UNIVERSITI PUTRA MALAYSIA

RELATIONSHIP BETWEEN NUTRITION LITERACY AND DIETARY ADHERENCE AMONG HEMODIALYSIS PATIENTS FROM SELECTED DIALYSIS CENTERS IN THE KLANG VALLEY, MALAYSIA

LIM JUN HAO

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By

LIM JUN HAO

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

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Faculty : Medicine and Health Science

Limited health literacy and dietary non-adherence are significant public health issues in the hemodialysis (HD) population, especially in low-and-middle-income countries, where health resources and dietitians are limited. Nutrition literacy is a specific type of health literacy concerning eating practices. It has recently been recognised as a plausible predictor of dietary adherence in HD patients. Yet, information pertaining to nutrition literacy and dietary adherence among Malaysian HD patients is scant. Importantly, theoretical frameworks have posited the putative mechanisms that explain the relationship continuum from health literacy and its determinants to dietary adherence through patient's related factors (i.e., knowledge, health belief, and self-management skills). Nevertheless, empirical study to address such a mechanism is scarce. Thus, this study aimed to explore an existing health literacy skills framework to (1) determine the prevalence rates of limited nutrition literacy and dietary non-adherence, (2) identify the determinants of nutrition literacy, (3) examine the relationship between nutrition literacy and dietary adherence, and (4) investigate the mediation effects of patient-related factors on the relationship between nutrition literacy and dietary adherence among Malaysian HD patients.

A multi-centre, cross-sectional study was conducted at nine convenient and accessible dialysis centres in Klang Valley, Malaysia. A total of 250 multi-ethnic Malaysian HD patients who aged ≥ 18 years, dialysed thrice-weekly ≥ six months, absence of physical impairment, cognitive problem, terminal illness, and other conditions that might bias the study outcome, were randomly selected. Data collection was conducted via face-to-face interview using pretested and validated semi-structured questionnaire. Dietary adherence was measured using the End-Stage Renal Disease Adherence Questionnaire (ESRD-AQ) and serum potassium and phosphate levels. At the same time, self-management skills were assessed by the Perceived Kidney/Dialysis Self-Management Scale (PKDSMS). While self-developed and validated scales were used to gauge nutrition literacy (i.e., Dialysis Specific Nutrition Literacy Scale, DSNLS), dietary knowledge (i.e., Dialysis

Diet Knowledge Questionnaire, DDKQ) and five health belief model (HBM) constructs (i.e., Dialysis Diet-Related Health Belief Questionnaire, DDHBQ), including perceived benefits, perceived barrier, perceived seriousness, perceived susceptibility, and perceived self-efficacy. Data analyses were performed using IBM SPSS version 25 and Smart PLS version 3. Null hypotheses were tested based on the results of multiple linear regression and partial least squares structural equation modeling.

A total number of 218 HD patients were recruited. They consisted of 53.2% male and had a mean age of 54.8 ± 12.8 years. The ethnicity distribution was 56.4% Malay, 29.8% Chinese, and 12.8% Indians, resembling the Malaysian HD population. The majority of the study respondents have completed secondary education (46.3%). The mean dialysis vintage was 67.2 ± 54.3 months. Most of them had rarely received dietary advice from healthcare professional (44.5%), high level of dietary knowledge (52.3%), high perceived benefit (72.5%), moderately high perceived barrier (38.1%), high perceived seriousness (74.3%), moderately low perceived susceptibility (35.3%), and moderately low perceived self-efficacy (42.0%) of dietary adherence as well as moderately high self-management skills (55.5%).

Limited nutrition literacy was evident in 46.3% of HD patients. Older age (β=-0.212, p=0.017), lower education level [no formal education (β=-0.143, p=0.039), primary education (β=-0.462, p<0.001), and secondary education (β=-0.277, p=0.001), as compared to tertiary education], shorter dialysis vintage (β=0.159, p=0.016), and have never received dietary advice from healthcare professional [as compared to "*every 2-3 months*" (β=0.160, p=0.040) and "*when blood tests showed abnormal results*" (β=0.160, p=0.040)], were the determinants of nutrition literacy. Overall the multiple regression model explained 34.4% of variance of the nutrition literacy. The prevalence of dietary non-adherence was estimated at 65.1% based on patients' self-report. Age (β=0.185, p=0.024), gender (β_{female}=0.227, p=0.001), and nutrition literacy (β=0.372, p<0.001) were independent predictors of dietary adherence. Nutrition literacy appeared as a stronger predictor than sociodemographic factors, explaining about 10% variance of the self-reported dietary adherence. The relationship between nutrition literacy and dietary adherence was mediated comparably by self-efficacy (*SIE*=0.186, BC 95% CI 0.110 - 0.280) and self-management skills (*SIE*=0.192, BC 95% CI 0.103 - 0.304). Conversely, dietary knowledge, perceived benefits, barrier, seriousness and susceptibility could not explain the relationship between nutrition literacy and dietary adherence.

In conclusion, limited nutrition literacy and dietary non-adherence are prevalent in Malaysian HD patients. Patients with older age, lower education level, shorter dialysis vintage and have never received dietary advice from healthcare professionals are at risk of limited nutrition literacy. Nutrition literacy is an independent predictor of dietary adherence in Malaysian HD patients. It is causally linked to dietary adherence through self-efficacy and self-management skills. Therefore, nutrition literacy-enhancing interventions targeting on self-efficacy and self-management skills should be considered in promoting dietary adherence among Malaysian HD patients.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Sarjana Sains

HUBUNGAN ANTARA LITERASI PEMAKANAN DAN PEMATUHAN DIET DALAM KALANGAN PESAKIT HEMODIALISIS DARI PUSAT DIALISIS TERPILIH DI KLANG VALLEY, MALAYSIA

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Literasi kesihatan yang rendah dan ketidakpatuhan diet ialah masalah kesihatan awam yang penting dalam kalangan pesakit hemodialisis (HD), terutamanya di negara-negara yang berpendapatan rendah dan sederhana, di mana sumber kesihatan dan pegawai dietetik adalah terhad. Literasi pemakanan merupakan salah satu jenis literasi kesihatan yang berkaitan dengan amalan pemakanan. Kebelakangan ini, literasi pemakanan dianggap sebagai faktor peramal bagi pematuhan diet dalam kalangan pesakit HD. Walaubagaimanapun, maklumat mengenai literasi kesihatan yang berkaitan dengan pemakanan dan pematuhan diet dalam kalangan pesakit HD di Malaysia adalah terhad. Kerangka teori telah mencadangkan mekanisme bagi menjelaskan hubungan berterusan daripada literasi kesihatan dan penentunya kepada pematuhan diet melalui faktor yang berkaitan dengan pesakit (iaitu pengetahuan, kepercayaan kesihatan, dan kemahiran pengurusan kendiri). Namun, hanya terdapat segelintir kajian empirikal untuk mengesahkan mekanisme tersebut. Oleh itu, kajian ini bertujuan untuk meneroka kerangka kemahiran literasi kesihatan yang sedia ada untuk (1) menentukan kadar literasi pemakanan yang rendah dan pematuhan diet, (2) mengenal pasti penentu literasi pemakanan, (3) mengkaji hubungan antara literasi pemakanan dan pematuhan diet, dan (4) menentukan mediator bagi hubungan antara literasi pemakanan dan pematuhan diet dalam kalangan pesakit HD di Malaysia.

Kajian keratan rentas ini telah dilakukan di sembilan buah pusat dialisis yang terpilih di Lembah Klang, Malaysia. Seramai 250 orang pesakit HD pelbagai etnik yang berumur ≥ 18 tahun, sedang menjalani rawatan HD tiga kali seminggu ≥ enam bulan, tanpa gangguan fizikal, masalah kognitif, penyakit terminal, telah dipilih secara rawak. Pengumpulan data dilakukan melalui kaedah temu bual bersemuka dengan menggunakan borang soal selidik separa berstruktur yang teleh diuji dan disahkan. Pematuhan diet dinilai dengan menggunakan borang soal selidik Pematuhan Penyakit Ginjal Peringkat Akhir (ESRD-AQ) dan juga paras kalium dan fosfat dalam darah. Kemahiran pengurusan kendiri dinilai oleh Skala Persepsi Pengurusan Diri Ginjal /

Dialisis (PKDSMS). Manakala, skala yang dihasilkan dan disahkan sendiri iaitu DSNLS, DDKQ dan DDHB, digunakan untuk menguji literasi pemakanan, pengetahuan diet dan lima konstruk kepercayaan kesihatan berdasarkan Model Kepercayaan Kesihatan (HBM), termasuk i) tanggapan faedah, ii) tanggapan halangan, iii) tanggapan keterukan, iv) tanggapan kemungkinan, dan v) tanggapan keyakinan diri. Perisian IBM SPSS versi 25 dan Smart PLS versi 3 digunakan untuk menganalisis data. Hipotesis nul diuji berdasarkan keputusan regresi linear berganda dan "partial least squares structural equation modeling".

Seramai 218 orang pesakit HD telah menyertai kajian ini. Mereka terdiri daripada 53.2% lelaki dan mempunyai purata umur 54.8 ± 12.8 tahun. Taburan peserta mengikut etnik terdiri daripada 56.4% Melayu, 29.8% Cina, dan 12.8% India, selaras dengan taburan etnik pesakit HD di Malaysia. Majoriti responden mempunyai tahap pendidikan menengah (46.3%). Purata tempoh dialisis ialah 67.2 ± 54.3 bulan. Sebilangan besar daripada mereka jarang mendapat nasihat pemakanan daripada anggota kesihatan (44.5%) dan mempunyai tahap pengetahuan pemakanan yang tinggi (52.3%), tanggapan faedah yang tinggi (72.5%), tanggapan halanggan yang sederhana tinggi (38.1%), tanggapan keterukkan yang tinggi (74.3%) , tanggapan kemungkinan yang sederhana rendah (35.3%), tanggapan keyakinan diri yang sederhana rendah (42.0%) terhadap pematuhan diet serta kemahiran pengurusan kendiri yang agak tinggi (55.5%).

Seramai 46.3% pesakit HD didapati mempunyai tahap literasi pemakanan yang rendah. Pesakit berusia (β = -0.212, p = 0.017) dan mereka yang mempunyai tahap pendidikan yang rendah [tanpa pendidikan formal (β = -0.143, p = 0.039), pendidikan rendah (β = -0.462, p <0.001), dan pendidikan menengah (β = -0.277 , p = 0,001), dibandingkan dengan pendidikan tinggi], tempoh dialisis yang singkat (β = 0,159, p = 0,016), dan tidak pernah menerima nasihat pemakanan daripada anggota kesihatan [berbanding dengan "setiap 2-3 bulan" (β = 0.60, p = 0.040) dan "ketika ujian darah tidak normal" (β = 0.160, p = 0.040)] adalah penentu literasi pemakanan yang rendah. Secara keseluruhan, model regresi berganda menjelaskan 34.4% variasi terhadap literasi pemakanan. Kadar ketidakpatuhan diet dianggarkan sebanyak 65.1% berdasarkan penilaian kendiri pesakit. Umur (β = 0.185, p = 0.024), jantina (β_{wanita} = 0.227, p = 0.001), dan literasi pemakanan (β = 0.372, p <0.001) adalah peramal bebas pematuhan diet. Literasi pemakanan merupakan faktor peramal kepada pematuhan diet yang lebih kuat berbanding dengan faktor sosiodemografi, menjelaskan 10.0% variasi terhadap pematuhan diet. Hubungan antara literasi pemakanan dan pematuhan diet dimediasi oleh tanggapan keyakinan diri (*SIE* = 0.186, BC 95% CI 0.110 - 0.280) dan kemahiran pengurusan kendiri (*SIE* = 0.192, BC 95% CI 0.103 - 0.304). Sebaliknya, pengetahuan diet, tanggapan faedah, tanggapan halangan, tanggapan keterukan dan tanggapan kemungkinan tidak dapat menjelaskan hubungan antara literasi pemakanan dan pematuhan diet.

Kesimpulannya, masalah literasi pemakanan yang rendah dan ketidakpatuhan diet banyak berlaku dalam kalangan pesakit HD di Malaysia. Pesakit yang berusia, tahap pendidikan yang lebih rendah, tempoh rawatan dialisis yang singkat dan tidak pernah menerima nasihat pemakanan daripada anggota kesihatan berisiko mengalami masalah literasi pemakanan yang rendah. Literasi pemakanan merupakan peramal bebas kepada pematuhan diet dalam kalangan pesakit HD di Malaysia. Tanggapan keyakinan diri dan kemahiran pengurusan kendiri menjelaskan hubungan antara literasi pemakanan dan

pematuhan diet. Oleh itu, intervensi bagi meningkatkan literasi pemakanan haruslah menekankan pada tanggapan keyakinan diri dan kemahiran pengurusan kendiri dalam usaha mempromosikan pematuhan diet dalam kalangan pesakit HD di Malaysia.

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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 Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

1DDR	One Day Diet Recall
3DDR	Three Day Diet Recall
ADPKD	Autosomal Dominant Polycystic Kidney Disease
AMA	American Medical Association
ANOVA	Analysis of Variance
AVE	Average Variance Extracted
B	Unstandardized Regression Coefficient
BC 95% CI	Bias-corrected 95% Confident Interval
BA	Perceived Barrier
BCM	Body Composition Monitor
BE	Perceived Benefit
BHLS	Brief Health Literacy Screen
BIA	Bio-electrical Impedance Analysis
BMI	Body Mass Index
CCA	Confirmatory Composite Analysis
CKD	Chronic Kidney Disease
CMV	Common Method Variance
CR	Composite Reliability
CVI	Content Validity Index
DA	Dietary Adherence
DCHOI	Dietary Carbohydrate Intake
df	Degree of Freedom
DFI	Dietary Fat Intake
DEI	Dietary Energy Intake
DD	Dialysis Day
DDFQ	Dialysis Diet and Fluid Non-adherence Questionnaire
DDHBQ	Dialysis Diet Health Belief Questionnaire
DDKQ	Dialysis Diet Knowledge Questionnaire
DK	Dietary Knowledge
DKI	Dietary Potassium Intake
DNAI	Dietary Sodium Intake
DPHOSI	Dietary Phosphorus Intake
DPI	Dietary Protein Intake
DSNLS	Dialysis-specific Nutrition Literacy Scale
DV	Dependent Variable
EF	Perceived Self-Efficacy
EI:BMR	Energy Intake to Basal Metabolic Rate Ratio
ESRD	End-stage Renal Disease
ESRD-AQ	End-stage Renal Disease Adherence Questionnaire
etc.	Et cetera
F	F-test Value
FCCHL	Functional, Communicative, and Critical Health Literacy Scale
FFQ	Food Frequency Questionnaire
FL	Factor Loading
FP	Food Preference
FPSK, UPM	Faculty of Medicine and Health Sciences, Universiti Putra Malaysia
G	Glomerular Filtration Rate Category

GFR	Glomerular Filtration Rate
HBE	Harris-Benedict Equation
HBM	Health Belief Model
HBV	High Biological Value
HELIA	Health Literacy for Iranian Adults
HD	Hemodialysis
HLS-14	Health Literacy Scale-14
HLS-EU-Q	The European Health Literacy Questionnaire
HLQ	Health Literacy Questionnaire
HTMT	Heterotrait-Monotrait Ratio of Correlations
ICCs	Intraclass Correlations
I-CVI	Item-level Index of the Instrument
i.e.	That is
IOM	Institute of Medicine
IQR	Interquartile Range
ISAK	International Society for the Advancement in Kinanthropometry
IV	Independent Variable
K+	Serum Potassium
KB	Perceived Knowledge Barrier
KDIGO	Kidney Disease Improving Global Outcomes
Kt/V	Dialysis Adequacy
LB	Lower Bound
LFC	Limited Food Choices
LMIC	Low-and-Middle-Income Countries
MAM	Multidimensional Adherence Model
MLR	Multiple Linear Regression
MNT	Medical Nutrition Therapy
MREC	Medical Research and Ethnic Committee
MyFCD	Malaysian Food Composition Database
NA	Not Applicable
ND	Non-dialysis Day
NGO	Non-government Organization
NHMS	National Health and Morbidity Survey
NKF KDOQI	National Kidney Foundation Kidney Disease Outcome Quality Initiative
NL	Nutrition Literacy
NMRR	National Medical Research Register
NVS	Newest Vital Sign
p	Significant Value
PEW	Protein-energy Wasting
PD	Peritoneal Dialysis
PKDSMS	Perceived Kidney Disease Self-Management Scale
PLS-SEM	Partial Least Squares Structural Equation Modeling
PO43-	Serum Phosphate
PPD	Pusat Perubatan Dialisis
r	Pearson Correlation Coefficient
R2	Coefficient of Determination
REALM	Rapid Estimate of Adults Literacy in Medicine
RRT	Renal Replacement Therapy
S-CVI	Scale-level Index of the Instrument
S-CVI/Ave	Scale-level Index of The Instrument (Average)

SE	Perceived Seriousness
SD	Standard Deviation
SIE	Specific Indirect Effect
SMS	Self-management Skills
SPSS	Statistical Package for the Social Sciences
SU	Perceived Susceptibility
t	t-test value
TOFHLA	Test of Functional Health Literacy in Adults
TEM	Technical Error of Measurement
UB	Upper Bound
USRDS	United States Renal Data System
VIF	Variance Inflation Factor
WHO	World Health Organization
WK	Weekend

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

According to Kidney Disease Improving Global Outcomes (KDIGO, 2013), chronic kidney disease (CKD) is defined as kidney damage for more than three months. It is denoted by a measured glomerular filtration rate (GFR) lesser than 60ml/min/1.73m^2, as shown in Table 1.1. It describes a chronic condition in which the renal functions deteriorate progressively and irreversibly over time.

Table 1.1: Stages of CKD according to KDIGO (2013)

CKD Stage	GFR Categories (ml/min/1.73m^2)	Description
G1	≥ 90	Normal or high
G2	89-60	Mildly decreased
G3a	59-45	Mildly to moderately decreased
G3b	44-30	Moderately to severely decreased
G4	29-15	Severely decreased
G5	<15	Kidney failure
G5D	N/A	Chronic dialysis
G5T	N/A	Kidney transplantation

Notes: G stands for glomerular filtration rate category; neither GFR category G1 nor G2 fulfils the criteria of CKD in the absence of kidney damage evidence; D stands for dialysis; T stands for transplantation; N/A: Not applicable

The epidemic of CKD affected 11.0% -13.0% of the global population (Hill et al., 2016) and accounted for 1.2 million of annual healthy life lost worldwide (Wang et al., 2016). In Malaysia, the prevalence of CKD was estimated at 9.07 % (Hooi et al., 2013). It was recognized as the 7th leading cause of death by mortality rate in Malaysia from 2007 to 2017 (Institute for Health Metrics and Evaluation, 2018).

Over the illness trajectory, the kidney function of CKD patients would deteriorate progressively until the development of end-stage renal disease (ESRD). It refers to a condition in which the kidney functions are severely jeopardized, as denoted by a glomerular filtration rate lesser than 15 ml/min/1.73m^2 (Table 1.1) for more than three months (KDIGO, 2013). ESRD is a devastating public health issue, affecting more than 2 million individuals worldwide (Liyanage et al., 2015). According to the annual report of the United States Renal Data System (USRDS, 2018), Malaysia was ranked as the 8th country that recorded the highest incidence rate of ESRD in 2016 (i.e., 259 per million population). As a result of the ageing population and endemic diabetes, the incidence and prevalence of ESRD in Malaysia have increased drastically over the years. According to the 24th report of the Malaysian Dialysis and Transplant Registry in 2016, the national burden of dialysis has increased drastically from 17,097 patients in 2007 to 39,711

patients in 2016 (National Renal Registry, Malaysian Society of Nephrology, 2018). On top of that, it is forecast to increase further by 231.8% over the next two decades (Bujang et al., 2017a).

As a result of kidney failure, ESRD patients lose the ability to excrete toxic substances and fail to regulate the normal level of electrolytes. Thus, ESRD patients are required to undergo renal replacement therapy (RRT) to sustain life. Examples of RRT include hemodialysis (HD), peritoneal dialysis (PD), and kidney transplant. HD is the most common RRT for ESRD patients around the globe (USRDS, 2018). In Malaysia, as a result of the rapid growth of non-government organisations (NGOs) and private HD centres, approximately 90.0% of dialysis patients were receiving HD treatment in 2017 (National Renal Registry, Malaysian Society of Nephrology, 2018).

Notwithstanding, a typical 4-hour and thrice-weekly HD treatment alone is not sufficient to get rid of the accumulated toxic substances from the body (Achinger & Ayus, 2005). Therefore, in adjunct to dialysis treatment, ESRD patients would need to adhere to a variety of self-management activities such as taking prescribed medication, modifying diet as well as restricting fluid intake. This is challenging as it depends primarily on the patient's initiative to engage with these activities rather than receiving direct care from healthcare professionals (Lin et al., 2012). Failure to do so might predispose HD patients to a myriad of severe health complications, including cardiovascular events (Luo et al., 2015), frequent hospitalisation (Saran et al., 2003), and increased mortality (Miller, 2016).

Self-management activities in CKD care are getting more complex as the disease progresses. For instance, dialysis patients are required to adhere to a stricter diet and fluid regimens than CKD patients in their early stages (Kalantar-Zadeh & Fouque, 2017). Also, given the difference in treatment frequency (i.e., thrice-weekly for HD *vs* daily for PD), HD patients are required to adhere to a more restrictive dietary and fluid regimen than PD patients to prevent the excessive interdialytic accumulation of toxic wastes and fluid (Kopple, 2001). As a result, HD patients must possess adequate health literacy skills to acquire, process, and to act on complicated health-related information to manage their health conditions.

Health literacy is defined as "*the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions"* (Ratzan and Parker, 2000). Given the limited health resources, individuals in low-and-middle-income countries (LMIC) are prone to exhibit limited health literacy (World Health Organization [WHO], 2015). For instance, as an upper-middle-income country, Malaysia recorded a prevalence rate of 35.1% for limited health literacy in 2019 (National Health and Morbidity Survey [NHMS], 2019).

Health literacy research opens up a new line of inquiry. It has been applied to diverse research areas, including health promotion (Nutbeam et al., 2018), health behaviour (Aaby et al., 2017), health outcome (Berkman et al., 2011), and treatment adherence (Miller, 2016). The importance of health literacy in renal care has been underscored by

its consistent associations with health outcomes in CKD patients (Devraj & Gordon, 2009; Dageforde & Cavanaugh, 2013). HD patients with limited health literacy have been shown to experience greater difficulty in accessing and understanding health information, leading to mediocre self-management skills (Narva et al., 2015) and suboptimal treatment adherence (Green et al., 2013; Qobadi et al., 2015; Skoumalova et al., 2019).

Recently, the health literacy research paradigm has been extended into the field of nutrition and dietetics, giving rise to the term nutrition-specific health literacy or "nutrition literacy" in short (Velardo, 2015). It is a specific type of health literacy and well cited in the literature concerning eating practices (Cullen et al., 2018). Given its significant association with healthy dietary habits (Silk et al., 2008), Carbone & Zoellner (2012) have called for future studies to incorporate nutrition literacy into nutrition research and dietetics practice.

1.2 Problem Statement

Treatment adherence is essential for a successful HD treatment (Kugler et al., 2011; Unruh et al., 2005). Unfortunately, the problem of treatment non-adherence is pervasive among HD patients, posing on-going challenges to the global healthcare system (Chironda & Bhengu, 2016). Among treatment dimensions, the diet component is one of the most salient non-adherence treatment domains in the HD population (Daniels et al., 2018; Naalweh et al., 2017), attributed to its complexity and highly restrictive regimen (Biruete et al., 2017). For instance, the global prevalence of dietary non-adherence in HD patients ranged from 41.1-98.3% (Gebrie & Ford, 2019). In Malaysia, only about 27.7 % of HD patients adhered to the renal diet regimen (Chan et al., 2012).

In this regard, understanding factors contributed to poor dietary adherence in HD patients is imperative. Dietary adherence is a multifactorial problem, whereby a plethora of factors have been reported in the literature, varying with study locations and populations (Lambert et al., 2017). Generally, they can be classified into five domains, i) patient-related factors, ii) condition-related factors, iii) treatment-related factors, iv) healthcare system-related factors, and v) socio-economic factors (WHO, 2003). Nonetheless, there is a paucity of information regarding predictors of dietary adherence in Malaysian HD patients. To date, only socio-economic factors (i.e., age, sex, and employment status) have been revealed as the determinants of dietary adherence in Malaysian HD patients (Chan et al., 2012). Thus, there is a noteworthy knowledge gap about the influence of other factors on dietary adherence among HD patients in the local context.

Recently, a growing body of research has demonstrated the significant relationship between health literacy and dietary adherence in the HD population (Skoumalova et al., 2019; Lim et al., 2019; Indino et al., 2019). Notwithstanding, evidence in the literature were mixed as to whether health literacy could significantly predict dietary adherence in HD patients (Mazarova et al., 2017; Yang et al., 2019). This was in tune with a systematic review of health literacy and nutrition-related treatment adherence (Carrara & Schulz, 2018). Therefore, such a relationship warrants further investigation.

Besides the direct relationship, health literacy is also believed to exert an indirect effect on health behaviours through mediation as theorized by the health literacy skills framework (Squiers et al., 2012). Yet, empirical study to address such a mechanism in the HD population was scarce (Qobadi et al., 2015; Lim et al., 2019). Furthermore, the available evidence was not convincing due to the study limitations related to the instrument (i.e., single-dimensional health literacy assessment) and small sample size. Moreover, the statistical approach (i.e., Sobel test) used by the studies above in performing mediation analysis may not have been appropriate (Hayes, 2009).

In addition, the health literacy skills framework also posits the determinants of health literacy as part of the relationship continuum between health literacy and health behaviours. However, little is known in the local context as no study has ever reported the health literacy level of Malaysian HD patients and its associated factors in the literature. Hence, the theoretical generalizability of this health literacy skills framework (Squires et al., 2012) to the Malaysian HD population remains unknown.

Taken together, this study aimed to establish the causal model linking nutrition literacy to dietary adherence in the HD population by exploring an existing health literacy skills framework (Squires et al., 2016) using a robust statistical analysis (Sarstedt et al., 2020). This is to advance the understanding of the relationship between nutrition literacy and dietary adherence, which can serve as a basis to design intervention strategies to promote dietary adherence in the HD population.

1.3 Significance of the Study

To the best of our knowledge, this is the first theory-driven research to address the nutrition literacy for Malaysian HD patients and its causal relationship with dietary adherence. Given the use of appropriate inferential statistics using the probability sampling method, adequate response rate, and good sample representative with regards to ethnicity distribution, the results of this study have the potential of generalization (external validity) to reflect the Malaysian HD population at large. The findings of this study can help to inform policymakers as well as healthcare practitioners, such as nephrologists, dietitians, nurses, and dialysis technicians, regarding the essential role of nutrition literacy in patient-centred care for promoting dietary adherence in the Malaysian HD population.

Besides, this study has made several contributions to the literature. Firstly, this study provides empirical evidence to support the theoretical generalizability of the health literacy skills framework for the HD population. This study also addresses the ambiguous relationship between health literacy and dietary adherence in HD patients. In addition, our findings disentangle the unknown interrelationship between sociodemographic background, medical history, nutrition literacy, dietary knowledge, health belief, self-management skills, and dietary adherence by exploring the health literacy skills framework. This advances the understanding of how health literacy links to dietary adherence in the HD population.

The causal model established in this study can serve as a framework to guide future interventions to improve dietary adherence in the HD population. Besides, this study has also developed and validated questionnaires and scales psychometrically to assess nutrition literacy, dietary knowledge, and health belief for Malaysian HD patients, which can be adopted and modified in the future study.

1.4 Research Questions

1. What are the sociodemographic factors, medical history, accessibility to dietary advice, nutrition literacy, dietary knowledge, health belief, self-management skills, and dietary adherence among HD patients in Klang Valley?
2. What are the prevalence rates of limited nutrition literacy and dietary non-adherence among HD patients in Klang Valley?
3. What are the determinants of nutrition literacy among HD patients in Klang Valley?
4. Is nutrition literacy an independent predictor of dietary adherence among HD patients in Klang Valley?
5. What are the mediators for the relationship between nutrition literacy and dietary adherence among HD patients in Klang Valley?

1.5 Research Objective

1.5.1 General Objective

To investigate the relationship between nutrition literacy and dietary adherence among HD patients from selected dialysis centers in Klang Valley.

1.5.2 Specific Objectives

1. To determine the sociodemographic factors, medical history, accessibility to dietary advice, nutrition literacy, dietary knowledge, health belief, self-management skills, and dietary adherence among HD patients in Klang Valley.
2. To determine the prevalence rates of limited nutrition literacy and dietary non-adherence among HD patients in Klang Valley.
3. To determine the determinants of nutrition literacy among HD patients in Klang Valley.
4. To determine the predictive role of nutrition literacy on dietary adherence among HD patients in Klang Valley.
5. To determine the mediating roles of dietary knowledge, health belief, self-management skills on the relationship between nutrition literacy and dietary adherence among HD patients in Klang Valley.

1.6 Research Hypotheses

1. Sociodemographic factors, medical history and accessibility to dietary advice are determinants of nutrition literacy among HD patients in Klang Valley.
2. Nutrition literacy can significantly predict dietary adherence among HD patients in Klang Valley.
3. Dietary knowledge, health belief, and self-management skills mediate the relationship between nutrition literacy and dietary adherence among HD patients in Klang Valley.

1.7 Conceptual Framework of the Study

The conceptual framework (Figure 1) steered the study toward achieving the research objectives. It was underpinned by a health literacy skills framework, according to Squier et al., (2012), together with empirical findings from the literature. There are four main components in the conceptual framework, including determinants (factors that are associated with nutrition literacy), the independent variable (nutrition literacy), mediators (factors that connect nutrition literacy to dietary adherence), and the dependent variable (dietary adherence). This conceptual framework can be divided into two halves. The 1st half involves hypothesis testing for determinants of nutrition literacy (objective 3). Factors associated with health literacy among HD patients in the literature were incorporated. These include i) sociodemographic factors (i.e., gender, age, ethnicity, education level, marital status, income, and employment status), ii) medical history (i.e., dialysis vintage and comorbidities), and iii) accessibility to dietary advice. In contrast, the 2nd half involves hypothesis testing of causal pathways connecting nutrition literacy to dietary adherence in HD patients (objectives 4 and 5). Potential mediators (i.e., dietary knowledge, health belief, and self-management skills) that exerted significant relationships with health literacy and dietary adherence among HD patients in the literature were included.

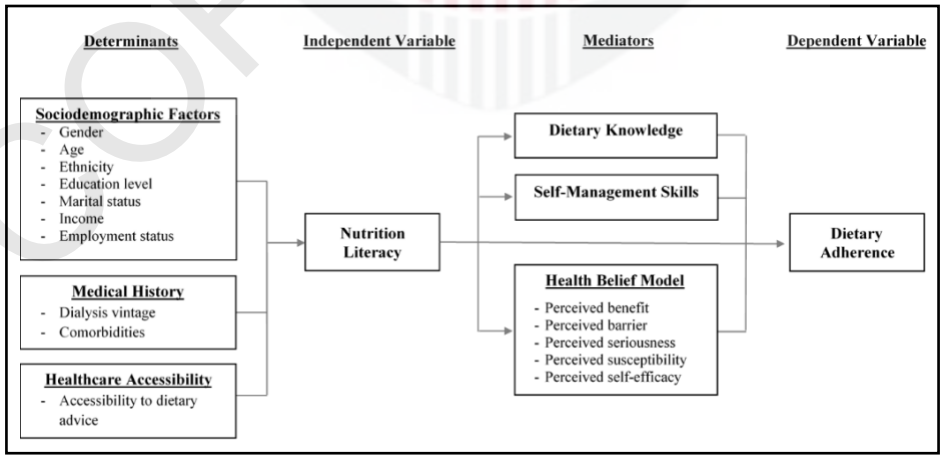

Figure 1.1: Conceptual Framework of the Study (adapted from Squires et al., 2012)

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BIODATA OF STUDENT

The student Lim Jun Hao was born in 1992. He received his primary education at S.J.K (C) Panchor, secondary education and pre-University (form 6) at S.M.K Munshi Sulaiman, Batu Pahat, Johor. He was a JPA scholar and has completed his bachelor's degree of Dietetics with Honours with Distinction (First Class Honours) from Universiti Sultan Zainal Abidin (UniSZA), Terengganu in 2016. He has humbly received "the best Dietetics students" award by Faculty of Health Sciences, UniSZA.

Before pursuing his master's degree of science at Universiti Putra Malaysia (UPM), he was actively involved in research. He has joined a nationwide research entitled "*Evaluation of Food Basket Programme for Malnourished Children, PPKZM*" collaborated by UPM and Ministry of Health (MoH), travelling to Sabah about 6 months for data collection. After that, he assisted a large scale randomized clinical trial which aimed to investigate the effects of Palm Tocotrienol (Vitamin E) in Chronic Hemodialysis (PATCH) study for about 2 years while doing his master study, from which he developed his research interest on hemodialysis patients.

The student is passionate about health pedagogy and education tool development. He is the cofounder of "*MyNutriKidney App*", which is a personalized nutrition tool to empower dietary self-management for patients with chronic kidney disease (CKD). Under the guidance of his supervisor, he has received Putra research grant (IPM) from UPM for the app development and evaluation. In addition, he was also involved in the development of a patient education booklet entitled "*Food Phosphate Guide for CKD Patients*". Besides that, he also has strong interests in health behaviour theory and applied statistics especially the application of Structural Equation Modeling (SEM) in studying patient's behaviour.

Throughout his postgraduate journey, he has received Graduate Research Fellowship (GRF) from UPM. Besides, he was also a recipient of *"Tabung Pendidikan Sarjana Johor, 2018"*. He has received education grant from Malaysian Dietitians' Association (MDA) to attend the 19th International Congress on Nutrition and Metabolism in Renal Disease (ICRNM) in Genova, Italy as poster presenter.

He is dedicated about research contribution by sharing his research findings and product in international and national conferences. He also involves in the peer review process for the Journal of Medical Internet Research (JMIR), a prestigious and leading journal in digital health. He wishes to continually contribute to research, dietetics profession, and patients in the future.

PUBLICATION

Lim, J.H., Chinna, K., Khosla, P., Karupaiah, T., & Daud, Z.A.M. (2020). Understanding How Nutrition Literacy Links to Dietary Adherence in Patients Undergoing Maintenance Hemodialysis: A Theoretical Exploration using Partial Least Squares Structural Equation Modeling. *International Journal Of Environmental Research And Public Health*, *17*(20), 7479. https://doi.org/10.3390/ijerph17207479