J. A., & Olea-Serrano, F. (2007). Diet quality of young people in southern Spain evaluated by a Mediterranean adaptation of the Diet Quality Index-International (DQI-I). *British Journal of Nutrition, 98*(6), 1267-1273. doi: 10.1017/S0007114507781424.

McGowan, L., Pot, G. K., Stephen, A. M., Lavelle, F., Spence, M., Raats, M., . . . Dean, M. (2016). The influence of socio-demographic, psychological and knowledge-related variables alongside perceived cooking and food skills abilities in the prediction of diet quality in adults: a nationally representative cross-sectional study. *International Journal of Behavioural Nutrition and Physical Activity, 13*(1), 111. doi: 10.1186/s12966-016-0440-4.

Mendes, A., Gavioli, L., Previdelli, Á. N., Fisberg, R. M., & Marchioni, D. M. L. (2015). The diet quality index evaluates the adequacy of energy provided by dietary macronutrients. *Revista de Nutrição, 28*(4), 341-348. doi: 10.1590/1415-52732015000400001.

Mendez, M. A., Popkin, B. M., Buckland, G., Schroder, H., Amiano, P., Barricarte, A., Huerta, J. M., Quiros, J. R., Sanchez, M. J., & Gonzalez, C. A. (2011) Alternative methods of accounting for underreporting and overreporting

when measuring dietary intake-obesity relations. *American Journal of Epidemiology, 173*, 448- 458.

Ministry of Human Resources Malaysia. *Malaysian Standard Classification of Occupations (MASCO)*. Human Resource Policy Division, Ministry of Human Resources Malaysia, Putrajaya, Malaysia. 2013.

Ministry of Trade, Cooperatives and Consumerism. (2017). *Government subsidies on controlled goods.* Ministry of Trade, Cooperatives and Consumerism, Putrajaya, Malaysia. Available online at: http://www.kpdnkk.gov.my/index.php/en/consumer/controlled-goods/goverment-subsidies-controlled-goods.

Mirnalini, K, Jr., Zalilah, MS, Safiah, MY, Tahir, A, Siti Haslinda, MD, Siti Rohana, D, Khairul Zarina, MY, Mohd Hasyami, S, Normah, H (2008) Energy and Nutrient Intakes: Findings from the Malaysian Adult Nutrition Survey (MANS). *Malays J Nutr 14*, 1-24.

Molarius, A., Seidell, J. C., Sans, S., Tuomilehto, J., & Kuulasmaa, K. (2000). Educational level, relative body weight, and changes in their association over 10 years: an international perspective from the WHO MONICA Project. *American Journal of Public Health*, *90*(8), 1260- 1268.

Monsivais, P., & Drewnowski, A. (2007). The Rising Cost of Low-Energy-Density Foods. *Journal of the American Dietetic Association, 107*, 2071-2076.

Monsivais, P., & Drewnowski, A. (2009). Lower-energy-density diets are associated with higher monetary costs per kilocalorie and are consumed by women of higher socioeconomic status. *Journal of American Dietetic Association, 109*(5), 814-822. doi: 10.1016/j.jada.2009.02.002.

Monsivais, P., Aggarwal, A., & Drewnowski, A. (2012). Are socio-economic disparities in diet quality explained by diet cost? *Journal of Epidemiology and Community Health*, *66*(6), 530-535. doi: 10.1136/jech.2010.122333.

Monsivais, P., McLain, J., & Drewnowski, A. (2010). The rising disparity in the price of healthful foods: 2004-2008. *Food Policy, 35*(6), 514-520. doi: 10.1016/j.foodpol.2010.06.004.

Monsivais, P., Perrigue, M. M., Adams, S. L., & Drewnowski, A. (2013). Measuring diet cost at the individual level: a comparison of three methods. *European Journal of Clinical Nutrition, 67*(11), 1220-1225. doi: 10.1038/ejcn.2013.176.

Monteiro, C. A. (2009). Nutrition and health. The issue is not food, nor nutrients, so much as processing. *Public Health Nutrition, 12*(5), 729-731. doi: 10.1017/S1368980009005291.

Morris, M. A., Clarke, G. P., Edwards, K. L., Hulme, C., & Cade, J. E. (2016). Geography of Diet in the UK Women's Cohort Study: A Cross-Sectional

Analysis. *Epidemiology - Open Journal, 1*(1), 20-32. doi: 10.17140/epoj-1-104.

Morris, M. A., Hulme, C., Clarke, G. P., Edwards, K. L., & Cade, J. E. (2014). What is the cost of a healthy diet? Using diet data from the UK Women's cohort study. *Journal of Epidemiology and Community Health*, *68*, 1043-1049.

Mozaffarian, D., Afshin, A., Benowitz, N. L., Bittner, V., Daniels, S. R., Franch, H. A., . . . Zakai, N. A. (2012). Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation, 126*(12), 1514-1563. doi: 10.1161/CIR.0b013e318260a20b.

Mullie, P., Clarys, P., Hulens, M., & Vansant, G. (2010). Dietary patterns and socioeconomic position. *European Journal of Clinical Nutrition*, *64*(3), 231-238. doi: 10.1038/ejcn.2009.145.

Murakami, K., Sasaki, S., Okubo, H., Takahashi, Y., Hosoi, Y., & Itabashi, M. (2007). Monetary costs of dietary energy reported by young Japanese women: association with food and nutrient intake and body mass index. *Public Health Nutrition, 10*(12), 1430-1439. doi: 10.1017/S1368980007000213.

Murakami, K., Sasaki, S., Takahashi, Y., & Uenishi, K. (2009). Monetary cost of self-reported diet in relation to biomarker-based estimates of nutrient intake in young Japanese women. *Public Health Nutrition, 12*(8), 1290-1297. doi: 10.1017/S1368980008003923.

National Cancer Institute. (2017). *Overview and background of the Healthy Eating Index.* Division of Cancer Control and Population Sciences. Available online at: https://epi.grants.cancer.gov/hei/

National Coordinating Committee on Food and Nutrition. *Malaysian Dietary Guidelines.* Ministry of Health Malaysia, Putrajaya, Malaysia. 2010.

Norimah, A. K., Safiah, M. Y., Jamal, K., Siti Haslinda, M. D., Zuhaida, H., Rohida, S., …& Azmi, M. Y. (2008). Food consumption patterns: Findings from the Malaysian Adult Nutrition Survey. *Malaysian Journal of Nutrition*, *14*(1), 25-39.

Okubo, H., Murakami, K., & Sasaki, S. (2016). Monetary value of self-reported diets and associations with sociodemographic characteristics and dietary intake among Japanese adults: analysis of nationally representative surveys. *Public Health Nutrition, 19*(18), 3306-3318. doi: 10.1017/S1368980016001695.

Organisation for Economic Co-operation and Development. (2014). *Obesity update.* Available online at: http://www.oecd.org/health/Obesity-Update-2014.pdf.

Panagiotakos, D. B., Pitsavos, C., & Stefanadis, C. (2006). Dietary patterns: a Mediterranean diet score and its relation to clinical and biological markers of

cardiovascular disease risk. *Nutrition Metabolic Cardiovascular Disease, 16*(8), 559-568. doi: 10.1016/j.numecd.2005.08.006.

Patterson, R. E., Haines, P. S., & Popkin, B. M. (1994). Diet quality index: capturing a multidimensional behavior. *Journal of the American Dietetic Association, 94*, 57–64.

Popkin, B. M., Adair, L. S., & Ng, S.W. (2012) Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews, 70,* 3-21.

Prime Minister's Department, Economic Planning Unit. *The Malaysian Economy in Figures*. The Economic Planning Unit, Putrajaya, Malaysia. 2016.

Puchau, B., Zulet, M. A., De Echavarri, A. G., Hermsdorff, H. H., & Martinez, J. A. (2009). Dietary total antioxidant capacity: A novel indicator of diet quality in healthy young adults. *Journal of the American College of Nutrition, 28,* 648–56.

Raffensperger, S., Kuczmarski, M. F., Hotchkiss, L., Cotugna, N., Evans, M. K., Zonderman, A. B. (2010). The effect of race and predictors of socioeconomic status on diet quality in the healthy aging in neighbourhoods of diversity across the life span (HANDLS) study sample. *Journal of National Medical Association, 102*(10), 923-930.

Rao, M., Afshin, A., Singh, G., & Mozaffarian, D. (2013). Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *British Medical Journal Open, 3*(12), e004277. doi: 10.1136/bmjopen-2013-004277.

Rehm, C. D., Monsivais, P., & Drewnowski, A. (2011). The quality and monetary value of diets consumed by adults in the United States. *American Journal of Clinical Nutrition, 94*(5), 1333-1339. doi: 10.3945/ajcn.111.015560.

Rehm, C. D., Monsivais, P., & Drewnowski, A. (2015). Relation between diet cost and Healthy Eating Index 2010 scores among adults in the United States 2007-2010. *Preventive Medicine, 73*, 70-75. doi: 10.1016/j.ypmed.2015.01.019.

Rennie, K. L., Coward, A., & Jebb, S. A. (2007). Estimating under-reporting of energy intake in dietary surveys using an individualised method. *British Journal of Nutrition, 97*(6), 1169-1176. doi: 10.1017/S0007114507433086.

Ryden, P. J., & Hagfors, L. (2011). Diet cost, diet quality and socio-economic position: how are they related and what contributes to differences in diet costs? *Public Health Nutrition, 14*(9), 1680-1692.

Saw, W. S., Nik Shanita, S., Zahara, B. A. M., Tuti, N. M. D., & Poh, B. K. (2012). Dietary intake assessment in adults and its association with weight status and dental caries. *Pakistan Journal of Nutrition, 11*(11), 1066-1072.

Schatzkin, A., Kipnis, V., Carroll, R. J., Midthune, D., Subar, A. F., Bingham, S., Schoeller, D. A., Troiano, R. P., & Freedman, L. S. (2003). A comparison of a food frequency questionnaire with a 24-hour recall for use in an epidemiological cohort study: results from the biomarker-based Observing Protein and Energy Nutrition (OPEN) study. *International Journal of Epidemiology, 32*(6), 1054-62.

Schroder, H., Marrugat, J., & Covas, M. I. (2006). High monetary costs of dietary patterns associated with lower body mass index: a population based study. *International Journal of Obesity, 30*, 1574-157.

Schroder, H., Serra-Majem, L., Subirana, I., Izquierdo-Pulido, M., Fito, M., & Elosua, R. (2016). Association of increased monetary cost of dietary intake, diet quality and weight management in Spanish adults. *British Journal of Nutrition, 115*(5), 817-822. doi: 10.1017/S0007114515005048.

Sloman, J.; Wride, A. *Economics*: Pearson Education; 2009.

Tan, A. K., Yen, S. T., & Feisul, M. I. (2012) Determinants of body weight status in Malaysia: an ethnic comparison. *International Journal of Public Health, 57*, 279-88.

Terano, R., Yahya, R. B., Mohamed, Z., & Saimin, S. B. (2015). Factor Influencing Consumer Choice between Modern and Traditional Retailers in Malaysia. *International Journal of Social Science and Humanity, 5*(6), 509-513. doi: 10.7763/ijssh.2015.v5.509.

Timmins, K. A. (2014). *How well do micro-economic factors explain obesity rates?* Unpublished PhD thesis, University of Leeds. Available online at http://etheses.whiterose.ac.uk/6853/1/Timmins_KA_FoodScience%26Nutrition_PhD_2014.pdf.

Timmins, K. A., Hulme, C., & Cade, J. E. (2013). The monetary value of diets consumed by British adults: an exploration into sociodemographic differences in individual-level diet costs. *Public Health Nutrition, 18*(1), 151-159. doi: 10.1017/S1368980013002905.

Timmins, K. A., Morris, M. A., Hulme, C., Edwards, K. L., Clarke, G. P., & Cade, J. E. (2013). Comparability of methods assigning monetary costs to diets: derivation from household till receipts versus cost database estimation using 4-day food diaries. *European Journal of Clinical Nutrition, 67*(10), 1072-1076. doi: 10.1038/ejcn.2013.157.

Turrell, G., Hewitt, B., Patterson, C., & Oldenburg, B. (2003). Measuring socio-economic position in dietary research: is choice of socio-economic indicator important? *Public Health Nutrition, 6*(2), 191-200. doi: 10.1079/PHN2002416.

U.S Department of Health and Human Services, National Center for Health Statistics. (2015). *NCHS data brief No.219*. Center for Disease Control and

Prevention. Available online at: https://www.cdc.gov/nchs/data/databriefs/db219.pdf.

United States Department of Labour. (2015). *Consumer Price Index*. U.S Bureau of Labor statistics. Available online at: https://www.bls.gov/cpi/questions-and-answers.htm#Question_1

Waijiers, P. M., Feskens, E. J., & Ocke, M. C. (2007). A critical review of predefined diet quality scores. *British Journal of Nutrition, 97*(2), 219-231.

Wan Abdul Manan, W. M., Nur Firdaus, I., Safiah, M. Y., Siti Haslinda, M. D., Poh, B. K., Norimah, A. K., Tahir, A., Mirnalini, K., Zalilah, M. S., Fatimah, S., Siti Norazlin, M. N., & Fasiah, W. (2012). Meal Patterns of Malaysian Adults: Findings from the Malaysian Adults Nutrition Survey. *Malaysian Journal of Nutrition, 18*(2), 221-230.

Waterlander, W. E., de Haas, W. E., van Amstel, I., Schuit, A. J., Twisk, J. W., Visser, M., . . . Steenhuis, I. H. (2010). Energy density, energy costs and income - how are they related? *Public Health Nutrition, 13*(10), 1599-1608. doi: 10.1017/S1368980009992989.

Weinstein, S. J., Vogt, T. M., & Gerrior, S. A. (2004). Healthy Eating Index scores are associated with blood nutrient concentrations in the third National Health And Nutrition Examination Survey. *Journal of American Dietetics Association, 104*(4), 576-584. doi: 10.1016/j.jada.2004.01.005.

WHO/FAO Joint Expert Consultation. (2003). *Diet, nutrition and the prevention of chronic diseases.* World Health Organization Technical Report Series, *916:*1-149.

Wilde, P. E., & Llobrera, J. (2009). Using the thrifty food plan to assess the cost of a nutritious diet. *The Journal of Consumer Affairs, 43*(2), 274-304.

Willett, W. (1998). *Nutritional Epidemiology.* 2nd edition. Oxford: Oxford University Press.

Willett, W., & Stampfer, M. J. (1986). Total energy intake: implications for epidemiologic analyses. *American Journal of Epidemiology, 124*(1), 17-27.

Wirt, A., & Collins, C. E. (2009). Diet quality: what is it and does it matter? *Public Health Nutrition, 12*(12), 2473-2492. doi: 10.1017/S136898000900531X.

World Health Organization (2000). *Obesity: preventing and managing the global epidemic*. *Report of a WHO Consultation*. WHO Technical Report Series 894, Geneva.

World Health Organization (2014). *World Health Statistics*. Available online at: http://apps.who.int/iris/bitstream/10665/112738/1/9789240692671_eng.pdf.

World Health Organization, Food and Agriculture Organization. (2003). *Diet, nutrition, and the prevention of chronic diseases*. Technical Report Series, nº 916. Geneva.

World Health Organization. (2016). *Salt Reduction Fact Sheet.* Available online at: http://www.who.int/mediacentre/factsheets/fs393/en/.

Xia, W., Yingying, O., Jun, L., Minmin, Z., Gang, Z., Wei, B., & Hu, F. B. (2014). Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *British Medical Journal, 349*:g4490 doi: 10.1136/bmj.g449.

Yang, E. J., Chung, H. K., Kim, W. Y., Kerver, J. M., & Song, W. O. (2003). Carbohydrate intake is associated with diet quality and risk factors for cardiovascular disease in U.S. adults: NHANES III. *Journal of the American College of Nutrition*, *22*(1), 71-79

Yun, S., Kim, H. J., & Oh, K. (2017). Trends in energy intake among Korean adults, 1998-2015: Results from the Korea National Health and Nutrition Examination Survey. *Nutrition Research Practice, 11*(2), 147-154. doi: 10.4162/nrp.2017.11.2.147.

Zhang, Q., Chen, X., Liu, Z., Varma, D. S., Wan, R., & Zhao, S. (2017). Diet diversity and nutritional status among adults in southwest China. *PLOS One, 12*(2), e0172406. doi: 10.1371/journal.pone.0172406.