



UNIVERSITI PUTRA MALAYSIA

**RELIABILITY AND VALIDITY ASSESSMENT ON A DIET QUALITY
INDEX AMONG ADULTS IN KAJANG AND KLANG, SELANGOR,
MALAYSIA**

MARIEM BOUGHOULA

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By

MARIEM BOUGHOULA

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in
Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

February 2020

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

RELIABILITY AND VALIDITY ASSESSMENT ON A DIET QUALITY INDEX AMONG ADULTS IN KAJANG AND KLANG, SELANGOR, MALAYSIA

By

MARIEM BOUGHOULA

February 2020

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Faculty : Medicine and Health Sciences

The objective of this study was to retest a previously developed diet quality index among the general Malaysian adult population. While the index was initially developed to assess the diet quality of Malaysian adults, it was previously tested only among university students. More precisely, this study will build on a previous study, done by Fokeena et. al., (2016) which examined dietary patterns among a sample of 320 university students at Universiti Putra Malaysia (UPM) using a 12-item diet quality index. This study consisted of two phases, where the objective of the first phase was to assess the reliability and validity of this same index, however among a sample of the general Malaysian free-living adult population, to assess their diet quality and to determine its relation to physical activity, body composition, and socio-demographic factors. Three forms of reliability were used, namely, internal consistency reliability, test-retest reliability and inter-rater reliability. Validity will be established through construct validity, concurrent validity, and validity with relation to body weight. The objective of the second phase is to establish construct validity using confirmatory factor analysis, to determine whether the model fits the data. A two phase cross-sectional study was conducted among 576 free-living adults, aged 19 – 59 years and living in Kajang and Klang, Selangor. Data were collected through face-to face interview and were used to determine the internal consistency reliability, test-retest reliability, construct validity, concurrent validity, as well as validity of the index with relation to body weight status. Test-retest reliability was measured among 30 adults from the sample. The index had a Cronbach's alpha value of 0.268 and mean inter-item correlation of 0.032. The intra-class correlation for test-retest reliability was above 0.7. Principal component analysis revealed the presence of three principal components or dimensions with eigenvalues exceeding 1, explaining 18.3%, 14.3% and 10.6% of the variance respectively. The minimum factor loading was greater than 0.4. Results from confirmatory factor analysis indicate that the model resembles satisfactory fitting based on adequacy criteria GFI, RMR and RMSEA. The overall fitting results were $\chi^2 = 146.09$; $cmin/df = 2.858$; GFI = 0.915; AGFI = 0.856; CFI = 0.732; RMR = 0.166; RMSEA = 0.092 and SRMR = 0.0928. The possible range of scores was 0 to 60. The mean total diet quality score was 34.5 ± 5.62 for the Kajang sample and 35.5 ± 5.03 for

the Klang sample. Diet quality scores showed a small correlation between diet quality scores and intakes of monounsaturated (-0.127) and polyunsaturated fats intake (-0.107). Only one statistically significant positive correlation was found, namely between diet quality scores and thiamin intake (0.109). Diet quality scores did not significantly correlate with body weight status. Using a cut-off value of 30.5, the proportion of respondents at risk of poor diet quality and at lower risk of poor diet quality in the Kajang sample were 23.9% and 76.1% respectively. The cutoff score for the Klang sample was 32.5. Based on that, the proportion of respondents at risk of poor diet quality and at lower risk of poor diet quality were 22.1% and 77.9% respectively. In both samples, a high proportion of respondents did not meet the dietary guidelines for cereals, cereal products and tubers; wholegrain cereals, fruits, vegetables, fish, and poultry, meat and egg. In addition, Klang respondents did not meet the dietary guidelines for milk and dairy products as well as legumes and their products. Significant differences in dietary guideline adherence were observed for wholegrain cereals, fruits, vegetables, milk and dairy products, fish, high-fat protein foods and sugar-rich foods in the Kajang sample, but only for the cereals, cereal products and tubers groups in the Klang sample. In both samples, respondents at lower risk of poor diet quality showed better adherence. Among the socio-demographic factors, diet quality was significantly correlated to age, ethnicity, educational level, employment status. Diet quality was not significantly correlated with BMI, waist circumference, physical activity level and understanding nutrition labels. Diet quality was significant to reading nutrition labels and sedentary behavior. The 12-item diet quality index is a valid and reliable instrument to measure diet quality of the general Malaysian adult population. However, since most respondents did not meet the dietary guidelines for most food groups, healthcare providers and future researchers who intend to use the index might consider using a higher cutoff score to classify 'at risk' and 'at lower risk of poor diet quality'.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENILAIAN KEBOLEHPERCAYAAN DAN KESAHIHAN INDEKS KUALITI DIET DALAM KALANGAN DEWASA DI SELANGOR, MALAYSIA

Oleh

MARIEM BOUGHOULA

Februari 2020

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Objektif kajian ini adalah untuk menguji semula indeks kualiti diet yang telah sedia ada dalam kalangan orang dewasa di Malaysia. Walaupun indeks ini dibentuk untuk menilai kualiti diet orang dewasa di Malaysia, ia hanya diuji dalam kalangan pelajar universiti sebelum ini. Dengan kata lain, kajian ini bertujuan untuk menambahbaik kajian sebelumnya yang dilakukan oleh Fokeena et. al (2016) bagi mengkaji corak pemakanan antara 320 pelajar Universiti Putra Malaysia (UPM) berdasarkan 12 item indeks kualiti diet. Kajian ini terdiri daripada dua fasa. Fasa pertama bertujuan untuk menilai kebolehppercayaan dan kesahan indeks kualiti diet yang sedia ada dalam kalangan orang dewasa Malaysia dan menentukan kualiti makanan serta hubungannya dengan aktiviti fizikal, komposisi badan, dan faktor sosio-demografi mereka. Terdapat tiga bentuk kebolehppercayaan telah digunakan, iaitu reliabiliti konsistensi dalaman (*internal consistency reliability*), reliabiliti ujian-ujian semula (*test-retest reliability*), dan kebolehppercayaan antara penilai (*inter-rater reliability*). Kesahan telah ditentukan melalui kesahan konstruk (*construct validity*), kesahan serentak (*concurrent validity*), dan kesahan berkaitan dengan berat badan. Manakala, fasa kedua bertujuan untuk menentukan kesahan konstruk melalui analisis faktor kesahan (*confirmatory factor analysis*) serta menilai sama ada model tersebut bersesuaian dengan data. Kajian ini dilaksanakan dalam dua fasa secara keratan rentas yang melibatkan 577 orang dewasa berumur 19 – 59 tahun dan tinggal di Kajang dan Klang, Selangor. Data dikumpulkan melalui temu bual secara bersemuka dan digunakan untuk menentukan reliabiliti konsistensi dalaman, reliabiliti ujian-ujian semula, kebolehppercayaan antara penilai, kesahan konstruk, kesahan serentak, serta kesahan berkaitan dengan berat badan. Reliabiliti ujian-ujian semula dilaksanakan pada 30 dewasa daripada kumpulan sampel tersebut. Indeks ini mempunyai kebolehppercayaan alpha Cronbach 0.268 dan nilai purata korelasi antara item 0.032. Korelasi intra-kelas bagi reliabiliti ujian-ujian semula adalah melebihi 0.7. Analisis komponen utama menunjukkan terdapat tiga komponen utama atau dimensi yang nilai eigennya melebihi 1, menjelaskan 18.3%, 14.3% dan 10.6% varians masing-masing. Pemuatan faktor minimum adalah lebih besar daripada 0.4. Keputusan dari analisis faktor kesahan menunjukkan bahawa model menyerupai persamaan yang memuaskan berdasarkan kriteria kecukupan GFI, RMR dan RMSEA.

Hasil analisis keseluruhan padanan ialah $\chi^2 = 146.09$; $c_{min} / df = 2.858$; $GFI = 0.915$; $AGFI = 0.856$; $CFI = 0.732$; $RMR = 0.166$; $RMSEA = 0.092$ dan $SRMR = 0.0928$. Jumlah skor adalah antara 0 hingga 60. Purata skor kualiti diet adalah 34.5 ± 5.62 bagi sampel Kajang dan 35.5 ± 5.03 bagi sampel Klang. Skor kualiti diet menunjukkan korelasi negatif yang kecil secara statistik antara skor kualiti diet dan pengambilan lemak monotaktepu (-0.127) dan politaktepu (-0.107). Hanya satu korelasi positif yang signifikan secara statistik didapati, iaitu antara skor kualiti diet dan pengambilan tiamin (0.109). Skor kualiti diet tidak berkait rapat dengan status berat badan. Dengan menggunakan nilai pemotongan sebanyak 30.5, nisbah responden Kajang yang berisiko terhadap kualiti diet yang kurang baik dan yang berisiko rendah masing-masing adalah 23.9% dan 76.1%. Manakala dalam sampel Klang, nisbah responden yang berisiko terhadap kualiti diet yang kurang baik dan yang berisiko rendah berdasarkan nilai pemotongan 32.5 masing-masing adalah 22.1% dan 77.9%. Dalam kedua-dua sampel kajian, sebahagian besar responden tidak memenuhi garis panduan pemakanan kepada bijirin, produk bijirin dan ubi-ubian; bijirin penuh, buah-buahan, sayur-sayuran, ikan, ayam, daging dan telur. Selain itu, responden Klang tidak memenuhi garis panduan pemakanan kepada susu dan produk tenusu serta kekacang dan produk kekacang. Perbezaan ketara dalam pematuan garis panduan diet diperhatikan untuk bijirin penuh, buah-buahan, sayur-sayuran, susu dan produk tenusu, ikan, makanan berprotein yang tinggi lemak dan makanan bergula dalam kalangan sampel Kajang, tetapi hanya untuk bijirin, produk bijirin dan kelompok ubi dalam kalangan sampel Klang. Responden yang berisiko rendah terhadap kualiti diet yang kurang baik menunjukkan pematuan diet yang lebih baik. Antara factor-faktor sosio-demografi, kualiti diet berkorelasi secara ketara dengan umur, etnik, tahap pendidikan, dan status pekerjaan. Kualiti diet tidak berkorelasi dengan indeks jisim badan, lilitan pinggang, tahap aktiviti fizikal dan pemahaman terhadap label nutrisi. Kualiti diet adalah amat penting terhadap pembacaan label nutrisi dan tingkah laku sedentari. Secara kesimpulannya, 12 item indeks kualiti diet adalah instrumen yang sah dan boleh dipercayai untuk menilai kualiti diet dalam populasi dewasa di Malaysia. Oleh sebab kebanyakan responden tidak memenuhi garis panduan pemakanan kepada kebanyakan kumpulan makanan, para pakar kesihatan dan penyelidik yang berniat untuk menggunakan indeks ini mungkin boleh mempertimbangkan penggunaan skor penggalan yang lebih tinggi untuk mengklasifikasikan 'berisiko' dan 'berisiko rendah' terhadap kualiti diet yang kurang baik.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

AHEI	Alternative Healthy Eating Index
AUC	Area Under the Curve
BMI	Body mass index
CDC	Centre for Disease Control and Prevention
CFA	Confirmatory factor analysis
CHEI	Chinese Healthy Eating Index
DASH	Dietary Approach to Stop Hypertension
DGA	Dietary Guidelines for Americans
DGI	Dietary Guidelines Index
DQ	Diet quality
DQI-I	Diet Quality Index international
DQI-R	Diet Quality Index Revised
DQS	Diet Quality Score
EFA	Exploratory Factor Analysis
FBQI	Food-Based Quality Index
FFQ	Food Frequency Questionnaire
GPAQ	Global physical activity questionnaire
HDI	Healthy Diet Indicator
HEI	Healthy Eating Index
HFI	Healthy Food Index
KM	Key message
KMO	Kaiser-Meyer-Olkin
KR	Key recommendation
LDL	Low-density lipoprotein
MANS	Malaysian Adult Nutrition Survey
MAR	Mean adequacy ratio
MDG	Malaysian Dietary Guidelines
MDS	Mediterranean Diet Scale
MET	Metabolic equivalents
MFP	Malaysian Food Pyramid
MOH	Ministry of Health

NAR	Nutrient adequacy ratio
NCCFN	National Coordinating Committee on Food and Nutrition
NCD	Non-communicable diseases
NHMS	National Health and Morbidity Survey
ODI	Overall diet index
PA	Physical activity
PAL	Physical activity level
PCA	Principal component analysis
RM	Malaysian Ringgit
RNI	Recommended nutrient intake
ROC	Receiver operating characteristic
SD	Standard deviation
SPSS	Statistical Package for Social Sciences
UPM	Universiti Putra Malaysia
USDA	United States Department of Agriculture
WHO	World Health Organization
YR	Year
YRS	Years

CHAPTER 1

INTRODUCTION

1.1 Background of Study

There has been a lively debate over the past decade on how to assess the dietary intake of individuals as well as populations, in addition to which dietary assessment methods to select for which purposes (Hu, 2002). Habitual dietary intake has long been utilized in epidemiological studies to investigate its association with the risk of developing chronic diseases such as cardiovascular disease, obesity and cancer (Alkerwi, 2014). Traditionally, however, the focus has been on single nutrients (rather than on the whole diet) and their association with the risk of developing chronic diseases (Hu, 2002; Tucker, 2010). This approach, however, has evolved and transitioned from specific nutrient-related diseases to chronic conditions that have complex and multiple etiologies (Tucker, 2010). It is now widely recognized that the human diet is composed of a complex mixture of foods, where each food consists of both nutrient as well as non-nutrient components that interact with one another (Kant, 1996). Thus, it may be difficult to detect the effect of a single nutrient, as it might be very minimal. Multiple nutrients however would have detectable effects and would produce statistically significant associations (Moeller et al., 2007). Therefore, in light of all these considerations, there was a need for an alternative strategy that would consider the diet as a whole in predicting diet-disease relationships. The term dietary pattern then came into effect (Jackson, et al., 2011).

Dietary pattern is defined as the quantity, proportion, variety or combination of foods and beverages in a diet, and their consumption frequency (USDA, 2015). To determine the nutritional quality of a certain dietary pattern, the nutrient content of its foods and beverages must be assessed and it must be determined where they stand in terms of nutrient requirements and standards for nutrient adequacy (Reedy et al., 2018). The study of dietary patterns arose as an alternative approach to investigate the association between diet and the risk of non-communicable diseases (NCDs). Dietary pattern analysis takes into consideration the effects of overall diet, rather than examining single nutrients or foods. Dietary pattern analysis can be more predictive of disease risk than single foods or nutrients, by offering a broader picture of food and nutrient intake. Studying the characteristics of the dietary pattern of a population allows for a more holistic classification of individuals' eating habits and enables the examination of their association with health outcomes (Hu, 2002).

Dietary pattern takes into consideration the whole diet as a single entity. The two most commonly used approaches to examine dietary pattern are score-based (a priori) and data-driven (a posteriori) (Moeller et al., 2007). Score-based approaches rely on existing dietary guidelines and recommendations, as well as scientific evidence on the role of nutrients in disease prevention. These approaches can be classified into four categories: variety or diversity scores, food-group patterning scores, nutrient adequacy

or density scores, and index-based summary scores (Moeller et al., 2007). The data-driven, or a posteriori approach employs statistical methods such as factor analysis or cluster analysis to reduce a set of food items into one factor or cluster, which is found to be associated to health outcomes (Moeller et al., 2007). The diet quality index (DQI) used in this study combines both approaches. First of all, Fokeena et al., (2016) used key messages from the Malaysian Dietary Guidelines (MDG) and the Malaysian Food Pyramid (MFP) to develop the 12-item DQI (a priori). Second, a scoring system was developed for each item of the index to further demarcate respondents with respect to diet quality. Third, exploratory factor analysis (EFA) will be used to determine whether there will be a need to reduce a set of food items into a single factor or cluster (a posteriori). Finally, confirmatory factor analysis (CFA) will be performed to verify the factor structure of the observed variables (i.e. the 12 food groups) and determine whether the model fits the data.

Indices are composite instruments which group, measure and quantify several related variables, clinical conditions, attitudes, behaviors and beliefs as one single entity (Kourlaba & Panagiotakos, 2009). Each index component is given scores and the total score is then used to describe behaviors, attitudes or health conditions. The development and use of indices are common in the field of social as well as health sciences (Kourlaba & Panagiotakos, 2009). As the holistic approach to dietary analysis was gaining more recognition, the field of nutritional epidemiology has witnessed the emergence of several dietary indices. Such tools serve as a quick, simple method to assess diet quality and evaluate the adherence to dietary guidelines and monitor overall dietary changes (Fransen & Ocké, 2008). A variety of diet quality indices have been developed worldwide. Some common examples of diet quality indices that have been developed in previous years include the Diet Quality Index (DQI), Healthy Eating Index (HEI), Alternative Healthy Eating Index (AHEI), Recommended Food Score (RFS), Dietary Guidelines Index (DGI), Healthy Diet Indicator (HDI), Dietary Quality Score (DQS) and MedDietScore among others (Kourlaba & Panagiotakos, 2009).

Prior to using a newly developed scale or index in the research or practice fields, it's psychometric properties must be established, in order to avoid any biased results that might lead to incorrect interpretations of the outcomes they are measuring (Anthoine, 2014). Psychometric properties include the determination of reliability, validity and responsiveness of instruments. Reliability and validity are important psychometric properties and key indicators of the quality of an instrument (Kimberlin & Winterstein, 2008). Another important aspect is to know whether a tool can also be effective in other settings and among other populations. This can be accomplished by establishing the reproducibility and external validity of the index, which will determine the possibility of using the index among the general public (Steckler & McLeroy, 2008). Establishing the external validity of this index will help demonstrate its effectiveness in assessing diet quality and hence it's potential use in assessing diet and disease associations.

1.2 Problem Statement

Malaysia has witnessed accelerated industrialization and urbanization in the past decades, which has induced changes in the lifestyle of Malaysian citizens. The country has also been experiencing continuous population growth. In 2016, the total population was approximately 31.7 million, with a 0.5 million increase as compared to 31.2 million in 2015, reflecting a 1.5 per cent growth rate for the same period (Department of Statistics, Malaysia, 2011). Urbanization has increased from 34.2% in 1980s to 41% in 1990, to 71% in 2010, and is not expected to be lower than 60% in 2020 (Noor, 2002; Siwar et al., 2016). Growth in population and income, along with lifestyle changes, have increased food demand and contributed to changes in food habits, food purchasing as well as consumption patterns (Noor, 2002). This accelerated industrialization and urbanization has brought with it the rapid growth of the fast food industry and the spread of fast food chains, nationwide, which has added another dimension to the change in food consumption patterns of Malaysians. These changes are affecting the nutritional quality of diets and are characterized by manifestation of both under and over nutrition, as well as an increase in obesity and other chronic diseases.

Changes in dietary habits and sedentary lifestyles are resulting in changes in health and increased prevalence of nutrition-related chronic degenerative diseases in the population. While there are efforts made by Malaysian health officials to lower infectious diseases and rates of malnutrition in the country, obesity rates and its associated risk only continue to rise (Chu & Moy, 2014; Khor, 2012; Rampal et al., 2007). According to the Institute of Public Health (IPH 2015) and the National Health and Morbidity Survey Malaysia (NHMS 2015), approximately one third of the Malaysian adult population is overweight, while 17.7% are obese. According to the National Health surveys, obesity rates among Malaysian adults tripled between 1996 and 2006, where the proportion of overweight and obese adults increased by 12.5 percent and 10 percent, respectively (Khor 2012; Rampal et al. 2007). The need to promote healthy nutrition and dietary habits among the population must be pursued vigorously. Therefore, there is an increasing need for an effective dietary assessment tool that can be used to assess the overall diet quality of free-living adults.

Most previous studies carried out among adults of the Malaysian general public have used the Healthy Eating Index (HEI) developed by Lee et. al., (2011). The HEI measures the degree of compliance of a person's diet to the recommendation of the Malaysian Dietary Guidelines (MDG) 2010 (NCCFN, 2010) for adults. The index did not however consider recommendations from the Malaysian Food Pyramid (NCCFN, 2010). In addition, it combined all fats into one single group; and did not assess sugar intake. In 2016, Fokeena et al., (2016) developed a Diet Quality Index using both the Malaysian Dietary Guidelines (MDG) 2010 (NCCFN, 2010) and the Malaysian Food Pyramid (NCCFN, 2010) and assessed its reliability and validity. In comparison to the HEI which included seven food groups and two nutrients, the DQI included 12 food groups yet no nutrients. Assessing the intake of a single nutrient would imply calculating the proportion of intake of the respective nutrient from the whole diet, which would be time-consuming, and thus the DQI included food groups only in order

to calculate component and total scores in a more efficient manner. With regards to diet quality groups, the HEI includes three classifications, namely Good, Needs Improvement, and Poor (Bowman *et al.*, 1998), while the DQI includes two classifications, namely “at risk of poor diet quality” and “at lower risk of poor diet quality,” and thus allows for easier classification of respondents. Table 1.1 highlights the differences between the Malaysian HEI and the DQI used in this study.

Table 1.1: Differences between Malaysian HEI and the DQI

Healthy Eating Index (Lee et al., 2011)	Diet Quality Index (Fokeena et al., 2016)
Based on Malaysian Dietary Guidelines only	Based on Malaysian Dietary Guidelines and Malaysian Food Pyramid
Total of nine components	Total of twelve components
Includes 7 food groups and two nutrients	Includes 12 food groups but does not include nutrients
Components are scored on a scale of 1 - 10	Components are scored on a scale of 0 – 5
Three diet quality groups or classifications	Two diet quality groups or classifications

The DQI developed by Fokeena et al., (2016) had several limitations that prevented it from being applicable to the general population. First of all, the population was limited to university students – one that had similar lifestyle and spent most of their day in the same place (i.e. university). Second, minority ethnicities (Chinese and Indians) were not studied well enough; particularly, very few Indians were included in the study (3%). Third, monthly allowance of students was assessed instead of household income, in an attempt to increase the accuracy of students’ income measurement (Fokeena et al., 2016). However, this strategy did not allow for the classification of students into low income and high income groups and thus it could not be determined whether there was a difference in diet quality between income groups. Fourth, the age of respondents was not widely distributed as more undergraduate than postgraduate students were included, and thus it was not possible to determine an association between age and diet quality. Finally, due to the conditions mentioned above, factor analysis led to the removal of five items out of the 12-item index, four of which are essential groups (i.e. Cereals, cereal products and tubers; Milk and dairy products; Poultry, meat and egg, and Legumes and their products). Therefore, the final instrument included 7 items. Recommendations from the previous study included testing the external validity of the DQI and determining its reliability and validity among the general Malaysian adult population by using the initially developed 12-item DQI (Fokeena et al., 2016). In addition, this study used household income to categorize respondents into low, middle

and high income groups. A wider range of age group and higher proportions of Chinese and Indians were included.

1.3 Research Questions

Question 1: Is the diet quality index reproducible among the Malaysian general adult population, and is it a reliable and valid instrument to measure diet quality?

Question 2: How will the proportion of respondents at risk of having a poor diet quality compare to those at lower risk of poor diet quality?

Question 3: How will respondents who are at risk of poor diet quality differ in terms of dietary guideline adherence from those who are at lower risk?

Question 4: Is there a significant relationship between diet quality scores and socio-demographic factors, food label knowledge, BMI and physical activity level?

1.4 Significance of Study

This study was undertaken to reproduce and validate a diet quality index that was previously developed to assess the diet quality of Malaysian adults but that was only tested among university students. The primary outcome of this study will be a quick, easy-to-use, reliable and valid instrument that could be used to measure the diet quality of free-living adults residing in urban Malaysia. This study will determine whether the reproduced index is a reliable, valid instrument that may be used to assess the diet quality of the Malaysian general adult population after external validation. This study should help categorize Malaysian adults at least into “at risk” or “at lower risk” of poor diet quality. Furthermore, findings generated would be helpful to determine the group of adults at risk of poor diet quality based on socio-demographic factors. Data generated in this study should help determine whether an association exists between poor diet quality and the body weight status of respondents and whether there was a clustering of diet quality, food labelling knowledge and physical activity level in this population. If proven to be reliable and valid, it could serve as an efficient tool for diet quality assessment in large population epidemiological studies, and would provide useful data for public health interventions towards improving the diet quality of the Malaysian adult population.

1.5 Study Objectives

1.5.1 General Objective

To reproduce and assess the reliability and external validity of a diet quality index among a sample of free-living adults in Kajang and Klang, Malaysia.

1.5.2 Specific Objectives

Phase 1:

- i. To assess the reliability and validity of the DQI based on the following:
 - Test-retest reliability
 - Internal consistency reliability
 - Construct validity
 - Concurrent validity
 - Validity through relation to health outcome (body weight status)
- ii. To assess the diet quality of free-living adults using the DQI among a sample of healthy adults in Kajang after it is tested for reliability and validity.
- iii. To compare the nutrient intake of adults who are at risk of poor diet quality and those who are at lower risk of poor diet quality among the selected sample.
- iv. To compare the adherence to dietary guidelines between individuals who are at risk of poor diet quality and those who are at lower risk of poor diet quality among the selected sample.
- v. To analyze the relationships between diet quality scores, socio-demographic factors, food label knowledge and physical activity level among the selected sample.

Phase 2:

To confirm the factors extracted from external factor analysis (EFA) by conducting confirmatory factor analysis among a different sample in Klang, and determining whether the model fits the data.

1.6 Scope of the Study

As mentioned previously, this study will examine the reliability and validity of a diet quality index. In general, the study will follow the same methodology used previously by Fokeena et al., (2016) to develop the respective index. However, since Fokeena's study was limited to university students while the present study was carried out among general adults, another reference study was used when deciding whether the index was reliable and valid. Specifically, a recent study discussing the evaluation of the reliability and validity of the Chinese Healthy Eating Index (CHEI) was referred to as a guidance to establish the reliability and validity of the index examined in this study (Yuan et al., 2018; Yuan et al., 2017). Reliability was tested using internal consistency reliability, through Cronbach's alpha coefficient. In addition, test-retest reliability was used as was done previously to the same index by Fokeena et al., (2016). Inter-rater reliability was also used as recommended by the Ethical Committee of UPM. Correlations between the score of certain components and the combined score of others was also explored as was done for the CHEI.

Validity was assessed using content validity, construct validity and concurrent validity. Construct validity will be explored through exploratory and confirmatory factor analyses. Exploratory factor analysis (EFA) was carried out as was done by Fokeena et al., (2016). Dimensions extracted were labeled according to the four aspects of diet quality in Malaysia, namely adequacy, balance, moderation and variety. Confirmatory factor analysis (CFA) is used to assess the fit between the observed data and an *a priori* conceptualized, theoretic model. In this study, CFA was conducted to determine whether the model fits the data, and specifies the relationship between latent factors (i.e. the 12 items of the DQI) and specifies the hypothesized causal relations between latent factors and their observed indicator variables (i.e. the relationship between the DQI items and the extracted dimensions).

1.7 Research Hypotheses

Hypothesis: The diet quality index is reproducible among the Malaysian general adult population and is a reliable and valid instrument to measure diet quality.

Hypothesis: The proportion of respondents at risk of poor diet quality will be higher than the proportion of respondents at lower risk of poor diet quality.

Hypothesis: Nutrient intake of respondents who are at risk of poor diet quality will differ significantly from those who are at lower risk.

Hypothesis: There is a significant relationship between diet quality scores and socio-demographic factors, food label knowledge, BMI and physical activity level.

1.8 Constitutive and Operational Definitions

Body Mass Index (BMI)

Constitutive definition: The ratio of a person's weight with respect to his or her height. It is calculated by dividing the weight in kilograms by the height in meters squared ($BMI = \text{weight [kg]} / \text{height [m]}^2$).

Operational definition: The BMI of all respondents was calculated by dividing the weight in kilograms by the square of the height in meters. After that, respondents were classified based on their BMIs into underweight, normal, pre-obese and obese according to the international cut-off values of the World Health Organization (World Health Organization, 2006).

Concurrent Validity

Constitutive definition: A type of evidence that can be used to defend the use of a certain test for predicting other outcomes. The test in question must be compared against a gold standard test. Validity is assessed by administering both instruments at the same time. The test is considered valid if the results agree with that of the gold standard criterion test (Roach 2006).

Operational definition: The nutrient intake of respondents, as determined through FFQ will be used to establish the concurrent validity of the reproduced diet quality index. Using diet quality score as both continuous and categorical variable, concurrent validity will be determined through correlation of the diet quality score with energy and nutrient intake by Spearman's Rank Order correlation as well as Kruskal Wallis test.

Construct Validity

Constitutive definition: Construct validity shows the capacity of an instrument to measure the underlying concept of interest that the researcher intends to measure (Roach, 2006).

Operational definition: Construct validity will be measured by running factor analysis on the diet quality index and determining what items, if any might have to be eliminated.

Cross-Sectional Study

Constitutive definition: A type of an observational study design in which the investigator measures the exposures and outcomes at a single point in time. Cross-sectional study designs are used for population-based surveys, in which respondents are selected based on inclusion and exclusion criteria set forth by the investigators (Setia, 2016).

Operational definition: This study is a two-phase cross-sectional study that was carried out in Kajang (phase 1), and Klang (phase 2). The study population consisted of Malaysian adults, from both genders, ages 19 to 59 years who were selected from the randomly selected townships of Kajang and Klang.

Diet Quality

Constitutive definition: The term is being used in numerous papers, yet there is still no official definition for it. “Across the literature, diet quality is an umbrella term frequently used to describe how well an individual's diet conforms to dietary recommendations.” (Alkerwi, 2014)

Operational definition: The main concern in this study, with regards to diet quality, is how healthy the respondents' diet is, or to what extent it can be considered healthy. The diet quality of the respondents will be assessed using a diet quality index.

Diet Quality Index

Constitutive definition: A diet quality index is a tool that groups, measures and quantifies several related variables such as human behaviors as one single entity. Each component of the index is given scores and the total score is then used to describe behaviors, attitudes or health conditions (Kourlaba & Panagiotakos, 2009). Diet quality indices that were designed according to the a-priori approach provide a summary of dietary patterns as a composite score. The score is determined according to pre defined criteria of what constitutes a healthy or unhealthy diet. A diet quality index typically measures the degree of adherence to a set of national dietary guidelines or a recommended diet model (e.g. Mediterranean diet), based on foods, nutrients or a combination of both.

Operational definition: A table featuring 12-food groups developed to assess diet quality. The Malaysian Dietary Guidelines and recommendations from the Malaysian Food Pyramid (NCCFN, 2010) were used in the development of the index. Seven out of fourteen key messages from the Malaysian Dietary Guidelines were selected and used in the formulation of the index. These messages resemble key messages 4 to 10 of

the Malaysian Dietary Guidelines, and pertain to dietary intake. Twelve food groups were formed and are as follows: (1) Cereal, cereal products and tubers, (2) Wholegrain cereals, (3) Fruits, (4) Vegetables, (5) Milk and dairy products, (6) Legumes and their products, (7) Fish, (8) Poultry, meat and egg, (9) High-fat protein foods, (10) Fat-rich foods, (11) Salt-rich foods and (12) Sugar-rich foods.

Internal Consistency Reliability

Constitutive definition: Internal consistency reliability measures how well all items on an instrument measure the the same concept or idea (Roach 2006).

Operational definition: Internal consistency will be utilized to determine the reliability of the diet quality scores. Internal consistency reliability will be determined by measuring cronbach's alpha. A value of $\alpha \geq 0.7$ is generally accepted. However, given the complexity of measuring diet quality, lower Cronbach's alpha values could be accepted as is in previous studies (Yuan et al., 2018; Caivano, Simone & Domene, 2013).

Inter-Rater Reliability

Constitutive definition: Degree of agreement among raters.

Operational definition: Due to the large sample of the study, three trained enumerators will assist in administering the questionnaire. Thus, it is important to achieve consensus and agreement among the enumerators. Inter-rater reliability will be determined by computing the interclass correlation coefficients (ICC) with a 95% confidence interval (CI) for each of the 12 groups in the DQI. An ICC ≥ 0.7 is generally accepted.

Metabolic equivalents (METs)

Constitutive definition: The ratio of the work metabolic rate to the resting metabolic rate. One MET is defined as one kcal/kg/hour and is roughly equivalent to the energy cost of sitting quietly.

Operational definition: A unit that will be used to measure the physical activity level of participants. Physical activity level will be measured in metabolic equivalents (MET)-minute per week using the Global Physical Activity Questionnaire (GPAQ).

Test-retest reliability

Constitutive definition: Test-retest reliability measures test consistency, or the reliability of test measured over time. It is achieved by giving the same instrument to the same group of individuals twice on more than one occasion with the assumption that no real change will have occurred between sessions.

Operational definition: Before administering the questionnaire on the sample population, it will first be administered on a sample of 30 individuals on two occasions that will be two weeks apart.

1.9 Conceptual Framework

This study investigates the assessment of the reliability and validity of a diet quality index among a sample of the general Malaysian adult population. Figure 1.1 below shows the conceptual framework of the study. Reliability of the index was determined through internal consistency reliability, test-retest reliability, as well as inter-rater reliability. Validity was assessed through construct validity, concurrent validity, convergent validity and validity through relation to body weight status (BMI and waist circumference). Once reliability and validity was assessed, the diet quality index was used to determine the diet quality scores and respondents were classified into distinct diet quality groups.

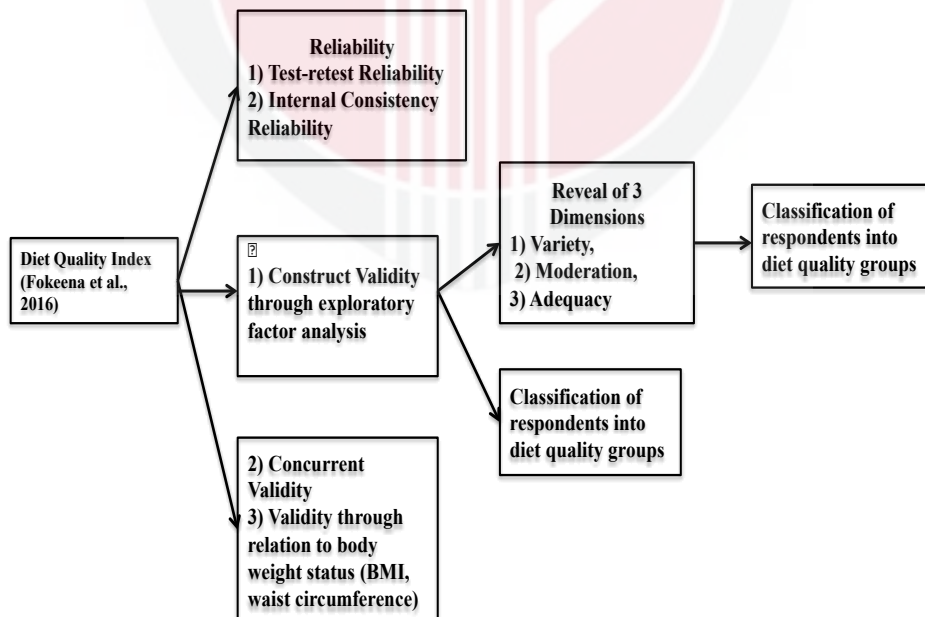


Figure 1.1: Conceptual Framework

REFERENCES

- Adjoian, T. K., Firestone, M. J., Eisenhower, D., & Yi, S. S. (2016). Validation of self-rated overall diet quality by Healthy Eating Index-2010 score among New York City adults, 2013. *Preventive Medicine Reports*.
<https://doi.org/10.1016/j.pmedr.2016.01.001>
- Ali Naser, I., Jalil, R., Wan Muda, W. M., Wan Nik, W. S., Mohd Shariff, Z., & Abdullah, M. R. (2014). Association between household food insecurity and nutritional outcomes among children in Northeastern of Peninsular Malaysia. *Nutrition Research and Practice*, 8(3), 304.
<https://doi.org/10.4162/nrp.2014.8.3.304>
- Ali Zainuddin, A., Nadzri Jai, A., Baharuddin, A., Mahadir Naidu, B., Ying Ying, C., Siew Man, C., ... Aris, T. (n.d.). *National health and morbidity survey 2014 : malaysian adult nutrition survey volume i methodology and general findings contributors*. Retrieved from
<http://iku.moh.gov.my/images/IKU/Document/REPORT/NHMS2014-MANS-VOLUME-1-MethodologyandGeneralFind.pdf>
- Alkerwi, A. (2014). Diet quality concept. *Nutrition*, 30(6), 613–618.
<https://doi.org/10.1016/j.nut.2013.10.001>
- Ambak, R., Tupang, L., Hasim, M. H., Salleh, N. C., Zulkafly, N., Salleh, R., ... Naidu, B. M. (2018). Who Do Not Read and Understand Food Label in Malaysia? Findings from a Population Study. *Health Science Journal*.
<https://doi.org/10.21767/1791-809x.1000548>
- Amoutzopoulos, B., Steer, T., Roberts, C., Cade, J. E., Boushey, C. J., Collins, C. E., ... Page, P. (2018). Traditional methods v. new technologies – dilemmas for dietary assessment in large-scale nutrition surveys and studies: a report following an international panel discussion at the 9th International Conference on Diet and Activity Methods (ICDAM9), Brisban. *Journal of Nutritional Science*.
<https://doi.org/10.1017/jns.2018.4>
- Anthoine, E., Moret, L., Regnault, A., Sébille, V., & Hardouin, J.-B. (2014a). Sample size used to validate a scale: a review of publications on newly-developed patient reported outcomes measures. *Health and Quality of Life Outcomes*, 12, 176.
<https://doi.org/10.1186/s12955-014-0176-2>
- Anthoine, E., Moret, L., Regnault, A., Sébille, V., & Hardouin, J.-B. (2014b). Sample size used to validate a scale: a review of publications on newly-developed patient reported outcomes measures. *Health and Quality of Life Outcomes*, 12, 176.
<https://doi.org/10.1186/s12955-014-0176-2>
- Ar, N., Mn, A., & Norfazilah A. (2013a). Factors influencing abdominal obesity by waist circumference among normal bmi population. *Malaysian Journal of Public Health Medicine* (Vol. 13). Retrieved from
<https://www.mjphm.org.my/mjphm/journals/Volume13:1/210-Factors>

Influencing Abdominal Obesity By Waist Circumference Among Normal BMI Population.pdf

- Ar, N., Mn, A., & Norfazilah A. (2013b). Factors influencing abdominal obesity by waist circumference among normal bmi population. *Malaysian Journal of Public Health Medicine* (Vol. 13). Retrieved from [https://www.mjphm.org.my/mjphm/journals/Volume 13:1/210-Factors Influencing Abdominal Obesity By Waist Circumference Among Normal BMI Population.pdf](https://www.mjphm.org.my/mjphm/journals/Volume%2013:1/210-Factors%20Influencing%20Abdominal%20Obesity%20By%20Waist%20Circumference%20Among%20Normal%20BMI%20Population.pdf)
- Armstrong, T., & Bull, F. (2006). Development of the World Health Organization Global Physical Activity Questionnaire (GPAQ). *Journal of Public Health*. <https://doi.org/10.1007/s10389-006-0024-x>
- Arvaniti, F., & Panagiotakos, D. B. (2008). Healthy Indexes in Public Health Practice and Research: A Review. *Critical Reviews in Food Science and Nutrition*, 48(4), 317–327. <https://doi.org/10.1080/10408390701326268>
- Asaad, G., Sadegian, M., Lau, R., Xu, Y., Soria-Contreras, D. C., Bell, R. C., & Chan, C. B. (2015). The Reliability and Validity of the Perceived Dietary Adherence Questionnaire for People with Type 2 Diabetes. *Nutrients*, 7(7), 5484–5496. <https://doi.org/10.3390/nu7075231>
- Ashby-Mitchell, K., Peeters, A., & Anstey, K. (2015). Role of Dietary Pattern Analysis in Determining Cognitive Status in Elderly Australian Adults. *Nutrients*, 7(2), 1052–1067. <https://doi.org/10.3390/nu7021052>
- Asma, A., Nawalyah, A. G., Rokiah, M. Y., & Nasir, M. T. M. (2010). Assessment of Diet Quality among Married Couples in a Selected Urban Area in Selangor, 16, 17–28.
- Atkins, J. L., Ramsay, S. E., Whincup, P. H., Morris, R. W., Lennon, L. T., & Goya Wannamethee, S. (n.d.). Diet quality in older age: the influence of childhood and adult socio-economic circumstances. <https://doi.org/10.1017/S0007114515000604>
- Atkins, J. L., Ramsay, S. E., Whincup, P. H., Morris, R. W., Lennon, L. T., & Wannamethee, S. G. (2015). Diet quality in older age: the influence of childhood and adult socio-economic circumstances. *British Journal of Nutrition*, 113(09), 1441–1452. <https://doi.org/10.1017/S0007114515000604>
- Azmi, M. Y., Junidah, R., Siti Mariam, A., Safiah, M. Y., Fatimah, S., Norimah, A. K., ... Tahir, A. (2009). Body mass index (BMI) of adults: Findings of the Malaysian Adult Nutrition Survey (MANS). *Malaysian Journal of Nutrition*.
- Bach, A., Serra-Majem, L., Carrasco, J. L., Roman, B., Ngo, J., Bertomeu, I., & Obrador, B. (2006). The use of indexes evaluating the adherence to the Mediterranean diet in epidemiological studies: a review. *Public Health Nutrition*, 9(1a). <https://doi.org/10.1079/PHN2005936>

- Ball, K., Crawford, D., & Mishra, G. (2006). Socio-economic inequalities in women's fruit and vegetable intakes: a multilevel study of individual, social and environmental mediators. *Public Health Nutrition*, 9(5), 623–630. <https://doi.org/10.1079/PHN2005897>
- Barclay, A. W., Petocz, P., McMillan-Price, J., Flood, V. M., Prvan, T., Mitchell, P., & Brand-Miller, J. C. (2008). Glycemic index, glycemic load, and chronic disease risk - A metaanalysis of observational studies. *American Journal of Clinical Nutrition*.
- Bartlett, J. W., & Frost, C. (2008). Reliability, repeatability and reproducibility: analysis of measurement errors in continuous variables. *Ultrasound in Obstetrics & Gynecology : The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology*, 31(4), 466–475. <https://doi.org/10.1002/uog.5256>
- Basiotis, P. P., Welsh, S. O., Cronin, F. J., Kelsay, J. L., & Mertz, W. (1987). Number of days of food intake records required to estimate individual and group nutrient intakes with defined confidence. *Journal of Nutrition*. <https://doi.org/10.1093/jn/117.9.1638>
- Bernstein, A. M., Sun, Q., Hu, F. B., Stampfer, M. J., Manson, J. E., & Willett, W. C. (2010). Major dietary protein sources and risk of coronary heart disease in women. *Circulation*. <https://doi.org/10.1161/CIRCULATIONAHA.109.915165>
- Bivoltsis, A., Trapp, G., Knuiman, M., Hooper, P., & Ambrosini, G. (2018). Can a Simple Dietary Index Derived from a Sub-Set of Questionnaire Items Assess Diet Quality in a Sample of Australian Adults? *Nutrients*, 10(4), 486. <https://doi.org/10.3390/nu10040486>
- Bjørnara, H. B., Hillesund, E. R., Torstveit, M. K., Stea, T. H., Øverby, N. C., & Bere, E. (2015). An assessment of the test-retest reliability of the New Nordic Diet score. *Food and Nutrition Research*. <https://doi.org/10.3402/fnr.v59.28397>
- Blichfeldt, B. S., & Gram, M. (2013). Lost in Transition? Student food consumption. *Higher Education*. <https://doi.org/10.1007/s10734-012-9543-2>
- Boundless. (2016). Biases in Experimental Design: Validity, Reliability, and Other Issues. Boundless.
- Bowman, S. A., Lino, M., Gerrior, S. A., & Basiotis, P. P. (1998). The Healthy Eating Index, 1994-96. *Family Economics and Nutrition Review*, 11(3), 2–14.
- Buyuktuncer, Z., Ayaz, A., Dedebyraktar, D., Inan-Eroglu, E., Ellahi, B., & Besler, H. T. (2018). Promoting a Healthy Diet in Young Adults: The Role of Nutrition Labelling. *Nutrients*. <https://doi.org/10.3390/nu10101335>
- Cai Lian, T., Bonn, G., Si Han, Y., Chin Choo, Y., & Chee Piau, W. (2016). Physical Activity and Its Correlates among Adults in Malaysia: A Cross-Sectional Descriptive Study. *PLOS ONE*, 11(6), e0157730. <https://doi.org/10.1371/journal.pone.0157730>

- Caivano, Simone; Domene, S. M. Á. (2013). Diet quality index for healthy food choices. *Revista de Nutrição*, 26(6), 693–699. <https://doi.org/10.1590/S1415-52732013000600008>
- Carlsen, M. H., Lillegaard, I. T., Karlsen, A., Blomhoff, R., Drevon, C. A., & Andersen, L. F. (2010). Evaluation of energy and dietary intake estimates from a food frequency questionnaire using independent energy expenditure measurement and weighed food records. *Nutrition Journal*. <https://doi.org/10.1186/1475-2891-9-37>
- CASSEY, P., & BLACKBURN, T. M. (2006). Reproducibility and Repeatability in Ecology. *BioScience*, 56(12), 958. [https://doi.org/10.1641/0006-3568\(2006\)56\[958:RARIE\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2006)56[958:RARIE]2.0.CO;2)
- Castell, G. S., Serra-Majem, L., & Ribas-Barba, L. (2015). What and how much do we eat? 24-hour dietary recall method. *Nutr Hosp*. <https://doi.org/10.3305/nh.2015.31.sup3.8750>
- Center for Health Statistics, N. (2011). *Anthropometry Procedures Manual*. Retrieved from https://www.cdc.gov/nchs/data/nhanes/nhanes_11_12/Anthropometry_Procedure_s_Manual.pdf
- Chadwick, R. (2004). Nutrigenomics, individualism and public health. *The Proceedings of the Nutrition Society*, 63(1), 161–166. <https://doi.org/10.1079/PNS2003329>
- Chan, Y. Y., Lim, K. K., Lim, K. H., Teh, C. H., Kee, C. C., Cheong, S. M., ... Ahmad, N. A. (2017). Physical activity and overweight/obesity among Malaysian adults: findings from the 2015 National Health and morbidity survey (NHMS). *BMC Public Health*, 17(1), 733. <https://doi.org/10.1186/s12889-017-4772-z>
- Cheah, Y. K., & Yip, C. Y. (2017). Factors determining the use of nutrition labels: The case of Malaysia. *Journal of Foodservice Business Research*. <https://doi.org/10.1080/15378020.2016.1222745>
- Choi, E. P. H., Chin, W. Y., Wan, E. Y. F., & Lam, C. L. K. (2016). Evaluation of the internal and external responsiveness of the Pressure Ulcer Scale for Healing (PUSH) tool for assessing acute and chronic wounds. *Journal of Advanced Nursing*, 72(5), 1134–1143. <https://doi.org/10.1111/jan.12898>
- Chong, S., Appannah, G., Sulaiman, N., Chong, S. P., Appannah, G., & Sulaiman, N. (2019). Predictors of Diet Quality as Measured by Malaysian Healthy Eating Index among Aboriginal Women (Mah Meri) in Malaysia. *Nutrients*, 11(1), 135. <https://doi.org/10.3390/nu11010135>
- Chong, S. P., Geetha Appannah, & Norhasmah Sulaiman. (2018). Household food insecurity, diet quality, and weight status among indigenous women (Mah Meri) in Peninsular Malaysia. *Nutrition Research and Practice*. <https://doi.org/10.4162/nrp.2018.12.2.135>

- Chu, A. H. Y., & Moy, F. M. (2014). Association between physical activity and metabolic syndrome among Malay adults in a developing country, Malaysia. *Journal of Science and Medicine in Sport / Sports Medicine Australia*, 17(2), 195–200. <https://doi.org/10.1016/j.jsams.2013.04.003>
- Collins, C. E., Burrows, T. L., Rollo, M. E., Boggess, M. M., Watson, J. F., Guest, M., ... Hutchesson, M. J. (2015). The comparative validity and reproducibility of a diet quality index for adults: The Australian recommended food score. *Nutrients*, 7(2), 785–798. <https://doi.org/10.3390/nu7020785>
- Cooke, R., & Papadaki, A. (2014). Nutrition label use mediates the positive relationship between nutrition knowledge and attitudes towards healthy eating with dietary quality among university students in the UK. *Appetite*. <https://doi.org/10.1016/j.appet.2014.08.039>
- Coulston, A. M. (2001). The search continues for a tool to evaluate dietary quality. *American Journal of Clinical Nutrition*, 74(4), 417.
- Daud, A., & Shahadan, S. Z. (2019). Association Between Body Mass Index and Cardiometabolic Risks Among Malay Obese Adults. *Clinical Nursing Research*, 28(2), 202–216. <https://doi.org/10.1177/1054773817724041>
- Dehghan, M., del Cerro, S., Zhang, X., Cuneo, J. M., Linetzky, B., Diaz, R., & Merchant, A. T. (2012). Validation of a semi-quantitative food frequency questionnaire for argentinean adults. *PLoS ONE*, 7(5). <https://doi.org/10.1371/journal.pone.0037958>
- Department of Statistics Malaysia. (2011). Population Distribution and Basic Demographic Characteristics 2010. *Population and Housing Census of Malaysia*. <https://doi.org/10.1094/ASBCMOA-StatisticalApp-1>
- Dhivyalosini, M., & Satvinder, K. (2015). Sociodemographic, oral health behaviour, and physical activity: factors in caries experience among 19-59 years old adults in a Malaysian population. *Makara Journal of Health Research*.
- Dixon, L. B. (2008). Updating the Healthy Eating Index to Reflect Current Dietary Guidance. *Journal of the American Dietetic Association*. <https://doi.org/10.1016/j.jada.2008.08.020>
- Drake, I., Gullberg, B., Ericson, U., Sonestedt, E., Nilsson, J., Wallstrom, P., ... Wirfalt, E. (2011). Development of a diet quality index assessing adherence to the Swedish nutrition recommendations and dietary guidelines in the Malmo Diet and Cancer cohort. *Public Health Nutrition*, 14(5), 835–845. <https://doi.org/10.1017/S1368980010003848>
- Drenowatz, C., Shook, R. P., Hand, G. A., Hébert, J. R., & Blair, S. N. (2014). The independent association between diet quality and body composition. *Scientific Reports*. <https://doi.org/10.1038/srep04928>
- Drewnowski, A., Henderson, S. A., Driscoll, A., & Rolls, B. J. (1997). The dietary

- variety score: Assessing diet quality in healthy young and older adults. *Journal of the American Dietetic Association*. [https://doi.org/10.1016/S0002-8223\(97\)00070-9](https://doi.org/10.1016/S0002-8223(97)00070-9)
- Drewnowski, A., Henderson, S. A., Shore, A., 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*. [https://doi.org/10.1016/S0002-8223\(96\)00185-X](https://doi.org/10.1016/S0002-8223(96)00185-X)
- Dunn, S., Datta, A., Kallis, S., Law, E., Myers, C., & Whelan, K. (2010). Validation of a food frequency questionnaire to measure intakes of inulin and oligofructose. *European Journal of Clinical Nutrition*, 65(10). <https://doi.org/10.1038/ejcn.2010.272>
- Dyett, P., Rajaram, S., Haddad, E. H., & Sabate, J. (2014). Evaluation of a validated food frequency questionnaire for self-defined vegans in the United States. *Nutrients*, 6(7), 2523–2539. <https://doi.org/10.3390/nu6072523>
- Economic Planning Unit. (2017). *The Malaysian Economy in Figures*. Prime Minister's Department. [https://doi.org/10.1016/S0197-2456\(02\)00197-6](https://doi.org/10.1016/S0197-2456(02)00197-6)
- Elmadfa, I., & Meyer, A. L. (2012). Diet quality, a term subject to change over time. *International Journal for Vitamin and Nutrition Research. Internationale Zeitschrift Fur Vitamin- Und Ernährungsforschung. Journal International de Vitaminologie et de Nutrition*, 82(3), 144–147. <https://doi.org/10.1024/0300-9831/a000104>
- Eng, J. Y., & Moy, F. M. (2011). Validation of a food frequency questionnaire to assess dietary cholesterol, total fat and different types of fat intakes among Malay adults. *Asia Pacific Journal of Clinical Nutrition*.
- Everitt, B. S. (n.d.). Gale Virtual Reference Library - Document - Repeatability. Retrieved from http://go.galegroup.com.ezproxy.uky.edu/ps/i.do?p=GVRL&u=uky_main&id=G_ALE%7CCX3450301990&v=2.1&it=r&sid=exlibris&userGroup=uky_main
- Fabián, C., Pagán, I., Ríos, J. L., Betancourt, J., Cruz, S. Y., González, A. M., ... Rivera-Soto, W. T. (2013). Dietary patterns and their association with sociodemographic characteristics and perceived academic stress of college students in Puerto Rico. *Puerto Rico Health Sciences Journal*, 32(1), 36–43.
- Fatihah, F., Ng, B. K., Hazwanie, H., Karim Norimah, A., Shanita, S. N., Ruzita, A. T., & Poh, B. K. (2015). Development and validation of a food frequency questionnaire for dietary intake assessment among multi-ethnic primary school-aged children. *Singapore Medical Journal*, 56(12), 687–694. <https://doi.org/10.11622/smedj.2015190>
- Fatihah, F., Ng, B. K., Hazwanie, H., Norimah, A. K., Shanita, S. N., Ruzita, A. T., & Poh, B. K. (2015). Development and validation of a food frequency questionnaire for dietary intake assessment among multi-ethnic primary school-aged children.

- Fayers, P. M., & Machin, D. (2007). *Quality of Life: The Assessment, Analysis and Interpretation of Patient-Reported Outcomes: Second Edition. Quality of Life: The Assessment, Analysis and Interpretation of Patient-Reported Outcomes: Second Edition*. <https://doi.org/10.1002/9780470024522>
- Flight, I., & Clifton, P. (2006). Cereal grains and legumes in the prevention of coronary heart disease and stroke: A review of the literature. *European Journal of Clinical Nutrition*. <https://doi.org/10.1038/sj.ejcn.1602435>
- Fokeena, Waqia B., Jamaluddin, R., & Khaza'ai, H. (2016a). Development and Assessment of the Reliability and Validity of a Diet Quality Index in a Sample of Malaysian University Students. *Journal of Food and Nutrition Research*, 4(4), 251–257. <https://doi.org/10.12691/JFNR-4-4-9>
- Fokeena, Waqia B., Jamaluddin, R., & Khaza'ai, H. (2016b). Development and Assessment of the Reliability and Validity of a Diet Quality Index in a Sample of Malaysian University Students. *Journal of Food and Nutrition Research*, Vol. 4, 2016, Pages 251-257, 4(4), 251–257. <https://doi.org/10.12691/JFNR-4-4-9>
- Fokeena, Waqia Begum, & Jeewon, R. (2012). Is there an association between socioeconomic status and body mass index among adolescents in mauritius? *The Scientific World Journal*. <https://doi.org/10.1100/2012/750659>
- Fournier, T., Tibère, L., Laporte, C., Mognard, E., Ismail, M. N., Sharif, S. P., & Poulain, J. P. (2016). Eating patterns and prevalence of obesity. Lessons learned from the Malaysian Food Barometer. *Appetite*. <https://doi.org/10.1016/j.appet.2016.08.009>
- Fransen, H. P., & Ocké, M. C. (2008). Indices of diet quality. *Current Opinion in Clinical Nutrition and Metabolic Care*, 11(5), 559–565. <https://doi.org/10.1097/MCO.0b013e32830a49db>
- Freisling, H., & Elmadfa, I. (2008). Food Frequency Index as a Measure of Diet Quality in Non-Frail Older Adults. *Nutrition and Health Promotion Ann Nutr Metab*, 52(1), 43–46. <https://doi.org/10.1159/000115348>
- French, S. A., Tangney, C. C., Crane, M. M., Wang, Y., & Appelhans, B. M. (2019). Nutrition quality of food purchases varies by household income: The SHoPPER study. *BMC Public Health*. <https://doi.org/10.1186/s12889-019-6546-2>
- Fromme, H., Gruber, L., Schlummer, M., Wolz, G., Böhmer, S., Angerer, J., ... Bolte, G. (2007). Intake of phthalates and di(2-ethylhexyl)adipate: Results of the Integrated Exposure Assessment Survey based on duplicate diet samples and biomonitoring data. *Environment International*. <https://doi.org/10.1016/j.envint.2007.05.006>
- Fung, T. T., Malik, V., Rexrode, K. M., Manson, J. E., Willett, W. C., & Hu, F. B.

- (2009). Sweetened beverage consumption and risk of coronary heart disease in women. *American Journal of Clinical Nutrition*. <https://doi.org/10.3945/ajcn.2008.27140>
- Fung, T. T., Pan, A., Hou, T., Chiuve, S. E., Tobias, D. K., Mozaffarian, D., ... Hu, F. B. (2015). Long-Term Change in Diet Quality Is Associated with Body Weight Change in Men and Women. *The Journal of Nutrition*. <https://doi.org/10.3945/jn.114.208785>
- Ghee, L. K. (2016). A review of adult obesity research in Malaysia. *Medical Journal of Malaysia*. <https://doi.org/10.4103/0022>
- Gibney, M. J., Margetts, B. M., Kearney, J. M., & Arab, L. (2013). Assessment of Nutritional Status in Individuals and Populations. In *Public Health Nutrition*.
- Guenther, P. M., Casavale, K. O., Reedy, J., Kirkpatrick, S. I., Hiza, H. A. B., Kuczynski, K. J., ... Krebs-Smith, S. M. (2013). Update of the Healthy Eating Index: HEI-2010. *Journal of the Academy of Nutrition and Dietetics*, 113(4), 569–580. <https://doi.org/10.1016/j.jand.2012.12.016>
- Guenther, P. M., Kirkpatrick, S. I., Reedy, J., Krebs-Smith, S. M., Buckman, D. W., Dodd, K. W., ... Carroll, R. J. (2014). The Healthy Eating Index-2010 is a valid and reliable measure of diet quality according to the 2010 Dietary Guidelines for Americans. *The Journal of Nutrition*, 144(3), 399–407. <https://doi.org/10.3945/jn.113.183079>
- Guenther, P. M., Reedy, J., & Krebs-Smith, S. M. (2008). Development of the Healthy Eating Index-2005. *Journal of the American Dietetic Association*, 108(11), 1896–1901. <https://doi.org/10.1016/j.jada.2008.08.016>
- Guenther, P. M., Reedy, J., Krebs-Smith, S. M., & Reeve, B. B. (2008). Evaluation of the Healthy Eating Index-2005. *Journal of the American Dietetic Association*, 108(11), 1854–1864. <https://doi.org/10.1016/j.jada.2008.08.011>
- Haines, P. S., Siega-Riz, A. M., & Popkin, B. M. (1999). The Diet Quality Index Revised: A measurement instrument for populations. *Journal of the American Dietetic Association*, 99(6), 697–704. [https://doi.org/10.1016/S0002-8223\(99\)00168-6](https://doi.org/10.1016/S0002-8223(99)00168-6)
- Hajian-Tilaki, K. (2013). Receiver operating characteristic (ROC) curve analysis for medical diagnostic test evaluation. *Caspian Journal of Internal Medicine*. <https://doi.org/10.1017/CBO9781107415324.004>
- Hamrik, Z., Sigmundová, D., Kalman, M., Pavelka, J., & Sigmund, E. (2014). Physical activity and sedentary behaviour in Czech adults: Results from the GPAQ study. *European Journal of Sport Science*. <https://doi.org/10.1080/17461391.2013.822565>
- Harnack, L., Nicodemus, K., Jacobs, D. R., & Folsom, A. R. (2002). An evaluation of the Dietary Guidelines for Americans in relation to cancer occurrence. *American*

- Harris, W. S., Mozaffarian, D., Rimm, E., Kris-Etherton, P., Rudel, L. L., Appel, L. J., ... Sacks, F. (2009). Omega-6 fatty acids and risk for cardiovascular disease: A science advisory from the American Heart Association nutrition subcommittee of the council on nutrition, physical activity, and metabolism; council on cardiovascular nursing; and council on epidem. *Circulation*. <https://doi.org/10.1161/CIRCULATIONAHA.108.191627>
- Hatløy, A., Torheim, L. E., & Oshaug, A. (1998). Food variety - A good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition*. <https://doi.org/10.1038/sj.ejcn.1600662>
- Heale, R., & Twycross, A. (2015a). Validity and reliability in quantitative studies. *Evidence-Based Nursing*, 18(3), 66–67. <https://doi.org/10.1136/eb-2015-102129>
- Heale, R., & Twycross, A. (2015b). Validity and reliability in quantitative studies. *Evidence Based Nursing*, 18(3), 66–67. <https://doi.org/10.1136/eb-2015-102129>
- Henchy, A. M. (n.d.). REVIEW AND EVALUATION OF RELIABILITY GENERALIZATION RESEARCH. Retrieved from https://uknowledge.uky.edu/edp_etds/5
- Hendrie, G. A., Rebuli, M. A., & Golley, R. K. (2017). Reliability and relative validity of a diet index score for adults derived from a self-reported short food survey. *Nutrition & Dietetics*, 74(3), 291–297. <https://doi.org/10.1111/1747-0080.12303>
- Hiza, H. A. B., Casavale, K. O., Guenther, P. M., & Davis, C. A. (2013). Diet Quality of Americans Differs by Age, Sex, Race/Ethnicity, Income, and Education Level. *Journal of the Academy of Nutrition and Dietetics*, 113(2), 297–306. <https://doi.org/10.1016/j.jand.2012.08.011>
- Hobart, J. C., Cano, S. J., Warner, T. T., & Thompson, A. J. (2012). What sample sizes for reliability and validity studies in neurology? *Journal of Neurology*, 259(12), 2681–2694. <https://doi.org/10.1007/s00415-012-6570-y>
- Hu, F. B. (2002). Dietary pattern analysis: a new direction in nutritional epidemiology. *Current Opinion in Lipidology*, 13(1), 3–9. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11790957>
- Huffman, F. G., De La Cera, M., Vaccaro, J. A., Zarini, G. G., Exebio, J., Gundupalli, D., & Shaban, L. (2011). Healthy eating index and alternate healthy eating index among Haitian Americans and African Americans with and without type 2 diabetes. *Journal of Nutrition and Metabolism*. <https://doi.org/10.1155/2011/398324>
- Huijbregts, P., Feskens, E., Räsänen, L., Fidanza, F., Nissinen, a, Menotti, a, & Kromhout, D. (1997). Dietary pattern and 20 year mortality in elderly men in Finland, Italy, and The Netherlands: longitudinal cohort study. *BMJ (Clinical*

- Huybrechts, I., Vereecken, C., De Bacquer, D., Vandevijvere, S., Van Oyen, H., Maes, L., ... De Henauw, S. (2010). Reproducibility and validity of a diet quality index for children assessed using a FFQ. *British Journal of Nutrition*. <https://doi.org/10.1017/S0007114510000231>
- Ishii, Y., Ishihara, J., Takachi, R., Shinozawac, Y., Imaeda, N., Goto, C., ... Tsugane, S. (2017). Comparison of weighed food record procedures for the reference methods in two validation studies of food frequency questionnaires. *Journal of Epidemiology*. <https://doi.org/10.1016/j.je.2016.08.008>
- Islami, N., Fahmi Teng, M., Binti Mat Zin, M., Binti Zakaria, N., Mohd, N. I., & Teng, F. (2017). *Groceries shopping practices and diet quality among Malaysian Introduction and Background*. *International Journal of Collaborative Research on Internal Medicine & Public Health* (Vol. 9). Retrieved from <http://www.iomcworld.com/ijcrimph/files/2017/v09-n07-01.pdf>
- Ismail, N. H., Manaf, Z. A., & Azizan, N. Z. (2012). High glycemic load diet, milk and ice cream consumption are related to acne vulgaris in Malaysian young adults: a case control study. *BMC Dermatology*. <https://doi.org/10.1186/1471-5945-12-13>
- Jackson, M. D., Walker, S. P., Younger, N. M., & Bennett, F. I. (2011). Use of a food frequency questionnaire to assess diets of Jamaican adults: validation and correlation with biomarkers. *Nutrition Journal*, 10, 28. <https://doi.org/10.1186/1475-2891-10-28>
- Johnson, R. K. (2002, November 1). Dietary intake--how do we measure what people are really eating? *Obesity Research*. John Wiley & Sons, Ltd. <https://doi.org/10.1038/oby.2002.192>
- Johnson, R. K., Soultanakis, R. P., & Matthews, D. E. (1998). Literacy and body fatness are associated with underreporting of energy intake in US low-income women using the multiple-pass 24-hour recall: A doubly labeled water study. *Journal of the American Dietetic Association*. [https://doi.org/10.1016/S0002-8223\(98\)00263-6](https://doi.org/10.1016/S0002-8223(98)00263-6)
- KANT, A. K. (1996). Indexes of Overall Diet Quality: A Review. *Journal of the American Dietetic Association*, 96(8), 785–791. [https://doi.org/10.1016/S0002-8223\(96\)00217-9](https://doi.org/10.1016/S0002-8223(96)00217-9)
- Kant, A. K., Schatzkin, A., Graubard, B. I., & Schairer, C. (2000). A prospective study of diet quality and mortality in women. *JAMA*, 283(16), 2109–2115. <https://doi.org/joc91695> [pii]
- Karupaiah, T., Chee, W., Swee, S., Siew, @bullet, Liew, Y., Boon, @bullet, ... Chinna, K. (2012). Dietary Health Behaviors of Women Living in High Rise Dwellings: A Case Study of an Urban Community in Malaysia. <https://doi.org/10.1007/s10900-012-9597-1>

- Kaur, S., Mohamed, H. J. B. J., Jalil, R. A., Yusof, B. N. M., & Yim, H. S. (2016). Validation and reproducibility of a culturally specific food frequency questionnaire (FFQ) for Malaysian Punjabis. *Malaysian Journal of Nutrition*.
- Kaur, S., Yim, H. S., Abdul Jalil, R., Mohd-Yusof, B. N., & Jan Mohamed, H. J. (2018). Socioeconomic Status and Glycemic Index Among Punjabis in Kuala Lumpur, Malaysia: Possible Association with Metabolic Syndrome. *Journal of Immigrant and Minority Health*. <https://doi.org/10.1007/s10903-018-0731-8>
- Kee, C. C., Jamaiah, H., Noor Safiza, M. N., Khor, G. L., Suzana, S., Jamalludin, A. R., ... Ahmad Faudzi, Y. (2008). Abdominal Obesity in Malaysian Adults: National Health and Morbidity Survey III (NHMS III, 2006). *Malaysian Journal of Nutrition*, 14(2), 125–135. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/22691770>
- KENNEDY, E. T., OHLS, J., CARLSON, S., & FLEMING, K. (1995). The Healthy Eating Index. *Journal of the American Dietetic Association*, 95(10), 1103–1108. [https://doi.org/10.1016/S0002-8223\(95\)00300-2](https://doi.org/10.1016/S0002-8223(95)00300-2)
- Khor, G. L. (2012). Food availability and the rising obesity prevalence in Malaysia. *IeJSME*, 6(supp 1), S61–S68.
- Kim, H.-Y. (2017). Statistical notes for clinical researchers: Chi-squared test and Fisher's exact test. *Restorative Dentistry & Endodontics*. <https://doi.org/10.5395/rde.2017.42.2.152>
- Kim, S., Moon, S., & Popkin, B. M. (2000). The nutrition transition in South Korea. *American Journal of Clinical Nutrition*. <https://doi.org/10.1093/ajcn/71.1.44>
- Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and reliability of measurement instruments used in research. *American Journal of Health-System Pharmacy*. <https://doi.org/10.2146/ajhp070364>
- Kline, R. (2013). Exploratory and confirmatory factor analysis. In *Applied Quantitative Analysis in Education and the Social Sciences*. <https://doi.org/10.4324/9780203108550>
- Kollannoor-Samuel, G., Segura-Pérez, S., Shebl, F. M., Hawley, N. L., Damio, G., Chhabra, J., ... Pérez-Escamilla, R. (2017). Nutrition Facts Panel use is associated with diet quality and dietary patterns among Latinos with type 2 diabetes. *Public Health Nutrition*, 20(16), 2909–2919. <https://doi.org/10.1017/S1368980017001860>
- Kourlaba, G., & Panagiotakos, D. B. (2009). Dietary quality indices and human health: A review. *Maturitas*, 62, 1–8. <https://doi.org/10.1016/j.maturitas.2008.11.021>
- Kris-Etherton, P. M., Harris, W. S., & Appel, L. J. (2003). Omega-3 fatty acids and cardiovascular disease: New recommendations from the American Heart Association. *Arteriosclerosis, Thrombosis, and Vascular Biology*. <https://doi.org/10.1161/01.ATV.0000057393.97337.AE>

- Kunaratnam, K., Halaki, M., Wen, L. M., Baur, L. A., & Flood, V. M. (2018). Reliability and comparative validity of a Diet Quality Index for assessing dietary patterns of preschool-aged children in Sydney, Australia. *European Journal of Clinical Nutrition*. <https://doi.org/10.1038/s41430-017-0020-y>
- Lafrenière, J., Harrison, S., Laurin, D., Brisson, C., Talbot, D., Couture, P., ... Lamarche, B. (2019). Development and validation of a Brief Diet Quality Assessment Tool in the French-speaking adults from Quebec. *International Journal of Behavioral Nutrition and Physical Activity*, 16(1), 61. <https://doi.org/10.1186/s12966-019-0821-6>
- Larsson, S. C., Virtamo, J., & Wolk, A. (2011). Red meat consumption and risk of stroke in Swedish men. *American Journal of Clinical Nutrition*. <https://doi.org/10.3945/ajcn.111.015115>
- Lee, Y. Y., & Wan Muda, W. A. M. (2019). Dietary intakes and obesity of Malaysian adults. *Nutrition Research and Practice*, 13(2), 159–168. <https://doi.org/10.4162/nrp.2019.13.2.159>
- Lian, T. C., Bonn, G., Han, Y. S., Choo, Y. C., & Piau, W. C. (2016). Physical activity and its correlates among adults in Malaysia: A cross-sectional descriptive study. *PLoS ONE*. <https://doi.org/10.1371/journal.pone.0157730>
- Lövestam, E., Orrevall, Y., Koochek, A., Karlström, B., & Andersson, A. (2014). Evaluation of a Nutrition Care Process-based audit instrument, the Diet-NCP-Audit, for documentation of dietetic care in medical records. *Scandinavian Journal of Caring Sciences*, 28(2), 390–397. <https://doi.org/10.1111/scs.12049>
- Lowik, M. R., Hulshof, K. F. A. M., Brussaard, J. H., & Lo, M. R. H. (1999). Food-based dietary guidelines: some assumptions tested for The Netherlands. *Br J Nutr*. <https://doi.org/10.1017/S0007114599001002>
- Madden, J. (1972). *Program evaluation : food stamps and commodity distribution in rural areas of central Pennsylvania*. University Park Pa.: Dept. of Agricultural Economics and Rural Sociology the Pennsylvania State University College of Agriculture. Retrieved from <https://www.worldcat.org/title/program-evaluation-food-stamps-and-commodity-distribution-in-rural-areas-of-central-pennsylvania/oclc/1312681>
- Mahadeva, S., Yadav, H., Rampal, S., Everett, S. M., & Goh, K. L. (2010). Ethnic variation, epidemiological factors and quality of life impairment associated with dyspepsia in urban Malaysia. *Alimentary Pharmacology and Therapeutics*. <https://doi.org/10.1111/j.1365-2036.2010.04270.x>
- Manan, W. A. W. M., Firdaus, N. I., Safiah, M. Y., Haslinda, S. M. D., Poh, B. K., Norimah, A. K., ... Fasih, W. (2012). Meal patterns of Malaysian adults: Findings from the Malaysian Adults Nutrition Survey (MANS). *Malaysian Journal of Nutrition*.
- Mara Baiocchi de CARVALHO, K., Said DUTRA, E., Pizato, N., Dias GRUEZO, N.,

& Kiyomi ITO, M. (n.d.). SEÇÃO TEMÁTICA -ASPECTOS EPIDEMIOLÓGICOS E CLÍNICOS NA PESQUISA EM ALIMENTAÇÃO E NUTRIÇÃO. <https://doi.org/10.1590/1415-52732014000500009>

Maskey, R., Fei, J., & Nguyen, H.-O. (2018). Use of exploratory factor analysis in maritime research. *The Asian Journal of Shipping and Logistics*, 34(2), 91–111. <https://doi.org/10.1016/J.AJSL.2018.06.006>

McCullough, M. L., Feskanich, D., Stampfer, M. J., Giovannucci, E. L., Rimm, E. B., Hu, F. B., ... Willett, W. C. (2002). Diet quality and major chronic disease risk in men and women: Moving toward improved dietary guidance. *American Journal of Clinical Nutrition*, 76(6), 1261–1271.

McCullough, M. L., & Willett, W. C. (2006). Evaluating adherence to recommended diets in adults: the Alternate Healthy Eating Index. *Public Health Nutrition*. <https://doi.org/10.1079/phn2005938>

McNutt, M. (2014). Reproducibility. *Science (New York, N.Y.)*, 343(6168), 229. <https://doi.org/10.1126/science.1250475>

Micha, R., Wallace, S. K., & Mozaffarian, D. (2010). Red and processed meat consumption and risk of incident coronary heart disease, stroke, and diabetes mellitus: A systematic review and meta-analysis. *Circulation*. <https://doi.org/10.1161/CIRCULATIONAHA.109.924977>

Moeller, S. M., Reedy, J., Millen, A. E., Dixon, L. B., Newby, P. K., Tucker, K. L., ... Guenther, P. M. (2007). Dietary Patterns: Challenges and Opportunities in Dietary Patterns Research: An Experimental Biology Workshop, April 1, 2006. *Journal of the American Dietetic Association*, 107(7), 1233–1239. <https://doi.org/10.1016/j.jada.2007.03.014>

Mohammadifard, N., Sajjadi, F., Maghroun, M., Alikhasi, H., Nilforoushzadeh, F., & Sarrafzadegan, N. (2015). Validation of a simplified food frequency questionnaire for the assessment of dietary habits in Iranian adults: Isfahan Healthy Heart Program, Iran. *ARYA Atheroscler*, 11(2). Retrieved from www.mui.ac.ir

Mohd Zaki, N. A., Rasidi, M. N., Awaluddin, S. M., Hiong, T. G., Ismail, H., & Mohamad Nor, N. S. (2018). Prevalence and Characteristic of Dietary Supplement Users in Malaysia: Data From the Malaysian Adult Nutrition Survey (MANS) 2014. *Global Journal of Health Science*. <https://doi.org/10.5539/gjhs.v10n12p127>

Moinester, M., & Gottfried, R. (2014). Sample size estimation for correlations with pre-specified confidence interval. *The Quantitative Methods of Psychology*, 10(2), 124–130.

Moreno-Gómez, C., Romaguera-Bosch, D., Tauler-Riera, P., Bennasar-Veny, M., Pericas-Beltran, J., Martinez-Andreu, S., & Aguilo-Pons, A. (2012). Clustering of lifestyle factors in Spanish university students: the relationship between

- smoking, alcohol consumption, physical activity and diet quality. *Public Health Nutrition*, 15(11), 2131–2139. <https://doi.org/10.1017/S1368980012000080>
- Myers, N. D., Ahn, S., & Jin, Y. (n.d.). Sample Size and Power Estimates for a Confirmatory Factor Analytic Model in Exercise and Sport: A Monte Carlo Approach. *Physical Education, Recreation and Dance*, 82(3), 412–423.
- Nadya, F. M. (2013). *The Use of Nutrition Label on Food Purchasing Decision among University Students in Kuantan, Malaysia*. *Health and the Environment Journal* (Vol. 4). Retrieved from <http://www.hej.kk.usm.my/pdf/HEJVol.4No.1/Article01.pdf>
- National Cancer Institute. (2018). 24-hour Dietary Recall (24HR) At a Glance. <https://doi.org/10.1016/j.radmeas.2009.10.016>
- National Coordinating Committee on Food and Nutrition. (2017). *Recommended Nutrient Intake for Malaysia: A Report of the Technical Working Group on Nutritional Guidelines*. Select Kami Resources. <https://doi.org/10.1002/jbm.a.31722>
- NCCFN. (2010). Malaysian Dietary Guidelines 2010.
- Nelson, M. C., Story, M., Larson, N. I., Neumark-Sztainer, D., & Lytle, L. A. (2008). Emerging Adulthood and College-aged Youth: An Overlooked Age for Weight-related Behavior Change. *Obesity*. <https://doi.org/10.1038/oby.2008.365>
- Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., ... Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*. [https://doi.org/10.1016/S0140-6736\(14\)60460-8](https://doi.org/10.1016/S0140-6736(14)60460-8)
- Nik Shanita, S., Norimah, N., & Abu Hanifah, S. (2012). Development and validation of a food frequency questionnaire (FFQ) for assessing sugar consumption among adults in Klang Valley, Malaysia. *Malaysian Journal of Nutrition*.
- Noor, M. I. (2002). The nutrition and health transition in Malaysia. *Public Health Nutrition*, 5(1A), 191–195. <https://doi.org/10.1079/PHN2001293>
- Nor Azian, M. Z., Hiong, T. G., Mohd Naim, R., Hasimah, I., Maria, S Awaluddin, Noor Safiza Mohamad Nor, R. S., & Zainuddin, A. A. (2015). Dietary supplement use among adults in Malaysia: finding from Malaysian Adults Nutrition Survey (MANS 2014). *Medical Journal of Malaysia*.
- Nurul-Fadhilah, A., Teo, P. S., & Foo, L. H. (2012). Validity and reproducibility of a food frequency questionnaire (FFQ) for dietary assessment in Malay adolescents in Malaysia. *Asia Pacific Journal of Clinical Nutrition*, 21(1), 97–103.
- Ortega, R. M., Pérez-Rodrigo, C., & López-Sobaler, A. M. (2015). Dietary assessment methods: dietary records. *Nutr Hosp*, 31, 38–45.

<https://doi.org/10.3305/nh.2015.31.sup3.8749>

Oxford Dictionary of English - Google Books. (n.d.). Retrieved March 10, 2020, from [https://books.google.com.my/books?id=anecAQAAQBAJ&pg=PA77&lpg=PA77&dq=relating+to+or+denoting+reasoning+or+knowledge+which+proceeds+from+theoretical+deduction+rather+than+empirical+observation+or+experience&source=bl&ots=T_kwewkNDP&sig=ACfU3U2-sVXiwE6cTfgomx8JFqfmlA5IQ&hl=en&sa=X&ved=2ahUKEwjBueLK9Y3oAhXyQ3wKHd1AB04Q6AEwB3oECAgQAQ#v=onepage&q=relating to or denoting reasoning or knowledge which proceeds from theoretical deduction rather than empirical observation or experience&f=false](https://books.google.com.my/books?id=anecAQAAQBAJ&pg=PA77&lpg=PA77&dq=relating+to+or+denoting+reasoning+or+knowledge+which+proceeds+from+theoretical+deduction+rather+than+empirical+observation+or+experience&source=bl&ots=T_kwewkNDP&sig=ACfU3U2-sVXiwE6cTfgomx8JFqfmlA5IQ&hl=en&sa=X&ved=2ahUKEwjBueLK9Y3oAhXyQ3wKHd1AB04Q6AEwB3oECAgQAQ#v=onepage&q=relating+to+or+denoting+reasoning+or+knowledge+which+proceeds+from+theoretical+deduction+rather+than+empirical+observation+or+experience&f=false)

Patterson, R. E., Haines, P. S., & Popkin, B. M. (1994). Diet quality index: Capturing a multidimensional behavior. *Journal of the American Dietetic Association*, 94(1), 57–64. [https://doi.org/10.1016/0002-8223\(94\)92042-7](https://doi.org/10.1016/0002-8223(94)92042-7)

Pei, C. S., Appannah, G., & Sulaiman, N. (2018). Household food insecurity, diet quality, and weight status among indigenous women (Mah Meri) in Peninsular Malaysia. *Nutrition Research and Practice*, 12(2), 135. <https://doi.org/10.4162/nrp.2018.12.2.135>

Pelto, G. H., Urgello, J., Allen, L. H., Chavez, A., Martinez, H., Meneses, L., ... Backstrand, J. (1991). Household size, food intake and anthropometric status of school-age children in a highland Mexican area. *Social Science and Medicine*. [https://doi.org/10.1016/0277-9536\(91\)90229-6](https://doi.org/10.1016/0277-9536(91)90229-6)

Pitsavos, C., Panagiotakos, D. B., Tzima, N., Chrysoshoou, C., Economou, M., Zampelas, A., & Stefanadis, C. (2005). Adherence to the Mediterranean diet is associated with total antioxidant capacity in healthy adults: The ATTICA study. *American Journal of Clinical Nutrition*. <https://doi.org/10.1093/ajcn.82.3.694>

Poh, B. K., Safiah, M. Y., Tahir, A., Siti Haslinda, M. S., Siti Norazlin, N., Norimah, A. K., ... Fatimah, S. (2010). Physical activity pattern and energy expenditure of Malaysian adults: Findings from the Malaysian adult Nutrition survey (MANS). *Malaysian Journal of Nutrition*.

Pon, L. W., Noor-Aini, M. Y., Ong, F. B., Adeeb, N., Seri, S. S., Shamsuddin, K., ... Wan, H. W. H. (2006). Diet, nutritional knowledge and health status of urban middle-aged Malaysian women. *Asia Pacific Journal of Clinical Nutrition*. <https://doi.org/10.1210/jc.2004-2225>

Pondor, I., Gan, W. Y., & Appannah, G. (2017a). Higher dietary cost is associated with higher diet quality: A cross-sectional study among selected Malaysian adults. *Nutrients*, 9(9). <https://doi.org/10.3390/nu9091028>

Pondor, I., Gan, W. Y., & Appannah, G. (2017b). Higher Dietary Cost Is Associated with Higher Diet Quality: A Cross-Sectional Study among Selected Malaysian Adults. <https://doi.org/10.3390/nu9091028>

Preedy, V. R., Hunter, L.-A., & Patel, V. B. (2013). *Diet Quality : An Evidence-Based*

- Approach, Volume 2. Nutrition and Health.* Retrieved from <http://edepot.wur.nl/265522>
- Rampal, L., Rampal, S., Khor, G. L., Zain, A. M., Ooyub, S. Bin, Rahmat, R. Bin, ... Krishnan, J. (2007). A national study on the prevalence of obesity among 16,127 Malaysians. *Asia Pacific Journal of Clinical Nutrition*, 16(3), 561–566.
- Rao, K. V., & Gopalan, C. (1969). Nutrition and family size. *Journal of Nutrition and Dietetics*, 6, 258–266. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/12304932>
- Reedy, J., Subar, A., George, S., & Krebs-Smith, S. (2018). Extending Methods in Dietary Patterns Research. *Nutrients*, 10(5), 571. <https://doi.org/10.3390/nu10050571>
- Report of the Working Group on Monitoring Scottish Dietary Targets. (n.d.). Retrieved January 7, 2019, from <https://www2.gov.scot/Publications/2005/01/20577/50687>
- Rezali, F. W., Chin, Y. S., Mohd Shariff, Z., Mohd Yusof, B. N., Sanker, K., & Woon, F. C. (2015). Evaluation of diet quality and its associated factors among adolescents in Kuala Lumpur, Malaysia. *Nutrition Research and Practice*, 9(5), 511–516. <https://doi.org/10.4162/nrp.2015.9.5.511>
- Roach, K. E. (2006). Measurement of Health Outcomes: Reliability, Validity and Responsiveness - Journal of Prosthetics and Orthotics, 2006 | American Academy of Orthotists & Prosthetists. Retrieved from http://www.oandp.org/jpo/library/2006_01S_008.asp
- Roberts, K., & Flaherty, S. J. (2010). *Review of dietary assessment methods in public health.* *National Obesity Observatory.* <https://doi.org/10.1093/bioinformatics/btg413>
- Roy, R., Hebden, L., Rangan, A., & Allman-Farinelli, M. (2016). The development, application, and validation of a Healthy eating index for Australian Adults (HEIFA-2013). *Nutrition*. <https://doi.org/10.1016/j.nut.2015.10.006>
- Royal, K. (2016). “Face validity” is not a legitimate type of validity evidence! *American Journal of Surgery*, 212(5), 1026–1027. <https://doi.org/10.1016/j.amjsurg.2016.02.018>
- Schröder, H., Marrugat, J., Vila, J., Covas, M. I., & Elosua, R. (2004). Adherence to the traditional mediterranean diet is inversely associated with body mass index and obesity in a spanish population.The MARARTHOM Investingators. *The Journal of Nutrition*. <https://doi.org/10.1093/ajcn.113.3.335S> [pii]
- Schulze, M. B., & Hoffmann, K. (2006). Methodological approaches to study dietary patterns in relation to risk of coronary heart disease and stroke. *The British Journal of Nutrition*, 95(5), 860–869. <https://doi.org/10.1079/BJN20061731>
- Schulze, M. B., Manson, J. A. E., Ludwig, D. S., Colditz, G. A., Stampfer, M. J.,

- Willett, W. C., & Hu, F. B. (2004). Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *Journal of the American Medical Association*. <https://doi.org/10.1001/jama.292.8.927>
- Sedek, R. (2018). The Use of Supplements among Adults in Selected Gymnasium in Kuala Lumpur, Malaysia. *Food Science & Nutrition Technology*. <https://doi.org/10.23880/fsnt-16000158>
- Setia, M. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology*. <https://doi.org/10.4103/0019-5154.182410>
- Seymour, J. D., Calle, E. E., Flagg, E. W., Coates, R. J., Ford, E. S., & Thun, M. J. (2003). Diet Quality Index as a predictor of short-term mortality in the American Cancer Society Cancer Prevention Study II Nutrition Cohort. *American Journal of Epidemiology*, 157(11), 980–988. <https://doi.org/10.1093/aje/kwg077>
- Shahar, S., Jan Bin Jan Mohamed, H., de Los Reyes, F., & Amarra, M. S. (2018). Adherence of Malaysian Adults' Energy and Macronutrient Intakes to National Recommendations: A Review and Meta-Analysis. *Nutrients*. <https://doi.org/10.3390/nu10111584>
- Shahril, M. R., Wan Dali, W. P. E., & Lua, P. L. (2013). A 10-week multimodal nutrition education intervention improves dietary intake among university students: Cluster randomised controlled trial. *Journal of Nutrition and Metabolism*. <https://doi.org/10.1155/2013/658642>
- Shannon, J., Shikany, J., Barrett-Connor, E., Marshall, L., Bunker, C., Chan, J., ... Orwoll, E. (2016). Demographic factors associated with the diet quality of older US men: baseline data from the Osteoporotic Fractures in Men (MrOS) study. <https://doi.org/10.1017/S1368980007258604>
- Shariff, Z. M., & Khor, G. L. (2009). Household food insecurity and coping strategies in a poor rural community in Malaysia. *Nutrition Research and Practice*. <https://doi.org/10.4162/nrp.2008.2.1.26>
- Shariff, Z. M., Sulaiman, N., Jalil, R. A., Yen, W. C., Yaw, Y. H., Taib, M. N. M., ... Lin, K. G. (2014). Food insecurity and the metabolic syndrome among women from low income communities in Malaysia. *Asia Pacific Journal of Clinical Nutrition*. <https://doi.org/10.6133/apjcn.2014.23.1.05>
- Shatenstein, B., Nadon, S., Godin, C., & Ferland, G. (2005). Diet Quality of Montreal-Area Adults Needs Improvement: Estimates from a Self- Administered Food Frequency Questionnaire Furnishing a Dietary Indicator Score. *J Am Diet Assoc*, 105, 1251–1260. <https://doi.org/10.1016/j.jada.2005.05.008>
- Shim, J.-S., Oh, K., & Kim, H. C. (2014). Dietary assessment methods in epidemiologic studies. *Epidemiology and Health*, 36, e2014009. <https://doi.org/10.4178/epih/e2014009>
- Shyam, S., Fatimah, A., Rohana, A. G., Norasyikin, A. W., Nik Shanita, S., Chinna, K.,

- ... Nor Azmi, K. (2016). Effect of including glycaemic index (GI) nutrition education, within the conventional healthy dietary recommendation framework, on body weight and composition of women with prior gestational diabetes mellitus: Results from a one-year randomised controlled. *Malaysian Journal of Nutrition*.
- Sijtsma, F. P., Meyer, K. A., Steffen, L. M., Shikany, J. M., Van Horn, L., Harnack, L., ... Jacobs, D. R. (2012). Longitudinal trends in diet and effects of sex, race, and education on dietary quality score change: the Coronary Artery Risk Development in Young Adults study. *American Journal of Clinical Nutrition*, 95(3), 580–586. <https://doi.org/10.3945/ajcn.111.020719>
- Siwar, C., Ahmed, F., Bashawir, A., & Mia, M. S. (2016). Urbanization and Urban Poverty in Malaysia: Consequences and Vulnerability. *Journal of Applied Sciences*, 16(4), 154–160. <https://doi.org/10.3923/jas.2016.154.160>
- Soederberg Miller, L. M., Cassady, D. L., Applegate, E. A., Beckett, L. A., Wilson, M. D., Gibson, T. N., & Ellwood, K. (2015). Relationships among food label use, motivation, and dietary quality. *Nutrients*. <https://doi.org/10.3390/nu7021068>
- Stacciarini, T. S. G., & Pace, A. E. (2017). Confirmatory factor analysis of the Appraisal of Self-Care Agency Scale - Revised. *Revista Latino-Americana de Enfermagem*, 25, e2856. <https://doi.org/10.1590/1518-8345.1378.2856>
- Steckler, A., & McLeroy, K. R. (2008). The importance of external validity. *American Journal of Public Health*. <https://doi.org/10.2105/AJPH.2007.126847>
- Steinfeldt, L., Anand, J., & Murayi, T. (2013). Food Reporting Patterns in the USDA Automated Multiple-Pass Method. *Procedia Food Science*, 2, 145–156. <https://doi.org/10.1016/J.PROFOO.2013.04.022>
- Steptoe, A., Wardle, J., Cui, W., Bellisle, F., Zotti, A. M., Baranyai, R., & Sanderman, R. (2002). Trends in smoking, diet, physical exercise, and attitudes toward health in European university students from 13 countries, 1990-2000. *Preventive Medicine*. <https://doi.org/10.1006/pmed.2002.1048>
- Suhr, D. D. (2005). Principal Component Analysis vs. Exploratory Factor Analysis. In *SUGI 30*. Retrieved from <http://www2.sas.com/proceedings/sugi30/203-30.pdf>
- Sulaiman, N., Shariff, Z. M., Jalil, R. A., Mohd Taib, M. N., Kandiah, M., & Samah, A. A. (2011). Validation of the malaysian coping strategy instrument to measure household food insecurity in kelantan, Malaysia. *Food and Nutrition Bulletin*. <https://doi.org/10.1177/156482651103200407>
- Sun, Q., Spiegelman, D., Van Dam, R. M., Holmes, M. D., Malik, V. S., Willett, W. C., & Hu, F. B. (2010). White rice, brown rice, and risk of type 2 diabetes in US men and women. *Archives of Internal Medicine*. <https://doi.org/10.1001/archinternmed.2010.109>
- Tan, A. K. G., Yen, S. T., & Feisul, M. I. (2012). Determinants of body weight status

- in Malaysia: An ethnic comparison. *International Journal of Public Health*. <https://doi.org/10.1007/s00038-011-0238-8>
- Tanja, T. T., Outi, N., Sakari, S., Jarmo, L., Kaisa, P., & Leila, K. (2015). Preliminary Finnish measures of eating competence suggest association with health-promoting eating patterns and related Psychobehavioral factors in 10-17 year old adolescents. *Nutrients*. <https://doi.org/10.3390/nu7053828>
- Teh, C. H., Lim, K. K., Chan, Y. Y., Lim, K. H., Azahadi, O., Hamizatul Akmar, A. H., ... Fadhli, Y. (2014). The prevalence of physical activity and its associated factors among Malaysian adults: findings from the National Health and Morbidity Survey 2011. *Public Health*, 128(5), 416–423. <https://doi.org/10.1016/j.puhe.2013.10.008>
- Thiele, S., Peltner, J., Richter, A., & Mensink, G. B. M. (2017). Food purchase patterns: Empirical identification and analysis of their association with diet quality, socio-economic factors, and attitudes. *Nutrition Journal*. <https://doi.org/10.1186/s12937-017-0292-z>
- Thorne-Lyman, A. L., Valpiani, N., Sun, K., Semba, R. D., Klotz, C. L., Kraemer, K., ... Bloem, M. W. (2010). Household Dietary Diversity and Food Expenditures Are Closely Linked in Rural Bangladesh, Increasing the Risk of Malnutrition Due to the Financial Crisis. *The Journal of Nutrition*, 140(1), 182S–188S. <https://doi.org/10.3945/jn.109.110809>
- Toft, U., Kristoffersen, L., Lau, C., Borch-Johnsen, K., & Jørgensen, T. (2007). The Dietary Quality Score: validation and association with cardiovascular risk factors: the Inter99 study. *European Journal of Clinical Nutrition*, 61, 270–278. <https://doi.org/10.1038/sj.ejcn.1602503>
- Trendel, O., & Werle, C. O. C. (2015). Distinguishing the affective and cognitive bases of implicit attitudes to improve prediction of food choices. *Appetite*. <https://doi.org/10.1016/j.appet.2015.10.005>
- Trichopoulou, A., Kouris-Blazos, A., Wahlqvist, M. L., Gnardellis, C., Lagiou, P., Polychronopoulos, E., ... Trichopoulos, D. (1995). Diet and overall survival in elderly people. *BMJ: British Medical Journal*, 311(7018), 1457–1460. <https://doi.org/10.1136/bmj.311.7018.1457>
- Trochim, W. M. K. (2006). The Research Methods Knowledge Base, 2nd Edition. *Atomic Dog Publishing, Cincinnati, OH*. <https://doi.org/10.2471/BLT.05.029181>
- Tucker, K. L. (2010). Dietary patterns, approaches, and multicultural perspective This is one of a selection of papers published in the CSCN–CSNS 2009 Conference, entitled Can we identify culture-specific healthful dietary patterns among diverse populations undergoing nutrition transition? *Applied Physiology, Nutrition, and Metabolism*, 35(2), 211–218. <https://doi.org/10.1139/H10-010>
- Usda, H. (2015). *2015 Dietary Guidelines Advisory Committee Report*. Retrieved from <https://health.gov/dietaryguidelines/2015-scientific-report/PDFs/Scientific->

- Van Lee, L., Geelen, A., Van Huysduynen, E., De Vries, J. H. M., Vant Veer, P., & Feskens, E. J. M. (2012). The dutch healthy diet index (DHD-index): An instrument to measure adherence to the Dutch guidelines for a healthy diet. *Nutrition Journal*. <https://doi.org/10.1186/1475-2891-11-49>
- Vaz, S., Falkmer, T., Passmore, A. E., Parsons, R., & Andreou, P. (2013a). The case for using the repeatability coefficient when calculating test-retest reliability. *PloS One*, 8(9), e73990. <https://doi.org/10.1371/journal.pone.0073990>
- Vaz, S., Falkmer, T., Passmore, A. E., Parsons, R., & Andreou, P. (2013b). The Case for Using the Repeatability Coefficient When Calculating Test-Retest Reliability. *PLoS ONE*, 8(9). <https://doi.org/10.1371/journal.pone.0073990>
- Vella-Zarb, R. A., & Elgar, F. J. (2009). The “freshman 5”: A meta-analysis of weight gain in the freshman year of college. *Journal of American College Health*. <https://doi.org/10.1080/07448480903221392>
- Verger, E. O., Mariotti, F., Holmes, B. A., Paineau, D., & Huneau, J. F. (2012). Evaluation of a diet quality index based on the probability of adequate nutrient intake (PANDiet) using national french and US dietary surveys. *PLoS ONE*. <https://doi.org/10.1371/journal.pone.0042155>
- Villegas, R., Xiang, Y. B., Elasy, T., Li, H. L., Yang, G., Cai, H., ... Shu, X. O. (2011). Fish, shellfish, and long-chain n-3 fatty acid consumption and risk of incident type 2 diabetes in middle-aged Chinese men and women. *American Journal of Clinical Nutrition*. <https://doi.org/10.3945/ajcn.111.013193>
- Vuholm, S., Lorenzen, J. K., & Kristensen, M. (2014). Relative validity and reproducibility of a food frequency questionnaire to assess dietary fiber intake in Danish adults. *Food & Nutrition Research*, 58(0). <https://doi.org/10.3402/fnr.v58.24723>
- Waijers, P. M. C. M., Feskens, E. J. M., & Ocké, M. C. (2007). A critical review of predefined diet quality scores. *British Journal of Nutrition*. <https://doi.org/10.1017/S0007114507250421>
- Ward, S. J., Coates, A. M., & Hill, A. M. (2019). Application of an Australian Dietary Guideline Index to Weighed Food Records. *Nutrients*, 11(6), 1286. <https://doi.org/10.3390/nu11061286>
- Westerterp, K. R., & Goris, A. H. C. (2002). Validity of the assessment of dietary intake: problems of misreporting. *Current Opinion in Clinical Nutrition and Metabolic Care*, 5(5), 1363–1950. <https://doi.org/10.1097/00075197-200209000-00006>
- Willett, W. C., McCullough, M. L., Hu, F. B., Wang, M., Chiuve, S. E., Stampfer, M. J., ... Rimm, E. B. (2012). Alternative Dietary Indices Both Strongly Predict Risk of Chronic Disease. *The Journal of Nutrition*.

<https://doi.org/10.3945/jn.111.157222>

- Williams, B., Onsmann, A., & Brown, T. (2012). Exploratory factor analysis: A five-step guide for novices. *EDUCATION Exploratory factor analysis: A five-step guide for novices. Australasian Journal of Paramedicine Australasian Journal of Paramedicine Journal of Emergency Primary Health Care (JEPHC)*, 8(3). Retrieved from <http://ro.ecu.edu.au/jephc/vol8/iss3/1>
- World Health Organization (WHO). (2006). Global database on Body Mass Index: BMI classification. [https://doi.org/10.1016/S0006-3495\(94\)80531-4](https://doi.org/10.1016/S0006-3495(94)80531-4)
- Yee, Y. S. S., Zaitun, Y., Chan, Y. M., & Norhaizan, M. E. (2013). Association between anthropometric status, dietary intake and physical activity with bone health status among premenopausal Chinese women in the Klang Valley, Malaysia. *Malaysian Journal of Nutrition*.
- Yuan, Y.-Q., Li, F., Dong, R.-H., Chen, J.-S., He, G.-S., Li, S.-G., & Chen, B. (2017). The Development of a Chinese Healthy Eating Index and Its Application in the General Population. *Nutrients*, 9(9), 977. <https://doi.org/10.3390/nu9090977>
- Yuan, Y.-Q., Li, F., Wu, H., Wang, Y.-C., Chen, J.-S., He, G.-S., ... Chen, B. (2018). Evaluation of the Validity and Reliability of the Chinese Healthy Eating Index. *Nutrients*, 10(2). <https://doi.org/10.3390/nu10020114>
- Yuan, Y. Q., Li, F., Dong, R. H., Chen, J. S., He, G. S., Li, S. G., & Chen, B. (2017). The development of a Chinese healthy eating index and its application in the general population. *Nutrients*. <https://doi.org/10.3390/nu9090977>
- Zakariah, N., Zainuddin, H., Ragunath, P., & Mustapha, F. I. (2018). *Physical Inactivity among Health Staff: What Influences the Behaviour?* *Malaysian Journal of Medicine and Health Sciences* (Vol. 14). Retrieved from http://www.medic.upm.edu.my/upload/dokumen/2018092410414503_MJMHS_Oct_2018.pdf
- Zimmerman, M., & Snow, B. (2010). An introduction to nutrition. Retrieved from <http://2012books.lardbucket.org/pdfs/an-introduction-to-nutrition>

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Mariam Boughoula was born in Madison, Wisconsin, U.S.A. on the 8th of August, 1988 to two Tunisian parents. In 2011, she earned her Bachelor of Science degree (B.Sc) in Dietetics from Kansas State University (KSU) in Manhattan, KS (Didactic Program in Dietetics). The final two years of undergraduate study required the successful completion of a total of 1,200 hours of supervised work practice in the field of dietetics, nutrition, foodservice and research. The author completed the aforementioned hours in hospitals in Saudi Arabia, where her parents currently live, as well as Tunisia – her home country. In 2014, she earned her Masters of Science (MS) in Nutritional Sciences with an emphasis in Clinical Nutrition from the University of Kentucky in Lexington, KY. She completed her practicum class in cardio-pulmonary rehabilitation nutrition at the UK Gill Heart Cardiopulmonary Rehab in Lexington, KY. She also received training and completed supervised work practice hours at the Barnstable Brown Kentucky Diabetes and Obesity Center, University of Kentucky, Lexington, Kentucky, where she took anthropometric measurements and diet histories of patients, and helped prepare and deliver diabetes education sessions for patients who visited the center. She later enrolled in 2015/2016 for a PhD in Nutrition in the field of Community Nutrition at the Department of Nutrition and Dietetics, the Faculty of Medicine and Health Sciences at University Putra Malaysia (UPM). This research was conducted under the supervision of Associate Prof. Dr. Rosita Jamaluddin.

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