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Nutritional Status, Dietary Intake and Body Composition

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Nutrition governance, good governance for nutrition and nutritional status of children under five years of age in Laguna, Philippines

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ABSTRACT

Introduction: Governance affects nutrition improvement. This study aimed to determine the association between nutrition governance (NG), nutritional status (NS) of children under five years (CU5) and good governance for nutrition (GGN) in Laguna, where malnutrition is a chronic problem. **Methods:** This cross-sectional study obtained data from thirty cities and municipalities (C/M) using desk review and face-to-face interviews. A developed scorecard generated NG and GGN data using 3-point scale with "0" as lowest/absence to "1" indicating partial to "2" as highest/full compliance. Total NG scores was 26 while 38 for GGN. NS was determined using Operation *Timbang* Plus data. Spearman's rank analysis statistically determined the associations between NG, NS, and GGN. **Results:** Underweight and wasting prevalence were low (6.1% and 3.4%) while stunting was high (17.7%). The median percentage scores of C/M on NG and GGN were 73.0%±14.0% and 82.0%±24.0%, respectively. Rosa City and Kalayaan had the highest NG score and the lowest underweight prevalence in urban and rural areas, respectively. Significant but negative associations were found between NG and underweight (r=-0.729, p<0.001), and stunting (r=-0.753, p<0.001). Likewise, GGN and underweight (r=-0.488, p=0.006), and stunting (r=-0.380, p=0.046) showed negative associations. **Conclusion:** C/M in Laguna with higher NG and GGN scores have lower CU5 underweight and stunting prevalence. The study recommended to local governments to invest in establishing separate nutrition unit, hiring technical and administrative staffs, formulating vision and mission, and building capacity on nutrition programme management.

Keywords: Nutrition governance, good governance for nutrition, underweight, stunting

INTRODUCTION

The developmental, economic, social and medical impacts of undernutrition are serious and lasting for countries (WHO, 2016). In 2013, roughly 161 million children under-five years of age (CU5) worldwide were found to be stunted, 99 million underweight and

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51 million wasted. The Philippines ranked 9th among the countries with the highest burden of stunting and 10th with the highest burden of wasting (Save the Children, 2015). A medium magnitude of underweight (19.9%), a high magnitude of stunting (30.3%), and a low magnitude of wasting (7.3%) were reported in the Philippines 8th National Nutrition Survey of Food and Nutrition Research Institute, FNRI (2013).

Child undernutrition is a result of insufficient nutrition intake and frequent infections. It impacts mental function and contributes to poverty by impeding individual's ability to lead productive lives that contributes to the continuing cyclical nature of poverty (UNICEF, WHO and World Bank, 2012). On the other hand, addressing malnutrition has multiple benefits such as preventing more than a third of child deaths per year; increasing gross national product by 11% in Asia; reducing burden of disability for children under-four years old by more than half; increasing school attainment by at least one year; and increasing wage rates by 5% to 50% (Haddad *et al.*, 2013). Both the strong evidences of the damage caused by undernutrition and the multiple benefits in reducing undernutrition led to the emergence of nutrition governance (Gillespie, 2013).

There have been many studies (Gillespie, 2013; Taylor, 2012; Mohmand, 2012; Acosta, 2011; Solon, 2006) and reports (e.g. IFPRI, 2015; WHO, 2013; UNICEF, 2012; WHO, 2009) about nutrition governance. Describing the operation of nutrition governance is important as it is a basic determinant of malnutrition that could influence the underlying and intermediate causes of malnutrition, based on the UNICEF Framework in 1990.

Nutrition governance encompasses processes and institutions, in which stakeholders articulate their interests, exercise their legal rights, meet their obligations, and mediate their differences to serve the needs of the people and solve their nutrition problems. On the other hand, good governance for nutrition entails four key elements such as efficiency, accountability, transparency, and participation that are important for sound plans and implementation of nutrition interventions. These are based on the United Nation Development Programme's (UNDP) definition of governance and World Bank, UNDP, Asia Development Bank (ADB), and Organisation for Economic Co-operation and Development's (OECD) views on good governance, applied in the context of nutrition.

The two concepts differ in terms of their focus areas. Nutrition governance pertains to the processes and institutions of decision-making to solve nutrition problems, while good governance for nutrition focuses on the quality of nutrition service delivery. Both concepts at the city and municipal level have not been thoroughly examined yet in the Philippines

Most of the nutrition governance studies were conducted at the international and national levels. Governance at the local level should also be investigated, since it is through the cities and municipalities by which linkage between the local government and non-government organisations is established. Furthermore, achievement of national nutrition goals may be seen as the interaction of nutrition governance and children's nutritional status at the local level.

This study aimed to determine the association between nutrition governance, nutritional status of CU5 and good governance for nutrition in Laguna. Specifically, the study aimed to describe the prevalence of underweight, stunting, and wasting among CU5 using Operation *Timbang* data; and

detailed the nutrition governance and good governance for nutrition in Laguna using the developed scorecard.

MATERIALS AND METHODS

Research design and sampling procedure

This cross- sectional study was conducted in Laguna, one of the provinces in CALABARZON or Region IV-A. The study covered all its six cities and 24 municipalities. Laguna was selected due to access to the study areas, limited study related to nutrition governance conducted in the past years, and varying capacity of its cities and municipalities to implement nutrition programmes in terms of human, natural, social, and financial resources. These criteria were considered to achieve the feasibility and objectives of the study.

Data collection procedure

The study utilised desk review and survey methods in data gathering. The survey data were used in ranking the cities and municipalities in Laguna based on their nutrition governance and good governance for nutrition scores.

Desk review

According to the Department of the Interior and Local Government (DILG) Guide to comprehensive development plan preparation for local government unit in 2009, cities and municipalities are expected to more effectively manage their own local development with the aid of various plans, such as the comprehensive land use plan (CLUP), city/municipal comprehensive development plan (C/MDP), executive legislative agenda (ELA), and annual investment plan (AIP). The CLUP is a long-term plan embodying programmes, projects and activities (PPAs) for physical development of city or municipality territory. On the other hand, the C/MDP is a 6- or 3-year plan (medium- or short-term) utilised by every city and municipal administration to develop and implement priority sectoral and cross-sectoral PPAs. In order to ensure that CLUP and C/MDP are implemented and monitored, the ELA provides a 3-year development roadmap that is mutually developed and agreed upon by both the executive and legislative departments, based in the context of vision, goals, and objectives of cities and municipalities. The AIP provides the total resource requirements for the budget year, including the detailed annual allocation for PPA (DILG, 2009).

Aligned with the C/MDP, the city/municipal nutrition action plan (C/MNAP) covers a 3-year plan containing the objectives and nutrition interventions that will be implemented to address the malnutrition problem at the city and municipal level. The C/MNAP operationalises the Philippine Plan of Action for Nutrition at the city and municipal level (NNC, 2012). As a basis to formulate the C/MNAP, the Operation *Timbang* (OPT) report provides information on the prevalence of malnutrition among CU5 in cities and municipalities; and aid in identifying underweight, wasted, and stunted CU5 and locating families with malnourished CU5 (NNC, 2012).

These documents provide secondary data related to the socioeconomic and demographic profiles of cities and municipalities, nutrition governance, good governance for nutrition, and nutritional status of CU5 that are used in desk review. the Philippine Standard Geographic Code (PSGC) Interactive of Philippine Statistics Authority, C/MDP, CLUP, ecological profile and OPT report were reviewed to determine the socioeconomic and demographic profile of the province. In order to identify and discuss the type of integration of C/MNAP into other local development

plans, the 2014 C/MNAP, ELA, AIP, C/MDP and CLUP were reviewed.

Local ordinances or resolutions on infant and young child feeding, micronutrient supplementation, food fortification, salt iodisation, food security, and nutrition and infections were reviewed to determine the legal basis of nutrition programmes implemented in the province.

Data on organisational structure were collected from the organisation charts of the city/municipal nutrition committee (C/MNC) to determine the number and composition of membership; as well as the vision and mission statements which may be posted in the bulletin board and/or documented in the C/MNAP. Data on the nutrition resources were obtained from physical evidences of nutrition offices manned with administrative support staff; and 2014 annual investment plan and/or report on the local budget for nutrition to determine fund sources.

Percent coverage of ten nutrition programmes implemented in cities and municipalities were collected from the 2014 accomplishment and documentation reports. The 2014 local budget for nutrition was reviewed to determine the funds released for nutrition. The minutes of the quarterly C/MNC meetings and the accompanying attendance sheets were gathered as well.

The total number of CU5 as well as the prevalence rates of stunting, wasting and underweight among CU5 were collected from the 2014 OPT report. The prevalence rates were classified according to its magnitude or severity based on WHO reference standards (1995).

Survey

Thirty (30) C/MNAOs were interviewed. The C/MNAO is the focal point person on nutrition in city / municipality. Informed consent was requested from the C/MNAOs before the interview. Data gathered during the interview were the socio-demographic profile of C/MNAOs, their understanding of the concept of nutrition governance, the general functions of C/MNCs and the strengths, weaknesses and actions for improvement in each performed function; incentives and rewards for Barangay Nutrition Scholars (BNS); as well as the proposed budget for nutrition by C/MNAOs.

Data collection tools

Two data collection tools were used in the survey, namely, the scorecard and the interview questionnaire. A scorecard was developed to quantify nutrition governance and good governance for nutrition using a scaling technique. The scorecard comprised four sections: 1) nutrition policies and programmes, 2) organisational structure and resources for nutrition, 3) efficiency and 4) accountability, transparency and participation. The first and second sections referred to nutrition governance while the third and fourth sections pertained to good governance for nutrition.

Both primary and secondary data were used as basis for scoring. Primary data were used for the items on functional C/MNCs, ratio of proposed budget for nutrition by C/MNAO to the released budget for nutrition by treasurer, BNS incentives and rewards and conduct of quarterly meetings. A 3-point scale was used, with “0” being the lowest/absence of compliance to “1” indicating partial compliance to “2” being the highest/full compliance. A total score of 26 points was given for nutrition governance, and 38 points for good governance for nutrition. Scores on nutrition governance and good governance for nutrition were classified as high if these were above the median score of cities and municipalities in Laguna, while below the median score was classified as

low. The scorecard was pre-tested in two cities and three municipalities in Cavite. Results of the reliability analysis showed that the Cronbach's alpha coefficient was high at 0.9805 for nutrition governance and 0.9769 for the quality of nutrition governance.

The interview questionnaire consisted of three sections. The first section was on the C/MNAO's profile which includes age, highest educational attainment, profession, position in city/ municipality, represented agency or unit office, type of work as C/MNAO based on time allotment, and length of service as C/MNAO. The second section referred to the C/MNAO's understanding on the concept of nutrition governance and the key elements in determining the quality of nutrition governance. The third section pertained to the operation of nutrition governance which involves strengths, weaknesses, and actions for improvement on each function performed by the C/MNC, BNS incentives and rewards, and practices on accountability, transparency and participation such as the number of times the C/MNC meet, and updating reports.

Data analysis

Descriptive statistics (frequency and percentage distribution, mean, median, standard deviation, and range) were used to analyse the socioeconomic and demographic characteristics of the cities and municipalities, sociodemographic profile of C/MNAOs, nutrition governance and good governance for nutrition scores of cities and municipalities, and nutritional status of CU5.

With the ordinal type of data generated and small-sized population, Spearman's Rank-Order Correlation was used to determine the association between nutrition governance, good governance for nutrition and nutritional status of children under-five year old (CU5) in Laguna. The level of significance was set at 5%.

RESULTS AND DISCUSSION

Socioeconomic and demographic profile of cities and municipalities in Laguna

Laguna covered a total land area of 1,917.85 km^2 as of 2007 based on Land Management Bureau as cited by NSCB (2010). The municipality of Cavinti (203.60 km^2) had the largest land area, while the municipality of Victoria (22.40 km^2) had the smallest land area. Rural areas covered 1,124.32 km^2, larger land area than the urban areas with 793.53 km^2.

Its total population was 2.67 million individuals as of May 1, 2010 based on the 2010 Census of Population and Housing as cited by NSCB (2010). The city with the largest population is Calamba (389,377 persons and 60,562 CU5), while the municipality with the least population is Famy (15,021 persons and 1,283 CU5). According to the Philippine Statistics Authority (2012), Laguna was the third most densely populated province in the country with 1,392 persons per km^2. The most densely populated city was San Pedro (12,238 persons per km^2), and Cavinti (103 persons per km^2) was the least densely populated municipality in the province.

Laguna had an annual income of Php 8.8 billion according to the Commission on Audit (COA) 2011 financial report. Majority (88.70 %) of the provincial's annual income was contributed by the Php 7.8 billion annual income of urban areas. The cities with the highest annual income in Laguna are Calamba (Php 1.9 billion), Sta. Rosa (Php 1.8 billion), and Biñan (Php 1.2 billion). The municipalities of Famy (Php 36 million), Rizal (Php 37 million), and Mabitac (Php 41 million) have the lowest annual income. The main economic sources of

urban areas are commerce and industry with a large percentage of industrial and manufacturing service sectors. On the other hand, the economy in the rural areas is highly dependent on agricultural, fishery and livestock production.

Sociodemographic characteristics of City/Municipal Nutrition Action Officers (C/MNAO)

All C/MNAOs in Laguna were in their middle adulthood stage. The oldest C/MNAO was 64 years old, while the youngest was 32 years old, with a mean age of 54±8 years (Table 1). Among the 30 C/MNAOs in Laguna, the proportion of bachelor's degree graduates was the largest (66.6%), followed by master's degree graduates (20.0%). There were equal proportions (6.7%) of C/MNAOs with doctorate degree units and master's degree/law units. With high level of education, C/MNAOs may have the capability to perform their roles and responsibilities.

The profession of C/MNAOs is classified based on the forty-three professional regulatory board of the Philippine Professional Regulation Commission. Majority (43.4%) of C/MNAOs in Laguna were not licensed nutritionists. Instead, they were Agriculturist (16.7%), Nurse (3.3%), Pharmacist (3.3%), Social worker (3.3%), Veterinarian (3.3%), Forester (3.3%), and Engineer (3.3%). Almost a quarter of the C/MNAOs (23.3%) did not have professional regulatory board because their pursued bachelor or master's degree (e.g. secretariat, home economics, English, and business management) are not included in the standards for board examination of Philippine Professional Regulation Commission.

Majority (66.7%) of the C/MNAOs in Laguna did not hold nutrition officer position in their city/municipality. Instead, they were heads of municipal offices of agriculture (23.3%), social welfare and development (3.3%), as well as planning and development (3.3%). Small percentages of the C/MNAOs were agricultural technologist (6.7%), administrative assistant (3.3%), social welfare officer/day care worker (10.0%), and nurse (3.3%). These C/MNAOs are commonly designated, particularly in rural areas. About 13.4% of them were designated as C/MNAOs without compensation. They worked voluntarily as C/MNAOs because they are close relatives or friends of the Mayor.

Nutrition is not commonly considered a separate department or unit in cities and municipalities. More than half (56.6%) of C/MNAOs in Laguna are working in various departments – agriculture (30.0%), social welfare and development (10.0%), health (10.0%), planning and development (3.3%), and population commission (3.3%).

More than half (53.3%) of C/MNAOs in Laguna work full time as designated C/MNAOs; and 33.3% of them are in the urban areas. In terms of length of service as C/MNAOs, less than half (46.7%) were designated for 1 to 11 years with median average of 16±10 years. The median length in service of designated C/MNAOs in urban areas (22±9) is double the median length in service of designated MNAOs in rural areas (11±10).

Nutritional status of children

Among the three forms of CU5 undernutrition, stunting had the highest median prevalence rate (17.8%); followed by underweight (6.2%) and wasting (4.4%). At the national level, FNRI-DOST (2013) reported similar findings that stunting is the most prevalent form of undernutrition in the Philippines at the rate of 30.3%.

Table 2 presents the ranking of cities and municipalities by nutritional status, and scores of nutrition governance and good governance for nutrition. The

Table 1. Sociodemographic characteristics of City/Municipal Nutrition Action Officers (C/MNAO) in Laguna

Characteristic	*Urban (n=13)*		*Rural (n=17)*		*Overall (n=30)*	
	n	*%*	*n*	*%*	*n*	*%*
Age range, years						
56-65	5	38.5	10	17.6	15	50.0
46-55	8	61.5	4	23.5	12	40.0
≤45	-	-	3	58.9	3	10.0
Mean (number of persons)	54±5		54±9		54±8	
Highest educational attainment						
Bachelor's degree graduate	9	69.2	11	64.7	20	66.6
Master's degree graduate	2	15.4	4	23.5	6	20.0
With master's degree/law units	1	7.7	1	5.9	2	6.7
Doctorate degree graduate	1	7.7	1	5.9	2	6.7
Profession						
Not Nutritionists (Agriculturist, Pharmacist, Nurse, Social worker, Midwife, Veterinarian, Forester, Engineer)	3	23.1	10	58.9	13	43.4
Nutritionists	7	53.8	3	17.6	10	33.3
Do not have Professional Regulatory Board	3	23.1	4	23.5	7	23.3
Position in city/municipality						
Nutrition officer	10	76.9	-	-	10	33.3
Heads of Municipal Agriculture/ Social Welfare/Planning and Development	1	7.7	8	47.1	9	30.0
Others (agriculture technologist, administrative assistant, nurse, social welfare officer/day care worker)	2	15.4	5	29.4	7	23.3
Designated as C/MNAO without compensation	-	-	4	23.5	4	13.4
Represented unit office						
Mayor	7	53.8	6	35.3	13	43.4
Agriculture	2	15.4	7	41.2	9	30.0
Social welfare and development	1	7.7	2	11.8	3	10.0
Health	2	15.4	1	5.9	3	10.0
Planning and development	-	-	1	5.9	1	3.3
Population commission	1	7.7	-	-	1	3.3
Type of appointment						
Full-time C/MNAO	10	76.9	6	35.3	16	53.3
Part-time C/MNAO	3	23.1	11	64.7	14	46.7
Length of service as C/MNAO, years						
1 – 11	4	30.8	10	58.9	14	46.7
12 – 22	5	38.4	4	23.5	9	30.0
23 – 34	4	30.8	3	17.6	7	23.3
Median (number of persons)	22±9		11±10		16±10	

Table 2. Ranking of cities and municipalities in Laguna by children's nutritional status, nutrition governance and good governance for nutrition

Rank	*Nutrition status*[†]			*Nutrition governance*[‡]	*Good governance for nutrition*[‡]
	Underweight	*Stunting*	*Wasting*		
1	Sta. Rosa	Cabuyao	Sta. Rosa	Sta. Rosa Calamba Pila	Kalayaan Pagsanjan
2	Cabuyao	Sta. Rosa	Cabuyao	Kalayaan Cabuyao Pagsanjan	Sta. Rosa Calamba
3	Pagsanjan	Calamba	Calamba	Biñan San Pablo	Biñan San Pablo Pangil
4	Los Baños	Biñan	Los Baños	Bay San Pedro	Cabuyao Pila San Pedro
5	Calamba	Pagsanjan	Rizal	Pangil Victoria	Alaminos Rizal Siniloan
6	Kalayaan	Pila	Santa Maria	Santa Cruz Los Baños Majayjay Nagcarlan	Mabitac Majayjay
7	Biñan	Santa Cruz	Pagsanjan	Alaminos Cavinti Famy Luisiana Lumban Mabitac Pakil Rizal	Victoria
8	Victoria	Los Baños	Biñan	Liliw Magdalena Sta. Maria Siniloan	Santa Cruz Nagcarlan
9	Bay	Rizal	Majayjay	Paete	Cavinti Pakil Bay
10	Pila	Liliw	Santa Cruz	Calauan	Luisina
11	Pakil	Majayjay	Mabitac		Liliw
12	Liliw	Bay	Pakil		Magdalena
13	Santa Cruz	San Pedro	Siniloan		Paete
14	San Pablo	Pangil	Nagcarlan		Lumban
15	Alaminos	Lumban	Lumban		Los Baños
16	Rizal	Nagcarlan	Pila		Famy
17	Majayjay	Cavinti	Cavinti		Santa Maria
18	Luisiana	Siniloan	Pangil		Calauan
19	Sta. Maria	Calauan	Liliw		
20	Lumban	Alaminos	Famy		
21	Nagcarlan	Mabitac	Alaminos		
22	Siniloan	Pakil	Calauan		
23	Cavinti	Santa Maria	San Pedro		
24	Calauan	Famy	Bay		
25	Pangil				
26	Mabitac				
27	Paete				
28	San Pedro				
29	Magdalena				
30	Famy				

[†]Lowest to highest prevalence rate

[‡]Highest to lowest scores

municipality of Famy had the highest prevalence rates of stunting (37.0%) and underweight (15.0%) CU5, while the municipality of Bay had the highest prevalence rate of wasting (10.3%). On the other hand, the city of Sta. Rosa had the lowest prevalence rates of wasting (1.1%) and underweight (1.0%) CU5 while the city of Cabuyao had the lowest prevalence rate of stunting (1.5%) CU5.

Ranking on nutrition governance, good governance for nutrition, and nutritional status

Sta. Rosa, Calamba, Pagsanjan, Cabuyao, and Biñan were among the top cities and municipalities with the highest level of nutrition governance and good governance for nutrition; and with the lowest prevalence of undernutrition.

Sta. Rosa, Calamba, Pagsanjan, Cabuyao, and Biñan had full integration of C/MNAP into their city/municipal plans and agenda, local ordinances on infant and young child feeding, full time C/MNAOs, and fund sources for nutrition action plan. They also had organised city/municipal nutrition committee with local government units (LGU) and NGO member agencies, except for the nutrition committee of Cabuyao which was composed of LGU members only. Except for Pagsanjan, all of them had fully functional nutrition committees; and established a separate nutrition office manned with full time administrative support staffs. Furthermore, all of them reviewed their own vision and mission statements for their C/MNC, except for Biñan.

Sta. Rosa, Calamba, Pagsanjan, Cabuyao, and Biñan had complete coverage of backyard gardening, supplementary feeding, and full immunisation programmes. Majority of them completely covered the target CU5 of vitamin A supplementation, iron supplementation, iodised salt utilisation, nutrition education, and breastfeeding promotion. All of them released 100% of the proposed budget for nutrition; updated and completed reports on nutrition such as accomplishment, documentation, and OPT reports; and conducted quarterly C/MNC meetings with majority of the members attended.

On the other hand, Nagcarlan, Cavinti, Lumban, Famy, and Calauan were among the top cities and municipalities with the lowest level of nutrition governance and good governance for nutrition; and with the highest prevalence of undernutrition.

Nagcarlan, Cavinti, Lumban, Famy, and Calauan did not have local ordinances on infant and young child feeding, and full time C/MNAOs. Except for Nagcarlan, all of them did not have vision and mission statements for nutrition committee; and only had partial integration of C/MNAO into their city/municipal plans and agenda. Excluding Calauan in terms of organisational structure and resources for nutrition, all of them had partially functional nutrition committee; and shared nutrition office with other sector.

Nagcarlan, Cavinti, Lumban, Famy and Calauan released less than the proposed budget for nutrition. Lumban, Famy, and Calauan did not have data on percent coverage of nutrition programmes because their accomplishment reports were not available. Nagcarlan and Cavinti reported incomplete coverage of nutrition programmes among the target CU5 for iron supplementation and vitamin A supplementation. Only Cavinti conducted quarterly C/MNC meetings in 2014 while C/MNC in Lumban met once in 2014. However, majority of the C/MNC members of Cavinti and Lumban did not attend the meeting.

Table 3. Correlation coefficients (*r*) of nutrition governance, good governance for nutrition and nutritional status of children 0-71 months in the cities/municipalities of Laguna

Categories	*Underweight*		*Stunting*		*Wasting*		*Good governance for nutrition*	
	r	*p-value*	*r*	*p-value*	*r*	*p-value*	*r*	*p-value*
Nutrition governance	-0.729	<0.001**	-0.753	<0.001**	-0.369	0.104	0.783	<0.001**
Good governance for nutrition	-0.488	0.006*	-0.380	0.046**	-0.171	0.383	1.000	-

Degree of association (R): 0.8-1, very strong; 0.6-0.79, strong; 0.4-0.59, moderately strong; 0.2-0.39, weak; 0.0-0.19, very weak or no relationship

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Associations between nutrition governance, good governance for nutrition, and nutritional status

The data on nutrition governance, good governance for nutrition and nutritional status passed the two assumptions for the use of Spearman's rho – the two variables are ordinal scale, and a monotonic relationship exist between the two variables. The significant associations among nutrition governance, good governance for nutrition and nutritional status in Laguna are shown in Table 3.

Among the three forms of undernutrition, underweight (r=-0.729, p<0.001) and stunting (r=-0.753, p<0.001) revealed a significant negative association with nutrition governance. Moreover, negative association between good governance for nutrition and underweight (r=-0.488, p=0.006); and negative association between good governance for nutrition and stunting (r=-0.380, p=0.046) were found significant.

The negative association of nutrition governance and good governance for nutrition with stunting and underweight implies that there is a likelihood that lower prevalence of underweight and stunting among CU5 will be achieved as cities and municipalities in Laguna obtained higher scores on nutrition governance and good governance for nutrition. This finding is similar to the study of Sunguya *et al.* (2014) which revealed that strong nutrition governance was associated with lower magnitude of stunting and underweight in low and middle-income countries.

Sunguya *et al.* (2014) further revealed that nutrition policies to address undernutrition are not significantly associated with a reduction in the magnitudes of undernutrition. Having a nutrition policy alone may not be enough to decrease the prevalence rates of undernutrition. Nutrition policies need to be operationalised by streamlining nutrition policies with development agenda and having a nutrition action plan with funds that involve other sectors. In the present study, majority of cities and municipalities that fully integrated their nutrition action plan into other local plans and agenda (e.g. executive legislative agenda, comprehensive development plan, land use plan, and annual investment plan) had low undernutrition prevalence. On the other hand, most of the cities and municipalities which partially integrated their nutrition action plans had high prevalence of undernutrition.

With full integration of nutrition action plan into other local plans and agenda, nutrition is understood as being

at the core of development. The study of Garret and Natalicchio (2011) found that nutrition fails to be integrated into broader development plans and agenda because there is no institution or unit office of nutrition. This supports the finding of the present study that majority of cities and municipalities in Laguna with separate office for nutrition manned by administrative support staff and full time C/MNAOs had full integration of nutrition action plan into other local plans and agenda.

In addition, Sunguya *et al.* (2004) reported that efforts to control undernutrition may not reach the majority of the population and any effort may yield poor outcomes if a nutrition strategy is not streamlined in development agenda. One of the variables of good governance for nutrition is efficiency, which includes percent coverage of nutrition programmes. As revealed in the present study, many cities and municipalities with incomplete coverage in majority of the nutrition programmes had partial integration of nutrition action plan into other local plans and agenda. On the other hand, majority of cities and municipalities with complete coverage in all nutrition programmes had full integration.

CONCLUSION AND RECOMMENDATIONS

Cities and municipalities in Laguna with higher scores on nutrition governance and good governance for nutrition tend to have lower prevalence of underweight and stunting among CU5. The significantly positive associations between nutrition governance and good governance for nutrition revealed that cities and municipalities with higher level of nutrition governance tend to be more efficient, accountable, transparent, and participative. These associations were explained by their type of integration of nutrition action plans into city/municipal development plans and agenda, availability of vision and mission statements of organised city/municipal nutrition committees, and availability of functional city/municipal nutrition committee.

Based on the results, the study recommends to the local government units to provide a separate institution or unit for nutrition manned with full time C/MNAO and administrative staff. This may enable revitalisation of functional city/municipal nutrition committees. In addition, the local nutrition committees should formulate and review their own vision and mission statements to strategically guide the committee in making and prioritising decisions for nutrition service delivery. The city/municipality is also recommended to increase investment on capacity building in nutrition program management at the individual and organisational level. Realising the heavy workload of C/MNAO, allied professionals may be tapped to undertake regular nutrition trainings.

Further investigations that focus on nutrition governance at the barangay level, as the smallest administrative level of the Philippine Local Government System, are also recommended. Other research can use longitudinal study to determine the effect of nutrition governance in the trend of undernutrition at the local level.

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Author's contributions

FLM wrote the manuscript, acquired and analysed data. FLM, TMTM, GNP and QNJV conceptualised and designed the study, and revised the manuscript.

Conflict of interest

All of the authors declared no conflict of interest.

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Stunting trends and associated factors among Indonesian children aged 0-23 months: Evidence from Indonesian Family Life Surveys (IFLS) 2000, 2007 and 2014

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ABSTRACT

Introduction: Stunting in childhood affects cognitive development and may increase the risk of non-communicable diseases in adulthood. Indonesia is the fifth largest contributor of stunting in the world, with a prevalence of 32.9% in children aged 0-2 years in 2013. This study aimed to determine the stunting trend and associated factors between 2000 and 2014. **Methods:** This study used data from Indonesia Family Life Surveys (IFLS) that have been conducted periodically since 1993. This study focused on households with children aged 0-23 months. Trend analysis used the IFLS data collected in 2000, 2007 and 2014, while bivariate analysis for determination of the different factors associated with stunting used IFLS data in 2000 and 2014. **Results:** Based on data from 1,263 children in 2000, 1,805 children in 2007, and 1,609 children in 2014, stunting prevalence slightly increased from 29.7% in 2000 to 32.6% in 2014. Significant associations between stunting and children's age, birth weight, mother's education, antenatal care, health sanitation and immunisation status were recorded in 2000. In 2014, stunting was significantly associated with children's age, birth weight, prelacteal food intake, ownership of Mother and Child Health Book and health sanitation status. **Conclusion:** Stunting in children below 2 years in Indonesia remains high, exceeding 30%. This study identified several contributing factors to stunting. Interventions to address these factors should be undertaken toward reducing stunting among young children in Indonesia.

Keywords: Stunting, stunting trend in Indonesia, undernutrition, IFLS

INTRODUCTION

Stunting remains one of the main nutritional problems in the world. It reflects the cumulative effects of chronic malnutrition during the 1,000 first days of life, and is also associated with lack of education, poverty, less healthy, and more vulnerable to non-communicable diseases and is indicative of a poor quality of life that negatively affects the nation's human resources, thus degrading its future productive capacity (Gluckman *et al.,* 2009). Barker's (1997) paper regarding *The Developmental Origins of Health and Disease* conceptualised life and health, starting from fertilisation through the foetal stage, to infancy and early childhood, as well as how

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environmental of conditions may cause health problems in adulthood.

The immediate causes of stunting can be divided in two; inadequate dietary intake and disease (particularly infectious disease). While the basic causes are lack of education, poverty, and socio-cultural reasons, other underlying causes include inadequate care and feeding practices, household food insecurity, unhealthy household environment and inadequate health services (UNICEF, 2013; Stewart *et al.*, 2013). Globally, Indonesia ranks fifth in terms of stunting. According to the Global Nutrition Report 2014 (based on data from 117 countries), Indonesia is one of the 17 countries with three major malnutrition problems: stunting, wasting and obesity. Indonesia is also one of the 47 countries with a high prevalence of stunting among children, and anaemia in women of reproductive age (International Food Policy Research Institute, 2014). The prevalence of stunting among children 0-2 years in 2013 at the national level was 32.9% (Balitbangkes, 2013).

Several studies on stunting in Indonesia have reported the following associated factors: birth weight, breastfeeding, complementary food, mother's education, health sanitation, antenatal care and immunisation (Aryastami *et al.* 2017; Rahman *et al.* 2015; Kusumawati *et al.* 2015; Hildagardis *et al.* 2014 and Nadiyah *et al.* 2014).

This study included the ownership of Mother and Child Health Book or Health Card as an additional factor of stunting. The health book/card includes reproductive health education such as pregnancy preparation and care during pregnancy for a healthy baby and how to monitor children's growth and development. This health book provides mother and family with information on maternal and child health issues. With this, it is aimed at empowering the community to lead a healthy life and to improve their access to health facilities and monitoring system (Kemenkes, 2015). However, the association between stunting and the ownership of Mother and Child Health Book has not been previously studied before.

The aim of this study was to record the trend and associated factors related to stunting among children aged 0-23 months in Indonesia based on Indonesia Family Life Survey (IFLS) data collected in 2000, 2007 and 2014.

MATERIALS AND METHODS

This study used data from Indonesian Family Life Survey (IFLS), which is conducted periodically in collaboration with the Research And Development (RAND) Corporation United States and other research institutions, for example Demographic Institute Universitas Indonesia, Centre for Health Policy Studies Universitas Gadjah Mada and SurveyMeter. Multistage random sampling was applied in the IFLS followed by simple random sampling. The IFLS randomly selected 321 areas in 13 provinces with intentional oversampling of smaller provinces by including villages and urban-villages. In the selected areas, a total of 20 households were randomly selected from each village enumeration area, and 30 households from the city enumeration area. The population of this study consisted of mothers with children aged 0-23 months. A total of 1,263 children in 2000, 1,805 children in 2007, and 1,609 children in 2014 were included in this study.

The year 2000 was taken as the first point of reporting on the stunting trend to avoid biases from the Asian Economic crisis that affected Indonesia in 1997.

This study included several associated factors of stunting: the age of children, birth weight, provision of prelacteal food, exclusive breastfeeding, provision of

complementary food, mother's education, mother's occupation, health sanitation, ownership of Mother and Child Health Book, antenatal care and complete immunisation. The chi-square test with $p<0.05$ and 95% confidence interval was applied to test for association between prevalence of stunting with those factors.

RESULTS

As shown in Figure 1, the stunting trend among children aged 0-23 month showed narrow fluctuations in 2000, 2007 and 2014. The prevalence of stunting was 29.7% in 2000, which increased to 34.4% in 2007, but slightly decreased to 32.6% in 2014.

In 2000, the proportion of stunting was significantly higher in older children aged 12-23 months (41.5%) compared to those aged 6-12 months (19.5%) (Table 1). In 2014, a similar result was found (42.3% for aged 12-23 months versus 25.3% aged 6-12 months). The proportion of stunted children with low birth weight under 2,500 gm (LBW) was significantly higher compared to non-low birth weight infants (41.4% versus 28.8% in 2000 and 50.0% versus 31.5% in 2014).

Another risk factor of stunting was provision of prelacteal food and beverages. While there was no significant association between stunting and the provision of prelacteal food in 2000, in 2014, the proportion of stunted children who received prelacteal food and drinks was significantly associated with stunting.

The maternal characteristic associated with stunting was low mother's education level, in which the proportion of stunted children more commonly occurred in mothers with lower education level (elementary school graduated) compared to the higher education level (junior high school or higher graduated) 32.8% versus 24.5% in 2000 and 34.8% versus 30.6% in 2014. However, only in 2000 was a

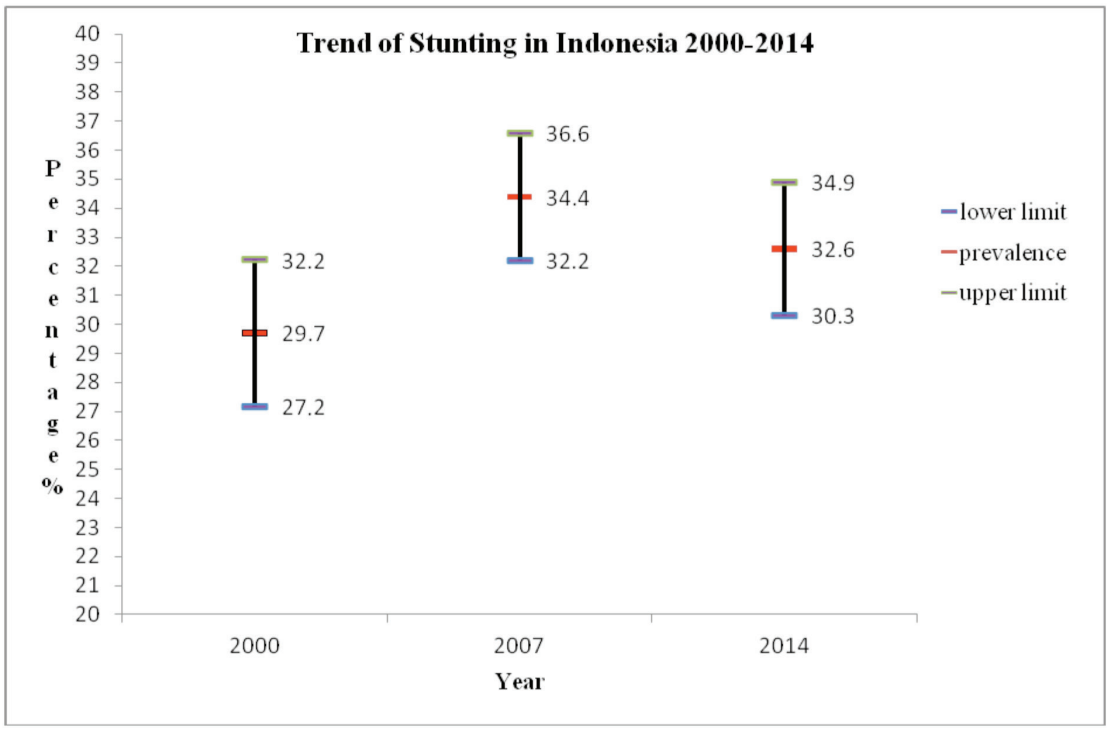

Figure 1. Trend of stunting in Indonesia, 2000-2014

Table 1. Variables associated with stunting

Variable	Year 2000				p	95% CI	Year 2014				p	95% CI
	Stunting		Not stunting				Stunting		Not stunting			
	n	%	n	%			N	%	N	%		
Age of children (months)					0.000	2.08-4.12					0.000	1.64-2.87
0-6	81	19.9	327	80.1			94	20.8	358	79.2		
6-12	54	19.5	223	80.5			87	25.3	257	74.7		
12-23	240	41.5	338	58.5			344	42.3	469	57.7		
Birth weight (g)					0.013	1.12-2.72					0.000	1.44-3.26
<2500	36	41.4	51	58.6			51	50.0	51	50.0		
≥2500	339	28.8	837	71.2			474	31.5	1033	68.5		
Provision of prelacteal					0.190	0.92-1.50					0.000	0.53-0.81
Not provided	184	31.5	400	68.5			312	29.4	749	70.6		
Provided	191	28.1	488	71.9			213	38.9	335	61.1		
Exclusive breastfeeding					0.225	0.36-1.28					0.709	0.79-1.41
Not provided	359	29.4	862	70.6			445	32.8	911	67.2		
Provided	16	38.1	26	61.9			80	31.6	173	68.4		
Provision of complementary food					0.945	0.59-1.78					0.489	0.86-1.35
Not on time	319	31.1	708	68.9			266	36.1	471	63.9		
Not yet on time	37	21.3	137	78.7			53	19.6	218	80.4		
On time	19	30.7	43	69.3			206	34.3	395	65.7		
Mother's education					0.002	1.16-1.94					0.068	0.99-1.50
<Junior high school	260	32.8	534	67.2			272	34.8	509	65.2		
≥Junior high school	115	24.5	354	75.5			253	30.6	575	69.4		
Mother's occupation					0.652	0.81-1.40					0.714	0.82-1.34
Employed	103	30.7	233	69.3			406	32.8	831	67.2		
Unemployed	272	29.3	655	70.7			118	31.8	253	68.2		
Health sanitation					0.001	1.40-3.61					0.022	1.05-1.83
Poor	353	31.2	779	68.8			443	33.9	863	66.1		
Good	22	16.8	109	83.2			82	27.1	221	72.9		
Ownership of Mother and Child Health Book/Health Card					0.062	0.99-1.61					0.001	1.16-1.79
Not own	217	31.9	463	68.1			298	36.5	518	63.5		
Own	158	27.1	425	72.9			227	28.6	566	71.4		
Antenatal care					0.009	1.10-1.96					0.091	0.96-1.69
Incomplete	94	36.3	165	63.7			91	37.3	153	62.7		
Complete	281	28.0	723	72.0			434	31.8	931	68.2		
Complete immunisation					0.020						0.210	0.88-1.75
No	358	29.2	869	70.8		0.21-0.90	474	33.1	956	66.9		
Yes	17	47.2	19	52.8			51	28.5	128	71.5		

significant association between stunting and mother's education shown. Besides education, prevalence of stunted children was significantly associated with poor health sanitation in 2000 and 2014.

Similarly, the proportion of stunted children whose mothers did not have complete antenatal care was higher than those whose mothers did complete (36.3% versus 28.0% in 2000 and 37.3% versus 31.8% in 2014). However, significant association was found in 2000 but not in 2014. Other variables such as exclusive breastfeeding, mother's occupation, and the provision of complementary food were not found to show a significant association with stunting both in 2000 and 2014.

DISCUSSION

The trend of stunting prevalence in Indonesia among children aged 0-23 months during the past 14 years appear to vary over a narrow range between 29.7% in 2000 and 32.5% in 2014. In using IFLS data, Rachmi *et al.* (2016) found stunting among children aged 2.0-4.9 years decreased from 50.8% in 1993 to 48.6% in 1997, 44.8% in 2000 and 36.7% in 2007. Their age groups and the periods differed from this study. This study found that in 2000, stunting prevalence was significantly related to the children's age, low birth weight, low mother's education, incomplete antenatal care, incomplete immunisation, and poor health sanitation. Meanwhile, in 2014, stunting prevalence was significantly associated with children's age, provision of prelacteal food, the absence of Mother and Child Health Book or Health Card as well as low birth weight. In both years, these associated factors of stunting can be attributed to low socio-economic and environmental health status.

This study's finding of a higher proportion of stunted children in the range of 12-23 months is in line with that from a study in Guatemala in 2008-2009, where it was found that the prevalence of stunting began to increase at the age of 6 months to 48 months (Martorell & Young, 2012). The period from 6 months onwards is critical for children as this is when they begin to show growth faltering and become stunted. Breastmilk alone is no longer enough to fulfil their nutritional need and they need appropriate dietary intake to support their growth and development. Another factor related to stunting found in this study is low birth weight, which is known to increase infant morbidity and mortality in infants (Maryunani, 2013). Low birth weight is generally caused by premature birth (pregnancy lasting less than 37 weeks) or poor foetal growth due to intra uterine growth retardation (IUGR) (Fikawati, Syafiq & Karima, 2016). Causes of low birth weight include chronic maternal malnutrition, stunted mothers, young age of mothers (under the age of 20 years) and infections (Kramer in Aryastami *et al.* 2017). LBW infants tend to have growth faltering compared with babies born with normal weight (Barker, Bergman & Ogra, 2008). Children with low birth weight are at a higher risk of stunting (Aryastami *et al.* 2017; Hildagardis *et al.* 2014; Nadiyah *et al.* 2014; Seedhom *et al.* 2014). The results of a systematic review of five countries (Brazil, Guatemala, India, The Phillipines, and South Africa) reported that malnutrition in pregnant mothers leads to risk of having stunted children, who grow into stunted adults having low economic productivity, and in a vicious cycle, have children with LBW (Victora *et al.,* 2008).

Another factor found in this study associated with stunting is incomplete immunisation, which puts the child at increased risks of infectious diseases. Recurrent infectious diseases lead to reduction in weight and body height (Stephensen, 1999 in Aryastami *et al.,* 2017). A study in Palu, Sulawesi, Indonesia by Rahman *et al.* (2015) found association between infectious disease

and stunting, in which children aged under 3 years old with poor immunisation records were at three times higher risk for stunting compared to those with good immunisation records.

This study found young children receiving prelacteal foods and beverages were more likely to be stunted. Children receiving prelacteal food are likely to be exposed to microbial contamination especially in households with poor sanitation conditions. Environmental sanitation is an underlying factor of stunting, and is defined by WHO (2008) as the practice of taking care of ourselves and environment to stay clean and free from risk of infection. Poor environmental sanitation related to stunting was reported by Torlesse *et al.* (2016) and Kusumawati *et al.* (2015), in which the risk of stunted children living with poor health sanitation is higher, whereby they are exposed to unhealthy house ventilation, insufficient lighting, lack of closed waste container and not having family latrine. These trigger the emergence of infectious diseases in children that can cause growth delay. Another study by Fink *et al.* (2011) in 172 countries from 1986-2007 found that the risk of stunting was lower in households with good environmental sanitation.

Although exclusive breastfeeding was not found significantly associated with stunting in 2000 and 2014, mothers should be encouraged to practice exclusive breastfeeding for at least 6 months (WHO, 2003). This recommendation is important for those living in locations with poor environmental health, owing to the likelihood of contamination of water and foods provided to young children. Coutsoudis & Bentley (2004) attributed obstacles to exclusive breastfeeding as fear that breastmilk alone was insufficient, using incorrect breastfeeding techniques, mothers not receiving support from husbands or health providers, and the promotion of formula milk.

A study in Palu, Sulawesi, Indonesia found that success of exclusive breastfeeding was possible with socio-cultural support (Rahman *et al.,* 2017). The success of exclusive breastfeeding is also related to completeness of antenatal care, at least once in the first trimester, twice in the second trimester, and twice in the third trimester. Pregnant mothers with incomplete antenatal care, followed by not having the Mother and Child Health Book or Health Card, may not obtain correct information on how to take care of their infant and proper exclusive breastfeeding. The Mother and Child Health Book and Health Card provide reproductive health education, including pregnancy preparation and care during pregnancy in order to give birth to a healthy baby. However, according to the 2013 National Basic Health Research, the percentage of mothers who have the Mother and Child Health Book is only 40.40%, and of these, only at 10.70% fully filled it up. This shows that Mother and Child Health Book has not yet been used as an adequate counselling medium (Trihono *et al.*, 2015).

CONCLUSION

Stunting remains as a public health problem in Indonesia. Its prevalence of 32.6% in 2014 has not decreased since 2000. Indonesia needs to address both the immediate and underlying factors associated with stunting.

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Authors' contributions

LH, principal investigator, settle on the concept and the design of the study, analyse and interpret the data, drafting the first article and revised based on input; RW, provide intellectual input to the analysis and its interpretation; RM, sufficient

input on the analysis of data; ELA, provide intellectual input and final approval of the article to be published.

Ethical approval

Ethical clearance was received from The Ethical Committee for Research and Community Development, Faculty of Public Health Universitas Indonesia No.573/UN2.F10/PPM.00.02/2017.

Conflict of interest

We declare that we have no conflict of interest.

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Wasting and associated factors among infants aged 0-23 months in 13 provinces in Indonesia: Evidence from Indonesia Family Life Surveys (IFLS) 2000, 2007 and 2014

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ABSTRACT

Introduction: Wasting is an acute form of under-nutrition. Frequent occurrence and long-term wasting can lead to stunting. Indonesia has one of the world's highest wasting prevalence of 12.1% and ranked the 4th highest for wasting globally in 2012. **Methods**: Data from Rand Corp Indonesia Family Life Survey for 2000, 2007 and 2014 were used to examine wasting trend, while data for 2000 and 2014 were used to determine the associated factors of wasting in infants aged 0-23 months. Data was analysed using SPSS. Logistic regression was used to predict the variables contributing to wasting. **Results**: Wasting prevalence in 2000, 2007 and 2014 were 12.0%, 11.2% and 10.1%, respectively. Birth weight correlated significantly with wasting prevalence in 2000 while in 2014, wasting prevalence correlated significantly with birth weight, birth length, poverty, and ownership of "Mother and Child Health Book". Logistic regression showed that birth weight was an important associated factor in 2000 and 2014, while ownership of "Mother and Child Health Book" was the only important associated factor of birth weight in 2014. **Conclusion**: The prevalence of wasting among young Indonesian children was lower in 2014 compared to 2000, but is still at a high level. Birth weight consistently remains the significant factor affecting wasting. It is important that the nutritional status of women be taken care of before and during pregnancy for optimal birth outcomes.

Keywords: Wasting, birth weight, birth length, trend, child care

INTRODUCTION

Nutrition for infants is one of the factors that determine the child's optimal growth and development. Lack of nutrition that occurs in human early life can lead to growth faltering. In addition, it may have an effect on cognitive development, morbidity and mortality of infants (Fikawati *et al.*, 2015). The period of the first 1,000 days of life is the period when development and growth of the child is progressing rapidly, both physically, cognitively and emotionally. Infants who suffer from serious malnutrition in this period showed poor brain development and low intelligence (Barker, 2009). The risk of non-communicable/chronic diseases is likely to occur in adulthood when severe malnutrition occurs in the first 1,000 days of life (Barker, 2008; Toran, 2006).

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Wasting is a serious nutritional problem suffered by infants and children in Indonesia. Based on reports by the United Nations Children's Fund (UNICEF), World Health Organization (WHO) and World Bank (2015), wasting prevalence affected 50 million children globally, or 7.4% of children under 5 years of age. The World Health Assembly Resolution in 2012 set a target to reduce wasting to less than 5.0% by 2025 (WHO, 2014). Based on 2014 Global Nutrition Report, Indonesia with 12.1% wasting was among 17 countries with high prevalence of wasting. Based on Ministry of Health, Republic of Indonesia 2013, wasting prevalence of children aged 0-59 months in 2007, 2010, and 2013 were 13.6%, 13.3%, and 12.1%, respectively. It is considered a social health problem for countries to have a prevalence of thin infants between 10.0-14.0%, and the problem is considered critical if wasting prevalence is ≥15.0% (WHO, 2010).

Multiple factors affect childhood wasting, including low birth weight (Sanders, 2013), low intensity of medical checkup during pregnancy (Saputra *et al.,* 2012), under-nutrition and poor parenting. Parenting-related factors that may affect wasting include prelacteal feeding (Nurya, 2011), exclusive breastfeeding (Nahar, 2010; Zongrone *et al.,* 2012), provision of supplementary feeding (Zongrone *et al.,* 2012), diarrhoeal infections (Yisak *et al.*, 2015; Saaka *et al.*, 2015), upper respiratory tract infections (Asfaw *et al.,* 2015), immunisation (Mishra *et al.*, 2013) and vitamin A supplementation (Hadi *et al.*, 2000). Factors that indirectly affect wasting include poor environmental sanitation, poverty, large number of family members (Yisak *et al.,* 2015), and lack of employment for people with low education (WHO, 2014; Ruel, 2008).

This study aimed at determining wasting prevalence and associated factors among infants aged 0-23 months in 13 provinces in Indonesia based on the Indonesia Family Life Surveys (IFLS) in 2000, 2007 and 2014.

MATERIALS AND METHODS

The study used secondary data obtained from Indonesia Family Life Survey (IFLS). IFLS has been conducted five times since 1993, i.e. IFLS-1 (1993), IFLS-2 (1997), IFLS-3 (2000), IFLS-4 (2007), and IFLS-5 (2014). IFLS was published by the RAND Corp (Research and Development). Data reported in this study were derived from IFLS 3, 4 and 5; covering 13 provinces, i.e. North Sumatera, West Sumatera, South Sumatera, Lampung, DKI Jakarta, Yogyakarta, West Java, Central Java, East Java, Bali, West Nusa Tenggara, South Kalimantan and South Sulawesi.

IFLS-3 (2000) included 31,000 individuals from 10,400 households; IFLS-4 (2007) included 43,500 individuals from 13,500 households; and IFLS-5 (2014) included 50,000 individuals from 15,000 households.

The subjects in this study comprised infants aged 0-23 month from 13 provinces. 1,482 people in 2000, 1,645 people in 2007, and 1,476 people in 2014, while the number of samples in this study was 1,263 people in 2000 and 1609 in 2014. Inclusion criteria included were completeness of the research variables as in Table 1, as well as biological children, while the exclusion criteria were sick children and multiple pregnancies.

Data collection of IFLS was implemented by answering the questionnaires provided by the interviewer; the questions were available in form of question books including: Book 2 on household economic level; Book 3 on individual characteristics; Book 4 on marriage, pregnancy, delivery, breastfeeding, and contraceptive records;

Book 5 on child morbidity and education; Book K on civil registration; and Book US on anthropometric measures.

Variables studied included infant's age, birth weight, pregnancy check-up, having Mother and Child Health Book, exclusive breastfeeding, prelacteal feeding, complementary feeding, vitamin A supplementation, primary immunisation records, upper respiratory tract infection (ISPA) records, records of diarrhoeal diseases, maternal education level, maternal employment status, poverty, environmental sanitation and the number of family members.

Data analysis using SPSS was conducted. The 2000 IFLS, 2007 IFLS, and 2014 IFLS data were used for trend on wasting, while 2000 IFLS and 2014 IFLS were used as required variables in this research.

The chi-square test was used to determine the correlation between dependent and independent variables; and logistic regression was used to predict the variables contributing to wasting. Ethical approval for the study was obtained from Research Ethical Committee Community Engagement, Faculty of Public Health Universitas Indonesia *No.573/UN2. F10/PPM.00.02/2017.* In addition, an informed consent letter approved by the ethics committee and signed by the respondents or the authorised representative in the presence of a witness was obtained.

RESULTS

Wasting prevalence among infants aged 0-23 month declined by 16.0% from 2000 to 2014. Wasting prevalence was 12.4% in 2007, 11.2% in 2007 and 11.0% in 2014. Table 1 shows the comparison of child characteristics in 2000 and 2014. Chi-square test was used to determine differences between these characteristics in 2000 and 2014.

Variables associated with wasting cases among infants aged 0-23 months in 2000 were mostly in the age range of 0-6 months (13.5%), mothers with low level of education (15.4%), mothers who were unemployed (12.7%), number of family members greater than 4 persons (12.3%), not poor (13.0%), incomplete pregnancy check up (14.3%), mothers did not have health card (12.8%), birth weight <2,500 gram 17.2%, birth length <48 cm (11.3%), prelacteal feeding (12.5%), mothers did not exclusively breastfeed their infants (12.0%), supplementary food was provided properly (14.5%), incomplete primary immunisation records (12.2%), existence of upper respiratory track infection (13.6%), existence of diarrhoeal disease records 11.1%, and poor environmental sanitation (11.6%).

In 2014, wasting cases were affected by almost similar socio-economic variables as in 2000: mostly in the range 6-12 months of age (11.4%), mothers with primary school education (12.3%), mothers who were unemployed (10.8%), number of family members was greater than 4 persons (10.3%), not poor (9.6%), incomplete pregnancy check up (13.1%), mothers did not have health card (12.1%), birth weight <2,500 gram (8.6%), birth length <48 cm (20.0%), prelacteal feeding (9.3%), mothers did not exclusively breastfeed their infants (11.1%), supplementary food was provided properly (10.6%), incomplete primary immunisation records (10.1%), existence of upper respiratory track infection (10.2%), existence of diarrhoeal disease records (10.2%), and bad environmental sanitation (10.5%).

Bivariate results showed that in 2000 the significant variables were birth weight (p=0.030), while in 2014, the significant the significant variables were birth weight (p=0.028), birth length (p=0.005), poverty (p=0.009), and

Table 1. Comparison of child characteristics in IFLS 2000 and 2014

Variable	*Wasting in 2000*		*p*	*Wasting in 2014*		*p*
	n	*%*		*n*	*%*	
Infant's age (month)			0.413			0.277
0-6	55	13.5		48	10.6	
6-12	35	10.3		47	11.4	
12-23	61	11.8		68	9.2	
Birth weight (g)			0.030			0.028
<2500	15	17.2		14	8.6	
≥2500-3900	128	12.0		144	8.3	
>3900	8	7.1		5	3.1	
Birth length (cm)			0.062			0.005
<48	123	11.3		131	20.0	
≥48	28	16.3		32	19.6	
Pregnancy check-up			0.196			0.095
Incomplete check-up	37	14.3		32	13.1	
Complete check-up	114	11.4		131	9.6	
Ownership of Mother and Child Health Book			0.322			0.007
Do not have the book	87	12.8		99	12.1	
Having the book	64	11.0		64	8.1	
Prelacteal feeding			0.580			0.431
Not given	78	11.5		112	10.6	
Given	73	12.5		51	9.3	
Exclusive breastfeeding			0.992			0.591
Not given	146	12.0		28	11.1	
Given	5	11.9		135	10.0	
Complementary feeding			0.472			0.152
Not proper	118	11.5		82	11.2	
Given	9	14.5		53	10.6	
Not given (yet)	24	13.8		27	10.0	
Supplementation of Vitamin A			0.822			0.281
Incomplete	95	11.3		102	10.3	
Complete	1	9.1		13	7.6	
Not given (yet)	55	13.5		48	10.6	
Primary immunisation records			0.120			0.972
Incomplete	150	12.2		145	10.1	
Complete	1	2.8		18	10.1	
Upper respiratory tract infection			0.727			0.986
Negative	145	11.9		158	10.1	
Positive	6	13.6		5	10.2	
Diarrhea disease			0.659			0.940
Negative	125	12.1		129	10.1	
Positive	26	11.1		34	10.2	
Poverty			0.618			0.009
Not poor	27	13.0		131	9.6	
Poor	124	11.8		146	9.6	
Environmental sanitation			0.219			0.322
Not good	131	11.6		137	10.5	
Good	20	15.3		26	8.6	
Maternal education level			0.454			0.243
Not school	29	15.4		4	4.8	
Primary school	38	10.9		36	12.3	
Junior high school	30	11.6		39	9.6	
Senior high school and above	54	11.5		84	10.1	
Maternal employment status			0.160			0.094
Not working	118	12.7		134	10.8	
Working	33	9.8		29	7.8	
Number of family members			0.717			0.851
1-4 persons	57	11.4		79	9.9	
>4 persons	94	12.3		84	10.3	

Table 2. Logistic regression of factors associated with wasting in infants aged 0-23 months in 2000

Variable	*OR*	*95% C.I For Exp (B)*		*p*
		Lower	*Upper*	
Birth weight (g)				
<2500	1.7	0.3	1.3	0.046
≥2500-3900	1.0			
Birth length (cm)				
<48	1.4	0.4	1.1	0.169
≥48	1.0			
Pregnancy checkup				
Incomplete check-up	1.2	0.5	1.2	0.307
Complete check-up	1.0			
Ownership of Mother and Child Health Book				
Do not have the book	1.1	0.6	1.3	0.499
Having the book	1.0			
Prelacteal feeding				
Not given	1.1	0.8	1.5	0.524
Given	1.0			
Poverty				
Not poor	1.1	0.7	1.7	0.761
Poor	1.0			
Primary immunisation record				
Incomplete	5.0	0.3	1.7	0.090
Complete	1.0			
Upper respiratory tract infection				
Negative	1.0	0.4	2.7	0.847
Positive	1.8			
Maternal employment status				
Not working	1.4	0.5	1.2	0.191
Working	1.0			

ownership of "Mother and Child Health Book" (p=0.007) (Table 1).

Multivariate results in logistic regression showed that in 2000 the significant variables were birth weight (Table 2 and 3). The statistical results showed that children born <2500 gram were likely to get wasting at the age of 0-24 months by 1.7 times greater than the children born normal birth weight ≥2500-3900 gram (p=0.046). While in 2014, the multivariate results in logistic regression showed that the significant variables were birth weight and ownership of Mother and Child Health Book. It can be concluded that children born <2500 gram were likely to get wasting at the age of 0-24 months by 2.3 times greater than normal birth weight (p=0.020). The children with do not have the book ownership of Mother and Child Health Book were likely to get wasting at the age of 0-24 months by 1.6 times greater than having the book ownership of Mother and Child Health Book (p= 0.013).

DISCUSSION

Based on the analysis of the IFLS data, wasting prevalence among ages 0-23 months showed a decreasing trend between 2000 and 2014. Nonetheless, the prevalence remains high at 11.0%.

Table 3. Logistic regression of factors associated with wasting in infants aged 0-23 months in 2014

Variable	*OR*	*95% C.I For Exp (B)*		*p*
		Lower	*Upper*	
Birth weight (g)				
<2500	2.3	0.1	1.2	0.020
≥2500-3900	1.0			
Birth length				
<48	1.6	0.4	1.0	0.079
≥48	1.0			
Pregnancy checkup				
Incomplete check-up	1.2	0.5	1.4	0.649
Complete check-up	1.0			
Ownership of Mother and Child Health Book				
Do not have the book	1.6	0.5	1.4	0.013
Having the book	1.0			
Prelacteal feeding				
Not given	1.2	0.6	1.2	0.284
Given	1.0			
Environmental sanitation				
Not good	1.4	0.4	1.3	0.316
Good	1.0			
Poverty				
Not poor	1.0	0.7	2.8	0.429
Poor	1.3			
Upper respiratory tract infection				
Negative	1.0	0.4	3.3	0.646
Positive	1.2			
Maternal employment status				
Not working	1.3	0.5	1.1	0.130
Working	1.0			

The IFLS in 2000 and 2014 showed that birth weight was the most dominant factor associated with wasting. This finding is in line with previous studies (Rayhan, 2006; Sanders, 2013; Nahar *et al.,* 2010; McDonald *et al.,* 2012). As children with low birth weight have less developed immune system, they are susceptible to diseases and infections. Moreover, it is difficult to catch up to their weight-for-age if not supported by environmental factors related to feeding patterns with nutrition intake needed by infants, which causes children to suffer from wasting (Dubois *et al.*, 2012). Birth weight may reflect the quality of health maintenance, including health care received by a mother during her pregnancy. If the foetus is undernourished during the pregnancy period, the infant growth will be short and not be proportional. Also, if the foetus is undernourished since the middle or the end period of pregnancy, the infant will be thin or short (Sanders, 2013).

The IFLS-5 (2014) showed that Health Card ownership was the most dominant factor associated with wasting, in line with studies by Muqni (2012) and Hidayat (2011). The Health Card records the growth and development

of children aged 0-60 months, and the card ownership indirectly affects nutritional status. The Health Card can be used to detect problems with their child's nutritional status early by checking their weight for age or weight to height measurement; this allows them to control the child's weight. The card is not merely a tool for health officers, but also a communication and education media for mothers (Muqni *et al.,* 2013; Hidayat, 2011).

Also associated with wasting is poverty status. However, it is not the most dominant factor associated with wasting. A similar finding was reported by Nahar *et al.* (2010), Arief *et al.* (2014) and Eme *et al.* (2013). Poverty becomes the basic cause of wasting problem as children with wasting come from the low-income families (Nahar *et al.*, 2010). Poverty will lead to insufficient food intake, and the families are less likely to have access to modern health care facilities while ill (Hong, Banta & Betancourt, 2006). Another study mentioned that poverty may change the infant's nutritional status because nutritious food availability often needs a large amount of funds, so poor families usually find it difficult (Arief *et al.*, 2014; Eme *et al.*, 2013).

Birth length was also associated with wasting although it was not the most dominant factor, in line with studies by Nurillah *et al.* (2016) and Hadi (2010). Birth length is an important parameter to figure out the linear growth of infant during in the womb. A low linear measurement usually indicates poor nutrition. Birth length is one of the determinants of, and significantly relates to, child growth and development (Nurillah *et al.*, 2016). The length may indicate nutritional problems as it is not only related to the shorter physical stature, but also to a child's cognitive functions (Hadi, 2010).

CONCLUSION

Prevalence of wasting among Indonesian young children appears to have decreased between 2000 and 2014, but wasting prevalence remains high. Birth weight was an important associated factor with wasting in Indonesia. It is recommended that nutritional and health care of women before pregnancy and during pregnancy be accorded high priority for healthy birth outcomes.

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Authors' contributions

RM, initiated the conception and determined the design of the research, analyzed and interpretated the data, wrote the first draft of manuscript and revised accordingly; RW, sufficient participation in the interpretation and analysis of data; LH, provide intellectual input to data interpretation; ELA, provide intellectual input to the first draft of the article, including the conception and design of the research and final approval of the version to be published.

Conflict of interest

There is no conflict of interest in this study.

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Food intake, nutritional and health status of Filipino adults according to occupations based on the 8th National Nutrition Survey 2013

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ABSTRACT

Introduction: The health and nutrition of a country's workforce plays an effective role in the social health and economic status of its society. **Methods:** This study determined the food intake, nutritional and health status of 69,505 Filipino adults and their households according to occupations using the 8th National Nutrition Survey conducted in 2013 by the Food and Nutrition Research Institute. Occupational grouping was based on the 1992 Philippine Standard Occupation Code. Descriptive statistics such as mean and percentages were generated using the survey module (svy) of Stata 12.0. **Results:** Chronic Energy Deficiency and anaemia were highest among adults with no occupation (12.3% and 14.8% respectively) and lowest among officials (4.3%) and those with special occupations (4.5%). Overweight, hypertension, high fasting blood sugar and high total cholesterol levels were highest among officials and lowest among farmers and professionals. Farmers had the highest percentage of smokers, alcoholic drinkers and with high physical activity level, while adults with no occupation had the lowest physical activity level. Households headed by special occupation groups had the highest energy intake, while farmers had the lowest protein, iron, vitamin A, thiamine, riboflavin, niacin and fat intakes. Crafts and related trade workers had the lowest percentage of households meeting the energy requirement (27.4%). **Conclusion:** The food intake, nutrition and health status of Filipino workers in certain occupations were poor, in need of improvement. A national policy on addressing the health, nutrition and welfare of workers is recommended.

Keywords: Filipino workers, nutritional status, health risks, food intake

INTRODUCTION

In 2016, approximately 40.8 million Filipino adults were employed in various occupations in the Philippines (PSA, 2016). The preliminary results of the Annual Labour and Employment Estimates for 2016, based on the average of the four Labour Force Survey (LFS) rounds, reported an annual labour force participation rate of 63.4% out of the 68.1 million population ≥15 y. This is equivalent to about 43.2 million economically active among the population comprising either the employed or unemployed persons. Employed persons are grouped into three major sectors - agriculture, industry and

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services sector. Those in the services sector comprised more than half (55.6%) of the total employed persons. About 19.6% were engaged in wholesale and retail trade or in the repair of motor vehicles and motorcycles. Workers in the agriculture made up the second largest sector accounting for 26.9%, while those in the industry sector, 17.5%. As for occupation groups, workers in the elementary occupations remained the largest group making up 28.1% of the total employed persons in 2016. Managers comprised the second largest occupation group (17.0%), followed by service and sales workers (14.8%) and skilled agricultural, forestry and fishery workers (12.4%).

Inadequate nutrition is one of the leading causes of micronutrient deficiencies such as zinc, folic acid, iron deficiency anaemia and chronic diseases like diabetes and heart disease, which may result in an increase in medical expenses, a decrease in work capacity and ultimately, economical detriments (Haas & Brownlie, 2001). Since proper nutrition affects individuals' health and work capacity, the workers' nutrition can play a useful and effective role in the social health and economic status of the society (Bowman, 2007). Achieving an adequate nutrition programme not only increases the workers' health status, but also affects the economic development of the society.

The kind and nature of work a person has, may impact health because of the cumulative effect of an individual's work commitment over the lifetime. Occupation can affect health through direct impacts, such as physical job conditions (e.g., manual labour, exposure to noise and heat), psychosocial job characteristics, stress, and social support (Gueorguieva *et al.*, 2009). Occupations may also affect health through indirect mechanisms via income, health insurance, prestige, and authority that are related to occupation (Ferrie *et al.*, 2005).

Another indirect effect of occupation may be the influence of peers or workplace characteristics on health habits (e.g., outside work or smoking bans) which in turn may affect health (Cheng *et al.*, 2000). The Whitehall studies reported that occupation has a significant impact on health, with a marked social gradient between British civil service grades and a variety of health outcomes, including coronary heart disease, self-reported health, and emotional well-being (Ferrie *et al.*, 2002; Stansfeld *et al.*, 2003).

The impact on health may worsen at older ages when occupational hazards accumulate and exert adverse effects beyond the working years. Evidence suggests that chronic stress, which is systematically related to occupation, results in a physiologic response, leading to overproduction of cortisol, translating into detrimental health effects that may accumulate over time (Miller & O'Callaghan, 2002). On the other hand, it is possible that differentials could narrow in old age if, for example, the relationship between occupation and health differs after retirement. Health could improve for those in manual occupations when retirees are relieved of the physical demands or psychosocial stress of their occupations.

Appropriate nutrition can play a part in improving the health status and increase the immunity of the body against diseases. An adequate intake of nutrients and energy may prevent the development of some diseases and nutritional disorders. In order to promote the nutritional status of a group, there is a need to gather information about the nutritional status of workers according to occupations. The present study was conducted to determine food intake, nutritional and health status of Filipino workers in different occupations.

MATERIALS AND METHODS

The study used data from 8th National Nutrition Survey (NNS) conducted by the Food and Nutrition Research Institute, Department of Science and Technology (FNRI-DOST) in 2013. The NNS was conducted in 79 provinces, 45,047 households and 172,323 individuals to provide national and regional estimates of nutritional status of the Filipino population. The NNS was based on a stratified multi-stage sampling design for household-based surveys covering all the 17 regions, including the National Capital Region.

The first stage was the selection of primary sampling units, which consisted of a barangay or a contiguous barangays with at least 500 households. The second stage involved the selection of enumeration areas, which consisted of a contiguous area in a barangay or a barangay with 150-200 households. The last stage (ultimate sampling units) consisted of the households. All members of the household were included in the survey. The occupations of household members were categorised into occupational groups based on the 1992 Philippine Standard Occupational Classification (PSOC) of Philippine Statistics Authority (PSA, 2018).

The sample size per component of the NNS in this report is shown in Table 1. The number of respondents

Table 1. Distribution of sample sizes by survey components and by occupational groups of household heads: Philippines, 2013

Component	*Sample size*
Anthropometry - ≥20 y	69,505
Biochemical - Haemoglobin 6 months old & over†	33,852
Clinical and health (≥20 y)	
Blood pressure	73,992
Smoking, Alcohol†	20,163
Blood sugar (≥20 y)†	18,495
Lipids (≥20 y)†	19,010
Households	35,825
Dietary intake†	8,592
Socioeconomic status (or wealth quintile)	35,584
Occupation of household heads	
Special occupation	204
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	2,378
Professionals	755
Technicians and associate professionals	909
Clerks	677
Service workers and shop and market sales workers	1,384
Farmers, forestry workers and fishermen	10,133
Craft and related trades workers	2,931
Plant and machine operators and assemblers	3,216
Elementary occupation: Labourers and unskilled workers	4,536
No occupation	8,663
Missing occupation‡	39

†used for national estimates only

‡estimates were not presented from households with small sample size (in some components)

per component varies if the component was designed to generate national or regional level estimates. The 2013 NNS used 69,505 respondents to assess the nutritional status of adults ≥20 y based on weight and height measurements. The Health Survey Component provided national estimate on anaemia, and the risk factors related to non-communicable diseases, including hypertension, diabetes, and cholesterol levels (DOST-FNRI, 2015). The Food Consumption Survey (FCS) collected data on food and nutrient intakes at the household level. It provided information on the quantities of food consumed, the nutritive value of the diet and the adequacy of intake of the population (DOST-FNRI, 2015).

The 2013 NNS used the wealth index to disaggregate the household into five wealth quintile groups. The wealth index used principal component analysis to group the households based on the households' assets, characteristics of housing unit, access to utilities and infrastructure variables of the 2013 NNS.

A written informed consent was obtained from all the participants of this study through the mother or guardian. Ethical clearance was provided by the FNRI Institutional Ethics Review Committee (FIERC).

Descriptive statistics were used in reviewing data on the food intake, nutrition and health status of Filipino workers by various occupations in the Philippines. Data were analysed using Stata 12.1.

RESULTS

According to the World Health Organization (WHO), malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients (WHO, 2016). Using this

Table 2. Prevalence of chronic energy deficiency, overweight, and obesity among adults, ≥20 y by occupation

Occupation groups	*Form of malnutrition*		
	CED	*Overweight*	*Obese*
	% (SE)		
All adults	10.0 (0.1)	24.3 (0.2)	6.8 (0.1)
Special occupations	8.1 (1.8)	28.4 (3.3)	6.4 (1.4)
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	4.3 (0.4)	37.0 (0.8)	12.6 (0.6)
Professionals	5.1 (0.5)	32.1 (1.1)	10.4 (0.8)
Technicians and associate professionals	5.8 (0.7)	29.0 (1.2)	10.0 (0.8)
Clerks	7.0 (0.7)	29.6 (1.1)	9.3 (0.7)
Service workers and shop and market sales workers	8.3 (0.5)	27.5 (0.8)	7.5 (0.5)
Farmers, forestry workers and fishermen	11.4 (0.3)	14.9 (0.4)	2.4 (0.2)
Craft and related trades workers	8.9 (0.5)	22.0 (0.8)	4.2 (0.4)
Plant and machine operators and assemblers	5.9 (0.5)	31.1 (0.9)	8.2 (0.5)
Elementary occupation: Labourers and unskilled workers	9.5 (0.5)	22.0 (0.5)	6.5 (0.3)
No occupation	12.3 (0.2)	24.0 (0.3)	7.0 (0.2)

definition, the prevalence of malnutrition among Filipino workers aged ≥20 y by occupational group in the Philippines is summarised in Table 2. Results showed that Chronic Energy Deficiency (CED) was highest among adults with no occupation (12.3%) followed by farmers, forestry workers and fishermen (11.4%), and lowest among officials (4.3%) and professionals (5.1%). The prevalence of CED in these two occupational groups was higher than the national prevalence for CED. Overweight and obesity on the other hand were highest among officials (49.6%) and professionals (42.5%) yet lowest among farmers, forestry workers and fishermen (17.3%).

In general, 1 out of 10 Filipino adults is anaemic (Table 3). This suggests that the Philippines has a mild category of public health significance for anaemia. Anaemia is highest among adults who have no occupation (14.8%) and those who are farmers, forestry workers or fishermen (10.6%), and lowest among adults with special occupations (4.5%) and plant and machine operators and assemblers (5.3%).

The prevalence of hypertension among adults ≥20 y in the Philippines is 22.3%. By occupation, hypertension was highest among officials (28.5%), plant and machine operators and assemblers (25.8%), and craft and related trade

Table 3. Prevalence of anaemia, hypertension and high fasting blood glucose among adults ≥20 y by occupation

Occupational grouping	*Anaemia*		*Hypertension*		*Fasting Blood Glucose*	
	n	*%*	*n*	*%*	*n*	*%*
All adults	18309	11.1	73992	22.3	18495	5.6
Special occupations	83	4.5	283	19.6	80	3.7
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	1123	9.7	4189	28.5	1120	10.3
Professionals	588	9.6	2233	17.7	591	5.9
Technicians and associate professionals	445	8.3	1668	20.4	432	5.6
Clerks	543	8.7	1996	19.1	546	4.0
Service workers and shop and market sales workers	922	8.5	3270	18.6	917	3.9
Farmers, forestry workers and fishermen	3441	10.6	12143	23.9	3309	3.6
Craft and related trades workers	1007	8.1	3422	24.5	976	4.8
Plant and machine operators and assemblers	891	5.3	3360	25.8	855	6.4
Elementary occupation: Labourers and unskilled workers	2181	8.3	8050	20.6	2132	5.8
No occupation	7071	14.8	33310	21.9	7523	5.9

workers (24.5%), yet lowest among professionals (17.7%).

Diabetes type 2 prevalence based on high fasting blood glucose level in 2013 among Filipino adults is 5.6%, based on the cut-off of 126 mg/dL. By type of occupation, adults with high positions like officials (10.3%), plant and machine operators and assemblers (6.4%), and professionals (5.9%) have the highest prevalence of diabetes. Diabetes prevalence among officials is almost double than the national prevalence (5.6%). Surprisingly, unemployed adults also have a high prevalence of diabetes (5.9%). Lowest prevalence of diabetes was seen among farmers, forestry workers and fishermen (3.6%).

In this analysis, lipid profile was determined using the cut-offs based on the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III). Results showed (Table 4) that more than half (52.8%) of Filipino adults in general have desirable cholesterol level, more than one-fourth (28.6%) have borderline-high cholesterol level, while close to one-fifth (18.6%) have high cholesterol level. By occupational group, adults working in the farm, forest or into fishing have the highest percentage of desirable cholesterol level (65.4%). Borderline-high to high cholesterol levels are highest among adults who work as officials (34.4% and 27.4%), while least among farmers,

Table 4. Cholesterol distribution among adults ≥20 y by occupation of household heads

Occupation groups	*n*	*% Distribution by cholesterol levels*								
		Desirable			*Borderline-high*			*High*		
		<200			*200-<240*			*≥240*		
		%	*95% CI*		*%*	*95% CI*		*%*	*95% CI*	
All adults	19,010	52.8	51.6	54.0	28.6	27.8	29.4	18.6	17.8	19.4
Special occupations	82	52.4	40.0	64.8	27.6	16.6	38.6	20.0	11.1	28.9
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	1,134	38.2	35.2	41.2	34.4	31.7	37.1	27.4	24.8	30.1
Professionals	604	46.2	41.7	50.8	33.4	28.9	37.8	20.4	17.0	23.9
Technicians and associate professionals	446	45.6	40.3	51.0	33.3	28.3	38.3	21.1	16.4	25.8
Clerks	559	50.8	45.6	55.9	30.2	26.0	34.5	19.0	15.5	22.5
Service workers and shop and market sales workers	942	51.5	48.0	55.0	30.3	27.1	33.6	18.2	15.6	20.7
Farmers, forestry workers and fishermen	3,405	65.4	63.2	67.6	23.1	21.4	24.8	11.5	10.2	12.9
Craft and related trades workers	1,010	56.2	51.4	61.0	28.5	25.0	32.0	15.3	12.6	18.0
Plant and machine operators and assemblers	878	49.8	46.1	53.4	31.3	28.2	34.4	19.0	15.9	22.0
Elementary occupation: Labourers and unskilled workers	2,195	55.2	52.4	58.1	28.8	26.4	31.2	16.0	14.1	17.9
No occupation	7,741	51.2	49.7	52.6	28.2	27.1	29.2	20.7	19.6	21.7

Table 5. Proportion of current smokers among adults ≥20 y by various occupations

Occupational group	*n*	*Smoking status*								
		Never			*Current*			*Former*		
		%	*95% CI*		*%*	*95% CI*		*%*	*95% CI*	
All Adults	20,163	59.2	58.2	60.1	25.4	24.5	26.2	15.5	14.7	16.3
Special occupations	97	42.8	30.5	55.0	33.9	24.1	43.6	23.4	11.5	35.2
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	1,225	60.7	57.7	63.6	21.9	19.4	24.4	17.4	14.9	19.9
Professionals	676	80.2	75.9	84.4	9.2	6.3	12.1	10.7	7.8	13.5
Technicians and associate professionals	485	55.9	50.8	61.0	23.7	19.9	27.5	20.4	15.4	25.4
Clerks	620	71.9	67.1	76.7	13.2	10.0	16.4	14.9	11.5	18.3
Service workers and shop and market sales workers	1,042	61.7	58.1	65.2	23.6	20.8	26.5	14.7	12.3	17.1
Farmers, forestry workers and fishermen	3,467	35.2	33.1	37.2	45.8	43.8	47.9	19.0	17.5	20.5
Craft and related trades workers	1,091	39.2	35.0	43.4	43.4	39.0	47.7	17.4	14.9	19.9
Plant and machine operators and assemblers	950	36.0	31.8	40.2	44.0	40.3	47.8	20.0	17.4	22.6
Elementary occupation: Labourers and unskilled workers	2,322	54.2	51.8	56.5	31.6	29.4	33.9	14.2	12.5	16.0
No occupation	8,174	71.6	70.4	72.8	14.7	13.8	15.7	13.7	12.7	14.6

forestry workers or fishermen (23.1% and 11.5%).

Smoking status was defined using the WHO Stepwise Approach to Surveillance which grouped smoking status into three categories namely current smokers, former smokers and individuals who have never smoked at all. Table 5 shows that only one-fourth of adults in general are current smokers, while more than half (59.2%) never smoked at the time the survey was conducted in 2013. By occupational group, farmers, forestry workers and fishermen (45.8%) have the highest percentage of current smokers, followed by plant and machine operators and assemblers (44.0%), and craft and related trades workers (43.4%), the percentages of which are almost double compared to the general population (25.4%).

In this review, alcohol drinking is defined using the operational definition of alcohol consumption by WHO (2014). Table 6 shows that about 5 of 10 adults, ≥20 y are current drinkers, 1 of 10 are former drinkers, while about 4 of 10 adults are lifetime abstainers. Adults working as plant and machine operators and assemblers (71.8%) have the highest percentage of current drinkers, followed by adults with special occupations

Table 6. Alcohol drinking status among adults ≥20 y by occupation

Occupational group	*n*	*Drinking status*								
		Lifetime abstainers			*Former drinkers*			*Current drinkers*		
		%	*95% CI*		*%*	*95% CI*		*%*	*95% CI*	
All adults	20,163	38.3	36.8	39.8	13.6	12.5	14.6	48.2	47.0	49.4
Special occupations	97	18.5	10.4	26.7	12.8	4.7	20.9	68.7	58.7	78.6
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	1,225	38.1	35.0	41.1	14.3	12.1	16.4	47.7	44.4	51.0
Professionals	676	46.8	42.2	51.3	12.3	9.4	15.3	40.9	36.5	45.4
Technicians and associate professionals	485	29.9	25.7	34.2	12.7	9.4	16.0	57.4	52.6	62.2
Clerks	620	40.0	35.3	44.7	13.1	10.2	16.1	46.9	42.0	51.7
Service workers and shop and market sales workers	1,042	33.7	29.9	37.5	12.1	9.7	14.5	54.2	50.2	58.2
Farmers, forestry workers and fishermen	3,467	24.8	22.5	27.0	10.1	8.6	11.6	65.2	63.0	67.3
Craft and related trades workers	1,091	22.8	19.8	25.7	11.5	8.6	14.4	65.7	61.9	69.4
Plant and machine operators and assemblers	950	19.6	15.9	23.2	8.6	6.7	10.5	71.8	68.0	75.6
Elementary occupation: Labourers and unskilled workers	2,322	34.6	32.2	37.0	12.3	10.6	14.0	53.1	50.6	55.6
No occupation	8,174	49.5	47.4	51.5	16.5	15.0	17.9	34.1	32.5	35.7

(68.7%), and craft and related trades workers (65.7%).

In terms of physical activity, more than half (54.5%) of the Filipino adults in general has high physical activity level. By type of occupation, farmers, forestry workers and fishermen have the highest percentage with high level of physical activity (79.9%) which is indicative of the kind and type of work they have in the field or at sea. This group is followed by adults working in craft and related trades (69.4%), and those who have elementary occupation like labourers and unskilled workers. Highest percentage of low physical activity level is seen among adults with no occupation (59.1%), followed by clerks (56.8%), and professionals (55.6%) (Table 7).

In terms of food intake, Tables 8 and 9 summarised the mean one-day per capita food intake of the households by occupational group of household heads. Households with special occupations have the highest energy intake, while the group of farmers and fishermen had the lowest protein, iron, vitamin A, thiamine, riboflavin, niacin and fat intakes. Households headed by craft and related trade workers have the lowest percentage of households meeting the energy requirement (27.4%). Households headed by farmers and fishermen have the lowest percentage of households

Table 7. Physical activity level of adults ≥20 y by various occupations

Occupational groups	*n*	*Physical activity*[†]					
		Low			*High*		
		%	*95% CI*		*%*	*95% CI*	
All adults	19,551	45.5	43.8	47.1	54.5	52.9	56.2
Special occupations	92	52.6	42.1	63.1	47.4	36.9	57.9
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	1,191	50.1	46.6	53.6	49.9	46.4	53.4
Professionals	637	55.6	50.5	60.7	44.4	39.3	49.5
Technicians and associate professionals	471	49.5	43.8	55.1	50.5	44.9	56.2
Clerks	595	56.8	52.1	61.5	43.2	38.5	47.9
Service workers and shop and market sales workers	980	42.8	38.9	46.6	57.2	53.4	61.1
Farmers, forestry workers and fishermen	3,443	20.1	17.8	22.5	79.9	77.5	82.2
Craft and related trades workers	1,052	30.6	26.6	34.5	69.4	65.5	73.4
Plant and machine operators and assemblers	898	38.4	34.3	42.5	61.6	57.5	65.7
Elementary occupation: Labourers and unskilled workers	2,225	30.9	28.2	33.6	69.1	66.4	71.8
No occupation	7,953	59.1	57.2	60.9	40.9	39.1	42.8

[†]A person not meeting any of the following criteria is considered being physically inactive and therefore at risk of chronic disease:
- 3 or more days of vigorous-intensity activity of at least 20 minutes per day; OR
- 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day

meeting the requirement for protein (52.5%), vitamin A (20.1%), thiamine (27.4%) and riboflavin (14.9%)

DISCUSSION

The nutritional and health status of Filipino adults ≥20 y working in various occupations is of concern. Adults without occupations, farmers, forestry workers and fishermen are chronically energy deficient and anaemic. These findings are in line with the studies of Clemens *et al.* (2015) and Roelfs *et al.* (2011), who reported associations between unemployment and increased risk of both ill-health and mortality. These associations may occur in part through adverse health-related behaviours – principally smoking, diet, exercise, and alcohol consumption. In the case of farmers, forestry workers and fishermen in the Philippines, the living condition of this occupational group, coupled with poor health, high risk to extreme events, poverty and poor quality of diet, may have contributed to the occurrence of CED. Previous studies showed that populations with lower socioeconomic status were more prone to anaemia (Alaofe *et al.*, 2009; Luo *et al.*, 2011).

Table 8. Per capita mean one-day energy and nutrient intake by occupation of household heads should add "% meeting Philippines RDAs for energy and each nutrient"

Occupation groups	Energy (kcal)	Protein (g)	Iron (mg)	Vit. A (mcg RE)	Calcium (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vit. C (mg)	Carbohydrates (g)	Fats (g)
All households	1813	56.6	9.4	534.2	394.8	0.83	0.76	18.3	43.8	310.6	37.9
Special occupations	2036	65.6	10.7	1092.6	425.9	0.95	1.15	21.9	46.4	320.9	54.1
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	1914	63.6	10.3	628.3	397.1	0.95	0.87	20.2	44.0	306.6	47.5
Professionals	1941	68.6	10.9	591.4	471.3	0.99	0.97	21.8	55.0	292.2	54.2
Technicians and associate professionals	1875	62.3	10.5	1130.5	406.6	0.88	1.09	20.2	45.3	293.9	49.9
Clerks	1813	59.2	9.9	770.5	377.7	0.92	0.86	19.4	37.4	291.0	45.7
Service workers and shop and market sales workers	1808	59.4	9.6	727.9	374.1	0.93	0.89	19.6	38.6	294.5	42.9
Farmers, forestry workers and fishermen	1815	52.4	8.8	375.8	392.5	0.74	0.63	16.7	46.9	338.1	27.7
Craft and related trades workers	1776	54.3	9.3	556.9	364.9	0.83	0.74	17.6	39.6	304.2	37.7
Plant and machine operators and assemblers	1789	57.6	9.3	480.5	385.9	0.87	0.75	18.5	40.4	293.6	42.4
Elementary occupation: Labourers and unskilled workers	1768	53.7	8.9	482.8	365.2	0.80	0.72	17.6	38.7	310.3	34.5
No occupation	1806	58.0	9.7	548.5	426.1	0.83	0.79	18.9	47.3	302.1	40.1

Table 9. Percentage of households meeting energy and nutrient intake by occupation of household heads

Occupation groups	*Energy*	*Protein*	*Iron*	*Vit. A*	*Calcium*	*Thiamin*	*Riboflavin*	*Niacin*	*Vit. C*
All households	34.9	59.9	15.2	27.5	11.0	36.1	23.5	83.6	29.6
Special occupations	46.4	80.2	17.4	38.4	19.6	56.2	47.4	90.3	41.3
Officials of government and special-interest organisations, corporate executives, managers, managing proprietors and supervisors	42.1	70.3	21.2	33.8	13.4	45.3	30.7	88.9	30.6
Professionals	41.2	74.7	21.2	43.9	22.0	45.0	43.5	90.4	46.7
Technicians and associate professionals	37.7	72.0	21.0	33.8	12.8	44.1	27.7	90.1	32.2
Clerks	31.7	64.0	14.9	29.4	11.1	43.2	25.4	86.9	21.0
Service workers and shop and market sales workers	35.0	66.0	13.9	33.2	9.7	48.0	33.5	87.9	21.7
Farmers, forestry workers and fishermen	33.9	52.5	12.1	20.1	10.4	27.4	14.9	76.6	32.5
Craft and related trades workers	27.4	56.9	11.0	29.2	8.2	38.7	21.8	84.9	25.9
Plant and machine operators and assemblers	30.2	63.9	11.5	28.6	10.1	40.3	25.9	88.0	25.9
Elementary occupation: Labourers and unskilled workers	31.6	54.7	11.2	25.8	8.4	33.2	21.0	82.3	25.6
No occupation	39.9	61.6	21.3	28.9	12.7	35.7	26.5	84.4	31.6

While there are reports of an increase in weight associated with unemployment (Monsivais *et al.*, 2015), this does not hold true with the present study as adults with no occupation have the highest prevalence of CED. Other studies suggest a fall in body mass index (BMI) ranking during unemployment (Jonsdottir & Asgeirsdottir, 2014). According to Hughes (2017), an increase or decrease in weight is associated with unemployment, and may be gender specific or dependent on pre-unemployment BMI. On the other hand, the high prevalence of overweight and obesity observed among adults working as officials or professionals could be attributed to several work characteristics such as long work weeks (Solovieva *et al.*, 2013) and shift-work to psychosocial factors such as job stress (Nigatu *et al.*, 2016; Proper *et al.*, 2016). In contrast, workers who toiled for >40 hours per week or were exposed to a hostile work environment were significantly more likely to be obese (Luckhaupt *et al.*, 2014). Long work hours may be contributing to the rising obesity problem by reducing time for physical activity, particularly for individuals working with high ranks, managers or in sedentary occupations (Cook and Gazmararian, 2018). On the other hand, hostile work environments, like other stressors, may promote obesity through an increase in total caloric intake (Groesz, *et al.*, 2012). Longitudinal studies of workplace and hostility may help clarify this relationship.

Hypertension is a significant risk factor to cardiovascular diseases. The high prevalence of hypertension observed among officials and plant and machine operators and assemblers could be attributed to psychological and social factors that have been reported as contributors to the onset and trajectory of hypertension. Psychosocial factors, such as hostility and job strain, have been found to be associated with higher circulating levels of catecholamines, higher cortisol levels, and increased blood pressure over time (Cuevas, Williams & Albert, 2017).

The type of occupation is reportedly a risk factor for type-2 diabetes mellitus (DM). Nagaya *et al.* (2006) showed that Japanese manager/administrative workers aged ≥50 y showed increased risk to DM. In the present study, adults working as officials had the highest prevalence of overweight and obesity. The same occupational group had the highest number of hypertension and high fasting blood glucose level. According to Pavlou *et al.* (2018), many mechanisms have been proposed to explain why hypertension and T2DM co-exist in the same individuals. Obesity and increased visceral adiposity present as the most important pathogenetic factors. Moreover, insulin resistance is also a very important component for the development of both entities. Insulin resistance is associated with increased vascular adhesion molecules expression, oxidative stress, inflammation, and decreased vascular nitric oxide levels, which in turn promote vascular stiffness resulting in persistent hypertension (Smulyan *et al.*, 2016).

Tobacco and excessive alcohol consumption are addictive behaviours, listed among the 10 leading risk factors that cause death and disability in the world, and health consequences are greater if their consumption is combined (Reis, Quintal & Lourenc, 2018). When alcohol and tobacco are used together, this increases the risk of some types of cancer and cardiovascular diseases, more than the use of either drug alone (Lee *et al.*, 2005). In this review, the opportunity to obtain alcoholic beverages and tobacco cigarettes inexpensively, when combined with social pressure by peers to drink and smoke, is an especially powerful explanation for high rates of alcoholism among adults with

special occupations, farmers, forestry workers, fishermen, plant & machine operators and assemblers.

Strong evidence shows that physical inactivity increases the risk of many adverse health conditions, including the world's major non-communicable diseases (NCDs) such as coronary heart disease (CHD), type 2 diabetes (T2DM), and breast and colon cancers, and shortens life expectancy (Lee *et al.*, 2012). High percentage of farmers, forestry workers, fishermen, plant and machine operators and assemblers showed high physical activity level. In contrast, low levels of physical activity were reported among adults with no occupation, clerks and professionals. This result provides potential avenues for public health interventions.

In terms of dietary intake, the lowest prevalence of household heads meeting energy and nutrient requirement based on the Philippine Dietary Reference Intakes (PDRI) are those that are involved in heavy works such as craft and related trades, plant and machine operation and assembly, elementary occupation (labourers and unskilled), clerical works and farming, and forestry and fishing. Those with the highest proportion of households meeting the energy and nutrient intake are those headed by special occupations, officials and professionals. It is expected that with occupations requiring heavy work, the nutrient demand and energy expenditure are high. Therefore, adequate nutrient and energy intake of workers are essential. If daily energy expenditure is higher than the energy intake, consequently the energy balance becomes negative and it can affect the work power. Dietary analysis of the study conducted in South Africa showed 56% deficit of energy in farmers (Christie, 2008). In a study conducted on forest workers in Greece, there was a decrease in the received energy equal to 1193 kcal/d (Gallis, 2007). In a study by Capanzana *et al.* (2018), households headed by fishermen and farmers in the Philippines had higher prevalence of stunting and underweight among children 0-10 years old compared to other occupation groups of household heads.

Given the results of the present study, it is evident that the food intake, nutritional and health status of workers by various occupations demand attention. The World Health Organization defines health as not only the absence of disease but also a state of complete mental and physical wellbeing in relation to the productivity and performance of an individual, thus, a well-nourished, healthy workforce is a pre-condition for sustainable development. At the same time, the nutritional well-being of a population reflects the performance of its social and economic sectors, and to a large extent, is an indicator of the efficiency of national resource allocation. Investing in health and nutrition of workers is therefore wise because the enormous social and financial costs of malnutrition are averted. Moreover, improved nutrition has an enhancing effect on investments in health, education and agriculture sectors (FAO, 2004).

There is a growing worldwide recognition that worksite health and wellness programmes afford an excellent opportunity to positively impact the health profile of a large proportion of a country's workforce population (Despres *et al.*, 2014). Workplaces have been established as one of the priority settings for health promotion in the 21st century (Malik *et al.*, 2014). They have been shown to directly influence the physical, mental, economic and social well-being of employees and as a result, the health of their families. The concept of promoting health in the workplace is becoming increasingly relevant as more

organisations recognise the importance of a healthy workforce to obtain success across their organisation. There are several benefits for employers in investing in the health of their employee, such as reduced sickness absence, increased productivity and better staff retention (Abdin *et al.*, 2018).

In the study of Henke *et al.* (2011), Johnson & Johnson (J&J) was one of the first to implement a comprehensive workplace wellness programme and one of the few companies with data obtained through a longitudinal study of their health and wellness programmes. J&J realised an overall increase in the number of employees classified as low-risk (defined as 0 to 2 health risks) from 78% to 87.5% over the course of a 5-year period. During the same time period, they reported reductions in the percentage of employees who were sedentary (from 39% to 21%), used tobacco (12% to 3.6%), had high blood pressure (14% to 6.4%), and high cholesterol (19% to 6.2%).

The evidence is clear that the benefits to workers who engage in wellness programmes are tangible. By making healthier lifestyle choices, workers can greatly impact their energy, quality of life, and overall well-being; reduce their health risks; and minimise the likelihood of developing chronic health conditions.

CONCLUSION

The food intake and nutritional and health status of Filipino workers in the studied occupations were poor and needs to be improved. While chronic energy deficiency and anaemia were high in certain occupational groups, overweight, hypertension, high fasting blood sugar and high total cholesterol were high on others. Smoking, alcoholic drinking and physical inactivity were contributors to low health status in certain occupations. The needs of occupational groups at-risk to malnutrition should be prioritised for improvement. A comprehensive national policy on health, nutrition and welfare improvement among workers is recommended.

Authors' contributions

DVA and MVC contributed to the design, data analysis and drafting of the manuscript; GPG contributed to the design, acquisition of data and data analysis.

Conflict of interest and funding disclosure

The authors declare that they have no conflict of interests. This study was funded by the WorldFish Philippines. The funding body had no role in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript.

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Prevalence of food insecurity and associated factors among free-living older persons in Selangor, Malaysia

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ABSTRACT

Introduction: Older persons are vulnerable to food insecurity. This study aimed to determine the prevalence of food security and associated factors among free-living older persons in Petaling District, Selangor. **Methods:** A total of 220 free-living older persons aged 60-87 years were selected by using the cluster sampling method in this cross-sectional study. Face-to-face interviews were conducted to obtain information concerning the demographic and socioeconomic background, food security, oral health, and psychosocial status. Chi-square test and binary logistic regression analysis were used to analyse the studied variables. **Results:** The median age of the respondents was 65.5 years, and 19.5% were found as food insecure. There were significant associations between marital status (χ^2=6.818), education level (χ^2=6.242), occupation status (χ^2=7.540), monthly income (χ^2=9.940,), and oral health status (χ^2=9.627) with food security status. Those with a low monthly income (AOR=2.449, 95% CI: 1.046-5.732), poor oral health status (AOR: 3.306, 95% CI: 1.387-7.889) and living in rented accommodation (AOR=6.218, 95% CI: 1.458-26.518) were more likely to be food insecure. **Conclusion:** Respondents with an income lower than the poverty line income (PLI), living in rented accommodation and poor oral health status face increased risk of food insecurity. A nutrition assistance programme is suggested to improve the socioeconomic and food security status of older persons. Regular oral check-ups are recommended to improve the oral health status of the elderly.

Keywords: Older persons, food security status, food insecurity, Malaysia, oral health

INTRODUCTION

Ageing leads to gradual decrease in the physical and mental capacity, and growing risk of disease (WHO, 2015). The United Nations have established the cut-off age for older people as 60 years and above. In Asia, the older people made up 11.0% of the total population in 2012, and this is expected to increase to 24.0% by 2050 (United Nations, 2012).

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In 2010, about 5.0% of Malaysia's total population consisted of older persons, and Malaysia is expected to become an ageing society by 2021 (Department of Statistics Malaysia, 2012).

Food insecurity occurs whenever the ability to procure enough food is uncertain, being unable to live a healthy life and unsatisfied feeding (Schroeder & Smaldone, 2015). A lack of access to nutritious foods may lead to the earlier onset of ageing symptoms (Food Security and Agriculture Cluster, 2013). Food insufficiency, hunger, and malnutrition are terms that are closely related to food insecurity (Norhasmah, Zalilah & Asnarulkhadi, 2010). Several studies have reported food insecurity prevalence in the older population. About 13.0% of older Australians were food insecure (Russell *et al.*, 2014) while 19.0% of the elderly in the United States were food insecure (Hernandez *et al.*, 2017). In Malaysia, Rohida *et al.* (2017) reported prevalence of food insecurity among the older in Lubuk Merbau, Kedah was 27.7%, while Nurzetty Sofia *et al.* (2017) found 6.9% prevalence in an urban area in the Klang Valley.

Several factors are associated with food insecurity. Low monthly income and unemployment are consistently associated with food insecurity (Garg *et al.*, 2015; Wang *et al.*, 2015). Low-income persons are more likely to consume non-nutritious foods due to lower prices (Wang *et al.*, 2015) or use assistance programmes whenever they face financial constraints (Oemichen & Smith, 2016). In addition, low social support has been found to be independently associated with food insecurity (Markwick *et al.*, 2014).

It is known that food insecurity contributes to poor nutritional status among various populations. A food insecure person is one whose intake of nutrients is lower than those who are food secure (Davison & Kaplan, 2015). Similarly, Na *et al.* (2016) found that food insecure households are less likely to consume vegetables and fruits than food secure households. Poor nutritional status includes malnutrition, decreased resistance to infection, and lengthier hospital stays among the older (Barker *et al.*, 2011).

Besides, there is a lack of study on the contribution of oral health towards food security status among the older. Previous studies on food security status and poor oral health were mostly conducted among children (Chi *et al.*, 2014; Santin *et al.*, 2016). There is a need to assess the contribution of oral health on food insecurity status among the elderly.

There are limited published studies on factors affecting food insecurity among the older in Malaysia This study is aimed at determining the prevalence of food security and associated factors among free-living older persons in the urban Petaling district, Selangor.

MATERIALS AND METHODS

Study design and samples

This cross-sectional study was conducted in two selected sub-districts (Petaling II and Damansara) in Petaling district. Petaling district was selected due to it having the highest older population in Selangor (Department of Statistics Malaysia, 2012). After obtaining the estimated total number of elderly residents in a sub-district from the headman (*Penghulu*) of the Petaling district, two out of six sub-districts were needed to meet the sample size requirement. The two sub-districts were selected based on the simple random sampling carried out by using select cases method in IBM SPSS version 21. All of the older person residents in the residential areas in Petaling II and Damansara sub-districts were recruited. As food security status was determined

at the individual level, more than one respondent in a household could be included. A total of 273 older were identified in both sub-districts, of which 220 gave their consent to participate giving an overall response rate of 80.6%. Individuals with hearing problems and critical mental illness, such as Alzheimer's disease, were excluded.

Measurements

The researchers made house visits and conducted face-to-face interviews with the respondents to collect data on the demographic and socioeconomic background, food security, oral health, and psychosocial status. The respondents were asked by the researcher based on the pre-tested questionnaire. Demographic and socioeconomic background includes age, gender, marital status, living arrangements, house status, household size, education level, occupation status, and monthly income. Food security status was determined using the six-item Short Form of Food Security Status (United States Department of Agriculture, 2012). This is a short form module of the 18-item U.S. Household Food Security Status Module and 10-item U.S. Adult Food Security Status Module. The short form module has been shown to assess food insecure households and very low food security with reasonably high specificity and sensitivity with minimal bias compared to the 18-item measure (United States Department of Agriculture, 2012). Those who responded affirmatively to none or one item were considered as having high or marginal food security. Those who responded affirmatively to two to four items were considered as having low food security, and those who responded affirmatively to five or six items were considered as having very low food security. Low and very low food security were considered to indicate food insecurity. In this study, reliability test was carried out and the Cronbach's alpha (α) obtained was 0.749 with item-scale correlation ranging from 0.245 to 0.657.

The Geriatric Oral Health Assessment Index (GOHAI) was used to assess the oral health status. This comprised a 12-item scale consists of a six-point scale in which the lowest point scale is designated as 'never', and the highest point scale is designated as 'always'. A total score of 50 and below indicates poor oral health status; a total score of 51 - 56 indicates moderate oral health status, while 57 - 60 score indicates good oral health status (Nicholas *et al.*, 2010). The GOHAI showed the Cronbach's alpha (α) of 0.873 with item-scale correlation ranging from 0.228 to 0.744. The six-item Lubben Social Network Scale (LSNS-6) was used to measure the psychosocial status. This part comprises two sub-scales; namely, family and friend relationships. A total score of 12 or below indicates at-risk of social isolation (Boulos *et al.*, 2013). In this study, the LSNS-6 shows acceptable reliability with Cronbach's alpha (α) at 0.616 and the item-scale correlation ranging from 0.251 to 0.495. The Ethics Committee for Research Involving Human Subjects, Universiti Putra Malaysia [FPSK (EXP15) P014] gave approval, and written consent from the respondents was obtained prior to data collection.

Statistical analysis

Data were analysed using IBM SPSS version 21. Descriptive statistics – frequency, percentage, median, and interquartile range (IQR) – were used to analyse all the variables. The chi-square test was used to determine association between each categorical variable and food security status. Binary logistic regression was used to determine the factors associated with food insecurity by adjusting for all covariates associated

with food insecurity with $p<0.20$ in the unadjusted analyses. The significance level was set at $p<0.05$.

RESULTS

The distribution of the respondents based on the demographic and socioeconomic background, oral health, and psychosocial status are shown in Table 1. Over two-thirds of the respondents (70.9%) were aged 60 to 69 years. Just over half (57.7%) of the respondents were female, and 33.2% were separated or widowed. Almost all of the respondents were Malay and 6.8% of them lived alone. Over half of the respondents (57.7%) lived with less than five household members. Over half of the respondents (57.7%) had attained primary education level, and 52.3% were unemployed or a housewife. In addition, 4.5% of the respondents lived in rented accommodation, and 54.1% had a monthly income of less than Poverty Line Income (PLI) or below than RM940 (241.21 USD). In terms of oral health status, about 24.1% of the respondents had poor oral health status. About 16.8% of the respondents were at risk of social isolation.

The prevalence of food insecurity among the respondents was 19.5% while 18.2% had low food security and 1.3% had very low food security. Being separated or widowed (51.2% vs. 28.8%), living in rented vs. owner accommodation (14.0% vs. 2.3%), having lower vs. higher secondary education (86.0% vs. 65.0%), being unemployed or as housewife (69.8% vs. 48.0%), and having a monthly income of less than the poverty line income (76.7% vs. 48.6%) were significantly more prevalent among the food insecure respondents, compared to the food secured (Table 2). In addition, poor oral health status was significantly higher among the food insecure respondents (34.0%) than the food secured (13.5%) However, no significant associations were found between age group, gender, living arrangement status, household size, and psychosocial status, and food security status in this study.

Respondents with a monthly income of less than the PLI were twice as likely to suffer food insecurity (AOR=2.449, 95% CI: 1.046-5.732). Respondents who lived in rented accommodation had the highest odds of food insecurity compared to those who lived in their own house (AOR=6.218, 95% CI: 1.458-26.518). Also, respondents with poor oral health status were three times more likely to become food insecure compared to those who had good oral health status (AOR=3.306, 95% CI: 1.387-7.884) (Table 3).

DISCUSSION

The prevalence of food insecurity (19.5%) in the studied sample of older people living in an urban area was consistent with the findings of Brewer *et al.* (2010), and Hernandez *et al.* (2017), who respectively reported that 18.7% and 19.0% of older people in United States were food insecure. In contrast, the prevalence of food insecurity in this study was lower than that (27.7%) among older people in rural areas (Rohida *et al.*, 2017). The difference may be due to differences in income sources and levels available in an urban setting compared to the rural FELDA settlement in the study by Rohida *et al.* (2017). The latter were dependent primarily on income from rubber and oil palm small holdings. The respondents in this study had several sources of income including salary, retirement pension or monthly financial aid (from welfare department). Majority of the respondents received monthly living allowance from their working adult children, and also through other financial support such as payment of utility bills and groceries. A similar finding of children providing

Table 1. Demographic, socioeconomic background, oral health and psychosocial status (*n*=220)

Demographic background	*n*	*%*	*Median (IQR)*
Age (years)			65.50(8)
60-69	156	70.9	
70-79	57	25.9	
≥80	7	3.2	
Gender			
Male	93	42.3	
Female	127	57.7	
Ethnicity			
Malay	218	99.0	
Non-Malay	2	1.0	
Marital status			
Married	147	66.8	
Single/Separated/Widow	73	33.2	
Living arrangement			
Living alone	15	6.8	
Living with others	205	93.2	
House ownership status			
Own	210	95.5	
Rent	10	4.5	
Household size[†]			4(3)
1-4	127	57.7	
>4	93	42.3	
Education level			
No formal education	25	11.4	
Primary education	127	57.7	
Secondary education	62	28.2	
Tertiary education	6	2.7	
Occupation status			
Employed	18	12.3	
Unemployed/housewife	70	47.6	
Retired	59	40.1	
Monthly income (RM)[‡]			900(1100)
<RM940 (241.21 USD)	119	54.1	
≥RM940 (241.21 USD)	101	45.9	
Oral health status[§]			
Poor	53	24.1	
Moderate	63	28.6	
Good	104	47.3	
Psychosocial status[¶]			
At-risk of social isolation	37	16.8	
Normal	183	83.2	

[†]Average household size based on the average family size (persons) by Malaysian census (2010)
[‡]Income category based on the Poverty Line Income (PLI) by Economic Planning Unit (EPU, 2014), USD= RM3.90 (on 30th January 2018)
[§]Cut-off by Nicholas *et al.* (2010)
[¶]Cut-off by Boulos *et al.* (2013)

Table 2. Association between factors and food security status

Variables	*Food secure n (%)*	*Food insecure n (%)*	χ^2/ *Fisher's exact*	*p*
Age (years)			-	0.580†
<75	158 (89.3)	40 (93.0)		
≥75	19 (10.7)	3 (7.0)		
Gender			0.849	0.357
Male	78 (44.1)	15 (34.9)		
Female	99 (55.9)	28 (65.1)		
Ethnicity			-	0.353†
Malay	176 (99.4)	42 (97.7)		
Non-Malay	1 (0.6)	1 (2.3)		
Marital status			6.818	0.009*
Married	126 (71.2)	21 (48.8)		
Single/Separated/Widow	51 (28.8)	22 (51.2)		
Living arrangement			-	0.741†
Living alone	13 (7.3)	2 (4.7)		
Living with others	164 (92.7)	41 (95.3)		
House ownership status			-	0.005†*
Own	173 (97.7)	37 (86.0)		
Rent/others	4 (2.3)	6 (14.0)		
Household size			0.639	0.424
1-4	105 (89.8)	28 (90.7)		
>4	72 (10.2)	21 (9.3)		
Education level			6.242	0.012*
Below secondary level	115 (65.0)	37 (86.0)		
Secondary and above level	62 (35.0)	6 (14.0)		
Occupation status			7.540	0.023*
Employed	29 (16.4)	2 (4.7)		
Unemployed/housewife	85 (48.0)	30 (69.8)		
Retired	63 (35.6)	11 (25.6)		
Monthly income (RM)			9.940	0.002*
<940	86 (48.6)	33 (76.7)		
≥940	91 (51.4)	10 (23.3)		
Oral health status			9.627	0.008*
Poor	35 (19.8)	18 (41.9)		
Moderate	52 (29.4)	11 (25.6)		
Good	90 (50.8)	14 (32.6)		
Psychosocial status			0.015	0.903
Normal	148 (83.6)	35 (81.4)		
At-risk of social isolation	29 (16.4)	8 (18.6)		

*Significant at level $p<0.05$
†Fisher Exact Test

Table 3. Factors associated with food security status

Variables	*Adjusted OR (95% CI)*	*p*
Marital status		0.571
Married	1.000 (ref)	
Single/ Separated/ Widow	1.274 (0.552-2.939)	
Education level		0.157
Below secondary level	2.060 (0.758-5.603)	
Secondary and above level	1.000 (ref)	
Occupation status		
Employed	1.000 (ref)	
Unemployed/housewife	3.486 (0.730-16.660)	0.118
Retired	2.782 (0.545-14.198)	0.219
House ownership status		0.014*
Own	1.000 (ref)	
Rent	6.218 (1.458-26.518)	
Monthly income (RM)		0.039*
<RM940	2.449 (1.046-5.732)	
≥RM940	1.000 (ref)	
Oral health status		
Poor	3.306(1.387-7.884)	0.007*
Moderate	1.351(0.531-3.440)	0.528
Good	1.000 (ref)	

*Significant at level $p<0.05$, Cox & Snell $R^2=0.146$, Nagelkerke $R^2=0.233$. Model fits well.

groceries to their older parents was reported by Tengku Fatimah Muliana (2016). Further, their adult children often provided groceries for the parents.

Low education and being unemployed were associated with food insecurity, and this finding is consistent with the results of previous studies (Alvares & Amaral, 2014; Kim *et al.*, 2011; Wang *et al.*, 2015). Low education level was associated with instable job and low wages (Nie & Souza, 2018). Being non-married was also significantly associated with food insecurity (Alvares & Amaral, 2014). Spouses could help the older people in preparing balanced meals, especially among those with poor physical functions (Chang *et al.*, 2017). Those who eat alone or eat without spouse had low eating pleasure and at a high risk of losing interest in food (Oemichen & Smith, 2016).

In the current study, an income of less than the PLI increases the odds of food insecurity by 2.4 times (AOR=2.449; 95% CI: 1.046-5.732), compared with those with income above the PLI. Low income persons were more likely to consume low nutritional value foods such as sugary and high fat foods due to the affordable price (Wang *et al.*, 2015). Further, low income persons reduced the size of meals and daily meal frequency (Norhasmah *et al.*, 2011).

Respondents living in rented accommodation were found to increase the odds of food insecurity by six folds, probably owing to high rental and other living costs in urban areas. Similar findings were reported by Matheson & Mclntyre (2014) and Russell *et al. (*2014). Risk of food insecurity increased when the monthly accommodation cost is high (Sriram & Tarasuk, 2016).

Poor oral health status was one of the main factors found associated with food insecurity among the older persons. Muhamad Adib Aiman and Norhasmah (2014) had reported a similar finding. The most common oral health problem faced by the older people is loss of teeth leading to difficulty in chewing (Ozkan *et*

al., 2011). Chewing difficulty can lead to limited intake of food with hard texture (Iwasaki *et al.*, 2016). Older people with no teeth (edentulous) had significantly greater difficulty in eating raw food, such as fruits than the older with their real teeth (dentate) (De Andrade *et al.*, 2012).

Social networks provide protective benefits by sharing food and nutrition concerns (Chhabra *et al.*, 2014). Previous studies found less social support positively associated with food insecurity (Dean *et al.*, 2011; Markwick *et al.*, 2014). Majority of the respondents in this study reported had high social support, living with or nearby family members in keeping with tradition (Noran *et al.*, 2010). Hence, psychosocial status was not a significant factor associated with food security status among older people in this study.

There are several limitations in this study. This is a cross-sectional study whereby the causal relationship between two variables could not be drawn. Further, this study covered sensitive issues such as shortage of food due to financial constraints, which might be an embarrassing topic for to discuss with the respondents. It is suggested that olfactory functions (smell and taste function) in future studies on food security status of older people.

CONCLUSION

Food insecurity prevalence of 19.5% was present among a sample of older persons living in Petaling district, an urban area. Social programmes are recommended to improve the food security status of older people, include providing food assistance, oral health check-ups and encouraging family members to spend more time with their older parents.

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Authors' contributions

SFM collected and analysed the data as well as wrote the manuscript; NS supervised the flow of the research and reviewed the manuscript; ZMS reviewed the manuscript; ZI reviewed the manuscript.

Conflict of interest

All of the authors declared no conflict of interest.

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Comparison of maternal nutrition literacy, dietary diversity, and food security among households with and without double burden of malnutrition in Surabaya, Indonesia

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ABSTRACT

Introduction: Double burden of malnutrition in the form of stunted child and overweight/obese mother has been increasing in countries experiencing nutrition transition. This study aimed to compare maternal nutrition, literacy, dietary diversity, and food security of households categorised by nutritional status of mother-child pairs. **Methods:** This cross-sectional study included a total of 685 children under 5 years of age from 14 community health centres (*posyandu)* in a poor urban area of Surabaya, Indonesia. The Lemeshow formula was used to compute sample size. The children and their mothers were categorised into mother-child pairs based on maternal body mass index (BMI) and height-for-age *z-score* for the child: non-overweight mother-non-stunted child (NM), non-overweight mother and stunted child (SC), overweight/obese mother and non-stunted child (OWT), stunted child and overweight/obese mother (SCOWT). Nutrition literacy was determined using questionnaires, dietary diversity was estimated using household dietary diversity scores, and food security was determined using the Household Food Insecurity Access Scale (HFIAS). **Results:** The prevalence of households with SCOWT double burden of malnutrition was 21.2%, OWT 37.7%, SC 15.3% and 25.8% were normal (NM). There were significant differences in maternal nutrition literacy, dietary diversity and household food security status. Households with NM pairs were shown to be most food secure followed by OWT, SC and lastly, the SCOWT pairs. **Conclusion:** Households with double burden of malnutrition have relatively lower nutrition literacy, dietary diversity, and food security. This study indicates the importance of developing nutritional strategies to enable low-income households to make healthy food choices.

Keywords: Nutrition literacy, dietary diversity, food security, double burden of malnutrition, Indonesia

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INTRODUCTION

Over two decades ago, Popkin (1994) postulated the growing problem of nutrition transition as part of a complex interrelation of demographic and epidemiologic transition. In his recent publication, Popkin (2015) argued that the underlying cause for rapid nutrition transition in low and middle income countries (LMICs) is related to changes in agricultural systems, advancement of technologies and mechanisation that decrease physical activity, urbanisation, and tremendous growth of the modern food system. As a result, nutrition transition is believed to be the driving force for the global epidemic of overweight and obesity (Popkin, 2012) and double burden of malnutrition (Doak *et al.*, 2005). Secondary data analysis from Brazil, China, Indonesia, the United States, and Vietnam revealed households with double burden of malnutrition in the form of stunted child under 5 years of age and overweight mother (SCOWT) were more likely to occur in an urban setting and within a high-income population (Doak *et al.*, 2005). A recent review revealed nearly all developing countries were facing the problem of double burden of malnutrition, and the increase in per capita income was associated with the increase in the overweight/underweight ratio (Abdullah, 2015).

With the fourth largest population in the world, Indonesia is believed to be experiencing the double burden of malnutrition (Oddo *et al.*, 2012; Sekiyama *et al.*, 2015). A study in rural Indonesia reported that the prevalence of SCOWT was 11% in 2012 (Oddo *et al.*, 2012), while in 2015, SCOWT prevalence was 30.6% in rural areas (Sekiyama *et al.*, 2015). Understanding specific features of SCOWT among populations undergoing nutrition transition might help explain approaches to achieve good nutrition at this critical time in children's lives.

SCOWT households tend to be characterised by consumption of foods with higher fat and protein content compared to underweight and normal weight households (Doak *et al.*, 2002). Though easily distinguished from the "underweight only" households, the double burden of malnutrition (SCOWT) was relatively difficult to distinguish from the "overweight only households" (OWT) (Doak *et al.*, 2005). Boutizou (2015) reported that low dietary diversity was associated with an increased likelihood of double burden of malnutrition. High consumption of animal-based foods was associated with a decrease of likelihood of SCOWT in rural Indonesia (Sekiyama *et al.*, 2015).

We hypothesised that SCOWT households lacked the necessary knowledge for choosing healthy foods, leading to poor dietary diversity. This inability could be driven by a low level of knowledge in nutrition, and not merely caused by limited access to healthy foods. Bandura (2004) argued that knowledge of health benefits provides the necessary precondition for change. Knowledge in nutrition could be measured as nutrition literacy described as the degree to which individuals have the capacity to obtain, process, and understand basic nutrition information and services needed to make appropriate nutrition-related decisions (Gibbs *et al.*, 2016). In the tenets of the Social Cognitive Theory (SCT), Bandura (2004) argued that cognitive precondition in the form of knowledge was not enough for people to overcome the impediments to adopt new lifestyle habits and retain them without additional self-influence and personal-efficacy.

MATERIALS AND METHODS

This cross-sectional study was conducted in the second largest city in Indonesia,

Surabaya. This site was chosen according to the criteria of having more than 15% prevalence of children under 5 years old suffering from underweight, based on the monthly child growth monitoring data in the community-driven integrated health post, or in Indonesian language, "*Pos Pelayanan Terpadu*" or "*posyandu*" (Mahmudiono, 2007). We defined the double burden of malnutrition as the coexistence of stunted child under five and overweight/obesity mother in the same household (SCOWT).

A minimum sample size of 662 participants was computed based on maximising detection for SCOWT households, 82.5% statistical power with a 5% margin of error, a general assumption of 50% response distribution, using 1.5 design effect from the clustering of *posyandu*. In anticipation of 5% non-response rate, we targeted 700 mother-child pairs.

We employed a systematic cluster sampling method involving 14 *posyandu* in an urban poor population of Surabaya, Indonesia. Seven *posyandu* were randomly selected from each of two sub-districts with high prevalence of underweight children (more than 15% based on the report of Surabaya District Health Office). During the *posyandu* meetings, mothers were informed about the study and invited to participate by signing an informed consent. Inclusion criteria included agreement to participate and having a child aged under 5 years. In each of the 14 *posyandu*, 50 households with eligible pairs of mothers and under-five children were selected for this study. After cleaning the data to remove extreme values and missing data, a total of 685 mother-child pairs were included in the final study sample.

Weight and height of the mother as well as the child were taken at the *posyandu*. A stadiometer SECA 213 (Seca GmbH & Co. Kg, Germany) was used to measure height, and a Camry EB6571 digital scale (Guangdong, China) was used to the nearest 0.01 kg to measure weight. Measurements were conducted twice if the reading from the first and second measurements was less than 0.5 cm difference for height and 0.05 kg for weight. A third measurement was carried out if the first and second measurements had more than the above-mentioned difference. The age of the child was determined from the health-monitoring card/registry in the *posyandu*. Background information of the households was recorded. The World Health Organization (WHO) child growth standard 2006 was used as a reference for determining the child nutrition status based on the index of height-for-age *z*-score (HAZ) (WHO, 2016). According to that standard, a child is categorised as stunted if the HAZ is below -2 standard deviations. The conventional cut-off points for determining maternal overweight (BMI of 25.00 kg/m^2 to 29.99 kg/m^2) and obesity (BMI >30.00 kg/m^2) were employed (Gibbs *et al.*, 2016).

Based on the BMI and height-for-age measurements of the mothers and children respectively, the eligible mother-child pairs were categorised as follows: non-overweight mother-non-stunted child (NM) pair, non-overweight mother and stunted child (SC) pair, overweight/obese mother and non-stunted child (OWT) pair, and stunted child and overweight/obese mother (SCOWT) pair.

Nutrition literacy was measured in five domains: relationship between nutrition and health, knowledge of macronutrients, skill in food measures, numeracy and label reading, and skills in grouping food in categories (Gibbs *et al.*, 2016). Only three domains of nutrition literacy were used in this study; the three domains were: macronutrients, household food measures, and food groups. The macronutrients domain had 6-item, close-ended questions

modified from the original questionnaire (Cronbach's α=0.497). The 6-item questionnaire in the household food measure domain was adapted to reflect the common household measurements used in Indonesia (Cronbach's α=-0.344). The food groups domain was also adapted from the original American "MyPlate" to the Indonesian version of MyPlate known in Indonesian language as "*Piring Makanku*" (Cronbach's α=0.564). The major difference between MyPlate and "*Piring Makanku*" was that in Indonesian "*Piring Makanku*" water is substituted for milk (Kemenkes, 2014).

Dietary diversity was assessed according to the Food and Agriculture Organization of the United Nations guidelines to measure the household and individual dietary diversity (FAO, 2011). Mothers were asked to recall food intake during the past 24 hours by answering a series of questions about each of 16 food groups. In keeping with the FAO guidelines, the 16 food groups were aggregated into 12 food groups, and the answers were used to create the household's dietary diversity score (HDDS). The 12 food groups listed in the final HDDS were cereals (including rice and noodles), tubers/roots, vegetables, fruits, fish (including fresh water fish, dried fish, and seafood), meat and poultry, eggs, nuts and seeds, dairy products, spices, oils and fats, and sweets. Scores for the 12 food-group categories ranged from 0 to 12 (Cronbach's α=0.281).

Food security was assessed using nine items from the household food insecurity access scale (HFIAS) questionnaire (Coates *et al.*, 2007). Originally, the score for the HFIAS ranged from 0 through 27 with a lower score indicating food security. In this study, we performed principle component analysis (PCA) to derive the measure of food security from the set of nine HFIAS questions. We used Varimax rotation with the Kaizer Normalization method for rotation of the data, and set factors with an eigenvalue of greater than 1.0 to be included as measures of food security. Table 3 shows the PCA results for the nine-items set of HFIAS questions.

Test of normality was conducted on the studied variables and for those not normally distributed, the Kruskal-Wallis test with post hoc analysis with Bonferroni correction was used. Significance was set at $p<0.05$ for Kruskal-Wallis and $p<0.0083$ for Bonferroni correction. Descriptive statistics and Chi-square tests were used to describe the demographic characteristics of the sample. The measurement of food security status was derived from principle component analysis (PCA) with Varimax rotation. Statistical analysis was performed using SPSS Statistics version 23 (IBM Corporation, Philadelphia, USA).

This study was conducted according to the guidelines outlined in the Declaration of Helsinki, and all procedures involving human subjects/patients were obtained from the Institutional Review Board (IRB) of Kansas State University, USA (reference or proposal number: 7646). In Indonesia, approval for the study was granted by the Surabaya City Review Board (Bakesbangpol No: 1366/LIT/2015). Written informed consent was obtained from the mothers. Respondents were told they could withdraw their participation in the study at any time without consequences.

RESULTS

Description of the sample

This study found that 21.2% of the sample experienced double burden of malnutrition in the form of SCOWT living in the same household. The prevalence of OWT was 37.7%, while that for SC was 15.3%. Just over one fourth (25.8%) of the households had mothers with normal BMI and normal child height-for-age *z*-score (NM).

Significant differences were found between the mother-child nutritional status categories and several demographic characteristics, such as maternal education, total number of children living in the same household, father's occupation, household income and monthly food expenditure (Table 1). However, no significant difference was observed for child's gender, maternal general literacy, family type, number of children under 5 years of age in the household and maternal occupation across the different mother-child categories.

The percentage of mothers who did not attend high school education was the highest among OWT pairs (24.1%), followed by SCOWT pairs (16.3%), as compared to the NM pairs (14.1%). Households with SCOWT pairs also had a higher percentage of 3 to 4 children living at home (7.9%) than the NM pairs (4.5%). The percentage of fathers with a steady occupation, as government employees, or in the private sector as tradesmen was relatively higher among NM pair households (17.8%) than the SCOWT pair households (9.6%). In terms of total monthly income, the percentage of households earning more than Indonesian Rupiahs (IDR) 2,500,000 (USD 165) was higher among NM pairs (9.7%) and OWT pairs (10.2%) than SCOWT pairs (4.3%) and SC pairs (2.1%). The monthly food expenditure among households was significantly different among the groups of households. The majority of respondents (77.4%) reported monthly food expenditure was around IDR 500,000 to IDR 1,500,000 (USD 33 to USD 99).

Nutrition literacy, dietary diversity, food insecurity

Nutrition literacy results are shown in Table 2. The SCOWT households were among the lowest for maternal literacy and dietary diversity scores. They were the worst-off in terms of food insecurity rank.

The follow-up post hoc analysis revealed that maternal nutrition literacy between households with SCOWT pairs was significantly lower than households with NM pairs as well as OWT pairs (Table 3).

Dietary diversity result showed a modest score for all the categories; however, post hoc analyses indicated that NM significantly outperformed the other three categories (Table 3). NM households were shown to be the most food secure followed by the OWT pairs, SC pairs and lastly, the SCOWT pairs.

Two factors emerged in this study as household food security measures. The first factor was related to possible disruption of "food quality," and the second factor emphasised concerns about lack of "food quantity" in the household for the preceding last 4 weeks. Table 3 shows there was significant difference in food security measures in terms of both "food quality" ($p<0.001$) and "food quantity" ($p=0.019$) among the four pair categories based on the Kruskal-Wallis test. In the post hoc analysis with Bonferroni correction, the "food quality" measure in the SCOWT pairs was significantly higher than the NM pairs, SC pairs, as well as OWT pairs. In the "food quantity" measure, the SCOWT pairs were significantly lower than the SC pairs.

DISCUSSION

There were significant differences in maternal nutrition literacy, dietary diversity, and PCA-derived food security measures (quality of food and quantity of food) among the households with and without double burden malnutrition. Maternal nutrition literacy and lack of food quality were distinctly different in the SCOWT and OWT households only.

Table 1. Demographic background of mother-child pairs (*n*=685)

Variable	*NM pairs*[†]		*SC pairs*[‡]		*OWT pairs*[§]		*SCOWT pairs*[¶]		*p-value*
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	
Child's gender									0.065
Male	87	12.7	60	8.8	115	16.8	81	11.8	
Female	90	13.1	45	6.6	143	20.9	64	9.3	
Mother's general literacy									0.059
Illiterate	8	1.2	12	1.8	23	3.4	14	2.0	
Partially literate	18	2.6	15	2.2	33	4.8	28	4.1	
Literate	151	22.0	78	11.4	202	29.5	103	15.0	
Maternal education									0.000***
No schooling	4	0.6	9	1.3	14	2.0	11	1.6	
Primary	58	8.5	57	8.3	93	13.6	74	10.8	
Secondary	34	5.0	19	2.8	58	8.5	27	3.9	
High-school	64	9.3	19	2.8	78	11.4	26	3.8	
College	17	2.5	1	0.1	15	15.0	7	1.0	
Family type									0.410
Nuclear family	112	16.4	61	8.9	159	23.2	89	13.0	
Extended family	65	9.5	44	6.4	99	14.5	56	8.2	
Number of children at home									0.006**
1-2 children	141	20.6	77	11.2	177	25.8	87	12.7	
3-4 children	31	4.5	25	3.6	77	11.2	54	7.9	
>4 children	5	0.7	3	0.4	4	0.6	4	0.6	
Number of children under 5 years old in the household									0.969
1 child	159	23.2	97	14.2	232	33.9	129	18.8	
2 children	17	2.5	8	1.2	25	3.6	15	2.2	
3 children	1	0.1	0	0.0	1	0.1	1	0.1	
Maternal occupation									0.465
Housewife without maid	135	19.7	86	12.6	187	27.3	112	16.4	
Housewife with maid	2	0.3	4	0.6	11	1.6	9	1.3	
Government officer (PNS/BUMN/Army/ Police)	1	0.1	0	0.0	2	0.3	0	0.0	
Private sector	13	1.9	3	0.4	20	2.9	6	0.9	
Trade and entrepreneur	15	2.2	8	1.2	19	2.8	9	1.3	
Labour/miscellaneous services	11	1.6	4	0.6	19	2.8	9	1.3	
Paternal occupation									<0.001***
Government employee (PNS/BUMN/Army/ Police)	28	4.3	1	0.2	30	4.6	4	0.6	
Private sector	60	9.2	26	4.0	72	11.1	34	5.2	
Trade and entrepreneur	28	4.3	20	3.1	38	5.8	25	3.8	
Labour	35	5.4	36	5.5	81	12.5	45	6.9	
Other	20	3.1	17	2.6	24	3.7	26	3.9	
Household's monthly income									0.007**
<IDR 1,000,000 (<$100)	25	3.7	18	2.6	50	7.3	32	4.7	
IDR 1,000,000 – 1,500,000 ($100 – 150)	47	6.9	44	6.4	77	11.2	50	7.3	
>IDR 1,500,000 – 2,000,000 (>$150 – 200)	28	4.1	17	2.5	34	5.0	21	3.1	
>IDR 2,000,000 – 2,500,000 (>$200 – 250)	11	1.6	12	1.8	27	3.9	13	1.9	
>IDR 2,500,000 – 3,000,000 (>$250 – 300)	30	4.4	8	1.2	23	3.4	19	2.8	
>IDR 3,000,000 (>$300)	36	5.3	6	0.9	47	6.8	10	1.5	
Household's monthly food expenditure									0.049*
<IDR 500,000 (<$50)	16	2.3	13	1.9	17	2.5	6	0.9	
IDR 500,000 – 1,000,000 ($50 – 100)	71	10.4	54	7.9	118	17.2	68	9.9	
>IDR 1,000,000 – 1,500,000 (>$100 – 150)	51	7.4	28	4.1	90	13.1	51	7.4	
>IDR 1,500,000 – 2,000,000 (>$150 – 200)	14	2.0	5	0.7	16	2.3	10	1.5	
>IDR 2,000,000 – 2,500,000 (>$200 – 250)	13	1.9	4	0.6	7	1.0	5	0.7	
>IDR 2,500,000 (>$250)	12	1.8	1	0.1	10	1.5	5	0.7	

[†]NM pairs=Pairs with nutritional status of both mother (Body Mass Index or BMI between 18.5 to 25.0) and child (Height-for-age *z*-score/HAZ between -2 to + 2) was normal.
[‡]SC pairs=Pairs with stunted child (HAZ less than -2) and normal mother (BMI between 18.5 to 25.0).
[§]OWT pairs=Pairs with overweight/obese mother (BMI>25.0) and normal child (HAZ between -2 to + 2).
[¶]SCOWT pairs=Pairs with stunted child (HAZ less than -2) and overweight/obese mother (BMI>25.0).
Values were significantly different from households with normal mother-child pairs: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$. *P* was obtained with X^2 tests.

Table 2. Descriptive statistics of household's categories based on mother-child pairs in relation to nutrition literacy, dietary diversity, and food insecurity

Variable	*Median*	*IQR*	*Skewness (SE)*	*Kurtosis (SE)*
Nutrition literacy score				
NM pairs	19	3.5	-0.630 (0.183)	0.822 (0.363)
SC pairs	18	4.0	-1.256 (0.236)	2.933 (0.467)
OWT pairs	18	3.0	-0.442 (0.152)	0.284 (0.302)
SCOWT pairs	17	4.0	-0.746 (0.201)	2.154 (0.400)
Dietary diversity score				
NM pairs	7	2.0	-0.013 (0.183)	0.362 (0.363)
SC pairs	6	2.0	0.545 (0.236)	0.663 (0.467)
OWT pairs	7	1.0	2.222 (0.152)	14.104 (0.302)
SCOWT pairs	6	2.0	0.107 (0.201)	-0.152 (0.400)
The HFIAS score				
NM pairs	1	6.0	1.361 (0.183)	0.815 (0.363)
SC pairs	4	9.0	0.939 (0.236)	-0.002 (0.467)
OWT pairs	2	7.0	1.311 (0.152)	0.961 (0.302)
SCOWT pairs	5	9.0	0.818 (0.201)	-0.129 (0.400)

IQR=Inter Quartile Range; SE=Standard Error; HFIAS=Household Food Insecurity Access Scale.

These results negate previous arguments that suggested households with double burden malnutrition (SCOWT) was not a distinct entity and merely a statistical artefact (Dieffenbach and Stein, 2012). Whether SCOWT households were biologically distinct, aligning with the Developmental Origins of Health and Disease (DOHaD) (Sata, 2016), for example, is yet to be confirmed.

Previous evidence showed that SCOWT prevalence was highly dependent on the prevalence of maternal overweight (Dieffenbach & Stein, 2012). Although the prevalence of OWT households was higher than other household categories, our study found that the prevalence of SCOWT was not dependent or having a multi-collinearity with the prevalence of OWT pairs. Maternal nutrition literacy among SCOWT households was significantly lower, while the PCA-derived measure of "food quality," representing a household's lack in "preferred" foods, was significantly different from OWT households. The SCOWT households were reported to have a significantly higher lack of "food quality" but not "food quantity" in comparison to the OWT households. A study in Guatemala had also shown that double burden malnutrition was most prevalent among households with per capita consumption in the middle quintile (Lee *et al.*, 2012).

The observed maternal nutrition literacy that was lower among SCOWT households indicated that mothers who are responsible for the household's grocery shopping, were not equipped to make healthy food choices. In order to assess nutrition literacy, only three domains of nutrition literacy were used in this study due to the socio-cultural differences with the original five domains (Gibbs *et al.*, 2016). There was no significant difference between the lack of "food quantity" between households with SCOWT and OWT pairs, but a significant difference in the lack of "food quantity" was found between SCOWT and SC households. The SCOWT households believed they were "food secure" although they had limitations in terms of access to preferred foods. These findings indicate the importance of nutritional and behavioural strategies

Table 3. Nutrition literacy, dietary diversity, food security, and nutritional status of mother-child pairs

Mother-child pairs	*Nutrition literacy*			*Dietary diversity*			*FS1*[†]			*FS2*[‡]		
	Mean rank	*p*	*Eta-squared*	*Mean rank*	*p*	*Eta-squared*	*Mean rank*	*p*	*Eta-squared*	*Mean rank*	*p*	*Eta-squared*
Kruskal-Wallis test		<0.001**	0.046		0.000**	0.030		<0.001**	0.045		0.019*	0.015
NM Pairs	391.89			388.34			313.19			332.89		
SC Pairs	290.49			298.05			343.71			381.91		
OWT Pairs	361.32			349.05			318.85			352.18		
SCOWT Pairs	288.75			307.87			419.27			308.40		
Post hoc analysis												
SCOWT-NM		<0.001***	0.065		0.000***	0.042		<0.001***	0.073		0.182	0.006
SCOWT	135.33			141.05			188.14			153.51		
NM	182.94			178.25			138.64			167.17		
SCOWT-SC		0.849	0.000		0.691	<0.001		0.002***	0.038		0.007***	0.029
SCOWT	124.76			127.00			137.30			115.14		
SC	126.52			123.42			109.20			139.80		
SCOWT-OWT		<0.001***	0.031		0.032	0.011		<0.001***	0.062		0.033	0.011
SCOWT	174.66			185.82			239.82			185.75		
OWT	217.37			211.09			180.74			211.13		
NM-SC		<0.001***	0.062		0.000***	0.049		0.200	0.006		0.028	0.017
NM	157.05			155.07			136.34			132.99		
SC	115.30			118.62			148.81			154.42		
NM-OWT		0.099	0.006		0.049	0.010		0.746	0.000		0.270	0.003
NM	229.91			233.02			215.22			209.73		
OWT	209.83			207.69			219.06			222.80		
SC-OWT		0.001***	0.028		0.017	0.016		0.248	0.004		0.164	0.005
SC	154.67			162.00			191.70			193.69		
OWT	193.12			190.14			178.05			177.24		

[†]FS1=Food quality as a measure of food security derived from principle component analysis.
[‡]FS2=Food intake as a measure of food security derived from principle component analysis.
685 among 700 households with non-missing variables were used for the Kruskal-Wallis test and sub-sequent post hoc analysis.
Values were significantly different for Kruskal-Wallis test: *p<0.05, **p<0.001.
Values were significantly different for post hoc analysis with Bonferroni Correction: ***

to enable mothers on a limited budget to make healthy food choices.

Post hoc analysis revealed that the difference in dietary diversity was significant between households with SCOWT pairs compared to NM pairs, but there was no significant difference in dietary diversity between SCOWT and OWT or SC pairs. These results are similar to the findings of a previous study in Indonesia (Sekiyama *et al.*, 2015).

The percentage of households earning more than IDR 2,500,000 ($165 USD) was higher among OWT pairs (10.2%) than SCOWT pairs (4.3%) and SC pairs (2.1%). In terms of monthly income, the discrepancy between SCOWT households and OWT households was wider than between SCOWT and SC households. These results are in line with the suggested aetiology of the double burden of malnutrition (Jehn & Brewis, 2009). Increases in household income is likely to lead to increased intake of energy-dense food, and not by nutrient-dense foods (Dieffenbach & Stein, 2012; Jehn & Brewis, 2009). Providing adequate nutrients to assist a child's rapid growth during the first 1,000 days of life should be emphasised (Victora & Rivera, 2014).

Our findings highlight the importance of food system in term of food security and dietary diversity related to double burden of malnutrition. Previous research showed that SCOWT households did not meet dietary diversity as well as daily energy needs due to insufficient food availability and high costs of food (Shamah-Levy *et al.*, 2017). Stunting in children is a result of long term nutritional insufficiency, owing to a lack of consumption of highly nutritious food required for the normal growth. Besides, children in food insecure households are likely to be exposed to less sanitary environment that might increase their infection risks (Caulfield *et al.*, 2006).

Even though Corace & Garber (2014) and Hall *et al.* (2016) reported disparities between nutrition knowledge and behaviour outcomes, nutrition literacy should be accompanied by enhancing self-efficacy, positive outcome expectations and building support systems (Bandura, 2004). A previous study in Indonesia revealed that interventions to enhance mother's self-efficacy could improve mother's positive behaviour towards feeding practices (Salarkia, 2016).

There are limitations encountered in this study. As a cross-sectional study, causal inference for the difference in features of households with double burden malnutrition in terms of maternal nutrition literacy, dietary diversity, and food security could not be made. Low levels of internal consistency were observed for all of the three domains of nutrition literacy and dietary diversity indicated by Cronbach's $\alpha<0.65$. Even though the questionnaires used in the study were previously validated in other peer-reviewed publications, adaptation to the local context in Indonesia might affect their validity. The use of *posyandu* as the basis for recruitment might limit the representation of children who were not registered in *posyandu*.

CONCLUSION

Compared to households without double burden of malnutrition, the SCOWT households had significantly lower maternal nutrition literacy and food security. The study results emphasised the importance of developing behavioural strategies to enable households subsisting on limited resources to make healthy food choices.

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Authors' contributions

TM was responsible for overall and/or sectional scientific management, formulating research question, making concept and design of the study, preparation of draft manuscript, doing revisions. He also gave final approval of the version to be published; and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. RR was responsible for substantial contributions in design and conception of the study, and was involved in manuscript preparation, providing critique, revision of the manuscript, and supervises the study. TSN carried out training for the enumerator and surveyor, input data and analysis of nutrition literacy data. DRA responsible for analysis data on food security, writing the method section and interpretation of the food security data. QR was responsible for revision of the manuscript and help data analysis for dietary diversity data. HM lead the data collection, coordinate the community health workers, setting up ground work for data collection. All authors have given approval of the final manuscript.

Conflict of interest and funding disclosure

We have no conflicts of interest to report for this study entitled *"Comparison of Maternal Nutrition Literacy, Dietary Diversity, and Food Security among Households with and without Double Burden of Malnutrition in Surabaya, Indonesia"*.

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Association between waist circumference at two measurement sites and indicators of metabolic syndrome and cardiovascular disease among Thai adults

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ABSTRACT

Introduction: Waist circumference (WC) is a measure of central obesity, which is an established indicator of the risk of chronic disease. The objective of this study was to investigate the applicability of WC and risk of metabolic abnormality at two frequently used measurement sites in Thailand namely, at the umbilicus level (WC-U) and midway between the lowest rib and iliac crest (WC-M). **Methods:** Healthy adults aged 35-60 years living in Sung Noen District, Nakhon Ratchasima Province, Thailand were recruited by convenience for the study (N=296). WC was measured at two locations (WC-U and WC-M). Socioeconomic, health-habits, and physical-activity data were collected. Six ml blood samples from each participant were taken for analysis of glucose, lipids and C-reactive protein concentrations. Association between WC-U and WC-M was determined statistically. **Results:** WC measurements taken at WC-U and WC-M correlated strongly with each other in men (r=0.978, p<0.001), and in women (r=0.873, p<0.001). Both WC-U and WC-M correlated significantly with BMI, blood pressure, triglyceride, and cholesterol levels in both men and women. Intraclass correlation analysis confirmed highly significant associations between these two WC-measurement sites in men (ICC=0.960, p<0.001) and women (ICC=0.808, p<0.001). **Conclusions:** The results confirmed that both WC-U and WC-M can be used to monitor health status in men and women; however, WC-U is a simpler procedure for community health-risk surveillance and for self-monitoring.

Keywords: Waist circumference, anthropometry, metabolic syndrome, cardiovascular disease, self-monitoring

INTRODUCTION

Classification of obesity typically relies on various measurements of body mass index (BMI) and waist circumference (WC), and both have been used as health risk indicators. Although relatively simple and straightforward for health professionals and the general population, BMI is a surrogate measurement of excess weight rather than excess fat.

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Thus, its use is limited especially among the elderly with diminished muscle mass, and trained athletes with high muscle mass. Changes in central obesity can also occur in the absence of BMI change.

Among these anthropometric markers, WC is a measurement of central obesity, a condition of excessive visceral fat accumulation in the abdominal area. Epidemiological data have shown an association between central obesity and hypertension, dyslipidaemia, cardiovascular diseases, and metabolic syndrome (Huxley *et al.*, 2010; Beydoun *et al.*, 2011; Nikolopoulou & Kadoglou, 2012). Visceral adiposity is also responsible for insulin resistance via induction of adipokines and pro-inflammatory cytokines disrupting the normal physiological insulin signalling (Coletta & Mandarino, 2011; Esser *et al.*, 2014). Owing to the strong associations of visceral fat (VF) with many non-communicable diseases, incorporating WC measurement as a part of health monitoring protocols and health promotion programmes is clearly necessary.

Presently, numerous organisations have established WC thresholds or cut-off values for different ethnic groups and specific countries (International Diabetes Federation, 2006; World Health Organization, 2008; He *et al.*, 2017). However, several abdomen measurement sites for WC exist and differ among the guidelines. The National Institute of Health (NIH) published a WC measurement site immediately above the iliac crest (National Institute of Health, 2000), whereas the World Health Organization (WHO) recommended taking the WC as the midpoint circumference between the lowest rib and the iliac crest (WHO, 2008). A study reported that WC according to the WHO guideline is not comparable between gender and geographical locations (Wang *et al.*, 2003).

In Thailand, the WHO method is generally preferred, but a simple measurement at the umbilicus level has also been suggested by Ministry of Health, Thailand. Owing to excess adipose tissue, locating the rib and the iliac crest can be difficult, thus it is unreliable in overweight and obese people. Without proper training, there will be individual differences in WC-M, measurements at midway between the lowest rib and the iliac crest, and therefore, it may not be suitable among rural populations with low literacy levels. To our knowledge, no studies have determined the differences between WC measurement sites in the Thai population, or whether both methods are comparable indicators of health risk.

In this study, we reported the differences between WC measurements taken at the midpoint between the lowest rib and iliac crest (WC-M) according to the WHO guidelines, and at the umbilicus level (WC-U). In addition, we investigated the association between the WC measurement at two different sites, and factors associated with metabolic syndrome (MetS) and cardiovascular disease (CVD), including lipid profiles, blood sugar, oral glucose tolerance test (OGTT) and blood pressure.

MATERIALS AND METHODS

Study population

A total of 218 participants, aged 35–60 years, from Sung Noen District, Nakhon Ratchasima Province, Thailand were recruited by convenience sampling. Sample size was calculated based on $[Z_{1-\alpha/2}{}^2\, p(1-p)]/d^2$. Exclusion criteria were BMI <18.5 kg/m^2, presence of severe chronic conditions requiring medication such as diabetes, cancer, chronic kidney disease, and coronary heart disease, as well as ongoing pregnancy or lactation.

Anthropometric assessment and questionnaire

A trained staff member measured the anthropometric measurements of height and weight of the participants in light clothing and without shoes. Weight (kg) was divided by height squared (m^2) to calculate BMI. Percentage body fat and VF were estimated with a bioimpedance analyser (HBF-375, Omron Healthcare, Kyoto, Japan). Individual average blood pressure was obtained from automatic sphygmomanometers after 5 min of rest in a sitting position. In order to measure WC, participants stood straight with arms and legs slightly apart. The staff member stood on the side and placed a measuring tape on unclothed skin at two horizontal planes, the WC-U and the WC-M. Measurements of each type of WC were taken twice and the average of the two measurements was used. Socioeconomic, health habits, and physical activity data were collected using a questionnaire composed of general information and food, with physical activity calculated in Metabolic Equivalent of Task (MET).

Blood analysis

Following overnight fasting, a 6 mL blood sample was taken from each participant, who was then administered orally 75 g glucose for an OGTT. Blood glucose at baseline (fasting blood glucose, FBG), at 2-h after glucose loading (2hBG), and glycated haemoglobin (HbA_{1C}) levels were measured by a Cobas® 6000 analyser (Roche Diagnostics Ltd., Basel, Switzerland). Fasting insulin levels were determined using a human insulin enzyme linked immunosorbent assay (ELISA) kit (EMD Millipore, Billerica, MA, USA). Homeostatic model assessment of insulin resistance (HOMA-IR) and of beta cell function (HOMA-β) were calculated by the following equations: HOMA-IR = fasting glucose (mmol/L) × fasting insulin (μIU/mL)/405; HOMA-β = [20 × fasting insulin (μIU/mL)]/[fasting glucose (mmol/L) – 3.5].

Levels of triglyceride (TG), serum total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-c) were analysed using the Cobas® 6000 analyser (Roche Diagnostics Ltd) while high-density lipoprotein cholesterol (HDL-c) was calculated from the following Friedwald equation: LDL-c = TC – (HDL-c + TG/5). A nephelometer (Siemens Healthcare GmbH, Erlangen, Germany), was used to determine the concentration of C-reactive protein (CRP).

The presence of MetS was determined using the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP) III criteria. In brief, MetS was defined as the presence of at least three of the following conditions: central obesity (>102 cm male and >88 cm female), hypertriglyceridemia (>150 mg/dl), low HDL-c (<40 mg/dl male and <50 mg/dl female), hypertension (≥130/85 mmHg) and FBG (>110 mg/dl).

Statistical analysis

SPSS version 18 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Continuous data were reported as mean and standard deviation, while categorical data were presented as frequency and percentage. Pearson's correlation coefficients were used to investigate the association between the two WC measurement locations, WC-U and WC-M, and the risk indicators for MetS and CVD. The differences in correlation coefficients between the two WC sites and the risk indicators for MetS and CVD were then determined by a test for equal correlation (http://vassarstats.net/rdiff.html). Intraclass correlation (ICC) was computed to demonstrate the strength of the relationship between the two WC location measurements and indicators of risk for MetS and CVD.

Ethics approval and consents to participate

Written informed consent was obtained from all subjects. The study was approved by the Ethics Committee of the Faculty of Tropical Medicine, Mahidol University (TMEC 13-073).

RESULTS

Socioeconomic and health habit characteristics of study groups

Table 1 shows socioeconomic and health habit data of participants, comprising 98 men and 120 women aged 35-61 years. Four-fifths of both men and women completed primary school. Most were farmers or worked in the industrial sector. More than half of the men smoked (58.2%) and consumed alcohol (61.9%), while only a few women smoked (3.3%) or drank alcohol (39.2%). Almost half of the participants failed to maintain the WHO (2011) recommended level of physical activity, i.e. at least 30 minutes' activity five times per week. One-third never exercised (35.7% of men and 35.8% of women), and 12.2% of men and 11.7% of women exercised less than three times per week.

Biometric and biochemical data of study groups

The MetS and CVD risk factors of the participants are shown in Table 2. Significant differences were found between the sexes in most of the study parameters, including higher levels of BMI, WC-U, WC-M, and body fat (BF) in women compared with men. The blood parameters of TC, LDL-c, 2hBG, HbA_{1c}, fasting insulin, HOMA-IR, and HOMA-β of women were significantly greater than in men, with the exception of TG and HDL-c levels.

Table 1. Demographic and health habits of participants

Variables	*Men (n=98)*		*Women (n=120)*	
	n	*%*	*n*	*%*
Education				
Illiterate	6	6.1	4	3.3
Primary school	80	81.6	98	81.7
High school	10	10.2	17	14.2
Other	2	2.0	1	0.8
Occupation				
Farmer	39	39.8	49	40.8
Factory worker	45	45.9	52	43.3
Grocer	5	5.1	8	6.7
Other	9	9.1	11	9.1
Smoking status				
Never smoked	25	25.5	112	93.3
Smoke	57	58.2	4	3.3
Used to smoke	16	16.3	4	3.3
Alcohol status				
Never drink	20	20.6	66	55.0
Drink	60	61.9	47	39.2
Used to drink	17	17.5	7	5.8
Frequency of physical activity				
Never	35	35.7	43	35.8
1-2 times/week	12	12.2	14	11.7
3-4 times/week	14	14.3	12	10.0
>4 times/week	37	37.8	51	42.5

Correlations between waist circumference measurements and risk factors of MetS and CVD

Table 3 shows the results of correlation analysis between the two WC locations: WC-U and WC-M, and the risk factors of MetS and CVD of the participants. In men, both WC-U and WC-M were significantly correlated with BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), BF, VF, TG, HbA_{1c}, fasting insulin, HOMA-IR, and HOMA-β. In women, WC-U and WC-M were significantly correlated with BMI, BF, VF, TC, LDL-c, HbA_{1c}, and HOMA-IR.

The intraclass correlation (ICC) analysis confirmed the degree of agreement between these two measurement sites (Table 4). The relatively high value of ICC (ICC = 0.960, $p<0.001$ in men and 0.808, $p<0.001$ in women) indicate no statistical differences between men and women for the MetS and CVD parameters.

Figure 1 shows the differences between the two waist circumferences measurements. A Bland-Altman plot described the mean differences and

Table 2. Metabolic syndrome (MetS) and cardiovascular disease (CVD) risk factors among male and female participants

Variables	*Men (n=98)*		*Women (n=120)*		*p*
	Mean	*SD*	*Mean*	*SD*	
Age (years)	47.04	6.07	46.17	5.68	0.137
BMI (kg/m^2)	23.66	4.00	25.93	4.47	<0.001***
WC-U (cm)	83.19	11.18	87.33	9.39	0.001***
WC-M (cm)	81.13	10.78	83.53	9.45	0.041*
BF (%)	21.68	6.00	33.15	5.39	<0.001***
VF (%)	9.74	5.18	8.84	4.85	0.094
SBP (mmHg)	123.00	15.31	122.98	20.24	0.499
DBP (mmHg)	75.87	12.11	74.16	11.75	0.149
TG (mg/dl)	168.50	102.08	145.28	95.97	0.043*
TC (mg/dl)	193.93	49.73	210.62	61.92	0.016*
LDL-c (mg/dl)	92.94	62.86	160.10	63.74	<0.001***
HDL-c (mg/dl)	82.43	48.31	50.52	15.12	<0.001***
FBG (mg/dl)	95.82	11.20	94.06	19.34	0.213
2hBG (mg/dl)	116.80	60.06	134.30	58.94	0.017*
HbA_{1c} (%)	5.24	0.52	5.52	0.88	0.003*
Fasting insulin (μU/ml)	5.48	4.42	7.16	6.67	0.017*
HOMA-IR	1.29	1.07	1.65	1.52	0.027*
HOMA-β	65.39	50.88	99.40	100.69	<0.001***
CRP (mg/dl)	3.21	7.68	3.75	9.00	0.319

Abbreviations: BMI, body mass index; WC-U, waist circumference at umbilicus level; WC-M, waist circumference at the midpoint between the lowest rib and iliac crest; BF, body fat; VF, visceral fat; SBP, systolic blood pressure; DBP, diastolic blood pressure; TG, triglyceride; TC, total cholesterol; LDL-c, low-density lipoprotein cholesterol; HDL-c, high-density lipoprotein cholesterol; FBG, fasting blood glucose; 2hBG, 2-hour blood glucose; HbA_{1c}, glycated haemoglobin; HOMA-IR, homeostatic model assessment of insulin resistance; HOMA-β, homeostatic model assessment of β-cell function; CRP, C-reactive protein

*$p<0.05$

**$p<0.01$

***$p<0.001$

Table 3. Correlation between metabolic syndrome and cardiovascular disease risk factors and the two waist circumference locations; umbilicus and the midpoint level in men and women

Variables	*WC-U*				*WC-M*				*Correlation comparison between WC-U and WC-M*	
	Men		*Women*		*Men*		*Women*		*Men*	*Women*
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*p*	*p*
BMI	0.937	<0.001***	0.825	<0.001***	0.929	<0.001***	0.852	<0.001***	0.330	0.203
BF	0.835	<0.001***	0.781	<0.001***	0.818	<0.001***	0.799	<0.001***	0.355	0.356
VF	0.943	<0.001***	0.757	<0.001***	0.933	<0.001***	0.779	<0.001***	0.284	0.341
SBP	0.395	<0.001***	0.106	0.250	0.399	<0.001***	0.182	0.046*	0.488	0.278
DBP	0.424	<0.001***	0.073	0.427	0.418	<0.001***	0.105	0.253	0.480	0.401
TG	0.345	<0.001***	-0.081	0.376	0.399	<0.001***	-0.106	0.251	0.333	0.425
TC	0.193	0.057	0.245	0.007**	0.188	0.064	0.230	0.012*	0.484	0.452
LDL-c	0.156	0.126	0.270	0.003**	0.164	0.106	0.238	0.009**	0.476	0.397
HDL-c	-0.020	0.842	-0.134	0.144	-0.045	0.661	-0.062	0.500	0.432	0.288
FBG	0.054	0.598	0.027	0.766	0.056	0.582	0.039	0.673	0.496	0.461
2hBG	0.107	0.295	0.123	0.182	0.129	0.207	0.124	0.176	0.440	0.496
HbA_{1c}	0.399	<0.001***	0.246	0.007**	0.348	<0.001***	0.271	0.003**	0.341	0.421
Fasting insulin	0.444	<0.001***	0.170	0.063	0.422	<0.001***	0.147	0.109	0.425	0.429
HOMA-IR	0.426	<0.001***	0.200	0.028*	0.411	<0.001***	0.186	0.042*	0.448	0.456
HOMA-β	0.435	<0.001***	0.143	0.120	0.410	<0.001***	0.117	0.204	0.417	0.421
CRP	0.117	0.251	-0.070	0.444	0.115	0.255	-0.204	0.798	0.496	0.363

Abbreviations: WC-U, waist circumference at umbilicus level; WC-M, waist circumference at the midpoint between the lowest rib and iliac crest; BMI, body mass index; BF, body fat; VF, visceral fat; SBP, systolic blood pressure; DBP, diastolic blood pressure; TG, triglyceride; TC, total cholesterol; LDL-c, low-density lipoprotein cholesterol; HDL-c, high-density lipoprotein cholesterol; FBG, fasting blood glucose; 2hBG, 2-hour blood glucose; HbA_{1c}, glycated haemoglobin; HOMA-IR, homeostatic model assessment of insulin resistance; HOMA-β, homeostatic model assessment of β-cell function; CRP, C-reactive protein.

*$p<0.05$

**$p<0.01$

***$p<0.001$

Table 4. Absolute agreement (ICC) and correlation coefficient (*r*) between WC-U and WC-M

Variables	*Absolute agreement (ICC)*		*Coefficient (r)*
	ICC	*95% CI*	
Men	0.960	0.800-0.985	0.978 (<0.001)
Women	0.808	0.445-0.912	0.873 (<0.001)

mean waist circumferences per subject. The overall mean difference in waist circumference between WC-U and WC-M was 3.018 cm (SD: 2.86, 95%; limits of agreement: -2.59 and 8.62 cm). The scatter of differences around the zero line was not constant, but the differences tended to be positive.

DISCUSSION

Studies have linked the increasing prevalence of obesity to the rise in MetS and CVD (Zalesin *et al.*, 2008; Song, Wang & Zhang, 2013; Global Burden of Metabolic Risk Factors for Chronic Diseases Collaboration *et al.*, 2014; Jung, Ha & Kim, 2016). Central obesity in particular, is a major predictor of these diseases, irrespective of changes in BMI. WC is a key anthropometric measurement of nutritional status as well as a predictor of health risks commonly reported in many studies (Janssen, Katzmarzyk & Ross, 2004; Klein *et al.*, 2007; Mbanya *et al.*, 2015; Tsukiyama *et al.*, 2016).

However, studies have not reported consistent results for WC measurements taken at different sites. Studies from Germany and China compared WC at the lowest rib, 1 or 4 cm above the umbilicus, midpoint, top of the iliac crest, and the narrowest waist and found all WC measurements correlated with BMI and body fat mass (Hitze *et al.*, 2008; Yang & Wang, 2017). However,

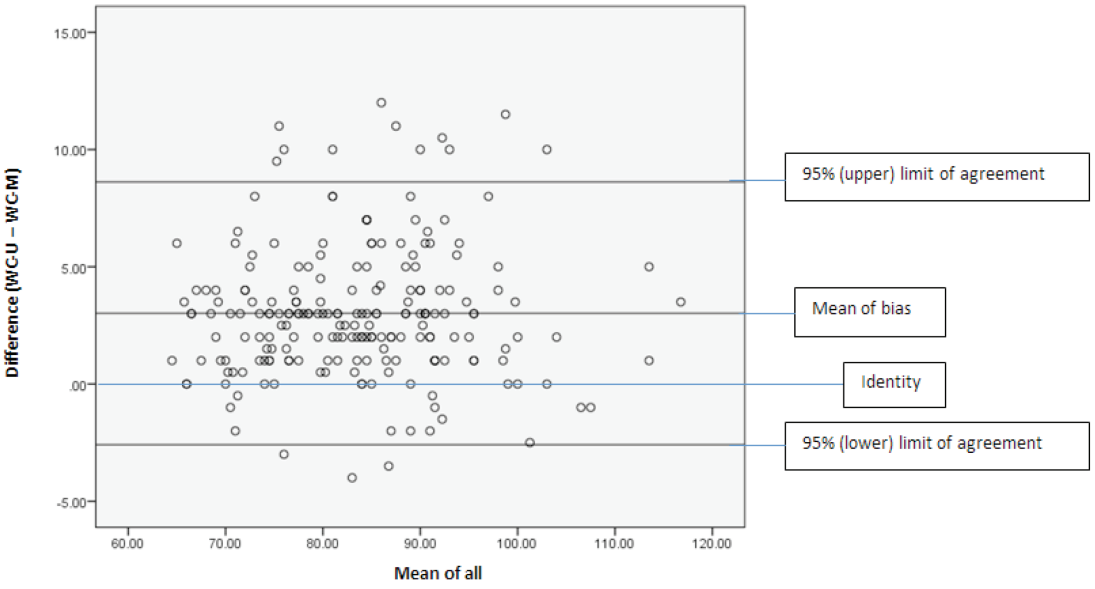

Figure 1. Bland-Altman plot of the mean difference in waist circumferences by WC-U and WC-M for each subject. The overall mean difference and 95% limits of agreement are shown.

a standardised anatomic point for WC measurement has yet to be defined. Therefore it is crucial to identify a simple and valid approach for health monitoring and promotion that is applicable to the general population.

In this study, we investigated the correlations of WC-U and WC-M between the study indicators that included the anthropometric parameters BMI, SBP, DBP, BF, VF, and the biochemical parameters TG, TC, LDL-c, HDL-c, FBG, 2hBG, fasting insulin, HOMA-IR, HOMA-β, and CRP. For all participants, both WC-U and WC-M were significantly correlated with BMI, BF, VF, HbA_{1c}, and HOMA-IR. Additionally, each of the two WC sites were significantly correlated with SBP, DBP, TG, fasting insulin, and HOMA-β in men (p<0.001), and with TC and LDL-c (p<0.05) in women. In other studies, Guan *et al* (2016) investigated the correlation between WC-U and MetS risk factors and found that all analysed correlations reached statistical significance (p<0.001). Similarly, a magnitude of association between WC-M and cardiometabolic risk factors was also reported (Sardinha *et al.*, 2016).

Based on the test of intraclass correlation and Bland and Altman plot test, our study found WC-U and WC-M significantly consistent for both men and women. Similarly, Harrington *et al.* found that WC-M did not differ significantly from WC-U among African-American males (Harrington *et al.*, 2013). Likewise, Ross *et al.* reported lack of significance in association between sex, age, and ethnicity, and morbidity of CVD and diabetes for different WC protocols (Rose *et al.*, 2008). This study further demonstrated that either WC-U or WC-M measurements can be used. The WC measurement position recommended by the International Society for the Advancement of Kinanthropometry (ISAK) is taken at the narrowest waist point between the lower costal (10th rib) bordering the iliac crest, or if it is not apparent, at the mid-point between the lowest rib and the top of the hip bone (iliac crest); however, these two measurement points have been found to be difficult with obese adults. Alternatively, WC-U is easy and simple to perform, and thus appropriate for regular self-monitoring (ISAK, 2001).

CONCLUSION

This study found significant associations between MetS and CVD risk factors and WC-M and WC-U measurements in a sample of Thai population. WC-U measurement is suitable for routine self-monitoring as the umbilicus is simpler to locate than the midpoint criteria of WHO. Furthermore, the umbilicus is readily identifiable in obese subjects and the method is reproducible by the general population with minimal training.

List of abbreviations

WC: Waist circumference; WC-U: Waist circumference at the umbilicus level; WC-M: Waist circumference at midway between the lowest rib and iliac crest; BMI: Body mass index; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; VF: Visceral fat; MetS: Metabolic syndrome; CVD: Cardiovascular disease; FBG: Fasting blood glucose; 2hBG: 2-h after glucose loading; HbA_{1c}: Glycated hemoglobin; ELISA: enzyme linked immunosorbent assay; HOMA-IR: Homeostatic model assessment of insulin resistance; HOMA-β: Homeostatic model assessment of beta cell function; TG: Triglyceride; TC: Total cholesterol; LDL-c: Low-density lipoprotein cholesterol; HDL-c: High-density lipoprotein cholesterol; CRP: C-reactive protein.

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Authors' contributions

NC obtained data, analysed and interpreted data, read and approved the final manuscript; CP designed the study, obtained data, read and

approved the final manuscript; CU obtained data, read and approved the final manuscript; PP designed the study, obtained data, read and approved the final manuscript; KK provided the research question, designed the study, obtained data, wrote the first draft, read and approved the final manuscript.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Association between intake of soy isoflavones and blood pressure among urban and rural Malaysian adults

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ABSTRACT

Introduction: Intake of soy isoflavones has been shown to be beneficial in reducing blood pressure, a known cardiovascular risk factor. This study investigated the association between intake of soy isoflavones and blood pressure among multi-ethnic Malaysian adults. **Methods:** A total of 230 non-institutionalised Malaysians aged 18-81 years were recruited through multi-stage random sampling from urban and rural areas in four conveniently selected states. Participants were interviewed on socio-demographics, medical history, smoking status, and physical activity. Measurements of height, weight, waist circumference (WC), and blood pressure (BP) were taken. Information on usual intake of soy foods was obtained using a validated semi-quantitative food frequency questionnaire. **Results:** The mean intake of soy protein of both urban (3.40g/day) and rural participants (3.01g/day) were lower than the USFDA recommended intake level of soy protein (25.00g/day). Urban participants had significantly higher intake of isoflavones (9.35±11.31mg/day) compared to the rural participants (7.88±14.30mg/day). Mean BP levels were significantly lower among urban (136/81mmHg) than rural adults (142/83mmHg). After adjusting for age, gender, educational level, household income, smoking status, physical activity, BMI and WC, soy protein intake was significantly associated with both SBP (R^2=0.205, β=-0.136) and DBP (R^2=0.110, β=-0.104), whilst soy isoflavones intake was significantly associated with SBP (β=-0.131). Intake of 1 mg of isoflavone is estimated to lower SBP by 7.97 mmHg. **Conclusion:** Higher consumption of isoflavones among the urban participants showed an association with lower levels of SBP. Use of biological markers for estimating isoflavones levels is recommended to investigate its protective effects on blood pressure.

Keywords: Soy protein, soy isoflavones, adults, urban, systolic blood pressure

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INTRODUCTION

Cardiovascular disease (CVD) has been the leading cause of death in Malaysia since the 1980's (Noor Hassim *et al.*, 2016). Amiri *et al.* (2014) has reported that obesity, hypertension and hypercholesterolaemia were the most predominant CVD risk factors in Malaysia, induced by unhealthy lifestyle and predominantly made up of low-income Malaysians. According to the Fifth National Health and Morbidity Survey of Malaysia (2015), obesity, hypercholesterolaemia and hypertension accounted for 51.2%, 47.7%, and 30.3% respectively among Malaysians.

Urbanisation, characterised with rapid economic development, fosters adverse effects concerning population health status, which is further influenced by a sedentary lifestyle that further magnifies the risk of developing CVD (Amiri *et al.*, 2014). However, several Malaysian studies reported a higher prevalence of CVD risk factors among populations in rural areas (Ching *et al.*, 2018; Noor Hassim *et al.*, 2016) due to older age, lower educational status, higher prevalence of smokers, obesity, hypertension, diabetes, unhealthy diet and more likely, depression (Noor Hassim *et al.*, 2016).

Among the many risk factors of CVD, diet plays an important role in its development and prognosis (Amiri *et al.,* 2014). The Dietary Approaches to Stop Hypertension (DASH) demonstrated the impact of dietary composition in combating the incidence of CVD, of which intermediate sodium level could lower mean systolic blood pressure (SBP) compared to the usual control diet (Blumenthal *et al.,* 2010). Besides this, several foods and food groups have been reported for their potential cardioprotective effects. These include long-chain n-3 fatty acids, dietary fibre, phytochemicals and vegetable proteins, especially soy (Alissa & Ferns 2014). Soy-based foods have attracted scientific attention since 1999, when the United States Food and Drug Administration (FDA) approved the health claim that 25 g of soy protein daily, along with a diet low in saturated fat, may reduce the risk of CVD (USFDA, 2018). Further, soy isoflavones in soy protein have been reported to have similar efficacy and health benefits towards prevention of CVD by reducing blood pressure among selected populations (Beavers *et al.,* 2012).

There are a number of large prospective cohort studies among Asian populations, investigating whether habitual soy food or isoflavones consumption is related to the incidence of CVD. Cumulative evidence from randomised clinical trials (RCT) included in meta-analysis as reported by Beavers *et al.* (2012), indicated that exposure to soy isoflavones can modestly, but significantly, improve endothelial function as measured by flow-mediated dilation. The Shanghai Women's Health Study reported an inverse relationship between soy food intake and the risk of coronary heart disease (CHD) (Zhang *et al.*, 2012).

By contrast, no significant associations were found between long-term soy food, soy protein, and soy isoflavones consumption on CHD, stroke, and total CVD-related mortality in the Singapore Chinese Health Study (Talaei *et al.,* 2014). It was postulated that low consumption of soy food in Western cohorts made it difficult to determine longitudinal associations between intake of isoflavones and CVD incidence or mortality (Zamora-Ros *et al.*, 2012). These inconsistent findings call for further investigations on the association of isoflavones consumption and the risks of CVD among multi-ethnic Malaysian adults residing in urban and rural areas. It is hypothesised that CVD

risk was higher in rural communities associated with lower isoflavones consumption.

MATERIALS AND METHODS

Recruitment of subjects

This cross-sectional study was part of the Malaysian population survey (Malaysian Community Salt Survey – MyCoSS). A sub-study to obtain data on isoflavones intake was conducted in four states of Malaysia namely, Kelantan, Terengganu, Pahang, and Johor that fell within the data collection period from October to December 2017. Informed consent was obtained from each participant, and ethical approval was obtained from the Universiti Kebangsaan Malaysia Medical Research and Ethics Committee (UKMMREC) (UKM1.21.3/244/NN-2017-142) and the Medical Research and Ethics Committee (MREC) of the Ministry of Health Malaysia (NMRR-17-3354-37402).

A total of 230 eligible participants were randomly selected from urban and rural areas or recognised as strata and achieved 100% response rate. The selection was provided by the Department of Statistics (DOS), Malaysia. The urban areas were development areas with a population of at least 10,000 and 60% of the population aged 15 years and above engaged in non-agricultural activities, while the remaining areas were classified as rural areas (DOS, 2015). The process of selecting a participant was cascading from a primary sampling unit (PSU), which is the cluster of enumeration blocks (EBs) to living quarters (LQs) to eligible persons and finally to sample the individual. When there was more than one eligible adult living in the same LQ, only one subject was selected using a Kish Table. Inclusion criteria were: Malaysian citizens aged 18-81 years old, non-institutionalised living status, and able to understand, communicate and speak well in Malay or English. Those who were pregnant and had been on isoflavone supplements for the past three months were excluded from this study.

Participants were interviewed to collect background data on:

1) socio-demographics: age, gender, ethnic, occupational, educational level and household income
2) medical history: diabetes mellitus (DM), hypertension, hypercholesterolaemia, heart diseases, stroke and kidney diseases
3) smoking status: categorised as never, current (smoked regularly in the last 12 months), and ex-smoker (stopped smoking more than 12 months ago)
4) dietary intake based on a semi-quantitative food frequency questionnaire (SFFQ) on isoflavones consumption

Habitual physical activity status was also obtained using a short form International Physical Activity Questionnaire (IPAQ) in a week was converted into metabolic equivalent task minutes per week (MET-minutes/week) and categorised as low (<600 MET-min/week), moderate (>600 MET-min/week) and high (>3000 MET-min/week).

Anthropometric measurements including height and weight were also taken and body mass index (BMI) was calculated and categorised based on World Health Organization (WHO) (1998) guidelines. Weight was measured using a validated and calibrated digital weighing scale (TANITA HD-319) and height using stadiometer SECA 213. Waist circumference (WC) was measured using SECA measuring tape and referred to WHO stepwise approach (WHO, 2008). Systolic (SBP) and diastolic blood pressures (DBP) were measured

using a digital OMRON HBP-1300 and categorised as normal (systolic BP ≤130 mmHg/diastolic BP ≤80 mmHg) and hypertension (systolic BP >130 mmHg/ Diastolic BP >80 mmHg) (AHA, 2018).

Dietary intake of soy protein, isoflavones, daidzein and genistein

The usual intake of soy isoflavones, daidzein, and genistein of the participants were based on nine items in a semi-quantitative food frequency questionnaire (SFFQ) for soy products. The SFFQ was validated by Haron (2009) based on a soy SFFQ to estimate the intake of isoflavones among US adults (Frankenfeld *et al.*, 2002). The SFFQ was modified to take into account local soy products commonly consumed by Malaysians (Tee *et al.*, 1997). Unfried *tofu*, fried *tofu*, soft *tofu*, egg *tofu*, *fucok* (*tofu* skin), tempeh, boxed soy bean drink, homemade soy bean drink and *tofu fah* was selected to be included in the SFFQ. The serving size was based on soy products of the Malaysian Food Composition Table (Tee et al, 1999). Frequency of consumption and portion size (small, medium, large) consumed during the previous one month were asked of the participants and rated using a four-point scale, ranging from never, to how many times in a day, week or month. The isoflavone intake was determined by referring to analytical values outlined by Haron (2009) and computed using the following equation:

$$\frac{\text{Participant's portion size}}{\text{Reference portion}} \times \text{frequency} \times \text{isoflavones content (mg) of the food item}$$

Estimation of soy protein (g) intake was also derived from the Singapore Food Composition Database and the United States Department of Agriculture (USDA) Nutrient Data Laboratory. Data were entered into a nutrition database (Nutritionist Pro™ Version 3.1.10, Axxya System, Texas, USA) for analysis.

Statistical analysis

The data were analysed using Statistical Package for Social Sciences (SPSS) version 23.0. Descriptive statistics were used to determine the association between socio-demographics data, anthropometric measurements, and BP with soy phytochemicals intake, based on strata. Since the intakes of soy protein, isoflavones, daidzein, and genistein were not normally distributed, all of the contributions from soy components were transformed using $\log^{10}$. Chi-square contingencies test was used to determine the difference between categorical data.

The Simple Linear Regression (SLR) was used to determine the association between continuous data of soy proteins, isoflavones, daidzein and genistein intakes with SBP and DBP. Multiple linear regression (MLR) was performed to determine the predictors by controlling for other covariates.

RESULTS

Participants living in rural areas had significantly lower educational levels and household incomes compared to urban residents. The prevalence of smoking, DM, hypertension, and hypercholesterolaemia were not statistically significant between the urban and rural subjects. The physical activity level was significantly higher among the rural respondents (Table 1).

There was no significant difference in mean body mass index (BMI) between men and women from urban and rural areas. However, the percentage of obesity among urban men was higher (66.7%) than their rural counterparts (33.3%). High mean values of waist circumferences (88.01 ± 13.39 cm) and SBP (141.56 ± 19.50 mmHg) were more prevalent among rural women (68.6%) as compared to urban women. A higher prevalence of rural women (68.6%) had abdominal obesity compared to urban women.

Table 1. Socio-demographics, medical history, smoking status, physical activity, anthropometric measurements and blood pressure according to urban and rural participants

Parameter	*N*	*Urban (N=94)*	*Rural (N=136)*	*p-value*
Gender				0.058
Men	102	48 (47.1%)	54 (52.9%)	
Women	128	46 (35.9%)	82 (64.1%)	
Age				0.901
18 – 39	60	26 (43.3%)	34 (56.7%)	
40 – 64	122	49 (40.2%)	73 (59.8%)	
> 64	48	19 (39.6%)	29 (60.4%)	
Age (*M*±*SD*)	230	50.68±14.23	50.76±15.34	0.969
Occupation				0.364
Unemployed	89	34 (38.2%)	55 (61.8%)	
Public/private sector	55	27 (49.1%)	28 (50.9%)	
Self-employed	86	33 (38.4%)	53 (61.6%)	
Ethnic				0.050
Malay	189	72 (38.1%)	117 (61.9%)	
Chinese	35	18 (51.4%)	17 (48.6%)	
Indian	6	4 (66.7%)	2 (33.3%)	
Educational level				0.020*
Did not go to school	25	6 (24.0%)	19 (76.0%)	
Primary/secondary school	157	63 (40.1%)	94 (59.9%)	
Tertiary education	48	25 (52.1%)	23 (47.9%)	
Household income				0.011*
<500	18	4 (22.2%)	14 (77.8%)	
500-2500	131	47 (35.9%)	84 (64.1%)	
>2500	81	43 (53.1%)	38 (46.9%)	
Household income (*M*±*SD*)	230	3793.09±4417.85	2206.54±195.63	0.000**
Medical history				
Heart diseases	13	7 (53.8%)	6 (46.2%)	0.243
Stroke	2	0 (0.00%)	2 (100%)	0.349
Diabetes mellitus	32	12 (37.5%)	20 (62.5%)	0.415
Hypertension	55	25 (45.5%)	30 (54.5%)	0.262
Hypercholesterolaemia	60	26 (43.3%)	34 (56.7%)	0.381
Kidney diseases	6	4 (66.7%)	2 (33.3%)	0.188
Smoking status				
Former	78	36 (46.2%)	42 (53.8%)	0.243
Current	51	20 (39.2%)	31 (60.8%)	0.785

Physical activity				0.238
Category 1 - Low physical activity level	54	19 (35.2%)	35 (64.8%)	
Category 2 - Moderate physical activity level	95	45 (47.4%)	50 (52.6%)	
Category 3 - High physical activity level	81	30 (37.0%)	51 (63.0%)	
Physical activity (*M*±*SD*) (MET-min/week)	230	2588.14±2875.25	3872.47±5475.02	0.038*
Body mass index (%)				
Men				0.322
Underweight (< 18.5)	2	1 (50.0%)	1 (50.0%)	
Normal (18.5 to 24.9)	47	20 (42.6%)	27 (57.4%)	
Overweight (25 to 29.9)	35	15 (42.9%)	20 (57.1%)	
Obese (> 30)	18	12 (66.7%)	6 (33.3%)	
Women				0.176
Underweight (< 18.5)	5	1 (20.0%)	4 (80.0%)	
Normal (18.5 to 24.9)	43	21 (48.8%)	22 (51.2%)	
Overweight (25 to 29.9)	45	13 (28.9%)	32 (71.1%)	
Obese (> 30)	35	11 (31.4%)	24 (68.6%)	
BMI (*M*±*SD*) (kg/m^2)				
Men	102	26.18±4.82	24.61±3.69	0.066
Women	128	26.27±5.39	27.70±5.86	0.175
Waist circumference (%)				0.030*
Low risk (men WC≤93.9 cm; women WC≤79.9cm)	114	50 (43.9%)	64 (56.1%)	
Increased risk (men WC 94.0 to 101.9cm; women, WC 80.0 to 87.9cm)	46	11 (23.9%)	35 (76.1%)	
High risk (men WC≥102.0cm; women, WC≥88.0cm)	70	33 (47.1%)	37 (52.9%)	
Waist circumference (*M* ±*SD*) (cm)				
Men	102	91.10 ± 10.87	88.48 ± 8.41	0.173
Women	128	86.01 ± 12.86	88.01 ± 13.39	0.414
Blood pressure (%) (mmHg)				0.495
Normal (Systolic BP ≤130 / diastolic BP ≤80)	131	57 (43.5%)	74 (56.5%)	
Hypertension (Systolic BP >130 / Diastolic BP >80)	99	37 (37.4%)	62 (62.6%)	
Blood pressure (*M* ± *SD*) (mmHg)				
Systolic		136.05 ± 19.50	141.56 ± 19.50	0.049**
Diastolic		81.52 ± 12.82	83.13 ± 13.12	0.357

*Significant difference at $p<0.05$ using chi-square contingencies test
**Significant difference at $p<0.05$ using independent samples t-test

Table 2. Mean intakes of soy protein, isoflavones, daidzein, and genistein

Parameter	*N*	*Soy protein (g/day)*		*Isoflavones (mg/day)*		*Daidzein (mg/day)*		*Genistein (mg/day)*	
		M±SD	*p-value*	*M±SD*	*p-value*	*M±SD*	*p-value*	*M±SD*	*p-value*
Strata									
Urban	94	3.40±3.85	0.014*	9.35±11.31	0.017*	6.47±8.00	0.027*	2.91±4.24	0.002*
Rural	136	3.01±5.27		7.88±14.30		5.91±10.41		1.96±4.77	
Gender									
Men	102	3.31±5.25	0.525	10.0±15.73	0.132	6.89±10.29	0.114	3.10±6.24	0.317
Women	128	3.06±4.30		7.28±10.58		5.54±8.79		1.75±2.44	
Ethnic									
Malay	189	2.84±4.73	0.007*	7.36±12.97	0.000*	5.36±9.21	0.000*	2.01±4.65	0.000*
Non-Malay	41	4.72±4.49		13.67±12.93		9.74±10.00		3.90±3.89	
Age									
18 – 39	60	3.16±3.77	0.553	10.05±14.77	0.088	7.27±10.16	0.078	2.76±5.82	0.565
40 – 64	122	2.95±4.55		7.33±11.08		5.44±8.79		1.91±3.23	
> 64	48	3.73±6.13		9.46±15.68		6.52±10.34		2.96±5.62	
BMI									
Underweight	7	1.63±1.12	0.394	2.13±2.11	0.159	1.88±2.16	0.276	0.48±0.49	0.063
Normal	90	3.14±4.30		7.89±10.87		6.10±8.76		1.78±2.83	
Overweight	80	3.55±5.00		9.81±14.16		6.70±9.58		3.11±5.42	
Obese	53	2.85±5.32		8.33±15.68		5.91±11.04		2.42±5.65	
WC									
Low risk	114	2.80±3.82	0.130	7.75±12.56	0.281	5.59±8.91	0.405	2.17±4.68	0.146
Increased risk	46	3.57±4.56		9.49±12.59		6.92±9.21		2.57±4.24	
High risk	70	3.51±6.03		9.02±14.52		6.53±10.60		2.49±4.66	
BP									
Normal	131	3.17±4.09	0.341	8.50±12.31	0.397	6.00±8.45	0.603	2.50±4.71	0.293
Hypertension	99	3.17±5.50		8.46±14.26		6.32±10.74		2.15±4.40	

*Significant difference at $p<0.05$ using Mann Whitney test

Table 3. Relationship between phytoestrogens intake and blood pressure of urban and rural participants

Phytochemicals	*Systolic blood pressure*					*Diastolic blood pressure*				
	SLR		*MLR*†			*SLR*		*MLR*†		
	β *(95% CI)*	*p-value*	*Adjusted* β *(95% CI)*	R^2	*p-value*	β *(95% CI)*	*p-value*	*Adjusted* β *(95% CI)*	R^2	*p-value*
Soy protein	-0.124 (-9.09, 0.20)	0.061	-0.162 (-10.37, -1.27)	0.205	0.012*	-0.202 (-7.20, -1.62)	0.002*	-0.201 (-7.31, -1.45)	0.110	0.004*
Isoflavones	-0.144 (-10.76, -0.57)	0.030*	-0.131 (-10.25, -0.10)	0.197	0.046*	-0.100 (-5.51, 0.73)	0.132	-0.112 (-5.99, 0.60)	0.086	0.108
Daidzein	0.119 (-0.25, 6.12)	0.071	0.103 (-0.48, 5.57)	0.192	0.099	0.078 (-0.78, 3.12)	0.237	0.066 (-0.98, 2.96)	0.079	0.321
Genistein	0.101 (-0.52, 4.24)	0.125	0.089 (-0.61, 3.87)	0.189	0.152	0.073 (-0.64, 2.26)	0.272	0.057 (-0.81, 2.09)	0.078	0.386

†The model was adjusted for age, gender, ethnic, educational level, household income, smoking status, physical activity, BMI and waist circumference

*Significance at *p*-value<0.05

Table 4. Relationship between isoflavones intake by quartiles and CVD risk parameters of urban and rural participants

CVD risk parameters		*Quartile range for isoflavones intake (mg/day)*				*p-value*
		Q1 = 0.74	*Q2 = 2.37*	*Q3 = 5.72*	*Q4 = 25.29*	
BMI						
M±*SD*		26.26±5.40	26.82±5.41	26.52±5.55	25.87±4.51	0.803
Obese (>30 kg/m^2), *n* (%)	53	14 (26.4)	14(26.4)	15(28.3)	10(18.7)	
WC						
M±*SD*		87.48±13.53	89.47±12.85	87.97±11.54	88.58±10.51	0.824
High risk (men WC≥102.0 cm; women WC≥88.0 cm), *n* (%)	70	18 (25.7)	19 (27.1)	14(20.0)	19 (27.1)	
SBP						
M±*SD*		145.75±25.94	138.77±18.95	135.93±19.18	136.74±19.59	0.038*
% High blood pressure (SBP ≥ 130 mmHg), *n* (%)	146	39 (26.7)	38 (26.0)	37 (25.3)	32 (21.9)	
DBP						
M±*SD*		84.38±13.72	82.76±11.86	82.09±13.64	80.62±12.72	0.236
% High blood pressure (DBP ≥ 80 mmHg), *n* (%)	140	38 (27.1)	37 (26.4)	33 (23.6)	32 (22.9)	

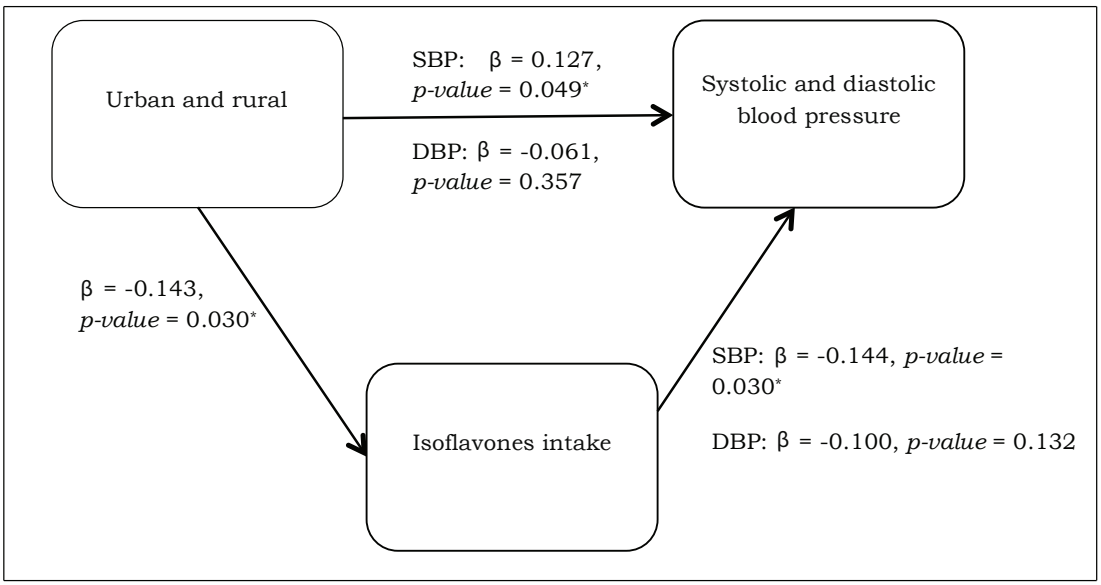
*p<0.05, indicates significant difference between isoflavones intake and CVD risk parameters using ANOVA test.

Mean intake of soy protein, isoflavones, daidzein and genistein were significantly different (p<0.05) between subjects from urban and rural areas. Urban respondents had higher intakes of these isoflavones (9.35 ±11.31mg/day) compared to the rural respondents (7.88±14.30mg/day) (p<0.05). Soy foods were popular among non-Malays with higher mean intake of isoflavones (13.67 ± 12.93 mg/day) compared to Malays (7.36 ±12.97mg/day) (p<0.05) (Table 2).

There was a significant association between soy protein intake of all participants with DBP (R^2=0.015, β=-0.202) and between intake of isoflavones with SBP (R^2=0.021, β=-0.144) (Table 3). After adjusting for age, gender, education level, smoking status, physical inactivity, BMI and WC, intake of soy protein was significantly associated with both SBP (R^2 =0.205, β=-0.162) and DBP (R^2=110, β=0.104). Intake of soy isoflavones remained significantly associated with SBP (R^2=0.197, β=-0.131) after adjusting for those covariates. The higher the intake of isoflavones, the lower the SBP with 1 mg of isoflavones associated with a lower level of SBP by 7.97 mmHg. Daidzein and genistein intakes showed no significant association with all the CVD risk parameters being investigated in this study.

Intakes of isoflavones at higher quartiles (Q3 and Q4) were associated with lower mean values of the studied CVD risk parameters (Table 4). However, only SBP level showed a significant difference across the quartiles.

The mediation analysis (Figure 1) shows a significant) effect of urban/rural strata effect on blood pressure changes in response to soy isoflavones consumption. After controlling for isoflavone intakes as a covariate, urban and rural strata no longer showed a significant difference on SBP level. This finding indicates that the intake of isoflavones could lower the SBP of the participants.



*p<0.05, indicated there is significant difference between isoflavones intake with the parameter using SLR test

Figure 1. Mediation analysis of strata, isoflavones intakes, and blood pressure.

DISCUSSION

The findings of this study revealed that adults in rural areas had a higher risk of CVD compared to the urban as indicated by high SBP and abdominal obesity. This could be due to rural participants being older with lower educational levels, lower household income, and higher prevalence of smokers, as also reported in other study (Noor Hassim *et al.*, 2016). Low socioeconomic status in the rural area, as assessed by occupation, education and income level was closely related to poor diet quality (Psaltopoulou *et al.*, 2017) and sedentary lifestyles (Amiri *et al.*, 2014), thus leading to higher risk of CVD events.

The high number of smokers among rural participants has led to increased risk of CVD and other non-communicable diseases. Their low educational level has increased the prevalence of hypertension and smoking (Psaltopoulou *et al.,* 2017) due to a lack of knowledge on the adverse effects of tobacco. Besides, low awareness and knowledge on the risks of CVD among rural populations has further attenuated the desire for a healthy lifestyle and regular health monitoring (Aminde *et al.*, 2017). The lack of sensibility in living a healthy lifestyle has led to poor dietary intake, inadequate physical activities and delay in seeking health or medical treatment especially among rural population (Aminde *et al.*, 2017).

Estimation of intake of isoflavones

The mean of soy protein intake among adults in the urban and rural areas observed in this study was 3.40g/day and 3.01g/day, respectively. These intake levels were much lower compared to the 25.00g/day intake of soy protein suggested by the United States Food and Drug Administration (USFDA) (1999) and the Ministry of Health Malaysia (2011). The intake of soy isoflavones among urban respondents (9.35±11.31mg/day) was higher compared to that in the rural area (7.88±14.30 mg/day). This may be attributed to media exposure about soybean nutrition and its benefits among urban residents (Sadeghian *et al.,* 2014). Urban Malaysian adults showed high acceptability towards soybean products due to its nutritive value (Murad *et al.*, 2014).

The intake of isoflavones in this study was much lower compared to the level reported by another Asian study (Wada *et al.,* 2013), but higher than that reported in a Western population of 0.50 - 0.80mg/day (Zamora-Ros *et al.*, 2012). Most of the Asian studies from Japan and China reported high intake of soy isoflavones as soy foods have been part of their diets culturally (Yamori *et al.*, 2017; Wada *et al.,* 2013). There are also differences in isoflavones content in soybeans, depending on both genetic and environmental factors including climate, the location of the plantation, planting date, crop year and storage conditions (Teekachunhatean, Hanprasertpong & Teekachunhatean, 2017).

In this study, Chinese and Indians had a higher intake of soy isoflavones, particularly from *tofu*, compared to Malay respondents. Shurtleff & Aoyagi (2013) reported that most Chinese and Indian consumed soy food in their daily diet. Indian vegetarians tend to consume high amount of soy products as their source of protein (Shurtleff & Aoyagi, 2013).

Association between intake of isoflavones and and blood pressure

This study found that soy protein and soy isoflavones intake had a significant association with blood pressures (BP). Soy protein intake showed a significant association with DBP, while soy isoflavones intake showed a significant association with SBP. It is known that blood pressure, especially SBP, is

important as an independent risk factor for coronary events, stroke, heart failure, and chronic kidney disease (Richardson *et al.,* 2016).

After adjusting for the covariates including age, gender, ethnic, educational level, household income, smoking status, physical activity, WC, and BMI, mean SBP was significantly lower among those who consumed higher quintiles of soy isoflavones, indicating a potentially cardioprotective effect due to soy intake. A meta-analysis of 11 trials by Liu *et al.* (2012) reported that isoflavones intake of 65–153mg/d demonstrated a significant, larger effect on lowering SBP among hypertensives (5.9mmHg).

Factors including racial differences influence the capacity of intestinal flora to convert the isoflavones glycosides, daidzein to its metabolites (Taku *et al.,* 2010). These metabolites have been reported to play a crucial role in the clinical efficacy of soy isoflavones in relations to cardiovascular health (Taku *et al.* 2010). The BP-lowering effect of isoflavones may also be attributed to the activation of endothelial nitric oxide synthase (eNOS) and stimulation of nitric oxide (NO) production (Richardson *et al.,* 2016). A study has suggested that isoflavones attenuate blood pressure elevation through acceleration of NO production and inhibition of inflammation (Yu *et al.* 2016). An increased in soy consumption has been associated with higher plasma concentrations of NO due to its direct non-genomic effects on eNOS activity in human aortic endothelial cells. (Si *et al.,* 2012).

Limitations of study

This study estimated the isoflavones intake using subjective dietary assessments which do not estimate normal eating intakes. Sodium intake, which is a major contributor to high blood pressure, was not included in this study. The CVD risk parameters included in this study were limited to anthropometric and blood pressure measurements. Hence, additional clinical data are suggested for future studies to determine the effect of different levels of isoflavones intake on the risk of cardiovascular diseases and health, preferably through a longitudinal study design.

CONCLUSION

Mean SBP was higher among rural participants and this was found associated with lower intake of soy isoflavones. The use of biological markers for estimating intake levels of isoflavones is suggested through a prospective study design or clinical trials to investigate the protective effects of isoflavones on blood pressure and other CVD risks.

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Authors' contributions

NFMR, conducted the study, data analysis and interpretation, prepared the draft of the manuscript and reviewed the manuscript; SS, principal investigator, conceptualized and designed the study, led the data collection, advised on the data analysis and interpretation, assisting in drafting of the manuscript and reviewed the manuscript; HH, led the data collection, advised on the data analysis and interpretation and reviewed the manuscript; RA, led the data collection, advised on the data analysis and interpretation and reviewed the manuscript; FO, led the data collection, advised on the data analysis and interpretation and reviewed the manuscript.

Conflict of interest

The authors report no conflict of interest to disclose in this work.

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Vitamin D status of Filipino adults: Evidence from the 8th National Nutrition Survey 2013

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ABSTRACT

Introduction: This study reports the vitamin D status of Filipino adults in selected areas in the Philippines and determinants of deficiency, based on the 2013 National Nutrition Survey (NNS). **Methods:** The NNS collected blood samples from all members aged ≥20 years from selected households of the National Capital Region (NCR), Cebu and Davao del Sur. Serum vitamin D was determined by electrochemiluminescence assay. Data on age, sunscreen use, intake of supplement were collected. Body mass index was calculated. **Results:** The overall prevalence of combined vitamin D deficiency (<50 umol/L) and insufficiency (51-75 umol/L) was 48.7%, and was highest in the NCR (54.1%) and lowest in Davao del Sur (28.9%). Adults in NCR were more likely to have vitamin D insufficiency compared with those in Cebu (OR=0.59) and Davao (OR=0.30). Females had higher prevalence (62.5%) of vitamin D insufficiency than males (32.1%). Higher prevalence of vitamin D insufficiency was observed among 20-39 y (55.5%) and lowest among ≥60 y (38.1%). The younger adults (20-39 y) were more likely to have vitamin D insufficiency compared to 40-59 y (OR=0.63) and the ≥60 y (OR=0.43). Among sunscreen users aged 20-39 y and 40-59 y in Cebu and Davao del Sur, mean vitamin D levels were significantly lower than non-sunscreen users. **Conclusion:** The 2013 NNS revealed a high prevalence of vitamin D insufficiency among Filipino adults. Gender, age, and area of residence were significant determinants of vitamin D insufficiency. Determining the vitamin D status is crucial in crafting interventions for its prevention and control.

Keywords: Vitamin D deficiency, Filipino, adults, survey

INTRODUCTION

Vitamin D, also known as the sunshine vitamin, is a fat-soluble vitamin whose primary physiological function is the maintenance of calcium levels in the body. Vitamin D, either from the diet or synthesised by sunlight is biologically inactive. It is converted to 25-hydroxyvitamin D or 25(OH)D by D-25-hydroxylase in the liver and then to 1,25-dihydroxyvitamin D or $1,25(OH)_2D$ by 25-hydroxyvitamin D-1α-hydroxylase in the kidney (DeLuca, 2004; Holick & Chen, 2008). The $1,25(OH)_2D$ is the biologically active form of vitamin D.

Although found naturally in food, only a small proportion of vitamin D is obtained from the diet (10-20%) with "good" sources, from salmon, fortified milk and other fortified products (IOM,

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1997). The rest is obtained through the conversion of sunlight (Holick, 1999). While sun exposure is an excellent source of vitamin D, sunscreen, clothing, skin pigmentation, and rainy season reduce vitamin D production (Mithal *et al.*, 2009).

Over the past decade, low concentrations of 25-hydroxyvitamin D (25-OH vitamin D) have been associated with bone and mineral metabolism. Clinical hypovitaminosis D has been associated with rickets in infancy and also causes muscle weakness and contributed to falls and bone fractures in adults (Mithal *et al.*, 2009). In the general population, serum 25-OH vitamin D concentrations <20 ng/ml are associated with poorer physical performance (Wicherts *et al.*, 2007) while concentrations <15 ng/ml are associated with musculoskeletal pain (McBeth *et al.*, 2010). Also, it has been associated with significant short- and long-term health effects including the risk of common chronic diseases such as diabetes, cardiovascular disease and cancer (Lee *et al.*, 2018; Tangpricha *et al.*, 2002).

The groups most at risk of vitamin D deficiency are breastfed infants, older adults, and dark-skinned people. Many factors reduce the skin's production of vitamin D3, including aging, sun protection behaviours such as application of sunscreen or covering most of their bodies with clothing, and the time of year with limited or no sunlight (Hyppönen & Power, 2007). Increased skin pigmentation is another factor. Melanin efficiently absorbs UVB radiations, so people with increased skin melanin pigmentation require longer exposures to sunlight to make the same amount of vitamin D3, compared with light skinned people (Holick, 2004).

Worldwide, an estimated 1 billion people have inadequate blood levels of vitamin D and deficiencies can be found in all ethnicities and age groups. Studies suggest that roughly 30–50% of the adult population is at risk of vitamin D deficiency (Holick, 2014).

The significant role of sunlight in vitamin D synthesis suggests a low prevalence of vitamin D deficiency in tropical countries. However, studies in some tropical countries carried out in Malaysia, India, Iran and Hawaii had shown a high prevalence of vitamin D deficiency (Moy & Bulgiba, 2011; Harinarayan, 2005; Rahnavard *et al.*, 2010; Binkley *et al.*, 2007). The Philippines is not spared from this problem even though the country is located at the Equator and is sunny all year round. The prevalence of vitamin D deficiency among post-menopausal Filipino women was 20% (Kruger *et al.*, 2010).

To date, there is a limited data about the vitamin D status of different age groups in the Philippines. This study reported the vitamin D status of Filipino adults aged ≥20 y in selected areas in the Philippines and its determinant factors of vitamin D deficiency, based on the 2013 National Nutrition Survey.

MATERIALS AND METHODS

Multi-staged stratified sampling design was employed in the 2013 National Nutrition Survey (NNS). The first stage of the sampling involved the selection of the Primary Sampling Unit (PSU), which consisted of one (1) barangay or contiguous barangays with at least 500 households. The second stage was the selection of Enumeration Area (EA) which consisted of contiguous areas in a barangay with 150-200 households. The last stage was the selection of the households in the sampled EA that served as the ultimate sampling unit. Samples were taken separately from the regions by urban and rural strata.

Study sites

The 2013 (8th) NNS covered 80 provinces including the National Capital Region (NCR formerly called Metro Manila) in 17 regions. The survey used the Philippine Statistics Authority (PSA) 2003 Master Sample (MS) which was the same listing of households utilised for the 2009 Labour Force Survey (LFS). This MS consisted of 4 replicates wherein each replicate could give national and regional estimates. The biochemical component of the Survey utilised one of the four replicates of the MS covering 100% of sample households. About 8,592 sample households were selected for the survey; however this study focused on only three sites because of financial constraint: (1) National Capital Region (NCR) in Metro Manila, which is a highly urbanised city in Luzon, (2) Cebu province in the Visayas, and (3) Davao del Sur province in Mindanao. NCR lies along the flat alluvial lands entirely within the tropics. Its proximity to the equator means that temperatures are hot year-round. The province of Davao del Sur, otherwise known as the Padada Valley, is an agricultural area. Cebu province consists of a main island and 167 surrounding islands and islets.

Sample population

There were approximately 3,409 individuals aged ≥20 y over (Mean = 40.1; SD = 14.8) whose blood samples were analysed for total serum 25-hydroxyvitamin D [(25-OH (D)]. In NCR, there were about 1867 individuals, while Cebu and Davao del Sur had 864 and 678 respectively.

Measurements

Weight was measured using a standard calibrated electronic SECA weighing scale. At least two measurements were obtained, with the average recorded to the nearest 0.1 kg. Standing height was obtained using the Microtoise tape – an L-shaped device (head-bar) to which a spring-loaded coiled tape measure was attached. At least two measurements were obtained, and averages were computed, and recorded to the nearest 0.1cm. Body mass index (BMI) was computed as weight (kg)/height in m^2. BMI was based on WHO (1995) reference adopting the cut- off: Chronic Energy Deficiency <18.5 kg/m^2; Normal 18.5-24.9 kg/m^2; Overweight 25.0-29.9 kg/m^2; Obesity ≥30.0 kg/m^2.

Sample collection, preparation and analysis

Blood samples were obtained in the morning (0600H to 0900H) via venipuncture. Precautions were considered throughout the procedures to minimise exposure of samples to air and light. Approximately 10 ml venous blood samples to accommodate all the biomarkers needed for the survey was extracted using sterile syringe and transferred to a blue top tube. After a marked separation of serum and red cell was seen, the tube was centrifuged for 10 minutes. Serum was pipetted into microcentrifuge tubes and kept in freezers or in ice chests with dry ice. Frozen blood samples were transported from the field to the Biochemical Laboratory (BL) of FNRI where these were stored in freezers at -80°C until analysis.

The best indicator of vitamin D status is the serum 25-hydroxyvitamin D [25(OH)D] concentration (IOM, 2011). Total serum 25-hydroxyvitamin D [(25-OH(D)] was analysed using Electro-chemiluminescence binding assay (ECLIA) method in a selected ISO 15189 accredited laboratory in Metro Manila. The cut offs for Vitamin D levels were: Deficient (<50 nmol/l), Insufficient (51-74 nmol/l) and Sufficient was ≥75 nmol/l (Holick, 2009; Holick & Chen, 2008).

Collection of other data

Data on age, gender, education, occupation, use of sunscreen, and supplements were collected via interview using structured pre-tested questionnaires. In this study 'no occupation' were students, pensioners, or housewives; 'service-related' comprised of labourers and factory and manufacturing workers.

Ethics

This study was carried out in accordance with the declaration of Helsinki, guided by the Council for International Organization of Medical Sciences Ethical Guidelines for Biomedical Research involving human subjects (CIOMS, 2008) and the National Guidelines for Biomedical/Behavioral Research (PCHRD-DOST, 2011). Only those who signed the informed consent form were

Table 1. Profile of participants characteristics by area (based on socio-economic, demographic and nutritional status)

Variables	*ALL (n=3409)*		*NCR (n=1867)*		*Cebu (n=864)*		*Davao del Sur (n=678)*		*p-value*
	n	*%*	*N*	*%*	*N*	*%*	*n*	*%*	
Age (Mean±SD)	40.1±14.8		40.0±14.8		41.1±15.3		39.4±13.7		
Age group (years)									0.010*
20-39	2162	56.3	1254	57.1	485	53.2	423	56.6	
40-59	1634	32.4	878	31.4	425	35.0	331	34.1	
≥60	659	11.3	379	11.5	173	11.8	107	9.3	
Gender									0.737
Male	2182	48.9	1223	48.8	527	48.9	432	49.8	
Female	2273	51.1	1288	51.2	556	51.1	429	50.2	
Total	4455	100	2511	100	1083	100	861	100	
Education									<0.001*
Elementary	1023	18.9	388	13.9	388	32.1	247	26.7	
High school	1728	40.0	1041	41.6	354	34.5	333	39.7	
College	1680	41.1	1071	44.5	331	33.4	278	33.6	
Occupation									<0.001*
Office worker	959	23.5	626	25.8	191	18.8	142	17.2	
Service related	1534	35.2	877	35.4	354	33.7	303	36.2	
Agriculture/ Fishery	235	3.5	10	0.4	133	10.9	92	10.0	
No occupation	1727	37.8	998	38.4	405	36.6	324	36.7	
BMI by age groups									
Underweight	433	9.9	181	9.4	88	10.1	75	10.8	
20-39 y	195	10.4	94	10.1	37	11.1	37	11.5	0.412
40-59 y	126	7.5	48	6.9	32	8.4	19	6.8	
≥60 y	112	14.8	39	13.5	19	11.4	19	21.5	
Normal	1599	37.7	641	35.0	346	40.3	297	44.6	
20-39 y	825	44.4	370	42.5	160	46.9	160	49.7	
40-59 y	517	29.3	176	24.7	126	33.1	103	38.3	0.003*
≥60 y	257	34.0	95	30.7	60	38.2	34	38.9	
Overweight/Obese	2122	52.3	1045	55.6	430	49.6	306	44.7	
20-39 y	784	45.2	402	47.5	136	42.0	121	38.9	
40-59 y	998	63.3	485	68.4	217	58.5	150	54.9	0.032*
≥60 y	340	51.1	158	55.8	77	50.4	35	39.6	
BMI (Mean±SD)	23.8±4.5		24.0±4.1		23.7±5.2		23.0±5.2		0.000*
Underweight	17.1±1.2		17.1±1.1		17.1±1.2		17.2±1.4		0.996
Normal	20.9±1.3		20.9±1.2		20.8±1.4		20.8±1.6		0.641
Overweight/Obese	27.1±3.4		27.1±3.13		27.4±4.1		26.7±3.8		0.067

Note: No Occupation (included Students, Pensioner and Housewife)
*Significant at $p<0.05$

included in the study. The conduct of the study was approved by the Food and Nutrition Research Institute (FNRI) Institutional Ethics Review Committee (FIERC-2013-008).

Statistical analysis

Descriptive statistics was used to describe the means, standard errors, confidence intervals and prevalence of vitamin D deficiency. Kolmogorov-Smirnov test was used to determine the normality of data. ANOVA was used to compare means of 25-OH vitamin D levels in the three areas. T-test was used to compare means of 25-OH vitamin D levels of the adults in the three areas who used sunscreen and supplements and those who did not. Chi-square test for association was used for categorical data across areas and gender to determine relationships between 2-3 variables. Logistic regression was conducted to determine which of the variables affects vitamin D deficiency. Variables included were age, sex, use of sunscreen, use of supplements, and BMI. STATA was used for all statistical analyses. Significance level considered in this study was $p<0.05$. Survey weights were applied in all anthropometric and all other data prior to analysis.

RESULTS

A total of 3,409 blood samples were collected from adult members aged ≥20 y (Mean = 40.1; SD = 14.8) from the sampled households: NCR (n=1867), Cebu (n=864) and Davao del Sur (n=678). Education and occupation were significantly different between groups. Elementary education was lowest in NCR but has the highest percentage of office workers (Table 1).

The prevalence of underweight was similar across all age groups ranging from 9.4% to 10.8%. However, the prevalence of overweight and obesity was significantly higher among the 40-59 y (63.3%) than in the other age groups, and was highest (68.4%) in NCR (Table 1).

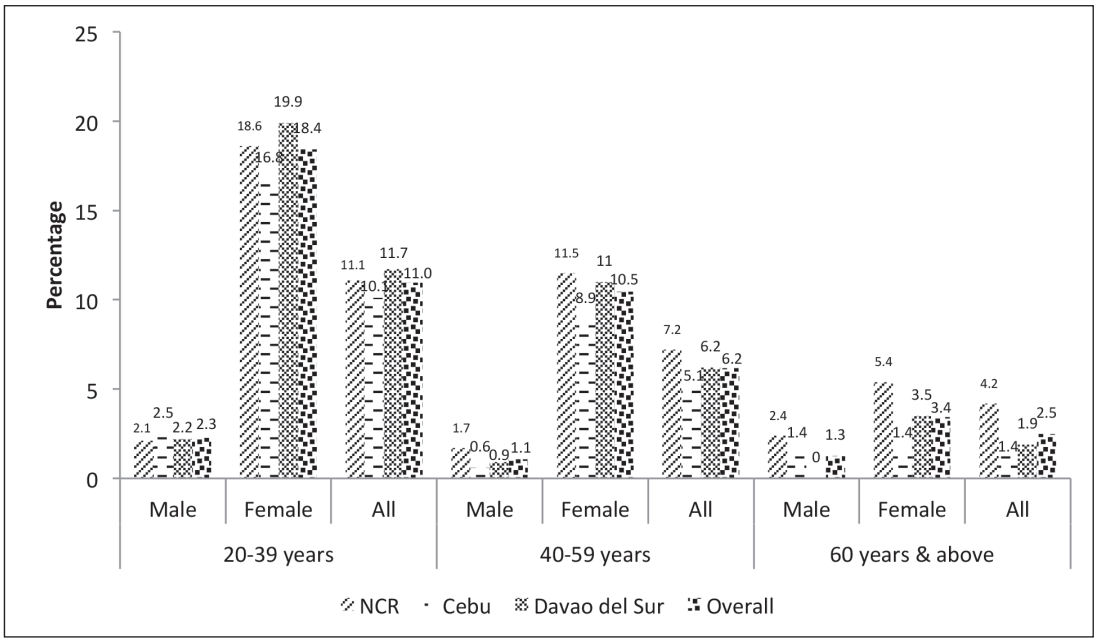

Figure 1. Percentage of adults using sunscreen by area, age and gender

Table 2. Mean of vitamin D levels and use of sunscreen by adults by area and age

Age (years)	National Capital Region			Cebu			Davao del Sur		
	Non-Sunscreen user	Sunscreen user	p-value†	Non-Sunscreen user	Sunscreen user	p-value†	Non-Sunscreen user	Sunscreen user	p-value†
	Mean±SE	Mean±SE		Mean±SE	Mean±SE		Mean±SE	Mean±SE	
20-39	71.7±1.6	65.1±3.9	0.075	84.2±2.9	59.5±4.7	<0.001*	97.7±3.4	78.0±4.2	0.002*
40-59	80.5±1.6	75.5±3.4	0.222	90.2±2.4	68.1±7.2	0.012*	105.1±4	82.1±2.9	0.016*
≥60	83.8±2.4	94.7±4.8	0.224	89.9±3.3	91.1±7.1	0.905	102.3±4	71.9±12	0.166
p-value‡	<0.001*	0.002*		0.210	0.062		0.112	0.851	

*Significant at $p<0.05$

†p-value for the difference between sunscreen user and non-sunscreen user by each age groups in each area (t-test)

‡p-value for difference between age groups who user sunscreen and who did not (ANOVA)

The use of sunscreen was more common among the 20-39 y (11.0%) while only 2.5% among the elderly participants. Among the 40-59 y, 6.2% used sunscreen. More female participants had used sunscreen than males and this was observed in all age groups and across the three areas (Figure 1). Among the 20-39 and 40-59 y who were sunscreen users in Cebu and Davao del Sur showed that, mean vitamin D levels were significantly lower than non-sunscreen users but this was not observed in NCR. Results also showed that in NCR the participants aged 20-39 y had significantly lower mean vitamin D levels than the other age groups (Table 2).

The study revealed that elderly participants (≥60 y) commonly used supplements (n=147; 24.3%) as compared with the 40-59 y (n=255; 19.2%) and in the 20-39 y (n=239; 16.3%). Comparing between areas in the elderly population, higher percentage of users were found in NCR (31.6%) than

Table 3. Mean serum vitamin D and percentage of vitamin D insufficiency by age, gender and area

Variables	Mean ± SE	Insufficiency†
	nmol/ml	N (%)
Over-all	81.1±1.1	1185(48.7)
Age group (years)		
20-39	76.1±1.5	579(55.5)
40-59	85.3±1.3	445(43.5)
≥60	87.4±1.9	161(38.1)
p-value	<0.001*	<0.001*
Gender		
Male	93±1.6	328(32.1)
Female	70.7±1.1	857(62.5)
p-value	<0.001*	<0.001*
Area		
NCR	76.2±0.9	755(54.1)
Cebu	85.7±2.0	260(43.8)
Davao del Sur	98.8±2.4	170(28.9)
p-value	<0.001*	<0.001*

*Significant at $p<0.05$

†Total of deficient and insufficient of vitamin D level

those from Cebu, (25.3%); and Davao del Sur (16.0%). Lowest percentage of supplement users was found among the 20-39 y with NCR having 19.4%, Cebu (13.0%) and Davao del Sur (16.4%). Males and female participants had almost similar percentage of users.

Mean vitamin D levels were highest among the participants from Davao del Sur (98.8±2.4 nmol/ml) and lowest was from the NCR (76.2±0.9 nmol/ml) while Cebu had 85.7±2.0 nmol/ml. The area with the highest proportion of deficient and insufficient levels was found among the participants in NCR (54.1%) and the lowest was from Davao del Sur (28.9%) while Cebu had 43.8% (Table 3).

Describing the population by age revealed that the prevalence of deficient and insufficient vitamin D was highest among the 20-39 y (55.5%); 40-59 y was 43.5%; and the lowest was among the elderly (38.1%). Females have a higher prevalence of deficiency and insufficiency (62.5%) as compared with males (32.1%) (Table 3).

The results of logistic regression analysis with vitamin D levels as dependent variable and sex, age, BMI, use of sunscreen, and use of supplement as independent variables showed that the determinant factors of vitamin D deficiency are gender, age and area. Females are 3.57 (p<0.001) times more likely to have vitamin D deficiency compared to the males. On the other hand, the adults aged 40-59 y (OR=0.62, p=0.007), and the elderly aged ≥60 y (OR=0.43, p=0.001), are less likely to have vitamin D deficiency compared to the younger adults. Adults in Cebu (OR=0.59, p=0.001) and Davao (OR=0.30, p<0.001) are less likely to have vitamin D deficiency compared to those in the NCR (Table 4).

Table 4. Multivariate logistic regression predicting the likelihood of being vitamin D insufficiency among Filipino adults in the NCR, Cebu and Davao

Determinants	*Adjusted OR*	*SE*	*95% CI*		*Wald*	*p-value*
			LL	*UL*		
Constant	0.79	0.1	0.6	0.9	-2.2	0.036
Sex						
Male (ref)						
Female	3.57	0.5	2.7	4.7	9.7	<0.001*
Age group (years)						
20-39 (ref)						
40-59	0.63	0.1	0.4	0.9	-2.9	0.007*
≥60	0.43	0.1	0.3	0.7	-3.7	0.001*
BMI						
<18.5	1.12	0.2	0.8	1.7	0.6	0.572
18.5-22.9 (ref)						
23.0-27.5	0.99	0.1	0.8	1.3	-0.1	0.958
>27.5	1.26	0.2	1	1.6	1.9	0.070
Sunscreen						
Do not use sunscreen (ref)						
Uses sunscreen	1.26	0.4	0.6	2.5	0.5	0.608
Supplement						
Do not take supplements (ref)						
Takes supplements	0.95	0.1	0.7	1.3	-0.3	0.740
Geographical location						
NCR (ref)						
Cebu	0.59	0.1	0.5	0.8	-3.8	0.001*
Davao	0.30	0.1	0.2	0.4	-6.6	<0.001*

DISCUSSION

Vitamin D is a prohormone that is essential for normal absorption of calcium from the gut. It is important to recognise that vitamin D is primarily made in the skin after exposure to ultraviolet radiation (UVR), and <10% is derived from dietary sources (Norris, 2001). Modern conditions of dress, lifestyle, and recommendations regarding sun avoidance to reduce risks of skin cancer may prevent a large proportion of the population from making healthy amounts of this vitamin.

Currently, there is no national data on mean vitamin D levels and prevalence of vitamin D deficiency in the Philippines. The 8th NNS conducted by the Department of Science and Technology – Food and Nutrition Research Institute (DOST-FNRI) in 2013 provided the opportunity to provide evidence on the vitamin D status of Filipino adults (20 to 59 y) and the elderly (≥60 y). However, this sub-study was conducted only in one highly urbanised city (NCR) and two provinces due to high cost of analysis. The NCR is located in Luzon, Cebu in Visayas and Davao del Sur in Mindanao.

The mean age of the participants was 40 y and overweight and obesity was very high across areas: ranging from 49.6% to 55.5%.

The present study revealed a very high prevalence of vitamin D insufficiency in the all the targeted areas especially in NCR, which had the highest prevalence. This may pose a health risk like osteomalacia, osteoporosis, diabetes, cardio vascular diseases and cancer (Lee *et al.*, 2018; Tangpricha *et al.*, 2002). In a vitamin D-deficient state, intestinal calcium absorption is only 10% to 15% and there is a decrease in the total maximal reabsorption of phosphate while in a vitamin D-sufficient state [25(OH)-D levels of <50 nmol/l (20 ng/ml)], net intestinal calcium absorption is up to 30%, although calcium absorption can reach 60% to 80% during periods of active growth (Misra *et al.*, 2008).

The Philippines is like other tropical countries with plenty of sunlight, and yet had shown high prevalence of vitamin D deficiency (Moy & Bulgiba, 2011; Harinarayan, 2005; Rahnavard *et al.*, 2010; Binkley *et al.*, 2007). In India, vitamin D deficiency was reported among 91% in healthy schoolgirls (Puri *et al.*, 2008) and in 78% of apparently healthy hospital staff (Arya *et al.*, 2004), using a cut-off level below 50 nmol/l. In Bangladesh, deficiency was 38% among women from high income group and 50% from low income group using a cut-off 37.5 nmol/l (Islam *et al.*, 2002). Prevalence of deficiency was 47% in Thailand, 49% in Malaysia, 90% in Japan and 92% in South Korea (Mithal *et al.*, 2009). Cut-off used for vitamin D insufficiency by these countries was <75 nmol/L.

This study revealed that the determinants of vitamin D level are age, gender and area. This study showed that the most vulnerable age group to having vitamin D insufficiency (<75 umol/L) are those in the 20-39 y. This high prevalence could be attributed to the use of sunscreens. The age group that has the high percentage of sunscreen users was mostly the females aged 20-39 y. In Cebu and Davao del Sur, the sunscreen users had lower vitamin D level compared to non-users. In the NCR, users and non-users have similar vitamin D levels. Sunscreen is used to avoid skin cancer due to exposure to sunlight and has become a common practice especially among young adult population. Sunscreen absorbs UV-B and some UV-A light and prevents it from reaching and entering the skin. A sunscreen with a sun protection factor (SPF) of eight can decrease vitamin D3 synthetic capacity by 95%, and SPF 15 can decrease it by 98% (Holick, 2004).

In adults who apply sunscreen properly (2 mg/cm2), the amount of vitamin D3 produced is decreased (95%). A previous study demonstrated lower vitamin D levels in people using SPF 15 sunscreens than in those not using sunscreen, however, these lower levels were not sufficient to cause PTH level elevations (Farrerons *et al.*, 1998). Sun exposure of the arms, legs, hands, or face for about 5 to 10 min for at least 2 or 3 times per week is enough for the production of vitamin D requirement.

The prevalence of vitamin D among the ≥60 y was 38%. It has been postulated that the older adult population is especially vulnerable to vitamin D deficiency due to a decreased capacity to synthesise vitamin D from sunlight (Parker *et al.*, 2010). Also, aging is associated with lower 7-dehydrocholesterol levels (Bischoff-Ferrari *et al.*, 2009), which is a precursor required for the synthesis of vitamin D in the skin. The mean vitamin D level of ≥60 y was significantly higher than the younger age groups maybe because of the high use of sunscreen among the younger population.

Moreover, the insufficient vitamin D was highest in NCR than in the other two areas despite its location in flat alluvial lands entirely within the tropics. It has been shown in previous studies that vitamin D production may be affected also by geography (Marks *et al.*, 1995). NCR is the centre of commerce, employment and education. The high percentage of vitamin D insufficiency in NCR is among the productive age groups of 20-59 y. This might be due to lesser time exposure to sunlight compounded by the high use of sunscreen. Increased urbanisation and increased time spent indoors at work may lead to decreased time spent outdoors and, therefore, decreased vitamin D synthesis. Shade reduces the amount of solar radiation by 60%, and windowpane glass blocks (UVR) ultraviolet radiation (Holick, 1995). For adequate vitamin D synthesis, exposure to the midday sun (between 1000 and 1500 hours) for 10-15 minutes in the spring, summer, and fall is considered sufficient for light-skinned people, providing 25% of the minimum erythema dose (MED) (Holick, 2003).

Another significant finding in this study is the higher odds of females to have vitamin D insufficiency than males. This is in congruent with the results of a previous study among in patients undergoing coronary angiography wherein gender significantly affected vitamin D status. Female gender was associated with lower vitamin D levels (14.5±10.9 vs. 15.9±9.5, p=0.007) and independently associated with severe vitamin D deficiency (41.9% vs. 30.4%, p<0.001; adjusted odds ratio (OR) (95% confidence interval (CI)=1.42 (1.08-1.87), p=0.01). The lower 25(OH)D levels observed in females, as compared to males, play a more relevant role in conditioning the severity of CAD (Verdoia *et al.*, 2015). Another study found contradicting results, male patients had significantly lower mean 25(OH)D concentrations than female patients 50.0 (22.0) nmol/l versus 53.6 (22.4) nmol/l (P=0.001) and a significantly (P=0.001) higher rate of vitamin D deficiency, 56% versus 47% (Johnson *et al.,* 2012). Another study found no significant association between vitamin D level and sex of the participants (Baradaran *et al.*, 2012). Different results might be due to different health conditions, lifestyle of respondents and time spent under the sun.

In previous studies, obesity was also associated with vitamin D deficiency (Wortsman *et al.*, 2000). The results of the study in Oslo, Norway showed the prevalence of vitamin D deficiency was highest in individuals with BMI ≥40 (Lagunova *et al.*, 2009). In this study, we did not find a significant role of BMI on

vitamin D levels among the overweight and obese population because the mean BMI (23.8±4.5) might not be too high to cause a deficiency.

CONCLUSION

There was a high prevalence of vitamin D insufficiency among Filipino adults living in the three studied areas. Gender, age, and area were significant determinants of vitamin D level. More studies should be conducted to confirm the results of the present study before we can say that there are evident age, gender and area - specific determinants of vitamin D status. There is a need also to evaluate vitamin D status among younger age groups to prevent and control the long- and short – term effects of the deficiency at an early age.

Limitations

Interpretation of results of this study is not maximised because data on time of sun exposure including time of day and duration of exposure were not collected. Data on vitamin D intake was not computed because there is no vitamin D in the Philippine Food Composition Table at time of analysis of this survey.

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Authors' contributions

IAA conceptualised and designed the study, analysed and interpreted the data, prepared the draft manuscript, provided critical revision and final approval of the revision to be published; LAP contributed in the design and write-up of the draft manuscript; MVC has contributed inputs in the draft manuscript.

Conflict of interest

The authors declare no conflict of interest.

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Maternal vitamin D intake and serum 25-hydroxyvitamin D (25(OH)D) levels associated with blood pressure: A cross-sectional study in Padang, West Sumatra

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ABSTRACT

Introduction: The association between vitamin D inadequacy and blood pressure (BP) has been studied in several populations. We examined the association of maternal vitamin D intake and serum 25(OH)D levels and BP among pregnant women in West Sumatra. **Methods:** This study was conducted using a comparative cross-sectional study in a maternal clinic selected by convenience in Padang. Pregnant mothers who attended the clinic in July-August 2015 were recruited. Inclusion criteria were pregnancy between 28-42 weeks, aged 20-35 years, and with less than three parity status. A total of 56 women were recruited and divided equally into either normotension or hypertension groups. Subjects with blood pressure less than 120 mmHg (SBP) and 80 mmHg (DBP) were placed in the normotension group, while subjects with ≥140 mmHg (SBP) and/or ≥90 mmHg) were in the hypertension group. Subjects completed a pre-tested semi-quantitative food frequency questionnaire. Three ml of non-fasting blood was drawn from each subject for determination of 25(OH)D, urea, creatinine, leukocyte, and blood glucose levels. **Results:** There was a significant difference in mean serum 25(OH)D, between the normotension and hypertension groups, at 36.85±21.58 pg/ml and 17.36±7.91 pg/ml, respectively. Only 20% of participants from the hypertension group had adequate vitamin D intake. Blood pressure status had a significant association with vitamin D intake status (p=0.001). **Conclusion:** Maternal vitamin D intake and 25(OH)D levels were associated with blood pressure status in this sample population. Further studies with a larger sample population are suggested to verify the findings of this study.

Keywords: Blood pressure, pregnancy, 25(OH)D, vitamin D intake

INTRODUCTION

One of the most common medical problem encountered during pregnancy is hypertension, which complicates 10% of all pregnancies (Berhan, 2016). Hypertensive disorders of pregnancy (HDP) include chronic hypertension (occurring before 20 weeks gestation, or persisting longer than 12 weeks after delivery), gestational hypertension

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(occurring after 20 weeks gestation), pre-eclampsia (occurring after 20 weeks gestation and either proteinuria or thrombocytopenia), and eclampsia (pre-eclampsia followed seizure) (Leeman *et al.*, 2016). In addition, more than 8% of all pregnancies are related to cardiovascular death as a result of hypertensive disorders during pregnancy (HDP) (Naderi *et al.*, 2017). Hypertension may also increase the risk of adverse maternal and foetal outcomes, such as preterm birth, intrauterine growth restriction (IUGR), perinatal death, acute renal or hepatic failure, antepartum haemorrhage, postpartum haemorrhage, low birth weight and maternal death (Kendrick *et al.*, 2015; Seyom *et al.*, 2015).

The United Nations Children's Fund (UNICEF) has found that women living in developing countries of the world are 300 times more likely to die because of childbirth or pregnancy-related complications than women living in developed countries. Maternal mortality is the global health indicator with the largest disparity between developed and developing countries. Every year, more than half a million women die because of pregnancy or childbirth complications.

The mean maternal mortality ratio (MMR) in Indonesia fell from 385 to 216 deaths per 100,000 live births in 1990-2015. Despite the 44% reduction, this condition is still far from the recommendation of Millennium Development Goal (MDG), which must reach 75%. Sustainable Development Goal (SDG) is targeting maternal deaths to be less than 70 per 100 000 live births in 2030. One of the main causes of maternal death is gestational hypertension (Alkema *et al.*, 2016; Statistics Indonesia *et al.*, 2013).

Vitamin D plays a critical role in regulating the Renin-Angiotensin System (RAS) and vascular smooth muscle. Thus, vitamin D has the potential to affect blood pressure (Wong *et al.*, 2010). Ullah *et al.* (2009) reported that vitamin D deficiency could increase the risk of hypertension by as much as 67%. The effect of lifestyle, inadequate maternal vitamin D intake, and lack of exposure to sunlight may lead to low vitamin D status (Ullah *et al.*, 2009). Li *et al.* (2004) had reported that low serum 25(OH)D levels could enhance Renin-Angiotensinogen II production, causing elevated blood pressure.

Low levels of 25(OH)D during the third trimester may lead to increased blood pressure or hypertension. Liu *et al.* (2013) studied low vitamin D status in pregnant mice leading to symptoms of pre-eclampsia that influenced Renin-Angiotensinogen II receptor. This condition affects the flow of blood, causing constrictions that may lead to increased blood pressure during pregnancy (Liu *et al.*, 2013). This study aimed to assess the association between maternal vitamin D intake and 25(OH)D serum levels with blood pressure status in pregnant subjects.

MATERIALS AND METHODS

Study design and subjects

This study was a comparative cross-sectional study with 61 pregnant mothers recruited from a maternal clinic selected by convenience in Padang, Indonesia. Pregnant mothers with a history of diabetes mellitus, kidney disorder, pre-eclampsia, eclampsia, anaemia, multiple pregnancies, and those taking medications that might affect vitamin D metabolism were excluded. This study was conducted from July-August 2015.

The subjects were healthy pregnant mothers with hypertension. The inclusion criteria were pregnant mothers within 28-42 weeks of gestation, aged 20-35 years, and with less than three parity statuses. All subjects were informed of the purpose of the study

and requested to participate after giving written consent; five subjects opted to drop out at this point. The subjects were divided equally into two groups namely, subjects with normotension (*n*=28) and those with hypertension (*n*=28).

Demographic and anthropometry data

Age, parity status, actual maternal body weight at third trimester, and height were recorded when the pregnant mothers attended antenatal care (ANC) in the selected maternal clinic. Unfortunately, we were not able to get pre-pregnancy body weight data. Body Mass Index (BMI) was presented in kg/m^2.

Dietary assessment

Maternal vitamin D intake was assessed by using a semi-quantitative food frequency questionnaire (SQ-FFQ) that was developed and validated by Lipoeto *et al.* (2004). The SQ-FFQ had been adapted to food habits of *Minangkabau*, an ethnic group inhabiting the Highlands of West Sumatra. The SQ-FFQ consisted of 223 general food items including potential sources of vitamin D in the targeted population.

Energy and nutrient intake were determined using the SQ-FFQ, which provided a snapshot of the dietary intake among the Minangkabau ethnic group residing in Padang. The SQ-FFQ also provided detailed information of the food choices and sources of nutrients consumed by the subjects in the last three months. Potential vitamin D-rich foods in the area were added to the questionnaire. The Bowes & Church's Food Values of Portions and the U.S. Department of Agriculture (USDA) Foods database (Pennington & Spungen, 2010; USDA, 2015) were used to estimate vitamin D content in the foods consumed. Intakes of energy, macronutrients (carbohydrate, protein, fat) and micronutrients were obtained using the Indonesian Food Database and Nutrisurvey (Version 2007, SEAMEO-TROPMED RCCN University of Indonesia, Jakarta, Indonesia).

Subjects with a daily energy intake of <500 kcal or >3500 kcal were excluded from further data analyses of food or nutrient intake because extreme values could interfere with the results (Willett, 1990). Nutrient intake was expressed in actual grams/day for macronutrients, µg/day for maternal vitamin D intake and as a percentage of total energy intakes. Maternal vitamin D intake status was defined as <15 µg/day for inadequate and ≥15 µg/day for adequate.

Vitamin D blood samples

Non-fasting venous blood samples (3ml) were collected from each pregnant mother in the third trimester of pregnancy. The blood samples were centrifuged at 3500 rpm for 10 min at 4^0C (Eppendorf Centrifuge 5810R, Hamburg, Germany). The serums were placed in aliquot vials and stored at -20^0C to 70^0C until analysed. Serum samples were protected from light oxidation and thawed once before analysis, which was completed after 6 months of data collection.

The blood samples were centrifuged at Dr M. Djamil Hospital, Padang and brought to Biomedical Laboratory of The Medical Faculty of Andalas University for Enzyme-linked Immunosorbent Assay (ELISA). The 25(OH)D for human reagent was checked by E-EL-0016 DVD/DHVD3 (1,25-Dihydroxyvitamin D3), using ELISA kit (Elabscience Biotechnology Inc., Wuhan, Hubei, China) utilising the Sandwich-ELISA method.

The micro ELISA plate provided in this kit had been pre-coated with an antibody specific to 25(OH)D. The enzyme-substrate reaction was terminated by the addition of a sulphuric acid solution whose colour turned to yellow. The optical density (OD) was measured spectrophotometrically at a wavelength of 450±2 nm. The OD value

is proportional to the concentration of 25(OH)D. The serum 25(OH)D results were expressed in pg/ml. The lower and upper limits of detection were 2.0 and 200.0 pg/ml, respectively. In the third trimester of pregnant mothers, the recommended level for 25(OH)D levels was 60-119 pg/ml (Abbassi-Ghanavati *et al.*, 2009).

Blood pressure measurement

Two measurements of general blood pressure were taken within a 5-minute period with a random zero sphygmomanometer with subjects in a sitting position with their backs supported and their legs uncrossed. Measurements were taken by trained midwives on-site during antenatal care check-up. The definition of hypertension as defined by the American College of Cardiology (ACC) and the American Heart Association (AHA), which had released a clinical practice guideline for the prevention, detection, evaluation, and treatment of high blood pressure (BP) in adults (Carey *et al.*, 2018) was used.

This guideline defines hypertension as a systolic blood pressure (SBP) equal to or greater than 140 mmHg or a diastolic blood pressure (DBP) equal to or greater than 90 mmHg. Pregnant mothers with blood pressure less than 120 mmHg (SBP) and 80 mmHg (DBP) were placed in the normotension group, 120-139 mmHg (SBP) or 80-89 mmHg (DBP) were in the prehypertension group, and with either ≥140 mmHg (SBP) and/or ≥90 mmHg) were in the hypertension group.

Statistical analysis

All data analyses were performed by statistical software package SPSS 20 and were expressed by mean (SD), and as frequencies and percentages for categorical variables. The presence of a normal distribution for each variable was tested by the Shapiro Wilk test. The subjects were stratified by hypertension and normotension group, and by maternal vitamin D intake status as defined previously. Comparisons between groups were performed using a chi-square test for categorical variables. Continuous variables were compared between groups by independent samples t-tests for normally distributed variables and the Mann–Whitney U test for non–normally distributed variables. Pearson chi-square, Yates corrected chi-squared, and Fisher's exact tests were performed for categorical variables. The student's t-test was used to compare the differences of mean of 25(OH)D serum levels between blood pressure classification. Finding at $p<0.05$ for a two-sided test was considered statistically significant with 95% Confidence Interval (CI) to see the relationship.

Ethics approval

The Research Ethics Committee of Medical Faculty, Andalas University, West Sumatera, Indonesia approved the study protocol. The letter number is 347/KEP/2014.

RESULTS

A total of 56 pregnant mothers aged 21-35 years participated in this study. The characteristics of the subjects according to blood pressure status are shown in Table 1. The association between maternal characteristics and blood pressure status showed variable results. There was no significant difference between parity status, age groups, and BMI status and blood pressure status.

Out of the 56 subjects, only twenty (35.7%) had adequate vitamin D intake of more than 15 *μg/day*. There was a significant difference in vitamin D intake between normotension and hypertension subjects (Table 2).

Table 1. Characteristics of study participants according to blood pressure status

Characteristics	*N (%)*	*Normotension*		*Hypertension*		*p-value*† *OR (95%CI)*
Age (years)			(%)		(%)	
a. 21-25	15(26.8)	7	(46.7)	8	(53.3)	0.666
b. 26-30	25(44.6)	14	(56.0)	11	(44.0)	
c. 31-35	16 (28.6)	7	(43.8)	9	(56.2)	
Parity status						0.060
a. Nulliparous	31 (55.4)	12	(38.7)	19	(61.3)	0.35 (0.11-1.05)
b. Multiparous	25 (44.6)	16	(64.0)	9	(36.0)	
Vitamin D intake (µg/day)						<0.001*
a. Adequate (≥15)	20 (35.7)	17	(85.0)	3	(15.0)	0.078 (0.019-0.32)
b. Inadequate (<15)	36 (64.3)	11	(30.5)	25	(69.4)	
Height T3 (cm)	56 (100.0)	28	(50.0)	28	(50.0)	0.904
BMI T3, (kg/m^2)						
a. <18	0	0	(0.0)	0	(0.0)	
b. 18-25	17 (30.4)	9	(52.9)	8	(47.1)	0.685
c. 25-30	33 (58.9)	17	(51.5)	16	(48.5)	
d. ≥30	6 (10.7)	2	(33.3)	4	(66.7)	
Urea (mg/dL)	56 (100.0)	28	(50.0)	28	(50.0)	0.818
Creatinine (mg/dL)	56 (100.0)	28	(50.0)	28	(50.0)	0.283
Blood glucose (mg/dL)	56 (100.0)	28	(50.0)	28	(50.0)	0.528
Leucocyte (mm$^{3)}$	56 (100.0)	28	(50.0)	28	(50.0)	0.069

SD=Standard deviation; BMI=Body mass index; T3=Third trimester.
†Categorical variables were expressed as numbers and percentages, and analysed using a chi-square test.
*Significant at $p<0.01$ level.

The difference in serum 25(OH) D levels between hypertension and normotension pregnant mothers was significant. Table 3 shows that the mean serum 25(OH)D level in normotension pregnant mothers was 6.85±21.58 pg/ml, while that of hypertension pregnant mothers was 17.36± 7.91 pg/ml. The minimum and maximum values of 25(OH)D for all subjects was 5.72 pg/ml and 93.92 pg/ml respectively.

The mean systolic blood pressure of pregnant mothers was 108.29±10.21 mmHg for normotension group, and 152.14±6.23 mmHg for hypertension group. The mean diastolic blood pressure of pregnant mothers was 71.93±5.56 for normotension group and 95.36±2.61 for hypertension group.

The mean maternal vitamin D intake

Table 2. Association of dietary vitamin D intake and blood pressure status

Vitamin D consumption (µg/day)	*Blood pressure*				*Total*		*p-value*†	*OR (95%CI)*
	Hypertension		*Normotension*		*N*	*%*		
	n	*%*	*n*	*%*				
≤15	25	69.4	11	30.6	36	64.3		
>15	3	15.0	17	85.0	20	35.7	0.0001	0.078
Total	28	50.0	28	50.0	56	100.0		

µg=microgram
†Categorical variables were expressed as numbers and percentages, and analysed using a chi-square test. Differences were considered statistically significant at $p<0.05$ level.

Table 3. Mean of 25(OH)D serum levels, blood pressure, and maternal Vitamin D intake between normotension and hypertension pregnant mothers

Variables	*Normotension*		*Hypertension*		*p-value*
	Mean	*SD*	*Mean*	*SD*	
25(OH)D levels (pg/ml)	36.85	21.58	17.36	7.91	0.0001*
Vitamin D intake (µg)	16.61	9.39	10.22	7.23	0.006*
Blood pressure (mmHg)					
a. Systolic	108.29	10.21	152.14	6.23	0.002*
b. Diastolic	71.93	5.56	95.36	2.61	0.006*

SD=Standard Deviation; Mean of variables were analysed using independent sample *t*-test. Mean differences were considered statistically significant at $p<0.05$ level.
*Independent sample *t*-test significant at $p<0.01$ level.

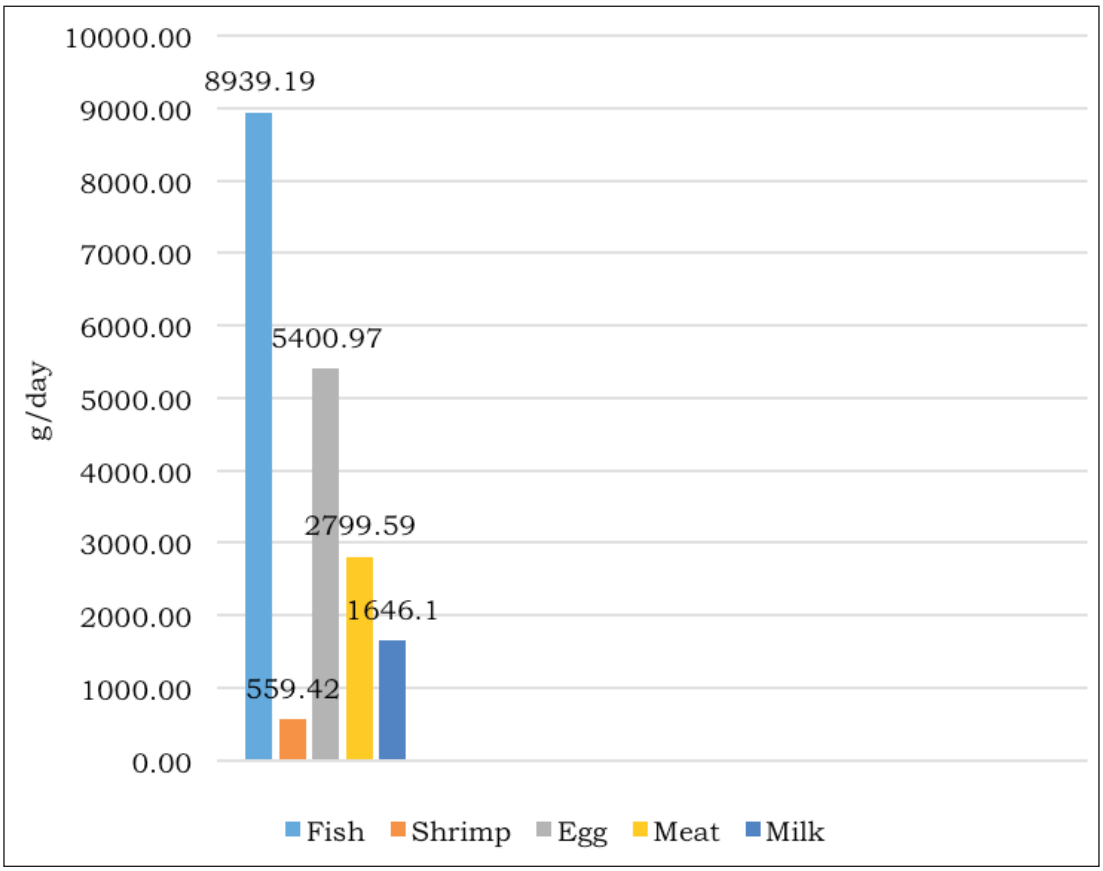

Figure 1. Sources of vitamin D-rich food (gram/day) consumed by pregnant mothers.

of normotension and hypertension was 16.61±9.39 µg/day and 10.22±7.23 µg/day, respectively. The minimum-maximum value of maternal vitamin D intake for all subjects was 4-36 µg/day. Based on the independent sample *t*-test analysis, maternal vitamin D intake was significantly different between normotension and hypertension mothers.

Vitamin D is not found naturally in foods commonly consumed by the subjects, and the highest sources of dietary vitamin D were fish, fortified

foods (mostly from milk and dairy products), and egg and meat (Figure 1).

The mean difference of dietary consumption of vitamin D-rich foods in pregnant mothers with normal blood pressure was 834.93±242.49 g/day, and 385.08±145.14 g/day for high blood pressure. Those with a higher intake of vitamin D-rich foods had lower blood pressure compared to those with lower intake of vitamin D-rich foods during pregnancy. The average intake of vitamin D sources during pregnancy in high blood pressure pregnant mothers was lower than that of normal blood pressure pregnant mothers (p=0.001).

DISCUSSION

Vitamin D deficiency and insufficiency are common throughout the world. Large epidemiological studies showed high prevalence of vitamin D deficiency in women, including antenatal and lactating mothers (Mithal *et al.*, 2009). This study revealed that the average maternal vitamin D intake was 13.42±8.91 µg/day, with the lowest and highest intake at 4 µg/day and 36 µg/day, respectively

There was a significant relationship between maternal vitamin D intake and blood pressure among the third trimester pregnant mothers. A total of 64.3% pregnant mothers in their third trimester consumed less than the recommended amount of vitamin D. Hyppönen *et al.* (2005) reported a relationship between the risk of high blood pressure with vitamin D deficiency. Low maternal vitamin D status may influence the risk of pre-eclampsia because of its effect on transcriptional gene, immune function, and blood pressure. Some experts suggest that 25(OH)D plays a role in the regulation of genes that are responsible for placental invasion and blood vessel formation (Evans *et al.*, 2004). The role of vitamin D in the modulation of immune function may affect immunologic response to the foetus.

In our previous study, we reported that 94.9% of young women aged 20-50 years had low 25(OH)D serum levels (Keumala Sari, 2013). Synthesis of vitamin D during pregnancy is higher than in non-pregnant mothers. Kidney and placenta produce vitamin D, 25(OH) D, by CYP27B1 enzyme activity. The production of 25(OH)D increases two folds in the third trimester of pregnancy. Their body's need for 25(OH)D serum leads to increased absorption of calcium in the intestine (Ma *et al.*, 2012).

During the third trimester, pregnant mothers should increase their vitamin D intake. The need for vitamin D may be greater during pregnancy because of the physiologically higher levels of 25(OH)D seen in the second and third trimester (Hollis and Wagner, 2013). The physiological increase of active metabolite vitamin D during pregnancy, due to elevated intestinal calcium absorption, raises the foetal need of calcium (250 mg/day in the third trimester), and may affect the immunomodulation system and placental development. This evidence again indicates the importance of having sufficient vitamin D intake during pregnancy (Specker, 2012).

Vitamin D supplementation is suggested for women with vitamin D deficiency, dark skin, less sun exposure, usage of long dress and veil daily, vitamin D metabolism disorders, pregnancy and breastfeeding mothers (Mithal & Kalra, 2014). Vitamin D supplementation during pregnancy is suggested at 2000-4000 IU/day for a safe dose (Hollis & Wagner, 2013).

The recent study by Bean e*t al.* (2017) in the U.S. population reported that vitamin D and calcium supplementation showed a positive association with reducing blood pressure. Low levels of vitamin D may impair calcium homeostasis by the renin-angiotensin

system in the kidneys. Systolic blood pressure was negatively and significantly associated with increasing 25(OH) D levels and an interaction between 25(OH)D and calcium intake levels was significantly associated with diastolic blood pressure. The results of this study suggest that the association between 25(OH)D levels and diastolic blood pressure may differ depending on the amount of calcium intake.

This study had several limitations, which include the small sample size, intake of vitamins from supplements and other potential confounding factors that were not assessed. The taking of repeated samples of maternal serum 25(OH)D concentrations during pregnancy should be considered for future studies.

CONCLUSION

Maternal 25(OH)D serum levels and vitamin D intake showed associations with blood pressure levels during the third trimester of pregnancy in this sample of subjects. Further studies with larger samples are suggested to verify these findings.

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Author contributions

Conceiving and conducting the experiments: NIL, NPS, FA. Performing the experiments: NPS, FA. Analyse the data: ASA, FF. Drafting of the manuscript: ASA. Primary responsibility for the final content of manuscript: NIL. All authors reviewed and approved the manuscript.

Conflicts of interest

The authors have no conflict of interest.

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Workplace and individual factors influence eating practices of Thai factory workers

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ABSTRACT

Introduction: The promotion of healthy eating practices in the workplace could reduce the burden of morbidity in the working population. Eating practices of employees are the result of multiple factors. This research aimed to examine the association between workplace and individual factors related to eating practice among factory workers by using the hierarchical linear modelling. **Methods**: Data were obtained from workers and managers in 26 factories located in a central province of Thailand. Workers completed self-administered questionnaires about individual data and eating practices including consumption of foods high in fat, salt and sugar. Factory managers were interviewed along with a survey of the worksite nutrition environment. **Results**: The multilevel modelling of data from 26 managers and 924 workers showed that none of the workplace factors studied predicted the employees' eating practices, i.e. workplace policy, attitude toward food and nutrition promotion of management personnel, healthy food in canteen, and workplace nutrition environment. At the individual level, attitude towards diet and health of factory workers was associated with eating practices (b=48.67, SE=1.71). Cross-level interactions between workplace nutrition environment and canteen management attitude towards health and diet of workers, were significantly associated with eating practices. This finding indicates that nutrition promotion at the workplace should take into consideration the key factors of offering healthy foods in canteens and supporting a healthy nutrition environment. **Conclusion**: Worksites should be encouraged to provide a healthy nutrition environment and offer healthy food choices in their canteens.

Keywords: Eating practice, workplace, nutrition environment, multilevel analysis

INTRODUCTION

Non-communicable diseases (NCDs) are a growing health problem throughout the world (WHO, 2013). Among these, cardiovascular disease, cancer and diabetes are now the leading causes of death among adults worldwide. In Thailand, the proportional mortality from NCDs was 71% of total adult deaths (WHO, 2014). Several studies have shown that dietary factors, such as higher levels of fibre, fruit and vegetable consumption, are associated with reduced risk of developing cancer,

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diabetes and cardiovascular diseases (Nishida, Shetty & Uauy, 2004). Public health organisations are promoting healthy eating behaviours to adults in both community and workplace settings to slow the spread of NCDs.

While there are various types of workplaces in Thailand, the expansion of industrialisation has resulted in an increased number of industrial workers. The industrial workforce is socio-economically and culturally diverse. Due to restrictive work schedules, workers dietary choices during working hours are based on their daily life activities and may not be healthy. For instance, it is more convenient and quicker to buy snacks or foods from the workplace canteen than to buy a nutritious meal from outside the factory. Food habits and eating patterns of factory workers were impacted by the constraints of their work in the factory setting (Thornton *et al.*, 2013; Price *et al.*, 2016). Another study by Manasigan *et al.* (2015) reported that one-third of the factory workers consumed high fat food every day and had a low frequency of daily fruit intake. A study of Thai workers in a garment factory found that most of the workers ate at the cafeteria at least once a day, and were likely to choose unhealthy foods such as fried foods and sweets (Boontem, 2007).

Poor eating patterns can lead to low work productivity, increased absenteeism, increased medical expenses, and increased morbidity (Asay *et al.*, 2016). In order to reduce rising health care costs due to unhealthy eating practices, it was suggested by the European Network for Workplace Health Promotion (ENWHP) that employers should implement plans that promote healthy dietary behaviours among their workers (Muylaert, Beeck & Broek, 2007).

Workplace nutrition interventions to improve eating behaviours had been studied extensively (Allan *et al.*, 2017; Geaney *et al.*, 2013; Kushida & Murayama, 2014). However, there is limited empirical evidence that examines the association of individual and workplace factors on the eating practices of factory workers. There are multiple levels of association between workplace and individual factors on eating behaviours. According to the previous reviews, the workplace can play a role in promoting health, since the workers are grouped in the same organisational nutrition environment influenced by political, physical, social, economic aspects of the workplace (Glanz *et al.*, 2005). Previous studies mostly focused on the physical nutrition environment, i.e. available foods. Hence it was suggested that studies on employee eating behaviours should include the economic, political, and socio-cultural factors of the workplace (Ni Murchu *et al.*, 2010).

Eating practices were defined as behaviours that are consistent with a level of health, where poor health is linked to diets with high fat, sugar or salt levels. The eating practices of employees are influenced by multiple factors at the level of the individual, including psychosocial and socioeconomic (Florindo *et al.*, 2015), past participation of nutrition promotion programmes (Mhurchu, Aston & Jebb, 2010), and characteristics of their work. The workplace may influence a person's eating practices with health promotion campaigns (Mhurchu *et al.*, 2010), providing social support for improving eating habits (Tamers *et al.*, 2011), the types of food that are available in workplace canteen (Bandoni *et al.*, 2011), and the general approach to nutrition in the work environment (Story *et al.*, 2008).

The purpose of this research was to determine the associations between factors at the workplace and eating practices among factory workers. The hierarchical linear model (HLM) or

multilevel model analysis is applied and the research outcome HLM is referred as mixed models, multilevel models, and random effect models (Goldstein, 2011; Faraway, 2016).

MATERIALS AND METHODS

Participants and settings

This study used a cross-sectional design. The research settings were industrial factories located in Muang, Bang Plee, and PhraPraDaeng districts in SamutPrakarn province, Thailand. The team used the Power IN Two-level (PINT) design software (Version 2.1) to determine the optimal sample size for the multilevel research design, using data from the 2007 health risk screening of 2,505 insured workers, collected by Thai Social Security Office (Samut Prakarn Provincial Health Office, 2007). Permission to use the data was obtained from Samut Prakarn Provincial Health Office. The alpha (α) was set at 0.01, the power was set at 0.80, and 0.10 for the effect size. The standard error was 0.034, which satisfied the power (0.80). The estimated sample size for the workplace level factors was 22 factories, and 880 workers for the individual level factors.

Participating factories were recruited according to criteria on diverse size and types of industrial production. Among the participating factories selected by convenience were six that produce household utensils, five build automobiles, four produce textiles, four each were chemicals and food producers, and three that specialised in metal or steel products. Eligible workers were selected using quota sampling techniques to ensure that two equally sized subgroups of manual and non-manual workers were represented. The research team selected the quota sampling technique because it is suitable for conducting research with heterogeneous populations (Sekaran & Bougie, 2012).

Research instrument

The research instruments consisted of separate tools designed for managers and workers. Studied variables were derived from the major domains in a Conceptual Model of Community Nutrition Environments (Glanz *et al.*, 2005), which comprised policy, environmental and individual variables related to eating behaviour. This study also used semi-structured interviews with managers and a validated questionnaire with workers.

The questionnaire was developed by the researchers based on the Checklist of Health Promotion Environments at Worksites (CHEW) (Oldenburg *et al.*, 2002) and the Nutrition Environment Measures Survey in Stores (NEMS-S) (Glanz *et al.*, 2007). After receiving feedback and recommendations from the advisory committee, the Index of Item-Objective Congruence (IOC) was used to determine the content validity. The Cronbach's alpha values were 0.81 for eating practice, 0.84 for perception of support for nutrition in the workplace, 0.67 for attitude toward healthy eating, 0.87 for perception of social support, and 0.78 for knowledge on healthy eating practices.

The description of the instruments is shown in Table 1. There were two levels of measurement. Level 1 individual level measurement consisted of work characteristics, knowledge and attitude, social and environment support, and eating practice. Level 2 workplace level measurement consisted of policy and plan for nutrition promoting, worksite nutrition environment, healthy food choice in canteen, and manager's attitude toward nutrition.

Data collection

Data collection was carried out from March-June 2011. The researcher made the appointment with each factory

Table 1. Description of research instruments

Measurement items and description	*Coding*
Level 1 Individual level measurement	
Job type	manual = 1, non-manual = 0
Nutrition programme participation	yes = 1, no = 0
Work schedule	shift work = 1, non-shift work = 0
Knowledge	
• 10 items about Thai dietary guideline, nutrient content in food, and diet relating to chronic diseases.	correct = 1, incorrect = 0
Attitude toward diet and health	
• 10 items about foods and health	positive attitude = 1, negative attitude = 0
Social support	
• 14 items about social support for healthy eating habits, including families, co-workers or bosses, and health care providers.	never=0, sometimes=1, often=2, very often=3
Environment support	
• 12 items of supportive worksite food environments for healthy eating	very much = 3, moderate =2, little = 1, none = 0
Eating practice	
• 12 items about eating practices in the previous six months. The frequency of consuming of high fat, high sodium, and high sweet foods.	never or less than once/month = 6, 1 time/month = 5, 2-3 times/month = 4, 2-3 times/week = 3, 4-6 times/week = 2, once/day = 1, more than 2 times/day = 0
Level 2 Workplace level measurement	
Policy and plan for nutrition promoting	
• Having written policy regarding food and nutrition promotion	Written policy = 2, verbal policy = 1, no = 0
• 4 items of having plan, budget, staff responsibility, and nutrition activities	yes = 1, no = 0
Worksite nutrition environment	
• 16 items about canteen management, place to eat outside the canteen, information, food welfare, and supportive facilities	yes = 1, no = 0
Healthy food choice in canteen	
• 5 items about availability of 1) fresh fruit, 2) vegetable, 3) milk, 4) whole grain rice, and 5) healthy menu.	yes = 1, no = 0
Manager's attitude toward nutrition	
• 9 items about importance of food and nutrition promoting for employees	unsure=0, less important=1, moderate=2, important=3, very important=4

manager to ensure all selected subjects could participate in the research. The individual questionnaires were distributed to 969 workers in all the selected factories during their break time which was approximately 30 minutes. A total of 42 sets of questionnaires were excluded as the workers did not answer more than two parts of the questionnaire. Three workers did not meet the inclusion criteria (two lactating women and one student trainee). In total, 26 management persons and 924 workers were included in the study. The researcher conducted individual interviews with the management personnel who were responsible for health promotion activities. After the interviews, the researcher asked for permission to observe the canteen and other eating locations.

Statistical analysis

Descriptive statistical analysis was performed using the Mahidol University Licensed version 17.0 of the Statistical Package for the Social Sciences (SPSS) software package. In order to investigate the associations between workplace-level factors, individual-level factors, and workers' eating practices, the research team applied version 7.0 of the Hierarchical Linear and Nonlinear Modeling produced by Scientific Software International, Inc. The two-level HLM analyses followed guidelines contained in Raudenbush and Bryk's book and in the software manual (Raudenbush & Bryk, 2002). HLM is also referred to as mixed models, multilevel models, and random effect models (Raudenbush & Bryk, 2002). HLM was more suitable for analysing the shared variance of grouped data with the different levels of explanatory factors than the traditional regression models.

Ethical considerations

The research protocol was approved by the Mahidol University Ethics

Table 2. General information about participating factories and workers

Characteristics of factory (n=26)	*n*	*%*
Location of factory		
Bangplee district	3	11.5
Muang district	19	73.1
Phrapadaeng district	4	15.4
Size (number of employees at factory)		
<100	2	7.7
100-499	11	42.3
500-1000	8	30.8
>1000	5	19.2
Labour union		
With labour union	10	38.5
Without union labour	16	61.5
Characteristics of the workers (*n*= 924)		
Male	402	43.5
Female	522	56.5
Age (year)		
<20	22	2.4
21-30	208	22.5
31-40	361	39.1
41-50	227	24.6
>50	106	11.5

Committees for Human Research in the Faculty of Public Health, (Reference Number: *MUPH 2011-012*). All participants were informed about the research objectives, procedures, and their human rights. Consent forms with a brief description of the study were distributed to all participants. They were asked to sign and return the consent forms to the researchers before data collection.

RESULTS

Background description of 26 managers and 924 workers are shown in Table 2. About half of the participants were manual workers (52.8%), and some of them engaged in shift work (27.4%).

Table 3 provides a summary of the descriptive results of both the outcome and the independent factors that were included in the 2-Level Hierarchical Linear Model. The mean score of eating practice was 46.75, with 35.2% of the participants had very low score of eating practice. This finding indicates that most of participants had poor eating practices. A relatively small percentage of workers had participated in nutrition programmes (17.6%). Knowledge level about healthy eating habits was moderate (Mean±SD=6.07±1.87). The participants had good attitude on healthy eating as the average score was 7.60±1.80. The perception scores of workers about the social and environment support in the worksite for nutrition were quite low (19.19±7.61, 15.19±6.50, respectively). The result was consistent with the incidence of policies and plans for nutrition promotion were quite low (1.31±1.67).

The two-level hierarchical linear model evaluated the associations of level 2 or workplace level factors and level 1 or individual level factors on worker's eating practices. This study found that the null model showed significant variations in workplace means τ_{00}=3.47, p<0.001) indicating that the average eating practice score varied significantly

Table 3. Descriptive results of outcomes and the independent factors in a two-level hierarchical linear model

Factors	*Mean*	*%*	*SD*	*Min*	*Max*
Eating practice score†	46.75		10.43	3	70
Very low (0-15)		35.2			
Low (16-30)		26.7			
Moderate (31-45)		23.6			
High (46-72)		14.5			
Individual level					
Job type (manual workers)		52.8			
Have experience of nutrition programme participation		17.6			
Work schedule (shift workers)		27.4			
Knowledge	6.07		1.87	0	10
Attitude toward diet and health	7.60		1.80	0	10
Perception of social support	19.19		7.61	0	42
Perception of worksite environment support	15.19		6.50	0	36
Workplace level					
Policy and plan for nutrition promoting	1.31		1.67	0	6
Worksite nutrition environment	10.12		2.86	5	16
Healthy food choice in canteen	2.54		0.99	0	4
Manager's attitude toward nutrition	29.19		3.42	24	36

†Range score 0-72 for eating practice

across the factories. The intra-class coefficient (ICC) of 0.32 indicates that about 32% of the total variability in eating practices could be attributed to the workplace. Meanwhile 17% of eating practice variance could be explained by the factors at the individual level.

As seen in Table 4, at the individual level, there was significant association with the worker's attitude towards diet and health (*b*=48.67, *SE*=1.71). At the workplace level, the average eating practice scores varied significantly among the 26 participating factories by an estimated intercept of 49.06 (*SE*=2.02). Other variables that had no significant effect on the eating practices of workers included workplace policy, the attitude of management, the availability of healthy food choices in the canteen, and the worksite nutrition environment. The cross-level interaction showed negative and statistically significant associations between healthy food choice in the workplace canteen, and between individual's attitude and eating practice ($p<0.01$). There was a positive interaction between worksite nutrition environment and the attitude about diet and health of employees and eating practice ($p<0.01$).

DISCUSSION

In previous studies, workplace factors that were linked to improved eating habits of workers included food-related policies, health and nutrition promotion, creating a supportive nutrition environment, and offering healthy foods in the workplace canteen (Bandoni *et al.*, 2011; Mache *et al.*, 2010; Quintiliani, Poulsen & Sorensen, 2010; Risica *et al.*, 2018). However, this study did not find a similar influence of the workplace. The contrast between the results of our study and others may be attributable to the differences in research designs.

Attitude is one psychosocial determinant of eating more fruit, vegetables and less fat (Risica *et al.*, 2018). This study found similar results

Table 4. Two-level hierarchical linear models of the workplace and individual level predictors of factory workers' eating practices

Variables	*b*	*SE*	*t-ratio*
Level 1 (individual level)			
Intercept	48.67**	1.71	28.52
Job type	-1.18	0.70	-1.70
Nutritional knowledge	-0.13	0.21	-0.63
Attitude towards diet and health	1.67**	0.22	7.44
Perception of social support	0.08	0.04	1.77
Perception of worksite environment support	0.01	0.08	0.14
Attending nutrition programme	0.16	0.89	0.18
Work shift	-0.04	0.68	-0.06
Level 2 (Workplace level)			
Intercept	49.06**	2.02	24.34
Policy	0.38	1.49	0.25
Manager's attitude	0.01	0.67	0.02
Healthy food choice in canteen	1.50	2.68	0.56
Worksite nutrition environment	-1.12	1.05	-1.06
Cross-level			
Healthy food choice in canteen and manager's attitude	-0.92**	0.30	-3.11
Worksite nutrition environment and manager's attitude	0.35**	0.11	3.06

**p-value<0.001

as the study by Naughton *et al.* (2015), which revealed that personal attitudes were significant predictors of healthy eating among adults.

This study's finding of a negative association between availability of healthy food in the canteen and positive attitude of the workers and lower frequency of purchasing canteen food should be interpreted with caution.

This study focused on studying food items sold in canteen but not outside the factories. Monsikarn (2015) found that workers who were not restricted from purchasing food from nearby food stalls outside the factories were likely to consume less healthy foods. An explanation why the workers preferred to eat food outside the factory despite having more healthful food options in the factory canteen could be due to the preference for the tastes of outside food (Aggarwal *et al.*, 2016; Monsikarn, 2015).

The finding of a positive statistically significant cross-level interaction of the workplace nutrition environment and the worker attitude and the eating practice appears to suggest that the higher the supportive nutrition environment score and attitude score, the less frequent the consumption of unhealthy foods. This result is similar to the finding by Watkins *et al.* (2008), who found that the employee's food choices were significantly influenced by their perception of the food quality in the workplace and time constraints. In addition, previous studies pointed out that the barriers to healthy eating include a lack of facilities to prepare, cook and store healthy foods (Nicholls *et al.*, 2017). Having good attitude towards healthy eating can be enhanced by creating a healthy food environment in the workplace (Glanz *et al.*, 2005).

Limitations and strengths

The limitations of this research include: the use of a non-probability sampling method, which may limit representativeness of the samples. Secondly, data about the perceptions of both management personnel and workers were determined using subjective criteria. Thirdly, limitations include recall bias for assessment of eating practice for the past six months and lack of confounding adjustment.

The major strengths of the research are that, to the best of our knowledge, this is the first study to use a multilevel modelling approach to examine multiple level factors relating to the eating practices of Thai factory workers.

CONCLUSION

Eating habits are influenced by multiple factors related to both workplace and individual levels. Strategies to promote healthy eating among factory should include two key elements:

i) Improve motivation of employees to consume healthful and tasty food options in the workplace canteen, and
ii) creating an environment in the workplace that is supportive of nutrition and healthy eating practices.

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Authors' contributions

CP wrote the manuscript; KJ offered final approval of the version to be submitted and any revised version; SS drafted the article and revising it critically for important intellectual content; AS supported in the data collection and revising it

critically for important intellectual content; WS analysed the data and revising it critically for important intellectual content.

Conflict of interest

There was no conflict of interest in this study.

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Application and validation of the weight efficacy lifestyle (WEL) questionnaire among type 2 diabetes mellitus patients in Malaysia

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ABSTRACT

Introduction: Self-efficacy for eating predicts successful weight loss and maintenance in Type 2 Diabetes Mellitus (T2DM) individuals. The Weight Efficacy Lifestyle (WEL) questionnaire determines self-efficacy for controlling eating. This study aims to validate the Malay-translated version of the WEL questionnaire and to establish the cut-off scores to define the level of eating self-efficacy in Malaysian T2DM individuals. **Methods:** A total of 334 T2DM individuals, aged 55.0±9.0 years, were recruited from a primary healthcare clinic based on sampling ratio. Medical records were reviewed for eligibility. Inclusion criteria included BMI ≥23kg/m^2, and no severe diabetes complications. The WEL questionnaire assessed eating resistance during negative emotions, food availability, social pressure, physical discomfort and positive activities, and was back translated into Malay language. Self-efficacy was rated on a 0-9 scale with higher WEL scores indicating greater self-efficacy to resist eating. Factor analysis established the factor structure of the WEL questionnaire. Inter-item and item-total correlations determined construct validity while internal consistency described the reliability of the structure. **Results:** A two-factor structure accounting for 49% of variance was obtained, and it had adequate reliability, as indicated by Cronbach's α of 0.893 and 0.781 respectively. Item-total correlations of r>0.700, p<0.01 and inter-item correlations of r<0.500, p<0.01 demonstrated construct validity. Cut-off scores of ≥44 and ≥32, respectively for factor one and two defined high eating self-efficacies in T2DM individuals. **Conclusion:** The Malay-translated version of the WEL questionnaire appears to be a valid and reliable tool to assess self-efficacy for controlling eating behaviour in Malaysian T2DM population.

Keywords: Diabetes, eating self-efficacy, Malay, reliability, validity

INTRODUCTION

The World Health Organization (WHO) reported that the prevalence of Type 2 Diabetes Mellitus (T2DM) and impaired glucose tolerance are rising at an alarming rate in South East Asia (WHO, 2011). The recent National Health and

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Morbidity Survey (NHMS) in Malaysia reported the prevalence of T2DM has increased to 17.5% as compared to 11.6% in 2006 and this is in tandem with the rise in obesity (NHMS, 2015). The National Diabetes Registry 2009-2012, showed 83.4% of Malaysian T2DM individuals were obese (Feisul & Azmi, 2013) and abdominal obesity was prevalent in 75% of the individuals (Zaki *et al.*, 2010).

It is well established that successful weight loss measures are through lifestyle changes such as diet and exercise (Chee *et al.,* 2017; Carels *et al.*, 2005). However, self-efficacy skills can influence an individual's motivation and capability to sustain the healthy lifestyle behavioural changes (Batsis *et al.*, 2009; Ames *et al.*, 2015). The concept of self-efficacy is central to Bandura's social cognitive theory which contends that behaviour is strongly stimulated by self-influence (Bandura, 1977). Self-efficacy relates to the ability of performing a certain task to attain certain goals even in difficult situations (Bandura, 1982). Several studies showed that higher baseline eating self-efficacy predicts greater weight loss during intervention and maintenance (Clark *et al.*, 1996; Martin, Dutton & Brantley, 2004; Bas & Donmez, 2009). This in turn led to higher diabetes treatment satisfaction and better glycaemic control (Chih *et al.*, 2010; Al-Khawaldeh, Al-Hassan & Froelicher, 2012).

One frequently used tool to measure eating self-efficacy is the Weight Efficacy Lifestyle (WEL) questionnaire developed by Clark and colleagues (Clark *et al.*, 1991). The questionnaire has been shown to be easy to use and a valid and reliable measure of eating self-efficacy (Ames *et al.*, 2015; Dutton *et al.*, 2004). The original factor analysis of the WEL indicated eating self-efficacy was best characterised by five situational factors which includes negative emotions, availability, social pressure, physical discomfort, and positive activities (Clark *et al.*, 1991). Thus far, the WEL validation studies reported internal consistency of Cronbach's α 0.700-0.900 in Caucasian population (Clark *et al.*, 1991) and African-American population (Dutton *et al.*, 2004). Recently, the short version of WEL questionnaire (WEL-SF) was developed (Ames *et al.*, 2012), and it has also demonstrated adequate internal consistency with Cronbach's α of 0.920 (Ames *et al.*, 2015). The WEL questionnaire has also been validated in a Norwegian population (Flolo *et al.*, 2014)

In Malaysia, the WEL questionnaire was used in a study among rural natives but it did not report a complete psychometric methodology (Chang, 2007). Hence, we aim to determine the factor structure, validity and reliability of the WEL questionnaire in Malaysian T2DM individuals and to determine the appropriate cut-off scores to define the level of eating self-efficacy applied to the study sample.

MATERIALS AND METHODS

Design, recruitment and settings

This cross-sectional study was conducted in a Primary Care Clinic, in Seremban, an urban township in Peninsular Malaysia. Individuals who were aged 30-65 years with T2DM, and were also overweight or obese with body mass index (BMI) of ≥23 kg/m² were recruited. Individuals diagnosed with Type 1 Diabetes Mellitus, Gestational Diabetes Mellitus, pregnant or lactating and with severe diabetes complications were excluded. A minimal sample size of 200 individuals was required to perform the factor analysis taking into consideration sample to variable ratio. A ratio of at least 10 individuals to each variable is desirable for factor analysis (Pett, Lackey & Sullivan, 2003). However,

in this study 334 individuals were recruited considering the Tabachnick's rule of thumb that suggests having at least 300 individuals for factor analysis (Tabachnick & Fidell, 2013). During recruitment, the T2DM individuals' list was reviewed from the register book available in the clinic. Individuals who did not fit the inclusion criteria were omitted from the list. Thereafter, the medical records were assessed for further eligibility for recruitment. Contact details of T2DM individuals who fulfilled the selection criteria were obtained. The eligible individuals were contacted through the phone for verbal consent after an explanation on the study objectives and procedure were given. Individuals who expressed interest to participate in the study were scheduled to come to the clinic for screening and face-to-face interview for the study.

Ethical approval was obtained from the Joint Committee for Research and Ethics, International Medical University (project number: BN&D I01/2012(10)2014) and the Ethics Committee of the Ministry of Health Malaysia (project number: NMRR-14-1042-19455). Recruited individuals provided written informed consent prior to study initiation and their anonymity was maintained.

Assessment measure

The weight efficacy lifestyle questionnaire

The WEL questionnaire is a 10-point Likert scale ranging from 0 (not confident) to 9 (very confident) to resist the desire to eat. The WEL yields five subscales scores ranging from 0-36 and a global sum of the subscales ranging from 0-180. The negative emotions subscale included questions about eating restraint while anxious, depressed, angry, and feelings of failure. The availability subscale assesses a person's ability to control or resist poor eating habits on the weekends, when different foods are available, during a party, and knowing when certain high-calorie foods are around. The social pressure subscale focuses on resisting eating when in need of saying "no to others", impolite to refuse a second helping, when others are pressuring to eat and resisting eating even when others may be upset. The physical discomfort focuses on resisting eating during times of bodily discomfort, fatigue, headache, or a rundown feeling. Lastly, the positive activities subscale assesses resistance to eat when watching television, while reading, before going to bed, or in a happy mood. Higher WEL scores indicate a higher self-efficacy to resist eating.

Procedure

Translation of questionnaire into Malay language

The translation and adaptation of the WEL questionnaire conformed to the recommendation by WHO (World Health Organization, 2007). The WEL questionnaire was translated into the Malay language and blinded back-translated into English by a group of investigators who were native speakers of Malay language. The Malay-language WEL questionnaire was compared with the English-version for identifying inadequate concepts or expressions. Subsequently, the original version and translated version was compared for conceptual equivalence of the items. The final version of the Malay language- WEL questionnaire was pre-tested in a small subset (n=30) of overweight and obese T2DM individuals independent of the study.

Socio-demographic and medical history

A general questionnaire was administered to collect information regarding the socioeconomic background, anthropometry, biochemical measures and medical history of the individuals.

Data analysis

Data was analysed using the Statistical Package for Social Science version 22 (SPSS Inc; Chicago, IL, USA). The data was checked for normality and presented as mean ± standard deviation (SD) for parametric distribution and as median ± interquartile range (IQR) for non-parametric distribution. Characteristics of study individuals were described using descriptive statistics.

Items selection for scale construction

Spearman-rho correlation was performed to determine the items to be selected for scale construction. Items were selected after having full-filled the criteria for item-total correlation coefficient of $r>0.700$ and inter-item correlation coefficient of $r<0.800$. Items were eliminated if individuals have low variability in response rate for the items and if the items failed to fulfil the selection criteria.

Scale properties and factor structure

The principal component factor analysis using varimax rotation was performed to determine the scale properties and factor structure of the WEL questionnaire upon elimination of items. The criteria that were used to determine how many factors to be retained were the Kaiser criterion, which selects those factors that have eigenvalues greater than one, observation of an "elbow" in the corresponding scree plot, and parallel analysis.

Reliability of the factor structure

The internal consistency reported as Cronbach's α was used to examine the reliability of the factor structure. A Cronbach's α of greater than 0.700 was considered desirable.

Convergent and discriminant validity

Convergent and discriminant validity are subsets of construct validity. Convergent validity refers to the degree to which two measures of construct that theoretically should be related are indeed related. This means that the variables within a single factor are highly correlated. The convergent validity was established by item-total correlation (Spearman-Rho) of individual items with the total score of the respective factor structure.

Discriminant validity refers to items that are supposed to be unrelated are indeed unrelated. This means that the variables within the factor structure are distinct and have correlation coefficients not exceeding 0.700 (a low to moderate correlation is often considered evidence of discriminant validity). Discriminant validity was established by inter-item correlation (Spearman-Rho) between items in their respective factor structures.

Determining the cut-off scores for the instrument without a gold-standard

The procedure used was applicable for items in a Likert scale (Barua, 2013; Barua *et al.*, 2014). The weightage of each response of each item is directly proportional to the Discrimination Index as well as Cronbach's α. Hence, the weighted score for reach response of each item is obtained by calculating the Observed Item Score multiplied by the product of Discrimination Index and Cronbach's α. The "Correction Factor" is calculated by the ratio of the total weighted score and the total raw score. The cut-off score of the instrument is obtained by multiplying the "Correction Factor" with the 75^{th} percentile of each item and summing them up together.

(1) Calculation of Discrimination Index (DI) of individual item
   = *Spearman-Rho Correlation Coefficient*
(2) Weightage of each response of each item of the questionnaire
   = *(Observed Item Score) X (Discrimination Index) X (Cronbach's α)*

(3) Correction Factor = *[(Total Weighted Score) / (Total Raw Score)]*
(4) The cut-off score of an instrument without a gold standard
= *Sum [(75th Percentile from Raw Score per Item) X (Correction Factor)]*

RESULTS

Characteristics of the study population

Table 1 shows the characteristics of the study population. A total of 334 T2DM individuals comprising 60% women and 40% men completed the study. The recruited individuals had a median age of 55.0±9.0 years. The majority of the participants were Indians (*n*=175, 52%), followed by Chinese (*n*=112, 34%) and Malays (*n*=47, 14%). Majority attained primary (*n*=106, 32%) or secondary (*n*=172, 51%) level of education, while some had no formal schooling (*n*=20, 6%) or attained tertiary level of education (*n*=36, 11%). Approximately 50% of individuals were living with diabetes for duration of 5-10 years and only 16% individuals had diabetes for more than 10 years. A combination of diabetes,

Table 1. Characteristics of the total population (*N*=334)

Variables	*n (%)*	*Mean±SD*	*Mdn±IQR*
Gender			
Men	132 (40)		
Women	202 (60)		
Ethnicity			
Malays	47 (14)		
Chinese	112 (34)		
Indians	175 (52)		
Education level			
None	20 (6)		
Primary	106 (32)		
Secondary	172 (51)		
Tertiary	36 (11)		
Duration on diabetes			
<5 years	112 (34)		
5-10 years	167 (50)		
>10 years	55 (16)		
Comorbidities			
DM	18 (5)		
DM and HPT	50 (15)		
DM and DYS	37 (11)		
DM, HPT and DYS	129 (39)		
DM, HPT, DYS and CVD	63 (19)		
Others†	37 (11)		
Age (years)			
Range: 28-73 years			55.0±9.0
Weight (kg)			74.6±16.8
Body mass index (kg/m²)			29.0±6.2
Waist circumference (cm)		100.8±11.5	
HbA1c (%)			7.8±1.4

Abbreviations: DM, diabetes mellitus; HPT, hypertension; DYS, dyslipidaemia; CVD, cardiovascular disease
All data is expressed in frequency (percentage individuals) unless stated otherwise
†Others include diabetes with combination of diseases such as liver disease, hypothyroidism, gout, hypocalcaemia, gastritis, asthma, nephropathy, retinopathy and neuropathy

hypertension and dyslipidaemia was the most common co-morbidity (*n*=139, 39%). Median BMI was of 29.0±6.2 kg/m² and median HbA1c level was of 7.8±1.4%.

Validation of the questionnaire

Items selection for scale construction

Item 8 "I can resist eating even when I feel impolite to refuse a second helping" from the social pressure subscale (r=0.672, p<0.01) and item 10 "I can resist eating when I am reading" from the positive activities' subscale (r=0.245, p<0.01) displayed item-total correlation of r<0.700. Moreover, the inter-item correlation coefficient of item 8 ranged from 0.413 to 0.782 and for item 10 ranged from 0.056 to 0.409. Therefore, in considering clinical judgement of low response rate and low item-total correlation of items 8 and 10, these items were eliminated.

Scale properties and factor structure

Table 2 shows the factor structure obtained for the 18-items translated WEL questionnaire. Factor analysis revealed that a two-factor structure was the most reasonable whereby a distinct "elbow" in the scree plot was observed at the eigenvalue that was second largest in magnitude. There was a dramatic decrease in magnitude from the largest eigenvalue (6.203) to the second largest eigenvalue (2.622). The remaining eigenvalues were 1.182 and 1.023 or less in magnitude. The number of

Table 2. Factor structure of the 18-item weight efficacy lifestyle questionnaire

Items	*Factor 1*	*Factor 2*
Availability		
2. I can control my eating on weekends	0.712	
7. I can resist eating even when there are different kinds of food available	0.747	
12. I can resist eating even when I am at a party	0.770	
17. I can resist eating even when high calorie foods are available	0.658	
Social pressure		
3. I can resist eating when I have to say 'no' to others	0.737	
13. I can resist eating even when others are pressuring me to eat	0.818	
18. I can resist eating even when I think others will be upset if I don't eat	0.776	
Positive activities		
5. I can resist eating when I am watching TV	0.523	
15. I can resist eating just before going to bed	0.532	
20. I can resist eating when I am happy	0.748	
Physical discomfort		
4. I can resist eating when I feel physically run down	0.480	
Negative emotions		
1. I can resist eating when I am anxious (nervous)		0.445
6. I can resist eating when I am depressed (or down)		0.684
11. I can resist eating when I am angry (or irritable)		0.640
16. I can resist eating when I have experienced failure		0.650
Physical discomfort		
9. I can resist eating when I have a headache		0.799
14. I can resist eating when I am in pain		0.753
19. I can resist eating when I feel uncomfortable		0.605

Extraction method: principal component analysis. Rotation Method: varimax
Factor loadings of ≥0.400 were retained

Table 3. Convergent validity (item-total correlation) and reliability (Cronbach's α) of the 18-item weight efficacy lifestyle questionnaire

Items	*Factor 1*		*Factor 2*	
Overall Cronbach's **α**	0.893		0.781	
	Cronbach's **α** if item deleted	Item-total correlation (r)†	Cronbach's **α** if item deleted	Item-total correlation (r)†
2. I can control my eating on weekends	0.883	0.719*		
3. I can resist eating when I have to say 'no' to others	0.880	0.712*		
4. I can resist eating when I feel physically run down	0.891	0.511*		
5. I can resist eating when I am watching TV	0.892	0.547*		
7. I can resist eating even when there are different kinds of food available	0.880	0.737*		
12. I can resist eating even when I am at a party	0.878	0.773*		
13. I can resist eating even when others are pressuring me to eat	0.876	0.784*		
15. I can resist eating just before going to bed	0.892	0.588*		
17. I can resist eating even when high calorie foods are available	0.886	0.632*		
18. I can resist eating even when I think others will be upset if I don't eat	0.879	0.733*		
20. I can resist eating when I am happy	0.880	0.749*		
1. I can resist eating when I am anxious (nervous)			0.806	0.622*
6. I can resist eating when I am depressed (or down)			0.736	0.716*
9. I can resist eating when I have a headache			0.731	0.638*
11. I can resist eating when I am angry (or irritable)			0.764	0.597*
14. I can resist eating when I am in pain			0.735	0.647*
16. I can resist eating when I have experienced failure			0.748	0.656*
19. I can resist eating when I feel uncomfortable			0.755	0.536*

†Item-total correlation is presented as Spearman-Rho correlation coefficient (r)
*Data significant at $p<0.01$

Table 4. Discriminant validity (inter-item correlation) of individual items of the 18-item weight efficacy lifestyle questionnaire

Factor 1	*Item 2*	*Item 3*	*Item 4*	*Item 5*	*Item 7*	*Item 12*	*Item 13*	*Item 15*	*Item 17*	*Item 18*	*Item 20*
Item 2	1.000	0.431*	0.338*	0.376*	0.513*	0.543*	0.463*	0.324*	0.448*	0.431*	0.532*
Item 3		1.000	0.416*	0.238*	0.505*	0.469*	0.697*	0.386*	0.323*	0.652*	0.443*
Item 4			1.000	0.262*	0.373*	0.362*	0.373*	0.277*	0.265*	0.364*	0.313*
Item 5				1.000	0.272*	0.371*	0.368*	0.349*	0.318*	0.320*	0.399*
Item 7					1.000	0.653*	0.526*	0.333*	0.405*	0.514*	0.550*
Item 12						1.000	0.544*	0.336*	0.465*	0.504*	0.564*
Item 13							1.000	0.426*	0.441*	0.723*	0.524*
Item 15								1.000	0.379*	0.341*	0.403*
Item 17									1.000	0.403*	0.479*
Item 18										1.000	0.506*
Item 20											1.000
Factor 2	*Item 1*	*Item 6*	*Item 9*	*Item 11*	*Item 14*	*Item 16*	*Item 19*				
Item 1	1.000	0.429*	0.248*	0.237*	0.180*	0.315*	0.128*				
Item 6		1.000	0.404*	0.295*	0.399*	0.418*	0.325*				
Item 9			1.000	0.595*	0.477*	0.275*	0.316*				
Item 11				1.000	0.486*	0.336*	0.222*				
Item 14					1.000	0.410*	0.475*				
Item 16						1.000	0.325*				
Item 19							1.000				

All data presented as Spearman Rho correlation coefficient (r)
*Data significant at $p<0.01$

factors to be retained was further confirmed by parallel analysis, which also suggested a two- factor solution. The two-factor structure accounted for 49% of the variance. Kaiser-Meyer-Olkin of sampling adequacy was 0.890 and Bartlett's test of sphericity was significant (χ^2 = 2582.8, p<0.001). Eleven items were loaded onto factor one and seven items were loaded onto factor two in the final solution where all the factor loadings were greater than 0.40. For comparison with the Clark and colleagues' validation study (Clark *et al.*, 1991), five factors were forced into the model. The results were not replicated in this study.

Convergent and discriminant validity and reliability

Item-total correlation coefficient of individual items of factor one and factor two were well above r>0.500 (Table 3). There was a high significant (*p<0.01) positive correlation of items in factor one and factor two with their respective total scores indicating high convergent validity. The reliability for the obtained factor structures was indicated by Cronbach's α of 0.893 for factor one and Cronbach's α of 0.781 for factor two. None of the individual Cronbach's α values after item deletion were found to be more than the overall Cronbach's α value for factor one and factor two.

In Table 4, the inter-item correlation coefficient of items within the factor structure was low to moderate with r<0.500. The low to moderate correlation coefficients possesses discriminant quality within the individual items of the factor structure. The difference in the discrimination power of each of these items was also statistically significant (p<0.01).

Cut-off scores of the instrument

The weighted score of the 18-items translated WEL questionnaire calculated by applying equations (1) and (2) in the methodology section. The total weighted score was 21187.2 while the total raw score was 38303.0. Correction factor obtained was 0.55 by applying equation (3) into the calculation.

Table 5 shows the cut-off score set for decisions on low and high levels of eating self-efficacy. Based on the crude mid-value of the minimum and maximum scores possible for factor one and factor two, scores of 50 and 32, respectively were generally to be used to define the levels of eating self-efficacy. However, by applying equation (4), the calculations revealed that the cut-off score for identification of high level of eating self-efficacy should be readjusted to 44 for factor one and 32 for factor two. The interpretation follows that if the overall score of any individual is <44 for factor one and <32 for factor two, then the person should be considered to have low eating self-efficacy level.

DISCUSSION

A two-factor structure of the translated 18-items WEL questionnaire was obtained after excluding item 8 "I can resist eating even when I feel impolite to refuse a second helping" from the social pressure subscale and item 10 "I can resist eating when I am reading" from the positive activities subscale. Low item-total correlation coefficients for items 8 and 10 suggest these items should be eliminated given their low psychometric quality. Moreover, these items were excluded as 75% of study individuals claimed they did not take a second helping to keep their blood glucose level under control, while 99% T2DM individuals claimed that they did not read while eating. Upon eliminating these items, the internal consistency improved by 5% for social pressure subscale (Cronbach's α improved from 0.844 to 0.887) and positive activities

Table 5. Calculation of cut-off value for measurement of high self-efficacy to resist eating for the 18-item weight efficacy lifestyle questionnaire

Factor 1	*Median (50^{th} Percentile)*	*75^{th} Percentile*	*Correction Factor (CF)*	*(75^{th} Percentile) X CF*
Item 2	6	7	0.55	3.85
Item 3	7	7	0.55	3.85
Item 4	7	8	0.55	4.40
Item 5	7	8	0.55	4.40
Item 7	5	7	0.55	3.85
Item 12	5	7	0.55	3.85
Item 13	7	7	0.55	3.85
Item 15	7	8	0.55	4.40
Item 17	5	7	0.55	3.85
Item 18	7	7	0.55	3.85
Item 20	5	7	0.55	3.85
Score range = 0-99				
Adjusted cut-off value				44
Crude mid-value				50
Factor 2	*Median (50^{th} Percentile)*	*75^{th} Percentile*	*Correction Factor (CF)*	*(75^{th} Percentile) X CF*
Item 1	7	8	0.55	4.40
Item 6	7	8	0.55	4.40
Item 9	8	9	0.55	4.95
Item 11	8	9	0.55	4.95
Item 14	8	8	0.55	4.40
Item 16	8	8	0.55	4.40
Item 19	7	8	0.55	4.40
Score range = 0-63				
Adjusted cut-off value				32
Crude mid-value				32

subscale (Cronbach's α improved from 0.589 to 0.646).

Interestingly, the two-factor structure obtained in this study may help differentiate eating self-efficacy level in two different situations, i.e. positive and negative. Items loaded onto factor one can be reckoned to differentiate eating self-efficacy in positive situations. Items in factor one consists of all items of the availability subscale (items 2, 7, 12 and 17), 3 items of social pressure subscale (items 3, 13 and 18), 3 items of positive activities subscale (items 5, 15 and 20) and item 4 of the physical discomfort subscale "I can resist eating when I am physically run down" (see Table 2). Combining resisting eating when feeling tired onto factor one is sensible as it may simply mean abundant food availability even when tired. Items loaded onto factor two can be reckoned to differentiate eating self-efficacy in negative situations. These items include all items of the negative emotions subscale (items 1, 6, 11 and 16) and remaining three items of physical discomfort subscale (items 9, 14 and 19). Compared to the original five-factor solution that consisted of four-items in each subscale, the new

two-factor structure showed a clear demarcation of items assessing eating self-efficacy when individuals are in positive environment (11 items) and as well as negative environment (7 items) (Table 2).

The distinct categorisation of adequate items to assess eating self-efficacy in these two tempting situations, may provide a global assessment and overall view of an individual's confidence level to resist eating when experiencing positive or negative situations. Assessing eating self-efficacy in T2DM individuals is essential to better manage their weight and glycaemic control (Chih *et al.*, 2010; Al-Khawaldeh, Al-Hassan & Froelicher, 2012). Understanding and knowing in which tempting situations eating self-efficacy level of T2DM individuals is either higher or lower, can help healthcare providers target individualised patient education to motivate and build their confidence into making successful dietary and lifestyle changes (Strychar, Elisha & Schmitz, 2012). Evidences showed that T2DM individuals with higher self-efficacy, had higher motivation to initiate behaviour changes (Chih *et al.*, 2010; Al-Khawaldeh, Al-Hassan & Froelicher, 2012; Strychar, Elisha & Schmitz, 2012).

The two-factor solution had good item-total correlation and inter-item correlation providing evidence in support of construct validity. Obtaining item-total correlation coefficient of $r>0.700$ simply means that these items belong to their respective construct and all these items should be retained providing evident of convergent validity. The factor analysis also revealed that the items were related to their respective construct. The low to moderate inter-item correlation coefficients showed that the items were independent of each other and clearly distinct. This provided evident of high discriminant validity. The internal consistency of the two-factor structure was also good and none of the individual Cronbach's α values after item deletion were found to be more than the overall Cronbach's α values of 0.893 (factor one) and 0.781 (factor two). Hence, all items of the Malay-translated WEL questionnaire were considered important and should be retained in this questionnaire for screening purposes.

This study's finding was consistent with the findings of other validation studies conducted on overweight or obese individuals where Clark and colleagues reported Cronbach's α ranging from 0.700 to 0.900 (Clark *et al.*, 1991), while Dutton and colleagues obtained Cronbach's α ranging from 0.690 to 0.840 (Dutton *et al.*, 2004). This validation study used the Malay-translated WEL questionnaire despite higher percentage of the T2DM individuals being non-Malays (86%). This did not affect the validation of the instrument as supported by the validity and high reliability of the instrument. This study was conducted in a governmental primary care clinic, in which Malay was the primary language for communication. Furthermore, the majority of the studied population were also either primary (32%) or secondary (51%) educated, who predominantly conversed in Malay rather than English or other languages with their healthcare providers. These individuals had a better understanding of the items in the Malay-translated WEL questionnaire and preferred to be interviewed in Malay.

The cut-off scores were determined using the Discrimination Index. This was because a basic consideration in evaluating the performance of a test instrument is the degree to which it discriminates between high and low responses (Barua, 2013; Barua *et al.*, 2014). Furthermore, the median and interquartile range of 75th percentile was considered as minimum cut-off for positive scoring scale in this study as the responses of the study population was

skewed and a low correction factor of less than 0.75 was obtained (Barua, 2013; Barua *et al.*, 2014). This study revealed that the cut-off score for defining high eating self-efficacy in positive situations (factor one) to be set at score ≥44 as opposed to the crude value of ≥50 while the cut-off score in negative situations (factor two) to be set at ≥32 same as the crude value. The adjustment of the cut-off scores was necessary considering the random variance of the population. Previously, no cut-off scores have been proposed to define the level of eating self-efficacy. In clinical and research settings, obtaining quantifiable information regarding eating self-efficacy is useful in screening programs. Results of quantifying the level of eating self-efficacy may provide information regarding individual's strength and weakness and this information can be used to assess performance of an intervention method or disease progress over time (Barua, 2013; Barua *et al.*, 2014).

This study failed to replicate the five-factor solution proposed in the original publication of Clark *et al.*, (1991). When five factors were included into the model, there was disagreement between the results of the present study and those of the original study. In our study, only the two-factor structure of the WEL-questionnaire was valid compared to the original five factor solution. This could be explained by socio-cultural differences of the population studied, as the original questionnaire was conducted amongst obese Caucasians. Similarly, studies conducted amongst Norwegians (Flolo *et al.*, 2014), African-Americans (Dutton *et al.*, 2004) and Turkish population (Bas & Donmez, 2009), did not replicate all the five-factor solution in assessing WEL. Geographic locations, socioeconomic status and food availability may also impact eating behaviour (Drewnowski & Kawachi, 2015).

A limitation of the study is that, as the questionnaire was not repeated amongst the T2DM individuals, the stability of the questionnaire over time could not be ascertained. The cut-off scores to define the level of eating self-efficacy were calculated without a gold-standard reference. Hence, future studies may include gold-standard instruments as reference to examine the sensitivity and specificity of the obtained cut-off scores. This was a questionnaire-based survey that may have a high response bias. Nevertheless, all interviews with the T2DM individuals were conducted face-to-face by the investigator to limit the response bias. Furthermore, this validation study was conducted amongst the T2DM individuals, thus, limiting its generalisability. This study used the original instead of the short version of WEL questionnaire as it was crucial to determine which of the 20 potential items psychometrically suited the studied population.

CONCLUSION

The 18-item Malay-translated WEL questionnaire was found to be a valid and reliable tool to measure self-efficacy for controlling eating behaviour in research and clinical settings among the Malaysian overweight and obese T2DM population. This study demonstrated that cut-off scores of ≥44 and ≥32, respectively may help discriminate individuals with high eating self-efficacy in positive (factor one) and negative (factor two) situations. The current findings suggest quantifying and defining the level of eating self-efficacy is essential in clinical settings for screening and diagnosing purposes. Health care professionals should consider measuring eating self-efficacy in overweight and obese individuals with diabetes, as it may provide insights about lack of confidence for controlling eating behaviour and readiness to

engage in behavioural change and thus, target those problem areas in weight loss interventions.

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Authors' contributions

All authors read and approved the final manuscript. HKGS, was involved in data collection and analysis, data interpretation and writing of the manuscript. VLKM, provided input on intellectual content of critical importance to the work described and editing of the manuscript. AB, was involved in data analysis and interpretation, provided input on intellectual content of critical importance to the work described and editing of the manuscript. SZMA, provided intellectual content of critical importance to the work described and editing of the manuscript. WCSS, was involved in conception and design of the study, data analysis and interpretation, editing and writing of the manuscript.

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Development and validation of a nutrient profiling model for Malaysian older population

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ABSTRACT

Introduction: Nutrient profiling is the science of ranking food based on the nutrient content that enables an individual to make healthier food choice without exceeding the daily energy recommendation. This study was aimed at developing and validating a nutrient profiling model for Malaysian older population. **Methods**: A total of six nutrient profiling models comprising different combinations of nutrients were developed. Each model was tested by scoring 94 food items in terms of 100 kcal and 100 g, and the Recommended Nutrient Intakes for Malaysian (2017) as the reference value. The scores in each model were correlated with energy density per 100 g of food. The best model to correctly rank food according to nutrient density was chosen for validation. Validation was done by comparing the healthiness classification of 174 food items as determined by Towards Useful Aging Food Nutrient Density Index (TUA FNDI) nutrient profiling model and the Malaysian Dietary Guidelines. **Results:** Models with sodium and total fat were better correlated with energy density. All six models were inversely correlated with energy density. TUA FNDI 9-2 model was chosen as the best model for validation. Overall, there was substantial agreement between TUA FNDI 9-2 model and the food-based dietary guidelines (κ=0.644, p=0.001). **Conclusion:** The inverse correlation between nutrient profiling models to energy density shows that foods with higher nutrient density contain lower energy. The validated TUA FNDI 9-2 model is recommended for older adults to make healthier food choices.

Keywords: Nutrient profiling, nutrient density, nutrient-dense food

INTRODUCTION

Nutrient profiling is the science of classifying or ranking foods according to their nutritional composition for application in disease prevention and health promotion (WHO, 2011). The idea of nutrient profiling evolved from the concept of nutrient density of food, which studies the nutrient content in a food item compared to the amount of energy that the food provides (Drewnowski, 2009). A nutrient-dense food contains a higher amount of nutrients than calories (McGuire, 2011). Although there is a wide range of nutrients in a food item, there are no specific criteria of the amounts and types of nutrients that should be included in order to classify a food as nutrient-dense (Drewnowski & Fulgoni, 2008). Hence, nutrient profiling provides a solution with a clearer basis and systematic approach to categorise food

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based on the amount of nutrient content. It enables food to be evaluated based on a specific algorithm or scoring system that contains several nutrients of interest that are related to a particular population (Garsetti *et al.*, 2007). For example, the Nutrient Rich Food (NRF) model that was developed for American population (Fulgoni, Keast & Drewnowski, 2009), and the UK Ofcom Nutrient Profiling Model that was developed by the United Kingdom Food Standards Agency (FSA) to monitor the advertisement of food products for children (Scarborough *et al.*, 2007). There are several applications of nutrient profiling model including nutritional quality assessment of a food, consumer education (Garsetti *et al.*, 2007), determination of eligibility of a food to carry the health claim for display as front-of-pack labelling, and reformulation of food product (Sacks *et al.*, 2011).

Nutrient profiling model needs to be specific and suitable for the target population. There is currently no nutrient profiling model that has been developed specifically for Malaysian older population. The interest to develop a nutrient profiling model for this population arises from the concern of poor nutritional status among older Malaysians (Nik Mohd Fakhruddin *et al.*, 2016). Physiological changes such as alteration of taste bud, changes in absorption and digestion process, presence of disease, polypharmacy and various psychological factors might leave a direct impact to elderly food intake, and thus resulted in reduction of energy intake (Malafarina *et al.*, 2013). Moreover, changes in body composition that usually comes with ageing lead to decrease in body's metabolism and consequently the decrease in energy requirement (St-Onge & Gallagher, 2010). However, despite all these changes, the nutrient requirement for elderly individuals either remained the same or increased (ter Borg *et al.*, 2015). Decreases in energy requirement and energy intake made obtaining sufficient amounts of nutrient a rather difficult process (Bernstein & Munoz, 2012).

Lack of nutrition knowledge was an indirect contributing factor of the failure of older Malaysians to adhere to the nutrient recommendations (Karim *et al.* 2008). The elderly should be provided with information on how to make healthier food choices (Bernstein & Munoz, 2012). Previous research had indicated that people with nutrient-dense diet (as assessed by nutrient profiling method) had a decreased risk of cardiovascular disease, diabetes and all-cause mortality (Chiuve *et al.*, 2012). This study aims to develop and validate a nutrient profiling model that identifies the nutrient density of food items, which will enable the elderly to make an informed food choice.

MATERIALS AND METHODS

Characteristics of the nutrient profiling model

The nutrient profiling model for Malaysian older population named Towards Useful Aging Food Nutrient Density Index (TUA FNDI), consisted of a combination of positive and negative nutrients. "Positive nutrients" are nutrients that should be taken in adequate amounts for health, while "negative nutrients" refers to nutrients that should be taken in limited amounts due to negative effects on health when taken excessively (Garsetti *et al.*, 2007).

This model was calculated using the threshold system that used certain reference values as a cut-off point to indicate the adequacy of nutrient intake (Garsetti *et al.*, 2007). The reference values used in this study were taken from the Recommended Nutrient Intakes for Malaysian Population (RNI) (NCCFN, 2017), for males aged ≥60 years with

moderately active physical activity level 1.6. The RNI recommendations for most nutrients are similar for both sexes, although for males, the recommended values for thiamine, riboflavin, niacin, iron and protein are slightly higher. Percentage RNI values for all nutrients were capped at 100% "as an act of fairness to avoid giving extra reward to any food item that contained extremely high amount of a positive nutrient and to avoid unnecessary penalisation of food items with very high amount of negative nutrient" (Drewnowski, 2005). Next, the algorithm used was the difference between the average sum of positive nutrients and the average sum of negative nutrients. Since this model used average values, it tends to give extra weight to the negative nutrients. This model was designed to give more weight to the negative nutrients as a precautionary step when addressing the nutrient needs of the older adult population with a high prevalence of chronic diseases. The development of this model used the similar approach as Drewnowski, Maillot & Darmon (2009), including the algorithm consisting of both negative and positive nutrients and the nutrient threshold level. However, the TUA FNDI model used different nutrients of interest appropriate for the needs of Malaysian elderly.

Selected nutrients

The choice of nutrients included in this study were based on previous studies on nutrient intake among communities with Malaysian older population (Shahar *et al.*, 2007; Nik Mohd Fakhruddin *et al.*, 2016), nutrient concerned stated in the RNI (NCCFN, 2017) and the availability of complete nutrients data in the Malaysian Food Composition database (Tee *et al.*, 1997). The algorithm of TUA FNDI was formulated to reflect healthy food intake as recommended by Malaysian Dietary Guidelines 2010 (MDG) (NCCFN, 2010). A total of eleven nutrients were selected for this model, including nine positive nutrients namely, protein, calcium (Ca), iron (Fe), potassium (K), vitamin A (Vit A), vitamin C (Vit C), thiamine, riboflavin and niacin, and two negative nutrients namely, total fat and sodium (Na). This model excluded total sugar due to a lack of complete nutrient data in the Malaysian Food Composition database (Tee *et al.*, 1997). Protein, Ca, Vit A and Vit C were added to indicate intake from "fish, meat, poultry and beans", "milk and milk products", and "fruits and vegetable" respectively. Nutrients that were added due to its low intake among the elderly were niacin (Nik Mohd Fakhruddin *et al.*, 2016), thiamine, riboflavin, Fe, and Ca (Shahar *et al.*, 2007). Potassium (K) was added to the model due to its health association with high blood pressure among the elderly (NCCFN, 2017).

Testing the TUA FNDI model

The TUA FNDI nutrient profiling models were tested to determine the best model that correctly categorised foods based on their nutrient density. A total of six models, each comprised a different nutrient combination was tested based on 100g and 100 kcal, making a total of twelve model variants (Table 1). The notation of TUA FNDI 7, 8 and 9 indicated that the models were made up of a combination of either 7, 8 or 9 positive nutrients. Meanwhile the notation of TUA FNDI *n*-1 or *n*-2 at the end indicated that the models consisted of one or two negative nutrients respectively. The test was conducted by correlating the score of a set of "test food" that was calculated using the TUA FNDI nutrient profiling model against energy density per 100 g of food.

The "test food" comprised a list of 94 food items that were extracted from the illustrated Malaysian Food Pyramid (NCCFN, 2010), and a selection of at least

Table 1. List of nutrient profile models tested and their building components

Nutrient profile model	*Reference value*	*Positive nutrients*	*Negative nutrients*	*Algorithm*
TUA FNDI 9-1	100 g	Protein, Vit A, Vit C, Thiamine, Riboflavin, Niacin, K, Ca, Fe	Na	$\frac{\sum\left(\frac{\%\ \text{RNI positive nutrients}}{9}\right) - (\%\text{RNI Na})}{\%\text{RNI energy}}$
TUA FNDI 9-1	100 kcal	Protein, Vit A, Vit C, Thiamine, Riboflavin, Niacin, K, Ca, Fe	Na	$\frac{\sum(\%\ \text{RNI positive nutrients})}{9} - (\%\text{RNI Na})$
TUA FNDI 9-2	100 g	Protein, Vit A, Vit C, Thiamine, Riboflavin, Niacin, K, Ca, Fe	Na, Total Fat	$\frac{\sum\left(\frac{\%\ \text{RNI positive nutrients}}{9}\right) - \sum\left(\frac{\%\text{RNI negative nutrients}}{2}\right)}{\%\text{RNI energy}}$
TUA FNDI 9-2	100 kcal	Protein, Vit A, Vit C, Thiamine, Riboflavin, Niacin, K, Ca, Fe	Na, Total Fat	$\frac{\sum(\%\ \text{RNI positive nutrients})}{9} - \frac{\sum(\%\text{RNI negative nutrients})}{2}$
TUA FNDI 8-1	100 g	Protein, Vit A, Vit C, Thiamine, Riboflavin, K, Ca, Fe	Na	$\frac{\sum\left(\frac{\%\ \text{RNI positive nutrients}}{8}\right) - (\%\text{RNI Na})}{\%\text{RNI energy}}$
TUA FNDI 8-1	100 kcal	Protein, Vit A, Vit C, Thiamine, Riboflavin, K, Ca, Fe	Na	$\frac{\sum(\%\ \text{RNI positive nutrients})}{8} - (\%\text{RNI Na})$
TUA FNDI 8-2	100 g	Protein, Vit A, Vit C, Thiamine, Riboflavin, K, Ca, Fe	Na, Total Fat	$\frac{\sum\left(\frac{\%\ \text{RNI positive nutrients}}{8}\right) - \sum\left(\frac{\%\text{RNI negative nutrients}}{2}\right)}{\%\text{RNI energy}}$
TUA FNDI 8-2	100 kcal	Protein, Vit A, Vit C, Thiamine, Riboflavin, K, Ca, Fe	Na, Total Fat	$\frac{\sum(\%\ \text{RNI positive nutrients})}{8} - \frac{\sum(\%\text{RNI negative nutrients})}{2}$
TUA FNDI 7-1	100 g	Protein, Vit A, Vit C, Thiamine, Riboflavin, Ca, Fe	Na	$\frac{\sum\left(\frac{\%\ \text{RNI positive nutrients}}{7}\right) - (\%\text{RNI Na})}{\%\text{RNI energy}}$
TUA FNDI 7-1	100 kcal	Protein, Vit A, Vit C, Thiamine, Riboflavin, Ca, Fe	Na	$\frac{\sum(\%\ \text{RNI positive nutrients})}{7} - (\%\text{RNI Na})$
TUA FNDI 7-2	100 g	Protein, Vit A, Vit C, Thiamine, Riboflavin, Ca, Fe	Na, Total Fat	$\frac{\sum\left(\frac{\%\ \text{RNI positive nutrients}}{7}\right) - \sum\left(\frac{\%\text{RNI negative nutrients}}{2}\right)}{\%\text{RNI energy}}$
TUA FNDI 7-2	100 kcal	Protein, Vit A, Vit C, Thiamine, Riboflavin, Ca, Fe	Na, Total Fat	$\frac{\sum(\%\ \text{RNI positive nutrients})}{7} - \frac{\sum(\%\text{RNI negative nutrients})}{2}$

TUA FNDI= Towards Useful Aging Food Nutritional Density Index
RNI= Recommended Nutrient Intakes for Malaysians

five commonly consumed food reported in a study among Malaysian older population, (named "LRGS Towards Useful Aging (TUA) Neuroprotective Model for Healthy Aging" (LRGS TUA) (Nik Mohd Fakhruddin *et al.*, 2016).

The list of test foods comprised these food groups namely, "cereals, grains and tubers", "vegetables", "fruits", "fish, meat, poultry, eggs and beans", "milk and milk products", "fat, salt and sugar", "snacks and *kuih*". Beverages such as coffee, tea, soft drinks, and artificially-flavoured juices were excluded because of the lack of complete available information on nutrient content of these beverages. Traditional *kuih* (traditional Malaysian dessert) and snacks were included because the intake of *kuih* was high in the elderly population (Shahar, Earland & Rahman, 2000). The "test foods" were then ranked from the highest to the lowest nutrient density to determine which models provide the most consistent result (Drewnowski *et al.*, 2009).

Validation of nutrient profiling model

The validation of TUA FNDI was performed by comparing the healthiness of food items as determined by the food-based dietary guidelines and the nutrient profiling model. This is a form of determining content validity as a basic validation process (WHO, 2011; Wicks, 2012). For this purpose, another list that was made up of 174 food items was extracted from both written text and illustration form in MDG (NCCFN, 2010). This is to enable a direct comparison to be made between the healthiness of the food items that were classified by the MDG and TUA FNDI nutrient profiling model. More foods were included in the validation food list compared to the "test food" list to ensure a more robust validation process. Then, foods in the validation food list were placed into seven food categories according to the key messages of the MDG (NCCFN, 2010). Foods that were encouraged in the MDG were considered as "healthy". These included 'Key Message 4: Eat Adequate Amount of Rice, Other Cereal Products (Preferably Whole Grain) and Tubers', and 'Key Message 5: Eat Plenty of Fruits and Vegetables Everyday'. On the other hand, foods that were discouraged in the MDG such as 'Key Message 9: Choose and Prepare Food with Less Salt and Sauces', and 'Key Message 10: Consume Food and Beverages Low in Sugar' were considered as 'less healthy'. On the other hand, the determination of the healthiness of the food item based on the TUA FNDI nutrient profiling model was done by dividing the foods into quartile. Foods in the first two top tiles were considered as 'healthy' while foods in the bottom two tiles were considered as 'less healthy'. Foods that were considered 'healthy' were labelled as 'YES' while 'less healthy' foods were labelled as 'NO' (Arambepola, Scarborough & Rayner, 2008).

Statistical test

All the data were tested for the normal distribution using normality test such as Kolmogorov-Smirnov test, skewness and kurtosis. Data that were normally distributed was described in mean and standard deviation while data that were not normally distributed were described in median and interquartile range. Difference in sociodemographic characteristics, anthropometry characteristics and nutrient intake data of the participants were calculated using *t*-test for normally distributed data and Mann-Whitney U test for not normally distributed data. Correlation of food score generated by TUA FNDI model to energy density of food was done using Spearman's correlation. The comparison of the healthiness classification generated by MDG and TUA FNDI nutrient profiling model was done using

kappa statistics to determine the level of agreement between the two methods. The *p*-value of ≤0.05 was considered as significant in this study.

This analysis made use of dietary data reported in the LRGS TUA study, which had included a total of 579 older subjects (Nik Mohd Fakhruddin *et al.*, 2016). The subjects provided written informed consent at the beginning of the study. This study was approved by the Research Ethics Committee of Universiti Kebangsaan Malaysia (UKM 1.5.3.5/244/NN-060-2013).

RESULTS

Characteristics of the participants

The average age of the participants was 68.2±5.5 years, with the majority being male (55.1%), Malay (59.4%), married (74.6%) and retired (58.0%). The median body mass index (BMI) was in the normal category (24.6 kg/m^2), but the body fat percentage of the subjects was above the normal level (38.6%). Female subjects (25.5 kg/m^2, 44.4%) had significantly higher BMI and body fat percentage compared to male participants (24.1 kg/m^2, 33.8 %) (Table 2).

Calorie intake was lower than the recommendation, while protein and carbohydrate intake were above the recommendations. Intake of several nutrients such as vitamin A, vitamin C and iron were above the RNI recommendation, while that of thiamine, niacin, potassium and calcium were 70.0% below the recommended values (Table 3). Male subjects had significantly higher intake of energy, protein, carbohydrate, thiamine, riboflavin, sodium and iron as compared to female subjects.

Development of nutrient profiling model

The "vegetable" group had the highest median score, followed by "fruits" group and "fish, meat, poultry and bean" group. Meanwhile "fat, salt and sugar" group intake had the lowest median score across all the models tested. Table 4 shows median score for the food groups according to each nutrient profiling model tested.

Overall, all the models were inversely correlated with energy density (p=0.001) (Table 5). Nutrient profiling models with two negative nutrients had stronger correlation to energy density compared to models with only one negative nutrient included. Overall, the models with the strongest correlation to energy density were TUA FNDI 9-2 for 100 g variant (r=-0.715, p=0.001) and TUA FNDI 9-2 for 100 kcal variant (r=-0.712, p=0.001). Lowering the amount of nutrients included in the models had a very minor effect to the performance of these models.

The higher ranks were occupied by foods from the "vegetable" group while foods from "fat, salt and sugar" groups dominated the lower ranks. The 100 g formula appears to favour food with less water content in placing them at higher ranks. However, the 100 g formula showed lack of consistency when ranking foods that were usually taken in small amounts. For example, the 100 g formula put powdered skimmed milk 11 ranks lower than the 100 kcal formula but placed dried anchovies 8 ranks higher, compared to 100 kcal formula. On the other hand, the 100 kcal models were able to correctly rank the foods according to nutrient density regardless of weight and water content. As a result, TUA FNDI 9-2 model with 100 kcal calculation-base was chosen as the final model.

Validation of nutrient profiling model

The indicator foods were classified according to the healthiness of the food. A substantial level of agreement was obtained when 46.0% of the food was

Table 2. Participants' characteristics

Characteristics	*Male (n=319)*		*Female (n=260)*		*Total (n=579)*	
Age (years) (mean±*SD*)	68.8±5.4		67.4±5.5		68.2±5.5	
Age (years) (range)	60.0-85.0		60.0-85.0		60.0-85.0	
	n	%	*n*	%	*n*	%
Gender	319	55.1	260	44.9	579	100.0
Ethnicity						
Malay	199	62.4	145	55.8	344	59.4
Chinese	101	31.7	112	43.1	213	36.8
Indian	18	5.6	3	1.2	21	3.6
Others	1	0.3	0	0.0	1	0.2
Marital status*						
Single	11	3.5	1	0.4	12	2.1
Married	288	90.3	144	55.4	432	74.6
Divorced	1	0.3	5	1.9	6	1.0
Widowed	19	6.0	110	42.3	129	22.3
Employment status*						
Not working	9	2.8	29	11.2	38	6.6
Employed full time	27	8.5	8	3.1	35	6.0
Employed part time	19	6.0	10	3.9	29	5.0
Self employed	58	18.2	16	6.2	74	12.8
Retired	201	63.0	135	51.9	336	58.0
Housewife	314	98.4	61	23.5	61	10.5

*Significant difference between male and female group ($p \leq 0.05$)
Source: LRGS TUA Neuroprotective Model for Healthy Aging (Nik Mohd Fakhruddin *et al.*, 2016)

Table 3. Anthropometric characteristics and nutrient intake of the participants

Characteristics	*Male*		*Female*		*Total*	
	Range	*Mean±SD*	*Range*	*Mean±SD*	*Range*	*Mean±SD*
Height (cm)	144.0-183.6	161.9±6.4	136.0-167.7	151.0±5.8	136.0-183.6	157.0±8.2
Waist circumference (cm)	61.0-131.0	88.4±10.6	61.2 - 120.2	87.3±11.0	61.0-131.0	88.0±10.8
	Interquartile range	*Median*	*Interquartile range*	*Median*	*Interquartile range*	*Median*
Weight (kg)	14.6	63.0	14.6	58.0	16.1	60.6*
Body mass index (kg/m^2)	4.5	24.1	6.2	25.5	5.3	24.6*
Body fat percentage (%)	15.4	33.8	12.7	44.4	16.0	38.6*
	Interquartile range	*Median (RNI %)*	*Interquartile range*	*Median (RNI %)*	*Interquartile range*	*Median*
Nutrients						
Energy (kcal)	551.5	1691 (84.1)	505.5	1501 (84.3)	554.4	1622*
Protein (g)	26.2	70.2 (123.2)	20.8	65.2 (118.5)	23.9	68.5*
Carbohydrate (g)	97.5	229.3	71.3	195.6	86.9	215.0*
Fat (g)	21.0	51.8	23.8	48.8	22.0	50.3
Vitamin A (RE)	799.0	1022.0 (170.3)	822.4	992.9 (165.5)	806.6	1013.6
Vitamin C (mg)	89.2	96.4 (137.7)	105.7	101.8 (145.4)	95.4	99.0
Thiamine (mg)	0.4	0.8 (64.8)	0.5	0.7 (63.0)	0.5	0.7*
Riboflavin (mg)	0.5	1.2 (90.8)	0.6	1.1 (95.5)	0.6	1.1*
Niacin (mg)	5.3	10.0 (62.3)	4.4	9.8 (69.8)	4.6	9.9
Sodium (mg)	1065.5	1345.1 (89.7)	935.8	1037.2 (69.2)	988.1	1184.1*
Potassium (mg)	620.3	1391.6 (29.6)	717.3	1365.2(29.1)	674.2	1389.9
Calcium (mg)	240.6	473.4 (47.3)	301.0	471.1 (47.1)	274.2	472.1
Iron (mg)	6.3	13.138 (119.5)	6.2	11.7 (106.8)	6.5	12.5*

*Significant difference between male and female group ($p \leq 0.05$)
Normally distributed data were expressed in mean ± standard deviation while not normally distributed data were expressed in median and interquartile range

Table 4. Median score for each food category according to MDG (2011)

Food category		*TUA FNDI 9-1*	*TUA FNDI 9-2*	*TUA FNDI 8-1*	*TUA FNDI 8-2*	*TUA FNDI 7-1*	*TUA FNDI 7-2*	*TUA FNDI 9-1*	*TUA FNDI 9-2*	*TUA FNDI 8-1*	*TUA FNDI 8-2*	*TUA FNDI 7-1*	*TUA FNDI 7-2*
Calculation unit		*100 g*	*100 g*	*100 g*	*100 g*	*100 g*	*100 g*	*100 kcal*	*100 kcal*	*100 kcal*	*100 kcal*	*100 kcal*	*100 kcal*
Cereals, grains and tubers (*n*=16)	Median	0.4	0.4	0.3	0.3	0.4	0.4	2.0	1.9	1.6	1.6	1.9	1.9
	Interquartile range	1.2	0.5	1.2	0.5	1.2	0.5	5.9	2.6	6.0	2.5	5.9	2.6
Fruits (*n*=16)	Median	1.7	1.9	1.9	2.1	2.2	2.3	8.4	9.4	9.4	10.2	10.6	11.1
	Interquartile range	3.0	2.9	3.4	3.2	3.8	3.7	11.6	12.4	12.8	12.9	14.7	15.1
Vegetables (*n*=15)	Median	5.3	5.5	5.7	6.2	6.4	7.2	23.7	25.3	27.2	27.8	31.4	30.8
	Interquartile range	15.1	14.6	16.7	16.5	18.3	18.0	31.4	30.1	34.1	32.9	34.8	36.3
Fish, meat, poultry and beans (*n*=14)	Median	1.3	1.3	1.3	1.2	1.4	1.3	6.5	6.2	6.2	6.1	6.8	6.5
	Interquartile range	0.7	1.2	0.5	1.0	0.5	1.0	3.0	5.7	2.6	4.9	2.7	5.1
Milk and milk products (*n*=5)	Median	0.2	0.8	0.4	0.8	0.5	1.0	4.7	3.7	5.7	4.0	6.6	4.8
	Interquartile range	4.1	3.5	4.1	3.6	4.3	3.7	20.5	19.4	20.5	19.8	21.5	20.8
Fat, salt and sugar (*n*=15)	Median	-1.5	-1.8	-1.3	-1.6	-1.0	-1.3	-5.9	-8.1	-5.0	-8.2	-4.9	-8.2
	Interquartile range	9.6	3.9	9.4	3.7	9.2	3.6	65.0	31.0	64.7	30.7	64.6	31.1
Snacks and *kuih* (*n*=13)	Median	-0.6	-0.7	-0.6	-0.7	-0.6	-0.7	-2.9	-3.4	-2.8	-3.3	-2.8	-3.3
	Interquartile range	1.4	1.0	1.4	1.0	1.4	1.0	7.0	5.0	7.0	5.0	6.9	5.0

Table 5. Correlation of TUA FNDI nutrient profile models to energy density per 100 g of food

Model	*N*	*Correlation coefficient (r)*	*p*
TUA FNDI 9-1 (100g)	94	-0.676	<0.001
TUA_FNDI 9-2 (100g)	94	-0.715	<0.001
TUA FNDI 8-1 (100g)	94	-0.671	<0.001
TUA FNDI 8-2 (100g)	94	-0.711	<0.001
TUA FNDI 7-1 (100g)	94	-0.664	<0.001
TUA FNDI 7-2 (100g)	94	-0.709	<0.001
TUA FNDI 9-1 (100kcal)	94	-0.664	<0.001
TUA FNDI 9-2 (100kcal)	94	-0.712	<0.001
TUA FNDI 8-1 (100kcal)	94	-0.662	<0.001
TUA FNDI 8-2 (100kcal)	94	-0.709	<0.001
TUA FNDI 7-1 (100kcal)	94	-0.655	<0.001
TUA FNDI 7-2 (100kcal)	94	-0.708	<0.001

categorised as 'YES' and 36.2% was categorised as 'NO' by both MDG and TUA FNDI nutrient profiling model. A slight disagreement was shown, as there was 4.0% of food categorised as 'YES' according to TUA FNDI but categorised as 'NO' by MDG. Apart from that, 13.8% of food was categorised as 'NO' by TUA FNDI but categorised by 'YES' by MDG. However, these small disagreements did not affect the overall agreement level between MDG and TUA FNDI as indicated by kappa statistics, κ=0.644.

DISCUSSION

This study has successfully developed a nutrient profiling model, the TUA FNDI, in which vegetable and fruit groups had a higher median score compared to other food groups, owing to the presence of relatively higher amounts of vitamins and minerals. In contrast, "fat, salt and sugar" food groups contain relatively lower amounts of positive nutrients. This finding is in line with the results of Drewnowski *et al.* (2009) and Fulgoni *et al.* (2009). Models that included total fat showed higher correlation to energy density owing to fat contributing to a large portion of energy in the food.

An interesting finding obtained was that chicken liver showed a high score based on the TUA FNDI model, given its good source of nutrients namely, 100 kcal of chicken liver is equivalent to 86.2 g and provides the daily requirement of riboflavin (84.8% RNI), iron (62.6% RNI) and niacin (33.4% RNI) (Tee *et al.*, 1997). Fahmida & Santika (2016) reported chicken liver as a wholesome food that provides high amounts of nutrients at an affordable cost for low socioeconomic households in Indonesia. However, 100 kcal of chicken liver contains 492.4 mg cholesterol and very high vitamin A (750% RNI). The National Health Service (NHS) United Kingdom suggested liver or liver products should not be taken more than once per week (NHS, 2017).

Overall, the models were inversely correlated with energy density. Nutrient profiling has been shown to be an effective way to convey information regarding the nutritional attributes of foods to consumers (Miller *et al.*, 2009).

Although the 100 g formula is easier to be presented to the elderly, however, the lack of consistency in foods reported as 100 g, led us to select the 100 kcal unit in the final model. The 100 g

formula is affected by the weight and water content of the food and this can influence the calculation of nutrient density score of food when calculated on weight basis (Drewnowski *et al.*, 2009). In contrast, the 100 kcal formula is not affected by water content and weight of the food (Sacks *et al.*, 2011). However, the 100 kcal formula may be harder to understand, especially among the elderly with low education level. Therefore, there is a need to convert the 100 kcal formula to 100g that is easier for the elderly to understand.

The validation was performed by comparing healthiness classification provided by MDG (NCCFN, 2010) and TUA FNDI nutrient profiling model. The results show substantial levels of agreement between both modes of classification. This shows the TUA FNDI nutrient profiling model can correctly categorise 'healthy' and 'less healthy' foods. This finding is in line with the results of Arambepola *et al.* (2008) and Wicks (2012). This study shows that TUA FNDI nutrient profiling model is a valid measure and can determine the nutrient density of food items correctly.

Nutrient profiling allows us to use numbers to portray the nutritional quality of foods in a holistic way and made it easier to understand (Di Noia, 2014; Alrige *et al.*, 2017). The score can be used as an educational tool by the health professionals and the elderly themselves to make better food choices that are rich in nutrients (Alrige *et al.*, 2017). Hence, nutrient profiling can be used as a tool to enhance the users' understanding about nutrition, enabling them to improve their dietary behaviour by avoiding diets that consisted of foods with low nutrient content (Alrige *et al.*, 2017).

The strength of this study lies in the development and testing of the model based on the nutritional needs of Malaysian elderly. Limitations include the lack of data on the contents of such negative nutrients as added sugar and saturated fats in the composition tables of foods consumed in Malaysia.

CONCLUSION

Overall, the TUA FNDI 9-2 model was able to categorise foods commonly consumed by the elderly according to nutrient density. Results from this study can be used by health professionals and by the elderly themselves as a reference for incorporating nutrient-dense food in their daily diet.

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Authors' contributions

RMB designed the methodology, conducted the data collection, data analysis and interpretation, wrote and revised the draft for the article; HMY involved in the methodology design, supervised the whole research, critically revised the draft and contributed ideas and expertise to improve the research; SS was the project leader and directly involved methodology design and fund acquisition of the research. She also supervised the whole research, critically revised the draft and contributed ideas for improvement.

Conflict of interest

We would also like to declare that there was no conflict of interest in writing this paper and conducting this research.

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Finger millet (*Eleusine coracana* L.) and white rice diets elicit similar glycaemic response in Asian Indians: Evidence from a randomised clinical trial using continuous glucose monitoring

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ABSTRACT

Introduction: Finger millet (FM) or *Eleusine coracana* L. is considered as a healthier cereal option, especially based on its higher dietary fibre, phytochemical and mineral contents. FM is also recommended for individuals with diabetes, as it is believed to elicit a lower glycaemic response. **Methods:** The glycaemic response of FM diet was evaluated and compared with white rice (WR) diets using a continuous glucose monitoring system (CGMS™) iPro 2™ among 14 healthy male and female volunteers aged 25-45 years with normal Body Mass Index (≥22.9kg/m^2) in a crossover trial. They were recruited from Madras Diabetes Research Foundation volunteers registry. The participants consumed randomised iso-caloric FM or WR based diets for five consecutive days and 24 h interstitial glucose concentrations were recorded. **Results:** The FM diet had significantly higher dietary fibre than WR (29.9 g vs 15.8 g/1000 kcal, $p<0.01$) but the other macronutrients were similar. The 5-day average incremental area under the curve (IAUC) of FM diet [Mean (95% CI) = 73.6 (62.1-85.1) mg*min/dl] was not significantly different from that for WR diet [Mean (95% CI) = 78.3(67.9-88.7) mg*min/dl]. **Conclusion:** Both finger millet and white rice diets showed similar 24 h glycaemic responses, despite the former having higher amounts of dietary fibre. The result suggests that use of FM flour-based food preparations and decorticated FM grains to replace WR in the Indian diets offer no significant benefit with regards to 24 h glycaemic response. Studies of longer duration with larger sample size are needed to verify our findings.

Keywords: Finger millet, white rice, dietary intervention, dietary fibre, diabetes

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INTRODUCTION

The prevalence of diabetes and obesity are rising rapidly. Individuals of south Asian origin specifically Asian Indians are known to be highly susceptible to diabetes (Anjana *et al.*, 2015). Although genetic factors may influence this susceptibility, lifestyle factors; faulty diets (high in refined carbohydrates) and sedentary lifestyle play a major role (WHO, 2003). In this context, foods with lower glycaemic properties are beneficial in combating the rising prevalence of the aforementioned disorders (Misra *et al.*, 2011).

Finger millet (FM) or *Eleusine coracana* L. is one of the most important millets consumed since ancient times. This millet contains higher levels of dietary fibre (12%), phytochemicals and minerals (Shobana *et al.*, 2013). Hence, millet preparations are often considered as healthy dietary options for individuals with diabetes. Additionally, there is a common perception that millet-based foods elicit a lower glycaemic response although systematic studies in this direction are lacking (Shobana *et al.*, 2013).

Though millets were a part of traditional Indian diets, their consumption has diminished considerably, notwithstanding their superior nutritional value (NSSO, 2014). Presently, polished white rice and refined cereal- based foods are the major staples in the southern Indian region (Radhika *et al.*, 2009) due to government support for rice prices in this region. Refined grains and their products increase the glycaemic load of diets owing to their higher glycaemic and insulinaemic responses and could lead insulin resistance (Willett *et al.*, 2002; Radhika *et al.*, 2009). Thus, it is crucial to study the glycaemic properties of ancient grains such as millets using appropriate methods so that they can be recommended as a healthier replacement to refined grain staples for individuals with diabetes.

Though FM contains higher levels of dietary fibre and phytochemicals (Shobana *et al.*, 2013), this grain remains less explored for its glycaemic properties (Glycaemic index) using standardised international GI testing protocol (Shobana *et al.*, 2013). There are mixed reports on the glycaemic indices/response of FM based foods. This is because few earlier studies (Lakshmi & Sumathi, 2002; Shukla & Srivastava, 2014), had shown that FM preparations elicit a lower glycaemic response compared to rice and other cereals while others have equally shown higher glycaemic responses for the millet- based preparations (Urooj *et al.*, 2006; Shobana *et al.*, 2007; Shobana, 2009).

In addition, FM-based food products with diabetes-friendly label claims (unpublished in-house market survey data) available in the market pose major challenges as there is usually no scientific backing for these claims. Systematic intervention studies on the glycaemic properties of FM-based foods or diets using appropriate protocols are scarce (Shobana *et al.*, 2013). We have earlier shown that the FM products used in the present study (iso-caloric FM diet, i.e. FM extruded snack, *upma* prepared from decorticated FM, FM vermicelli and FM flakes) belonged to the medium to high GI categories (Shobana *et al.*, 2018).

Continuous glucose monitoring (CGM) systems have been found to be useful to study the glycaemic response to diets over 24 hours for five consecutive days. We recently reported a study with brown rice vs. white rice (WR) based diets in overweight Asian Indians (Mohan *et al.*, 2014) using CGM. In the current paper, we aim to evaluate the glycaemic responses of FM-based diets compared to iso-caloric WR based diets

in 14 normal healthy individuals aged 20-40 y.

MATERIALS AND METHODS

Participants

Fourteen volunteers (7 males and 7 females) in the age group of 20-40 years with Body Mass Index (BMI) <22.9 kg/m^2 were recruited from our volunteer registry. Study participants were excluded if they were overweight (BMI ≥ 23 kg/m^2) (WHO, 2004) or were on any special diet, had a family history of diabetes, suffered from any illness or food allergy, used regular medications, or had a fasting blood glucose value of >5.6 mmol/l (>100 mg/dl) (American Diabetes Association, 2003). Pregnant or lactating women were also excluded (Figure 1). The study was conducted according to the guidelines laid down by the Declaration of Helsinki, and was approved by the Ethics Committee of the Madras Diabetes Research Foundation. All participants gave written informed consent before participation in the study.

Dietary intervention

In a randomised cross-over design, volunteers were assigned to FM and WR-based iso-caloric diets for breakfast, lunch and dinner for five consecutive test days as shown in Figure 1. The entire study protocol was explained to the participants in detail and they were encouraged to discuss any concerns they might have on any aspects of the dietary intervention or protocol. They were further requested to abstain from partying, smoking and alcohol as well as strenuous exercise during the study period and this was ensured by daily dietary recalls. The intervention menu

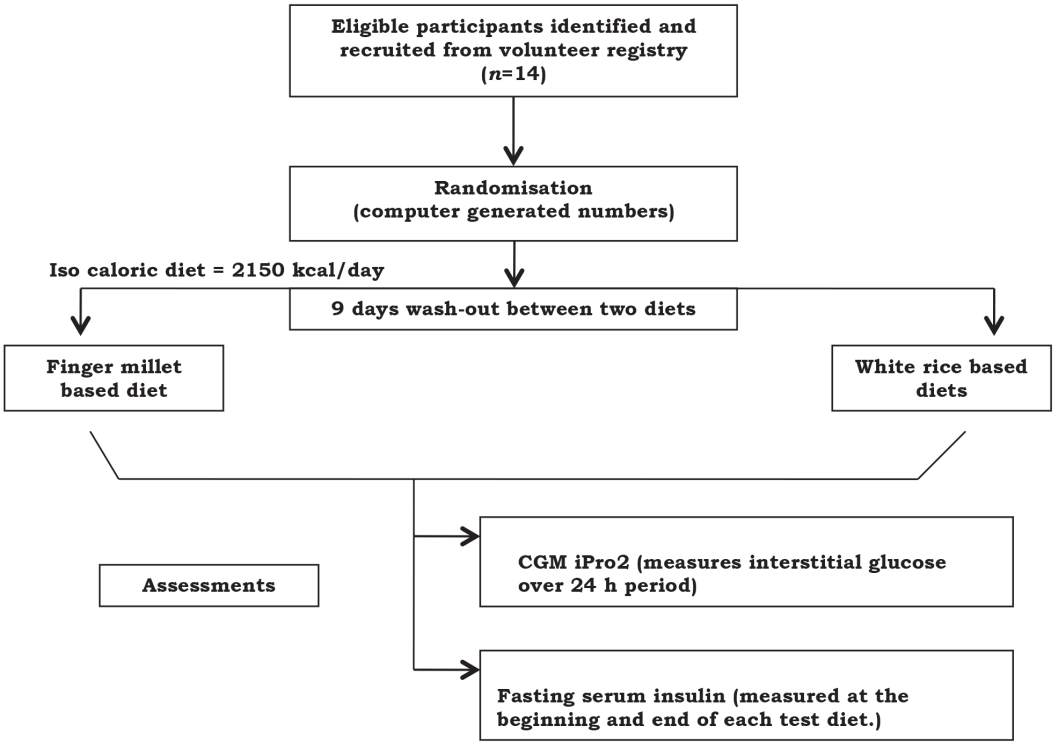

Figure 1. The study protocol

Table 1. Finger millet and white rice based diets menu plan

Menu	*Meal & Time*	*Finger millet diet*[†] *(Main course and accompaniments)*	*Quantity (g)*	*White rice diet (Main course and accompaniments)*	*Quantity (g)*
Day 1	Breakfast (8.30-9.30AM)	FMV *upma*	210	Rice vermicelli *upma*	275
		Sambar	150	*Sambar*	150
		Chutney-onion	75	Chutney-onion	75
	Mid-morning (11.00am -12.00 noon)	Lemon juice	200	Lemon juice	200
	Lunch (1.00-2.00PM)	Tomato flavored DFM	175	Tomato rice	175
		Plain cooked DFM	150	Plain rice	100
		Mixed vegetable *kootu*	75	Mixed vegetable *kootu*	75
		Cucumber *raitha*	100	Cucumber *raitha*	100
		Rasam	100	*Rasam*	100
	Mid-evening (4.00-4.30PM)	Tea with sugar	150	Tea with sugar	150
		FM based extruded snack	30	Masala puffed rice	30
	Dinner (8.00-9.00PM)	Finger millet *adai*	275	Rice *adai*	225
		Mint coriander chutney	150	Mint coriander chutney	150
Day 2	Breakfast (8.30-9.30AM)	DFM *upma*	250	Rice *upma*	240
		Sambar	125	*Sambar*	125
		Chutney-tomato	45	Chutney-tomato	45
	Mid-morning (11.00am -12.00 noon)	Vegetable soup	125	Vegetable soup	125
	Lunch (1.00-2.00PM)	DFM plain (cooked)	275	Plain rice	275
		Curry spicy gravy	100	Curry spicy gravy	100
		Cabbage *poriyal*	75	Cabbage *poriyal*	75
		Rasam	100	*Rasam*	100
		Curd	75	Curd	75
	Mid-evening (4.00-4.30PM)	Finger millet bread sandwich	168	Dhokla sandwich	100
	Dinner (8.00-9.00PM)	Finger millet *dosa*	220	Rice *dosa*	200
		Veg. *kurma*	175	Veg. *kurma*	175
Day 3	Breakfast (8.30-9.30AM)	Finger millet balls	175	Rice balls	235
		Legumes gravy	150	Legumes gravy	175
	Mid-morning (11.00am -12.00 noon)	Lemon juice	200	Lemon juice	200
	Lunch (1.00-2.00PM)	DFM *bisebelebath*	250	White rice *bisebelebath*	250
		DFM plain (cooked)	100	Plain cooked rice	100
		Potato *poriyal*	75	Potato *poriyal*	75
		Cucumber *raitha*	100	Cucumber *raitha*	100
		Rasam	100	*Rasam*	100
	Mid-evening (4.00-4.30PM)	Tea with sugar	150	Tea with sugar	150
		FM based extruded snack	30	Masala puffed rice	30
	Dinner (8.00-9.00PM)	FMV *kitchidi*	275	Rice vermicelli *kitchidi*	300
		Sambar	150	*Sambar*	150
		Coconut chutney	75	*Coconut chutney*	75

Day 4	Breakfast (8.30- 9.30AM)	Finger millet *pongal*	300	Rice *pongal*	275
		Brinjal *masiyal*	150	Brinjal *masiyal*	150
		Chutney-onion	75	Chutney-onion	60
	Mid-morning (11.00am -12.00 noon)	Vegetable soup	125	Vegetable soup	125
	Lunch (1.00 -2.00PM)	DFM (cooked)	300	Plain rice	300
		Sambar	125	*Sambar,*	125
		Beetroot *poriyal*	75	Beetroot *poriyal*	75
		Rasam	100	*Rasam*	100
		Curd	75	Curd	75
	Mid-evening (4.00-4.30PM)	Finger millet bread sandwich	168	Dhokla sandwich	100
	Dinner (8.00-9.00PM)	Finger millet *oothappam*	275	Rice *oothappam*	225
		Tomato *kurma*	175	Tomato *kurma*	150
Day 5	Breakfast (8.30- 9.30AM)	FMF *upma*	275	Rice flakes *upma*	275
		Sambar	150	*Sambar*	150
		Chutney-coconut	45	Chutney-coconut	45
	Mid-morning (11.00am -12.00 noon)	Lemon juice	200	Lemon juice	200
	Lunch (1.00 -2.00PM)	DFM (cooked)	275	Plain cooked rice	275
		Channa gravy	100	Channa gravy	100
		Brinjal *poriyal*	75	Brinjal *poriyal*	75
		Rasam	100	*Rasam*	100
		Curd	75	Curd	75
	Mid-evening (4.00-4.30PM)	Tea with sugar	150	Tea with sugar	150
		FM based extruded snack	30	Masala puffed rice	30
	Dinner (8.00-9.00PM)	Finger millet *roti*	225	Rice *roti*	225
		Vadai curry	165	*Vadai* curry	165

†FMV-Finger millet vermicelli, DFM- Decorticated finger millet, FMF- Finger millet flake

Table 2. Average nutrient composition of the iso-caloric control and test diets

Nutrients	*Finger millet based diet*		*White rice based diet*		*p-value*
	Mean	*SD*	*Mean*	*SD*	
Energy (kcal)	2146.0	2.0	2144.0	1.7	0.14
Carbohydrate (g)	356.6	7.1	358.8	17.4	0.71
Carbohydrate (% E)	66.5	1.3	66.9	3.3	0.67
Protein (g)	64.9	3.8	61.7	4.0	0.22
Protein (% E)	12.1	0.7	11.5	0.8	0.23
Fat (g)	49.4	3.7	54.6	5.8	0.05
Fat (% E)	20.7	1.6	22.9	2.4	0.04
Dietary fibre (g/1000 kcal)	29.9	1.8	15.8	1.3	<0.01
Dietary glycaemic load	209.2	26.3	207.0	24.0	0.91

was identical on all the test diet days except for the WR and FM component (Table 1).

The macronutrient composition of the FM and WR iso-caloric (≈2100kcal/day) test diets was similar except that the dietary fibre content was higher in FM diets (30 g/1000 kcal) as compared to WR rice-based diets (16 g/1000 kcal) (Table 2).

Finger millet (whole grain) was procured from the local market, pre-cleaned using a destoner, grader and aspirator and used for the preparation of FM recipes. Minimally polished FM, FM flakes (roller flaked), FM vermicelli (vermicelli prepared from a blend of FM, defatted soy and resistant maltodextrin) and FM ready-to-eat snack (an extruded snack prepared from FM flour blended with fenugreek fibre, defatted soya flour, vegetable oil and spices) were also included in the CGM menu. The details of the products are published elsewhere (Shobana *et al.*, 2018). WR (raw, BPT variety), WR based vermicelli and commercially available flakes were procured from the local market and used for the study. All meals were prepared and served at the test kitchen of Madras Diabetes Research Foundation. The nutrient compositions of the meals for CGM are shown in Table 2.

Anthropometric measurements

Anthropometric measurements including height, weight and waist circumference were measured at baseline and in the end of the study in the fasting state using standardised techniques (Deepa *et al.*, 2003).

Measurement of interstitial glucose concentration

The iPro™2 continuous Glucose Monitoring System (CGM) (iPro™2 Professional CGM- Medtronic Mini med, Northridge, USA) sensor was inserted on the lateral aspect of the abdominal wall and was used to obtain continuous interstitial glucose readings that have been shown to correlate with plasma glucose values (Monsood *et al.*, 2002). The iPro 2™ was worn for five complete days after which the participants returned the iPro 2™ recorder for uploading the data to a web-based software, which provided a summary of the glucose responses. The iPro 2 CGM system records 24 h glucose values in a recorder every 5th minute, giving a total of 288 readings over a 24 h period. The sensor was calibrated using finger prick capillary blood glucose and eight measurements taken at fasting, pre, post-meals and bedtime (breakfast, lunch and dinner) during the study period using a Hemocue 201^{+} glucose analyser (Hemocue Ltd, Angelholm,

Table 3. Baseline anthropometric and dietary profile of CGM study participants

Characteristics	*Value*
Female [n(%)]	7(50)
Age (years)	27.5±9.0
Weight (kg)	56.3±7.1
BMI (kg/m^2)	20.9±1.7
Waist circumference (cm)	76.1±6.8
Blood pressure (systolic)	108±16
Blood pressure (diastolic)	72±10
Energy (kcal)	1364±415
Carbohydrates (E%)	61.5±6.5
Protein (E%)	13.6±3.1
Total fat intake (E%)	26.6±4.3
Total dietary fibre (g)	14.9±4.7
Saturated fatty acid (E%)	9.2±2.2
Polyunsaturated fatty acid (E%)	8.1±1.3
Monounsaturated fatty acid (E%)	8.2±2.6
Trans fatty acid (E%)	0.003±0.005
Glycaemic load (GL)	101.2±23.9
Weighted GI	55.1±7.3
Refined cereals (g/day)	157.1±60.6
Whole cereals (g/day)	8.3±22.9
Legumes, dhal and whole (g/day)	47.3±26.4
Fruits and vegetables (g/day)	150.5±141.5
Tuber (g/day)	12.7±23.9
Milk and its products (g/day)	180.3±129.7
Non veg (g/day)	66.6±69.6
Fats edible oils (g/day)	26.6±4.3
Total added salt (g/day)	6.6±2.6
Total added sugar (g/day)	11.8±10.1

Sweden). A nine days wash out period was given between the two diets.

Biochemical measurements

A fasting venous blood sample was drawn and analysed for serum insulin concentration (enzyme-linked immunoassay; Dako, Glostrup, Denmark) at the beginning (Day 1) and end (Day 6) of the test and control diets (Figure 1).

Statistical analysis

Statistical analysis was performed using SAS software, version 9.0 (SAS Institute Inc., Cary, NC). Change in glucose concentration over five days measured as average 24 h glucose response was considered for analysis. The positive Incremental Area under the Curve (IAUC) was calculated geometrically by applying the trapezoidal rule. The average positive glycaemic response of individuals fed with two different test diets was measured as the change in sensor glucose concentration from baseline over a period of 24 h (7 am to next day 7 am) on each test day. Out of the 14 volunteers, data was completely missed during the 1st diet in 2 volunteers. Hence, the data from 12 volunteers were included for further analysis. The difference in glycaemic responses between FM diet and WR was assessed using a mixed

Table 4. Metabolic effects of finger millet based diet compared with white rice diet

Outcome	*Number of observations (number of participants)*	*FM*	*WR*	*FM vs WR*	*p-value*
Daily IAUC (mg-5 min/dL) 5-day [*M*(95% CI)]	58(12)	72.3(50.9,93.7)	72.7(54.6,90.9)	-0.4	0.57
Fasting interstitial blood glucose (mg/dl)				0.8	
Day 0	58(12)	86.7±13.1	87.1±12.9		0.78
Day 6		79.7±15.1	79.1±15.0		0.99
Postprandial glucose (mg/dl)		100.1±16.4	100.8±15.0		0.88
Fasting insulin (µIU/mL)					
Baseline mean	48(12)	9.8(7.1-12.5)	9.4(7.3-11.4)		0.06 (NS)
End of respective diet mean		7.6(5.0-10.2)	8.8(6.2-11.4)		
Change from baseline		-2.2[(-4.3-(-0.14)]	-0.6(-2.7-1.5)		
Absolute difference in % change from baseline				-13.5	

linear model. Paired samples *t*-test was used to assess the differences in the insulin responses from the baseline for the 2 diets. $P<0.05$ was considered to be statistically significant.

RESULTS

Table 1 shows the detailed menu for the both diets used in the study. Equivalent preparations (the difference was only the cereal component) with similar accompaniments were present in both the diets. The mean BMI and waist circumference of the volunteers were 20.9±1.8 kg/m^2 and 75.8±6.7 cm respectively. The average blood pressure of the participants was 108.4±16.1 mmHg (systolic) and 72.8±9.9 mmHg (diastolic). The percentage energy derived from carbohydrate, protein and fat were 61.5%, 13.6% and 26.6% respectively on average (Table 3).

Table 2 shows the average nutrient composition of both the diets. The diets were iso-caloric (2146 kcal/day and 2144 kcal/day for FM and WR based diets respectively) with similar carbohydrate content. The dietary glycaemic load (GL) was similar between the two diets (FM diet GL 209±26.3; WR diet GL 207±24.0) despite the FM diet having higher dietary fibre content (g/1000 kcal) compared to WR diet (29.9±1.8 g vs 15.8±1.3; $p<0.01$) g in WR based diets). The 5-day average glucose response to FM diet [Mean (95% CI) = 73.6(62.1-85.1) mg*min/dl] was similar to that of WR [Mean (95% CI) = 78.3(67.9-88.7) mg*min/dl] diet [$p=0.617$] (Table 4).

The cumulative change in interstitial glucose values from the baseline (average positive incremental area under the curve) is shown in Figure 2. There was no significant difference between the average postprandial glucose response of FM and WR diet (FM=100.1±16.4 vs WR=100.8±15.0; $p=0.880$). Further, we also observed no significant % change in fasting blood glucose at the end of the experiment between FM and WR (0.8). The average Δ insulin response for FM was -2.2[(-4.3-(-0.14)] µIU/ml and that of WR was -0.6(-2.7-1.5) µIU/ml. Though the % change in fasting insulin over the 5-day study period was 18% lower for FM-based diet compared to WR-based diet, this was only marginally significant.

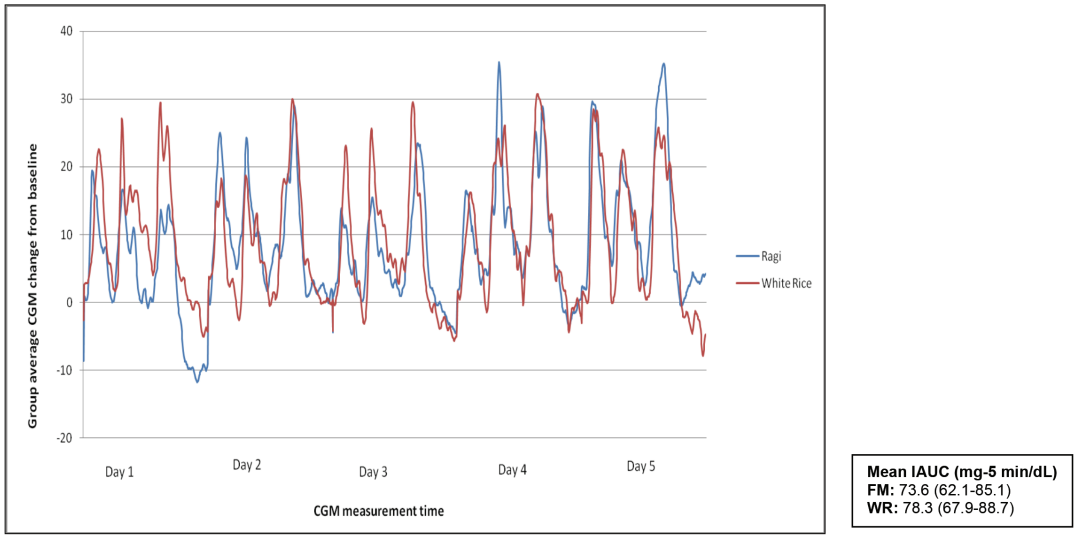

Figure 2. Average change in interstitial glucose concentrations from baseline of participants fed with finger millet and white rice based diets (n=12)

DISCUSSION

This study is to the best of our knowledge, the first of its kind to report on the 24 h interstitial glucose response to FM and WR based diets using CGM. We have examined beyond the 2 h blood glucose value to the glycaemic response of the whole using CGM. This gives us more holistic information about the two diets and their differences.

Despite higher fibre content, FM diet showed similar glycaemic response to iso-caloric WR diets among healthy Asian Indians. Dietary glycaemic load between FM and WR diets were also very similar. Fasting insulin was marginally decreased post-FM diet intervention.

Previous studies have demonstrated the usefulness of CGM in food research (Mohan *et al.*, 2014). Previous studies (Henry *et al.*, 2006; Mohan *et al.*, 2014) have demonstrated a lower 24 h IAUC for low-GI diets (lower in GL) compared to high-GI diets (higher GL) using CGM. In the present study, both the GI and GL were similar between FM and WR diets and this could be one of the explanations for similar 24 h glycaemic response.

WR contributes to nearly half of the daily calorie intake in south India. The high dietary glycaemic load and glycaemic index (GI) contributed by refined grains have been linked to an increased risk for metabolic syndrome and type 2 diabetes (Radhika *et al.*, 2009; Mohan *et al.*, 2009). Conversely, low GI and GL diets are known to be beneficial in lowering glycaemic and insulinaemic responses. Several studies have presented the beneficial effects of wholegrain consumption on the risk of diabetes, cardiovascular disease, and weight gain.

Moderate to high GI of FM foods may be due to the fragile endosperm which is typical to FM (Balasubramanian & Viswanathan, 2010). Unlike rice and other millets, cooked whole FM in the grain form is uncommon as it has very poor sensory qualities due to which the millet based preparations were flour-based since ancient days. Hence, FM-based food preparations (with fragile endosperm and finer particle size flour based) have higher digestibility characteristics as compared to other

cereal grain/flour- based preparations. In this study decorticated millet as a grain was used mainly during lunch in the FM diets. Earlier studies have also shown that the decorticated FM, either plain, cooked or served with '*dhal*' (lentil sauce), elicits a higher GI response similar like white rice (refined grain) (Shobana, 2009; Shobana *et al.*, 2011; Shobana *et al.*, 2018). These results are in agreement with our previous study on the glycaemic indices of minimally polished brown rice (MPR) and 24 h glycaemic responses of both brown and minimally polished rice diets (Mohan *et al.*, 2014; Shobana *et al.*, 2017) wherein even MPR showed glycaemic responses similar to that of WR. This indicates the detrimental effects of polishing of cereals/millets.

In the CGM menu, apart from decorticated millet, other millet-based preparations such as *adai* (pancake), *roti* (flattened bread, GI=104), dumplings (steamed FM balls, GI=68), preparations from the millet showed upper medium or higher glycaemic response, GI in earlier studies reported by several others (Urooj, Rupashri & Puttaraj, 2006).

The glycaemic response of cereal based preparations may depend on the nature of fibre present. There are studies which report that soluble fibres are more efficient in reducing the glycemic responses of foods (Brennan, 2005) such as beta glucans in oats and barley. FM dietary fibre is predominantly insoluble in nature (Devi *et al.*, 2014). Insoluble fibres are non-viscous and may protect the starch from digestive enzymes when they are intact. Any processing that disrupts its intactness, such as pulverising and grinding, may lead to loss in the functionality of insoluble fibre and thus allow rapid digestion of starch as in the case of bran flakes, breakfast cereals (Björck, Liljeberg & Östman, 2000). This could possibly explain the similar glycaemic response between FM and WR diets observed in the study despite the higher fibre content in FM-based diets.

Although prospective epidemiological studies have also shown that insoluble fibre can reduce incidence of type 2 diabetes, Jenkins *et al.* (2008) has shown that a low–glycaemic index diet was more effective than a high–cereal fibre diet in lowering HbA1C levels in subjects with type 2 Diabetes.

Several studies indicate that dietary polyphenols (from tea and cinnamon) are involved in insulin regulation (Anderson, 2008; Cameron *et al.*, 2008). Such studies are not available on the millet phenolics. FM seed coat is known to be a rich source of polyphenols and studies on these lines may throw light on the effect of FM phenolics on insulin regulation. However, in our present study, we found non-significant decrease in fasting insulin levels post five days of feeding FM diets and this warrants further evaluation with longer duration of feeding with FM diets.

Limitations of the study include the short duration of exposure with FM diets and small sample size. Studies with larger sample sizes with longer duration of feeding are needed to assess the long-term health effects of FM consumption, including among type 2 diabetic subjects. The strengths of our study include the randomised crossover and iso-caloric study design in which two diets were given to the participants in a random order, which enables us to fully control for within -subject differences in responses. The experimental kitchen at the centre where the study was performed had all the required facilities and well-trained research dietitians for standardising the test diet meals. CGM system (iPro2 model) is a minimally invasive glucose monitoring tool, thereby the participants were able to continue their day-to-day

activities while wearing the CGM device; hence the results are more representative of a real-life situation.

CONCLUSION

The use of several kinds of traditional South Indian preparations of FM allows us to examine the overall glycaemic response of commonly consumed finger millet foods as compared to that of WR-based preparations. The result suggests that use of FM flour-based food preparations and decorticated FM grains to replace WR in the Indian diets offer no significant benefit with regards to 24 h glycaemic response. However, studies of longer duration with larger sample size are needed to verify our findings.

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Authors' contributions

SS conceived the concept and initiated the first draft of the manuscript. RG and BRM conducted the CGM study and interpreted the data. CA and NL analysed the data and led the statistical analysis. VK and NG assisted in CGM study. MM incorporated the edits from different authors. VS, NGM, RU, RMA, CJKH, KK and VM reviewed the manuscript and helped with the interpretation of data. All authors contributed to their vision and finalization of the manuscript.

Conflict of interest

All authors do not have any conflict of interest. All authors declared that they have no duality of interest associated with this manuscript. No competing financial interests exist.

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SHORT COMMUNICATION

A randomised trial on walking exercise and banana consumption on self-reported depression symptoms among female adolescents in Surakarta, Indonesia

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ABSTRACT

Introduction: Depression disrupts an individual's well-being and is linked to the risk of degenerative disease. Previous studies suggested the effect of exercise and banana intake could induce the production of hormones that promote relaxation. This study examined the association between walking exercise and banana consumption on self-reported depression symptoms in female adolescents. **Methods:** This was a randomised controlled trial conducted in four high schools purposively selected in Surakarta. By using the Lemeshow formula, a total of 64 female students were recruited. Inclusion criteria were ages 15-17 years, normal body mass index (BMI)-for-age, consuming fruit <3 x/d, physical exercise <3 x/wk, non-smoking, non alcohol consumer, and not menstruating during study. The subjects were randomly distributed into four groups for the two-weeks study: (1) walking exercise daily for 1.6 km under 23 min, at a speed of 3.8 km/h on a treadmill; (2) banana intake of 2 servings daily (130 g/serving); (3) walking exercise and banana intake; and (4) control not prescribed banana or walking exercise. Self-reported depression symptoms was assessed by the Beck Depression Inventory II (BDI-II) questionnaire. Data were analysed using the linear regression model. **Results:** Banana consumption only (*MD*=-4.50, *SE*=1.92) and combination of walking exercise and banana consumption (*MD*=-5.36, *SD*=1.95) groups showed significantly lower depression scores at the end of intervention compared to the control group ($p<0.05$). **Conclusion:** Prescribed banana consumption or a combination of banana consumption and walking exercise showed potential for reducing self-reported depression symptoms among female adolescents.

Keywords: walking exercise, banana, depressive symptoms

INTRODUCTION

In 2015, 4.4% or 322 million people world-wide suffered from depression, which affects more women than men (5.1% and 3.6%, respectively) (WHO, 2017). As a single factor, it contributes to 4.3% of the burden of disability in the world in 2000 (WHO, 2013; Kessler *et al.,* 2013).

A nationally representative survey of adolescents aged 13-18 years in United States revealed 32% had anxiety disorders (Merikangas *et al.,* 2010). In

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Indonesia, the prevalence of mental health disorders characterised by depression symptoms was 6.0% among ages 15 years and older (Ministry of Health, Indonesia, 2013).

Lack of exercise was reported to be associated with an increased risk of depression (Hiles *et al.,* 2017). The review of Morgan *et al.* (2015) reported that exercise induces numerous molecular and neuronal adaptations in the brain stem, hypothalamus and basal ganglia. Exercise is known to increase β-endorphin, serotonin, dopamine, and norepinephrin and normalise cortisol levels (Melancon *et al.,* 2014; Sariss *et al.,* 2012; Morgan *et al.,* 2015). As such, exercise could be an alternative treatment or adjuvant for depression (Cleare *et al.,* 2015). Walking as an exercise decreases the grade of depression of pulmonary cancer patients (Chen *et al.,* 2015). An association between a high-quality diet of fruits and vegetables (≥5 times a day) with a lower risk of depression was reported in adults (Jacka *et al.,* 2011). Individuals who consumed more fruits and vegetables were associated with better mental health such as lower risk of depression (Carr *et al.,* 2013; Kulkarni *et al.,* 2015; McMartin *et al.,* 2013). Fruits are an important component of a low-energy healthy diet and are rich in vitamins, minerals, and numerous bioactive compounds with potential effects on brain health (Biswajit *et al.,* 2017). Bananas contain phenolics, carotenoids, biogenic amines, phytosterols, and minerals that have been associated with reduction of oxidative damage in cell membrane, and depression (Singh *et al.*, 2016; Scapagnini *et al.*, 2012). Bananas are reportedly used for treating depression in Iran and India (Tavakkoli-Kakhki *et al.*, 2014; Kumar *et al.*, 2012).

Depressed adolescents are likely to be more susceptible to eating disorders, dependency on drugs, and suicidal tendency (Thapar *et al.,* 2012). Studies have shown gender differences in patients with mental disorders, i.e. higher incidence of mood and anxiety disorders among females. Halley *et al.* (2013) found that more than half of the women population with depression experienced severe symptoms of depression during menstruation. Estrogen levels are 5-8 times higher compared to non-menstruation periods, and estrogen has a positive impact on corticotropin releasing factor (CRF). Findings of gender differences in CRF receptor signalling results in an enhanced arousal response and a compromised ability to adapt to chronic stress in females (Valentino *et al.,* 2012).

MATERIALS AND METHODS

This was a randomised controlled study conducted in four high schools purposively selected in Surakarta, Central Java. The inclusion criteria were: female adolescents aged 15-17 years, had a normal nutritional status [BMI-for-age *z*-score (≥-2SD - ≤+1SD)], reported fruit intake of <3 servings/d, exercise <3 times/wk, did not smoke and drink alcohol. Individuals with history of asthma or cardiac disease, an allergy to bananas, currently on an antidepressant course, taking omega-3 fatty acid supplements daily in the last one month, were excluded from the study. Screening was performed on subjects who filled out the demographic questionnaire. Body weight and height measurements were taken for calculating body mass index. It was conducted for a 2 wk period and another 2 wk washout period in-between from January 2018 to March 2018. The subjects gave informed consent and anonymity was maintained. By applying Lameshow formula, 44 subjects were calculated by adding 40% of total samples (Dettori, 2011). A total of 64 subjects were recruited and

randomised into four groups: (1) walking exercise only; (2) consuming banana only; (3) walking exercise and consuming banana and (4) control without walking exercise and consuming banana. They were asked to maintain their regular daily activities and diet (see Figure 1).

Walking exercise was performed 3 times/wk throughout the 2-weeks study. The exercise velocity, frequency, duration, and distance were all conducted and recorded under supervision. In each exercise session, each subject had to walk a distance of 1.6 km under 23 min, at a speed of 3.8 km/h on a treadmill (Precor 956i USA) in a fitness centre. During the exercise, subjects were accompanied by an instructor, and had a 5 min warm-up at the start and a 5 min cool down at the end. A piece of banana (*Musa Paradisaca var Sapientum L Kuntze*), also known as Ambon banana, was served two times/day (130 g/serving) throughout the 2 wk study. The bananas were weighed to ensure consistency of weight per serving.

The Beck Depression Inventory-II (BDI-II) questionnaire was selected as its validity and reliability for the general population of Indonesia was shown to have a Cronbach's alpha coefficient of >0.90 (Ginting *et al.,* 2013). It consists of 21 questions, each being scored on

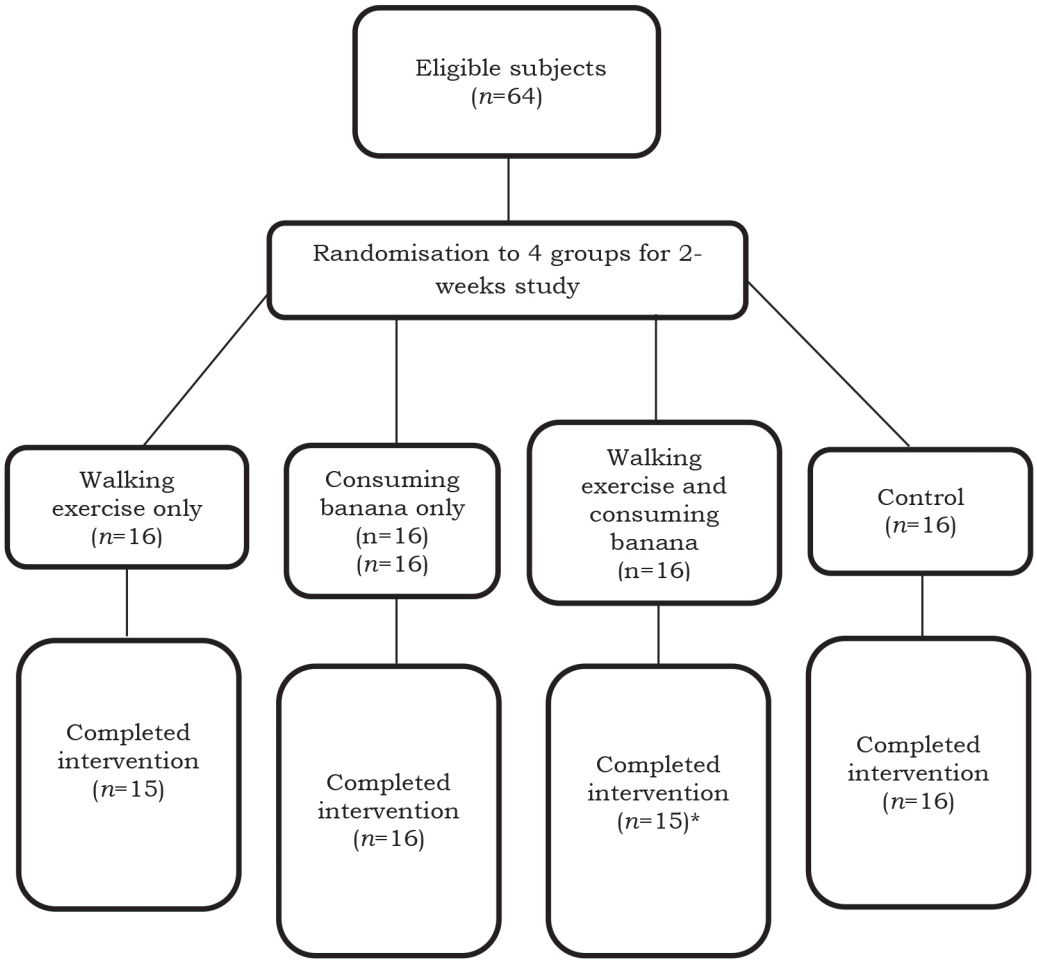

Figure 1. Study flow diagram of subjects randomised into four intervention groups

a scale value of 0 to 3, hence, the total score ranged from 0-63. Higher total scores indicate the presence of severe symptoms of depressive disorders:

- Score of 14–19: mild depression
- Score of 20–28: moderate depression
- Score of 29–63: severe depression

The subjects completed the Beck Depression Inventory questionnaire both before and at the end of the 2 wk intervention study.

IBM SPSS statistics v. 21 software was used for statistical analyses. Data normality was determined using the Kolmogorov-Smirnov test; while the homogeneity of the data was tested using the Levene test. Paired *t*-test was performed to describe the differences in the symptoms of depression before and after intervention with a $p<0.01$. In order to evaluate the effect of the intervention on all four groups, a one-way ANOVA was conducted followed by a post-hoc least significant difference (LSD) test with significance of $p<0.05$.

The study protocol was approved by the institutional review board of Health Research Ethics Committee of *Rumah Sakit Umum Daerah* (RSDU) Dr Moewardi, and Faculty of Medicine Universitas Sebelas Maret Surakarta with ethical number 1.175/XII/HREC/2017, and all procedures involving human subjects were performed in accordance with ethical standards.

RESULTS

There were significant differences in the self-reported scores for depression symptoms between each of the treatment groups and control before and after the intervention. Walking exercise only, consuming banana

Table 1. Differences in self-reported depression symptoms scores before and after intervention

Group	*Before Intervention (M±SD)*	*After Intervention (M±SD)*	*Paired t-test*	*p-value*
Walking exercise only	17.27±5.02	10.00±5.37	7.08	<0.001***
Banana consumption only	15.44±6.86	8.06±6.50	6.75	<0.001***
Walking exercise and banana consumption	13.27±4.02	7.20±4.81	6.26	<0.001***
Control	14.44±4.98	12.56±4.80	2.59	0.020*

*$p<0.05$; ***$p<0.001$

Table 2. Results of post-hoc test among intervention groups

Group	*Mean Difference*	*SE*	*p-value*	*95% CI*
Walking exercise only vs control	-2.563	1.951	0.194	-8.34, -0.66
Banana consumption only vs control	-4.500	1.919	0.022*	-6.47, 1.34
Banana consumption vs walking exercise	-1.938	1.951	0.325	-5.84, 1.97
Walking exercise and banana consumption vs control	-5.363	1.951	0.008*	-9.27, 1.46
Walking exercise and banana consumption vs walking exercise only	-2.800	1.982	0.163	-6.77, 1.17
Walking exercise and banana consumption vs banana consumption only	-0.863	1.951	0.660	-1.97, 5.84

SE=Standard error; CI=Confidence interval; *$p<0.05$

only, and the combined walking and banana consumption groups showed significantly lower depression symptoms scores compared to the control group (Table 1).

The post-hoc LSD test showed significant differences in the average depression scores between the banana consumption only group, the combined walking exercise and banana consumption group and the control group (p=0.022 and p=0.008, respectively) (Table 2).

DISCUSSION

To the best of our knowledge, this is the first study that investigated the impact of walking exercise and banana diet on self-reported symptoms of depression in a sample of female adolescents in Surakarta, Indonesia. The study showed that walking exercise, banana consumption, or combined showed potential of lessening self-reported depression symptoms. However, caution should be exercised when using the BDI-II "as a screen in nonpsychiatric populations where the base rate for major depression may be substantially lower" (Beck *et al.*, 1996).

Research has shown exercise to be an alternative, effective treatment for depression (Rethorst & Trivedi, 2013). In a meta analysis of exercise as a treatment for depression, Kvam *et al.* (2016) reported that physical exercise showed a significant effect on unipolar depression compared to control condition. Walking was the most preferred form of exercise, requires low expenses and is easy to perform (Busch *et al.,* 2016). Chen *et al.* (2015) found that 40 min of walking per day, 3 times/wk for 12 wk may reduce anxiety and depression in pulmonary cancer outpatients. However, Vanroy *et al.* (2017), found that 10 wk of walking exercise did not reduce depression in adults.

Walking on a treadmill for 30-45 min/wk for 8 wk may reduce the symptoms of depression in male and female patients of 18–30 years of age with major depression disorder (Olson *et al.,* 2017). Other studies that combined walking exercise and pharmacologic treatments showed that 6.4 km/h walks for 210 min/wk were associated with a greater improvement of depressive symptoms versus 4.8 km/h walks for 75 min/wk (Trivedi *et al.,* 2011).

A study of 100 college students with an average age of 19 years showed that snacking on one apple or banana daily for 10 days reduced their anxiety disorder compared to taking chocolate wafer or potato chips (Smith & Rogers, 2014). Carr *et al.* (2013) found that males aged 15-35 years who ate two kiwi fruits daily for 6 wk had reduced depression scores. Another study reported that adults who consumed a fruit and a vegetable for 14 d, showed decreased symptoms of depression, although the change was not statistically significant (Conner *et al.,* 2017).

The limitation of this study was the inability to control the homogeneity of dietary habits, food intake and other sports activity among subjects, as the movement of the subjects was not restricted.

CONCLUSION

Banana consumption only, or combined banana consumption and walking exercise as prescribed in this study for two weeks showed potential as an option to current strategies for treating depression symptoms. More studies are suggested using various types of fruit and exercise on a larger sample size.

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Authors' contributions

PES, conceptualised and designed the study, prepared the draft, led the data collection, created the manuscript; WB led the data collection, advised on data analysis and interpretation, and reviewed the manuscript; AS led the data collection, advised on data analysis and interpretation, and reviewed the manuscript.

Conflict of interest

The authors declare no conflict of interest and no financial interests.

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