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Development and Evaluation of a Culturally Sensitive Food Frequency Questionnaire for the Assessment of Prebiotic and Probiotic Intake of Urban-living, Low-to-medium-income Women

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Modern food product development has introduced maternal consumers to functional foods. Prebiotics and probiotics are well-known functional food components. This study developed a culturally sensitive, qualitative food frequency questionnaire (FFQ) to assess the prebiotic and probiotic intakes of healthy, urban-living Filipino women. Food items in the developed FFQ were based on five datasets of information. Reproducibility was tested by comparing respondents' (n = 73) responses on Day 30 (FFQ_1) and Day 31 (FFQ_2). Verification of the developed tool was conducted by comparing responses from the FFQs with multiple food recalls obtained from the same respondents and sampling time. Thirteen (13) food groups with 39 unique food items were included in the developed FFQ. Binomial results showed matched responses of food items (38/39) between FFQ_1 and FFQ_2. Comparison of the results of FFQ and multiple food recalls showed highly similar responses. The developed FFQ to assess prebiotic and probiotic intakes of women was reproducible and has been verified.

Keywords: food frequency questionnaire, maternal nutritional status, prebiotic, probiotic, reproducibility, verification

INTRODUCTION

Good nutrition during pregnancy has long been recognized as important for adequate fetal growth and desirable pregnancy outcomes (Marangoni *et al.* 2016). Weight gain during pregnancy is determined by overall nutrition adequacy, which is highly dependent on a sufficient supply of calories and essential nutrients (Baer *et al.* 2005). Therefore, adequate maternal intake of macronutrients such as carbohydrates, protein, and fatty acids – and micronutrients such as zinc, iron, folate, vitamin C, and calcium – has been recommended (Jensen 1995, Baer *et al.* 2005, Bayaga and Gavino 2006, Ballard and Morrow 2013).

Apart from the commonly measured nutrients in food products, the advent of modern food product development

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and food processing has introduced consumers to the so-called functional food components, which may be naturally present in or added to food to aid specific body functions in addition to being nutritious (Hill *et al.* 2014). This is particularly true among consumers in urban settings where processed food products are ubiquitous and readily available. Prebiotics and probiotics are some of the more well-known functional food components. Pérez-Cornago *et al.* (2015) explained that prebiotics are substances such as fructo- and galacto-oligosaccharides (FOS and GOS) that induce the growth or activity of beneficial microorganisms in the gastrointestinal tract, thereby contributing to the well-being of their host. Biesiekierski *et al.* (2011) also stated that some short-chain carbohydrates (SCCs) are considered potentially problematic in the gut because they can be fermented. These food items have been grouped and named FODMAPs (fermentable oligosaccharides, disaccharides, monosaccharides, and polyols).

Prebiotics – which are present in some fruits, vegetables, and whole grains – help increase the intestinal growth of beneficial bacteria such as *Bifidobacteria* and *Lactobacilli* that consequently reduce the presence of some pathogenic bacteria in the gut, including *Clostridium difficile* and *Enterobacteriaceae*. Based on the 2013 results of the National Nutrition Survey, the common diet of the adult Filipino women consisted of identifiable sources of prebiotics. These include cereals and cereal products, vegetables, fruits, sweetened beverages like soft drinks and powdered juices, and instant coffee (DOST-FNRI 2013). The food intake of pregnant and lactating Filipino women do not differ much compared to the food intake of the adult Filipino women, except for the higher rate of consumption of milk and milk products in the former groups. Milk and milk products may also be considered as prebiotic due to the presence of lactose, which may be fermented by the gut microbiota.

On the other hand, probiotics are live microorganisms that – upon ingestion in certain numbers – exert health benefits through the improvement of host intestinal balance (Hill *et al.* 2014). Examples include *Lactobacillus rhamnosus* GG and *Bifidobacterium animalis* ssp. *lactis*. Common local food products that may be considered as vehicles of probiotics include yogurt, miso, soy milk, milk, dark chocolate, pickles, olives, and other fermented food products (Dunn *et al.* 2011, Peres *et al.* 2012, Shori 2016).

Recognizing the continuous increase in consumer acceptance and patronage of functional foods – including those with prebiotics and probiotics – measuring their intake together with other commonly accounted for nutrients is imperative, particularly in studies that establish a relationship of consumption rates and nutritional/health status of a target population. However – for functional food components – quantitative measurement is impeded by the lack of composition databases, the establishment of which require significant input of resources. For prebiotics, accurate data are available only for major food commodity sources (van Loo *et al.* 1995, Campbell *et al.* 1997), although recent data have been reported in Australian fruits and vegetables (Muir *et al.* 2007, 2009). However, there remains little data for composite foods such as bread, pasta, noodles, various traditional fermented foods, *etc.*

Furthermore, problems associated with quantifying nutrient intakes are well-documented. Although considered as the gold standard in dietary assessment, Bingham *et al.* (1994) and Dunn *et al.* (2011) explained that weighed food diaries entail high participant motivation, high respondent burden, and lengthy data handling. FFQs – on the other hand – can provide a rapid, accurate, and inexpensive method for dietary assessment. In the absence of databases that can be used to quantitatively measure the intake of nutrients from the diet, FFQs can also be used to qualitatively describe the regularity of specific nutrient intake. The FFQ is a tool that allows consumers to recall the frequency and portion sizes of foods consumed over a specific time period; and are extensively employed in epidemiologic research due to their low cost, time-effectiveness, and ease of use (Gonzáles-Carrascosa *et al.* 2011). FFQs – which focused on measuring intakes of specific nutrients (Kent and Charlton 2017), food commodities (Burrows *et al.* 2015), or dietary components (Dunn *et al.* 2011) – have been used extensively in epidemiologic studies. However, a clear limitation is that when using FFQs to assess the intake of a specific population with unique dietary practices and food use, it is critical that the instrument be culturally appropriate to the population of interest (Pakseresht and Sharma 2010, Papazian *et al.* 2016). Furthermore, an FFQ should also be developed taking into consideration the characteristics of the target population such as lifecycle stage, physiological state, socioeconomic stratum, and other target population-specific characteristics. Location of residence should also be noted as this significantly influences the type of food availability.

With these considerations, this study aimed to develop a culturally sensitive, qualitative FFQ that can be used to assess prebiotic and probiotic intakes of urban-living Filipino women with low- to medium-income – including those of pregnant, lactating, and apparently normal healthy subjects. The developed tool was also evaluated for reproducibility and its functionality was verified using multiple 24-hour food recalls. Measuring prebiotic and probiotic intakes using a culturally sensitive, reproducible tool together with other nutrients is imperative to establish a relationship of consumption rates and nutritional status of a population.

METHODS

Ethics Clearance

All volunteers who participated in this study gave written informed consent to the protocol, which was approved by the Far Eastern University – Nicanor Reyes Memorial Foundation (FEU-NRMF) Institutional Ethics Review Committee, Diliman, Quezon City (Reference # FEU-NRMF IERC 2016-0114).

Study Sites

The cities of Makati, Mandaluyong, and Taguig in the National Capital Region (NCR), Philippines (Figure 1) were selected as study sites due to an organized nutrition consultation system implemented in these cities by their respective City Nutrition Offices. These systems allowed for easier home visits needed to achieve the objectives of the study. All study areas chosen carried the distinct characteristics of urbanized and commercial cities in the NCR. These included the following: (1) the residents of the study sites are engaged in nonagricultural jobs; (2) all three cities have a dense concentration of infrastructures such as houses, commercial buildings, roads, bridges, and railways; and (3) all three cities have crowded population. The Philippine National Census data of 2015 indicated that the population in these cities ranked 4th (Taguig), 9th (Makati), and 13th (Mandaluyong) in the NCR. Also, the majority of *barangays* in Makati City have health centers, which serve as the primary health care unit for the participants. These health centers served as the recruitment venue for the study. Each health center has nutrition staff familiar with the area and served as a guide during home visits. The cities of Mandaluyong and Taguig were the study sites for the reproducibility evaluation of the FFQ.

Figure 1. Markers show study sites where data in the FFQ development, reproducibility, and validity evaluations were obtained included the cities of Makati, Mandaluyong, and Taguig. The location of the laboratory where the study was conducted (Quezon City) is also marked.

Study Design

This research is a cross-sectional study, conducted as a part of a larger semi-longitudinal study aimed to establish the effect of maternal dietary intake on the microbiological and biochemical characteristics of their breastmilk. Figure 2 summarizes the steps taken by the investigators in the implementation of this study being reported.

Study Participants

The study employed unique sets of participants in each of the steps taken towards the development, pretest, reproducibility, and verification of the FFQ summarized in Table 1. The characteristics of these unique groups and their involvement in this study are presented in Table 1. In the selection of participants for the various stages of the study, the following criteria were followed. All participants should be 18–55 years; did not have present and past underlying conditions such as diabetes, dyslipidemia, cancer, an endocrine disorder, and chronic inflammation; and who may or may not be pregnant and lactating. All participants invited to be involved in the study were randomly selected from the clients who consulted at the barangay health centers for a specified duration *i.e.*, from August to October 2016. A total of 205 mothers were invited to participate in the study. Six mothers dropped out due to schedule conflicts with the face-to-face interviews and food recalls administration.

Development of the Qualitative FFQ

In order to come up with food items to be included in the FFQ, the study explored five datasets as sources of information. These datasets included (1) responses from completed food habits survey; (2) single 24-hour food

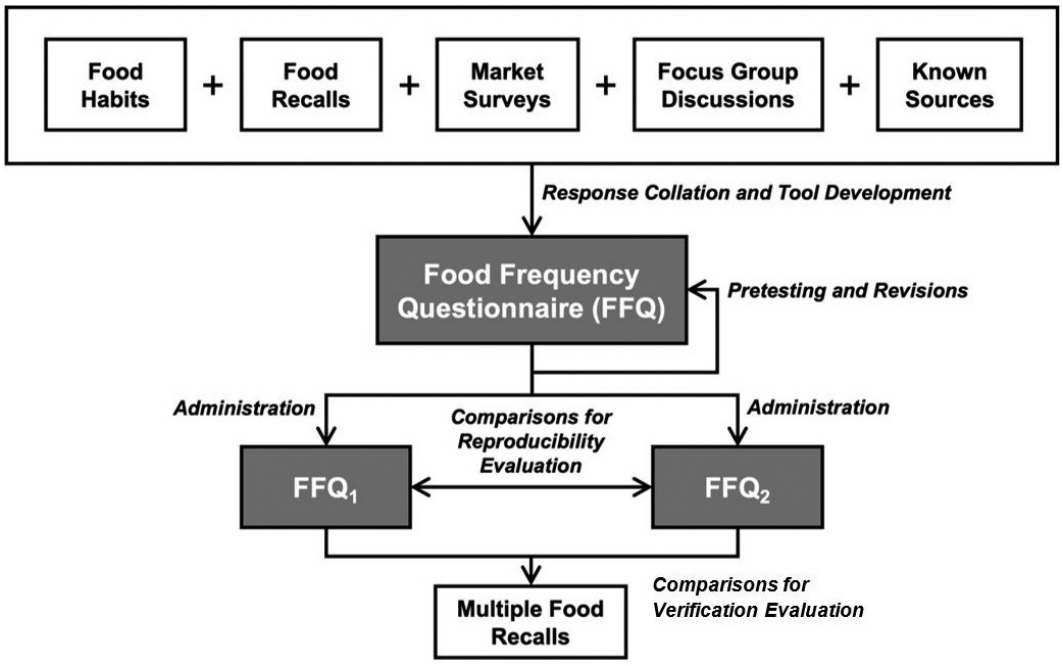

Figure 2. Schematic representation of the steps conducted in the development and evaluation of qualitative FFQ for prebiotic and probiotic intakes of identified target population.

Table 1. Participants profile, inclusion criteria, and their involvement in the development and evaluation of the FFQ.

Phase	Activity	Physiological state	n	Age
Development	Food habits and single 24-hour food recall	Pregnant	100	29.97 ± 6.60
		Lactating	99	30.66 ± 7.68
	Focus group discussion	Pregnant	6	28.00 ± 0.00
		Lactating	8	28.89 ± 5.54
		Non-pregnant, non-lactating	5	47.80 ± 15.80
Reproducibility and Verification	FFQ_1, FFQ_2, and three 24-hour food recalls	Pregnant	22	26.68 ± 5.72
		Lactating	23	27.78 ± 5.95
		Non-pregnant, non-lactating	28	35.36 ± 8.30

recalls; (3) surveys of common food sources accessible to the participants' residences; (4) answers from focus group discussions (FGDs); and (5) literature review on commonly available food items that are sources of FOS and GOS, FODMAPs, and glucose metabolism of *Bifidobacteria* (Campbell *et al.* 1997, Moshfegh *et al.* 1999, Muir *et al.* 2007, Martínez-Villaluenga *et al.* 2008, Biesiekierski *et al.* 2011, Dunn *et al.* 2011, Shu *et al.* 2014).

In the food habits survey and single 24-hour food recall, the participants were interviewed to complete questionnaires with the objective of obtaining general knowledge of commonly consumed prebiotic and probiotic food items. For the market surveys, the most commonly visited food sources (n = 5) identified from the food habits survey were visited. The surveys were done to confirm the available prebiotic and probiotics food in the locality and identify other prebiotics and probiotics that might have not been enumerated in the food habits survey. The food sources included wet markets located in four *barangays* of Makati City. FGDs were also conducted to determine if the prebiotic and probiotic food items available in the food sources and if those identified in the food habits survey questionnaire were actually being consumed by the participants. Reasons for the consumption of these food items were also asked. All questionnaires and guide questions used in the information gathering were written in Filipino and English. The developed qualitative FFQ

was pretested to ensure that the tool is acceptable to and easily understood by the target population. Revisions were made accordingly.

Previously trained licensed nutritionists-dietitians (RNDs) assisted in all steps of tool development and evaluation.

Evaluation of the Reproducibility of the Developed FFQ

The reproducibility of the developed qualitative FFQ was evaluated by administering the developed and pretested FFQ on Days 30 and 31 of a test month. These were labeled FFQ_1 and FFQ_2, respectively. The developed tool was deemed reproducible if the frequency responses obtained per food item from the two FFQs were not different. The same RND administered both FFQ_1 and FFQ_2 to the same participant.

Verification of the Developed FFQ

To determine if the prebiotic and probiotic food items listed in the developed FFQ – which represent usual intake – are reflected in the current intake of the intended target population, the results obtained from FFQ_1 and FFQ_2 were compared to food intake obtained from the same pool of participants measured by 24-hour food recalls. In the same month as the FFQ_1 and FFQ_2 were administered, three 24-hour food recalls were obtained from two weekdays and one weekend sampling times. During data gathering, participants were instructed to continue their normal consumption patterns. To assist participants in estimating the actual portions or amounts consumed, participants were shown common household measuring utensils (*e.g.*, cup, tablespoon, teaspoon, ruler, and thickness pads). RNDs administered all food recalls.

Statistical Analysis

The responses obtained in the two FFQs administered in the reproducibility phase were subjected to a two-tailed binomial test to determine if the responses for the two questionnaires matched (similar) or were mismatched (different). STATA Version 13.0 (Copyright 1985-2013 MP-Parallel Edition) was used in the analysis. The null hypothesis for this test was that the responses from both FFQs were independent of one another. The alternative hypothesis, then, was that the responses from both FFQs are dependent on each other. Individual responses per food item for both FFQs were placed side by side. If the responses matched, these were coded as 1 while for mismatched responses the code was 0. These responses were subjected to the binomial test. The level of significance was set at 0.05 based on a review of literature on binomial tests. Binomial results with p values of < 0.05 indicated matched response, while those $p \geq 0.05$ indicate mismatched responses.

In all the FGDs, the responses were organized by identifying common concepts, trends, themes, behaviors, terminologies, or phrases. During the process of organizing the data, patterns, connections, relationships, and trends that may develop from the responses were noted to substantiate results.

For the verification phase, the 15 most consumed food items from the three-day, 24-hour food recalls were compared to the 15 most consumed food items from the FFQs. To determine the most consumed food items from the recalls, all unique food items mentioned were listed. The number of times each unique food item appeared in the recall was counted, summed, and ranked from highest to lowest. Ranking of the most consumed food from the recalls was done based on frequency instead of usual weight of the food items because the recall responses were compared to a qualitative FFQ *i.e.*, there is no food weight involved, only frequency of consumption. For the FFQ, consumption frequencies were assigned where 'never' is 1, 'once a month' is 2, '2–3x a month' is 3, 'once a week' is 4, '2–3x a week' is 5, '4–6x a week' is 6, and 'once or more than once daily' is 7. The consumption frequencies of the responses from both FFQ_1 and FFQ_2 were added per each food item. The average frequency per each food item was calculated and ranked from the highest frequency of consumption to the lowest.

RESULTS

Development of the Qualitative FFQ

Results obtained from the food habits and food recall surveys (data not presented) revealed that the food items most commonly consumed by all participants that are potential sources of probiotics and prebiotics are rice, yeast bread (*pan de sal*), sweet rolls, doughnuts, and vegetables like squash (*Cucurbita maxima*) and *malunggay* or moringa (*Moringa oleifera*). Interestingly, consumption of a popular commercially available probiotic (Yakult™) was common among the participants.

During the food habits survey, five common procurement places (data not presented) were identified. These are wet markets located in Makati City, namely in *barangays* Comembo (n = 1), Rizal (n = 2), Olympia (n = 1), and East Rembo (n = 1). All of these food sources were visited to come up with a more inclusive list of prebiotics- and probiotics-containing food items that could potentially be consumed by the target population, which were not determined in the food habits and food recall surveys. All wet markets were found to be sources (data not presented) of a variety of cereals (white rice, brown rice, and glutinous rice); noodles (*bihon* and *miswa*); root

crops (potatoes, sweet potato, *ube*, taro, and cassava); dehydrated alimentary paste (spaghetti and macaroni); and yellow and white corn varieties. Baked products are also available in all markets, which included yeast breads (loaves and buns) and soda crackers. Vegetables such as cabbages (*Brassica oleracea, B. rapa*); bitter gourd; onion; and garlic are also available in all five markets visited. For fruits, the common items sold in all five markets were banana, apple, orange, coconut, ripe and unripe mango, ripe and unripe papaya, and pineapple. Beans and legumes available in all five markets are mung beans (*Vigna radiata*), mung bean sprouts, *tausi* (fermented black soybeans), *tokwa* (pressed soybean curd), and repacked peanuts. Yakult™ is also available in all the markets visited.

Results of the FGDs confirmed consumption of the prebiotics and probiotics sources enumerated in the food habits, food recalls, and market surveys. Unlike in the larger group that participated in the food habits and food recall surveys, it was noted that Yakult™ consumption was very high (94.7%) in the FGD groups; 74% of respondents drink the product on a daily basis. Other sources of probiotics and prebiotics such as fermented fruits, vegetables, grains, and fermented bean products were also determined in the FGDs, although at a considerably lower rate.

In addition to the literature review, the information gathered from these enumerated activities were used as the basis for formulating the FFQ, which intends to measure the frequency of consumption of prebiotic and probiotic food items in the immediate past month. Table 2 summarizes the 13 food groups (rice and products, root crops and products, noodles, cereals, breads, peanuts and beans and products, milk and related products, fermented food products, fruits, vegetables, other baked products consumed as snacks, high-sugar foods, and non-dairy beverages) and the specific food items included in each group in the FFQ contained in the nine-page questionnaire developed for this study. Overall, 39 specific food items were included in the developed FFQ. Furthermore, to represent the frequency of consumption of each of the listed food items, frequency descriptors namely 'never,' 'once a month,' '2–3x a month,' 'once a week,' '2–3x a week,' '4–6x a week,' and 'once or more than once daily' were indicated in the questionnaire. Only food items reported as being consumed at least once a week were included in the final FFQ.

Table 2. Food groups and specific food items per food group included in the developed qualitative FFQ.

Food groups	Food items listed under the food groups[1]
Grains and products	Cooked rice Corn Native rice cakes and delicacies Corn chips
Root crops and products	Boiled root crops Potato chips French fries Cassava cake
Noodles	Noodles and pasta Instant noodles
Cereals	Breakfast cereals Instant oatmeal Cereal drinks
Breads	Loaf bread and related products
Peanuts, beans, and products	Mung bean Mung bean sprouts Tofu Peanuts Peanut butter
Milk and related products	Milk (powdered or liquid fresh) Soya milk Chocolate flavored milk Evaporated milk Cheese Ice cream
Fermented food products	Yakult™ Yogurt *Tausi* (fermented black soy beans) *Miso* (fermented soy bean paste) Fermented viand
Fruits	Various types of fruits Fruit juice
Vegetables	Various types of vegetables
Biscuits eaten as snacks	
Sugary foods	Chocolates
Beverages	Soda Powdered juices Flavored green tea Beer

[1]In the developed FFQ, consumption frequencies were measured with the following categories: 'never,' 'once a month,' '2–3x a month,' 'once a week,' '2–3x a week,' '4–6x a week,' and 'once or more than once daily.'

Reproducibility of the FFQ

Reproducibility of the developed tool was assessed by comparing responses obtained from FFQ_1 and FFQ_2. Table 3 summarizes the results of the binomial test for the comparability of the responses obtained in the FFQ_1 and FFQ_2 obtained from all participants. Observed k in the table reflects the observed matched cases out of the total 73 responses. Results of responses in the FFQ_1 and FFQ_2 matched in 38 of 39 (97.44%) food items, with $p < 0.05$. The only response that did not match was that of French fries ($p > 0.06$), a common fast food item served in the urban areas. Overall, based on these results, the study deemed that the developed FFQ was reproducible.

Table 3. Binomial test of the FFQ responses of all the participants.

Food item	Participant responses (n = 73)	
	Observed k	*p*
Boiled rice	73	0.0000*
Boiled corn	51	0.0009*
Rice cakes	47	0.0186*
Corn chips	48	0.0095*
Cereal drink	59	0.0000*
Root crops	50	0.0021*
Potato chips	48	0.0095*
French fries	45	0.0603
Cassava cake	53	0.0001*
Pasta and noodles	52	0.0003*
Instant *Pancit Canton*	56	0.0000*
Breakfast cereals	63	0.0000*
Instant oatmeal	60	0.0000*
Breads	57	0.0000*
Mung bean or mung bean sprouts	52	0.0003*
Tofu or *Taho*	51	0.0009*
Peanuts	52	0.0003*
Peanut butter	49	0.0046*
Milk	56	0.0000*
Soymilk	66	0.0000*
Chocolate milk	59	0.0000*
Evaporated milk	53	0.0001*
Cheese	49	0.0046*
Ice cream	53	0.0001*
Yakult™	59	0.0000*
Yogurt	68	0.0000*
Tausi	66	0.0000*
Miso	57	0.0000*
Buro	59	0.0000*
Fruits	58	0.0000*
Fruit juice	61	0.0000*
Vegetables	61	0.0000*
Cookies	58	0.0000*
Cake	47	0.0186*
Chocolates	51	0.0009*
Soft drinks	54	0.0000*
Powdered juice	56	0.0000*
C2 Green Tea™	56	0.0000*
Beer	70	0.0000*

*Matched responses between FFQ_1 and FFQ_2 at $p < 0.05$ level of significance

Verification of the FFQ with 24-hour Recalls

Verification of the FFQ was determined by comparing the responses obtained from the developed tool to those obtained from multiple 24-hour food recalls. In this study, verification means comparing what is usually eaten – reflected in the FFQ responses – with the current diet obtained from the 24-hour recalls. Table 4 summarizes the results of the comparison of 15 most commonly consumed foods according to these two tools. Results showed that from the FFQ responses, rice was the only item consumed daily (at least once a day) and the rest of the items were eaten on a weekly basis (at least once to 6x a week). These are bread and related products, vegetables, fruits, cookies, pasta and noodles, mung beans and mung bean sprouts, soft drinks, chocolate and chocolate drinks, cakes, pies, doughnuts, powdered juice drink, root crops, milk, and French fries. Results revealed that the responses for the recalls and the FFQ were highly similar but did not match perfectly, in terms of types of food and frequency of consumption. Rice was (most commonly) regularly consumed based on the two tools. Among the responses obtained from the 24-hour food multiple recalls, only the consumption of 3-in-1 instant coffee did not have a counterpart response in the FFQ. Moreover, it can be

Table 4. Most commonly consumed food items that are potential sources of prebiotics and probiotics measured by multiple 24-hour food recalls and FFQ.

Rank	24-hour food recalls	FFQ[1]
1	Rice (n = 414)	Cereal and products (daily)
2	3-in-1 coffee (n = 120)	Breads and related products (weekly)
3	Milk (n = 102)	Vegetables (weekly)
4	Yeast bread (n = 64)	Fruits (weekly)
5	Soft drinks (n = 44)	Cookies and crackers (weekly)
6	Carrot (n = 51)	Pasta and noodles (weekly)
7	Cabbage (n = 47)	Mung beans and mung bean sprouts (weekly)
8	Noodles (n = 45)	Soft drinks (weekly)
9	Loaf bread (n = 37)	Chocolate (weekly)
10	String beans (n = 32) Chayote (n = 32)	Cake, pie, doughnut (weekly)
11	Instant noodles (n = 26)	Powdered juice drink (weekly)
12	Okra (n = 24)	Root crop (weekly)
13	Fried rice (n = 23)	Chocolate drink (weekly)
14	Potato (n = 22) Squash (n = 22)	Milk (weekly)
15	Chocolate drink (n = 18)	French fries (weekly)

[1]Daily means at least once a day; weekly means once to 6x a week

observed that more specific responses were determined in the food recalls compared to those in the FFQ. For example, food recall entries such as cabbage, string beans, chayote, okra, and squash were included under vegetables in the FFQ; while carrot and potato in the food recall responses were considered under root crops in the FFQ. Cakes, pies, doughnuts, and chocolates were responses in the FFQ that did not have equivalent responses in the 24-hour food recalls. The observed discrepancies may be attributed to the nature of the tools used and differences in the considered time frames from which the food intakes were measured. Recalls ask participants to remember all food intake within the last 24 hours compared to FFQs which ask participants to estimate the frequency of intakes of certain food items within a longer period of time frame (*e.g.*, one year). Thus, more specific food items are remembered and listed in the recalls than in FFQs. However, since the FFQ required the respondents to recall consumption of prebiotics and probiotics within the immediate past month (usual consumption), and the food recalls were obtained only within a more specific and shorter time frame (current consumption), greater diversity in food intake of prebiotics and probiotics was observed in the FFQs. The developed FFQ was more inclusive of all prebiotic- and probiotic-containing foods that may be consumed by the intended participants and are available within their immediate vicinities.

Nevertheless, considering the objective of this study, the responses obtained from the developed tool were verified with the multiple 24-hour recalls.

DISCUSSION

To the investigators' knowledge, this is the first attempt in the Philippines to develop a culturally sensitive tool that allows for the estimation of the frequency of intake of prebiotics and probiotics foods in the diet of urban-living Filipino women of low to medium income. The only known FFQ that measures prebiotic intake that emphasized on foods containing inulin and oligosaccharides was conducted in London, England – which involved apparently healthy adult males and females (Dunn *et al.* 2011). Majority of reports in the literature look into the relationship of probiotic supplements intake and autism, depression, diabetes, hypocholesterolemia, irritable bowel syndrome, constipation, lactose intolerance, obesity, cancer, vaginitis, bone density, and immunity. Probiotics are easier to identify than prebiotics in the current and usual diets. Probiotics are usually in the form of supplements or foods which contain live microorganisms with or without health claims (Hill *et al.* 2014). On the other hand – as reported by Biesiekierski *et al.* (2011) – prebiotic carbohydrates like FOS, GOS, and SCCs are naturally present in the diet, yet there are no convenient and accurate methods of measuring this food component in dietary frequency and/or intakes. Examples of food items that may contain prebiotics are fruits, vegetables, grains, and cereals. In the same article, FODMAPs were also cited to probably have a similar prebiotic effect in the gut. FODMAPs are found in a wide variety of foods and include lactose; fructose in excess of glucose (in pears, apples and honey); fructans and FOS (in artichoke, garlic, onions, rye, wheat); GOS (stachyose and raffinose in pulses); and sugar polyols (mannitol and sorbitol in stone fruits and artificial sweeteners).

The development of a qualitative FFQ in this study followed the method used in similar studies and incorporated the recommendations made by previous works (Teufel 1997, MacIntyre *et al*. 2000, Wentzel-Viljoen *et al*. 2011, Sheehy *et al*. 2013). Previous works cautioned that the identification of foods to be included in the list requires information on procurement, frequency of consumption, preparation, and serving methods of common foods usually consumed by the target participants to validate the 24-hour food recall of the same participants. The current study formulated a food habits questionnaire where these pieces of information were obtained. Aside from the food habits questionnaire, the most common sources of food were surveyed to verify whether the items eaten by the participants were indeed locally available. Survey of the food sources also revealed additional relevant food items that may be consumed but were not enumerated by the respondents. FGDs were conducted to determine reasons why certain foods in the list were not eaten and to explore other similar food items commonly eaten but were not included in the preliminary list (Teufel 1997). The FGDs also intended to determine if the prebiotic and probiotic food items included in the developed food list are locally available and whether those identified in the food habits questionnaire are being consumed and the reasons for consuming these. Following the FGDs, a final food list was formulated; the FFQ was pretested and then revised accordingly.

The reproducibility of this study was tested using a binomial test – which is different from the usual recommendations such as Bland-Altman, correlation coefficient, and Kappa statistic (Cade *et al.* 2002). These tests are ideal for semiquantitative FFQs. A binomial test was used due to the following reasons: (1) the food frequency responses are dichotomous (FFQ_1 and FFQ_2) and nominal; and (2) the sample items are independent; that is, one item has no bearing on the probability of another. In this study, dichotomous also refers to the two possible responses obtained: "matched" or "mismatched." Thus, these two labels also indicate they are nominal *i.e.*, they cannot be ordered and measured quantitatively. The

obtained results indicate instrument reproducibility, as indicated in the very high agreement between responses obtained in separately administered FFQ_1 and FFQ_2. The time interval in which the responses were obtained may explain the observed agreement rate.

It is recommended that in reproducibility studies, it is not advisable to administer a questionnaire at a very short interval as the participants may remember their previous responses; and alternatively, when the interval period is longer, variation in response contribute to reduced reproducibility (Cade *et al.* 2002). In this study, FFQ_1 and FFQ_2 were administered a day apart after completion of three 24-hour food recalls in one month. However, these aspects of the design were to ensure dietary assessment over similar periods. The developed qualitative FFQ asks the frequency of consumption of prebiotic and probiotic food items in the past month. Hence, FFQ_1 was administered on Day 30 and FFQ_2 on Day 31. This one-day gap design of the reproducibility study was similar to a study that determined the validation of an FFQ that measured inulin and oligofructose intake (Dunn *et al.* 2011).

It was not possible to use biomarkers to measure validity in this study because of the absence of such a marker of inulin and oligofructose intake (Dunn *et al.* 2011). Thus, the tool was verified by comparing the results obtained from the FFQ and independently obtained multiple food recalls from the same set of respondents. Results yielded highly similar but not perfectly matched responses. Greater diversity of prebiotic- and probiotic-containing food items was recorded for the responses in the FFQ than in the food recalls. This was attributed to the time frames required of the respondents to recall food intake. Retrospective methods for assessing dietary intakes such as dietary histories, FFQs, and 24-hour recalls have the disadvantage of measuring only memory of past diet, not the usual diet itself. People differ greatly in the frequencies with which they consume most foods and the ability to recall different food items reflecting short or long-term food consumption patterns varies greatly as well. Repetition generally improves performance in standard recall and recognition-memory experiments (Hintzman 2010). This implies that food items consumed habitually *e.g.*, daily or weekly, may be recalled more accurately than food items consumed without a pattern. The food items consumed regularly by the participants as evaluated from their recalls were also the most consumed food items as evaluated from the FFQs. Likewise, food items rarely consumed are recalled better than those consumed less often.

Krall *et al.* (1988) also reported that the accuracy of recall is dependent on numerous factors that influence the respondent's ability to remember past food habits. Possible factors that could have affected the FFQ responses of the study participants are intelligence, mood, and individual food consumption patterns as affected by certain cultural beliefs. Mood at the time of completing a dietary questionnaire is an important factor. Feelings of happiness, boredom, anxiety, or hunger may influence responses. Moreover, emotionally laden memories evoked about a particular time period in one's past may affect the recall of food eaten at that time (Bower 1981, Krall *et al*. 1988). Physiological states of the respondents (pregnancy and lactation) may have also resulted in the impairment of the ability to recall due to hormone and mood changes (Henry and Sherwin 2012, Krol *et al.* 2014, Davies *et al.* 2018). The effects of these factors were not determined in this study. Thus, this study emphasizes that completion of food recalls and FFQs be assisted by a trained interviewer to enable probing of dietary recall responses in cases where there is the difficulty of refreshing the memory.

This study aimed to develop and evaluate a dietary assessment tool *i.e.*, the FFQ, for the qualitative measurement of prebiotic and probiotic intakes of urban-living, low-to-middle income class Filipino women. The FFQ was developed from a wide source of information – namely completed food habits survey, single 24-hour food recalls, market surveys, FGDs, and literature review to ensure cultural sensitivity and comprehensiveness. The responses obtained from the developed tool were deemed reproducible and verified using multiple food recalls.

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CONFLICT OF INTEREST STATEMENT

The authors whose names are listed above certify that they have no affiliations and relationships with any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

REFERENCES

BAER HJ, BLUM RE, ROCKETT HRH, LEPPERT J, GARDNER JD, SUITOR CW, COLDITZ GA. 2005. Use of a food frequency questionnaire in American Indian and Caucasian pregnant women: A validation study. BMC Public Health. 5: 135. DOI:10.1186/1471-2458-5-135.

BALLARD O, MORROW AL. 2013. Human Milk Composition: Nutrients and Bioactive Factors. Pediatrics Clinical of North America. 60(1): 49–74.

BAYAGA CLT, GAVINO VC. 2006. Chapter IV: Benefits and Sources of Docosahexaenoic Acid (DHA) in Human Milk. In: Trends in Dietary Fats Research. Landow MV ed. New York: Nova Science Publishers, Inc. p. 69–87.

BIESIEKIERSKI JR, ROSELLA O, ROSE R, LIELS K, BARRETT JS, SHEPHERD SJ, GIBSON PR, MUIR JG. 2011. Quantification of fructans, galacto-oligosacchardies and other short-chain carbohydrates in processed grains and cereals. Journal of Human Nutrition and Dietetics 24: 154–176.

BINGHAM SA, GILL C, WELCH A, DAY K, CASSIDY A, KHAW KT, SNEYD MJ, KEY TJ, ROE L, DAY NE. 1994. Comparison of dietary assessment methods in nutritional epidemiology: Weighed records *v.* 24 h recalls, food-frequency questionnaires and estimated-diet records. British Journal of Nutrition 72: 619–643.

BOWER GH. 1981. Mood and Memory. American Psychologist 36: 129–148.

BURROWS TL, HUTCHESSON MJ, ROLLO ME, BOGGESS MM, GUEST M, COLLINS CE. 2015. Fruit and Vegetable Intake Assessed by Food Frequency Questionnaire and Plasma Carotenoids: A Validation Study in Adults. Nutrients 7: 3240–3251.

CADE J, THOMPSON R, BURLEY V, WARM D. 2002. Development, validation and utilisation of food-frequency questionnaires – A review. Public Health Nutrition 5: 567–587.

CAMPBELL JM, BAUER LL, FAHEY GC, HOGARTH AJCL, WOLF BW, HUNTER DE. 1997. Selected Fructooligosaccharide (1-Kestose, Nystose, and 1F-β-Fructofuranosylnystose) composition of foods and feeds. Journal of Agricultural Food Chemistry 45: 3076–3082.

DAVIES SY, LUM JAG, SKOUTERIS H, BYRNE LK, HAYDEN MJ. 2018. Cognitive impairment during pregnancy: A meta-analysis. The Medical Journal of Australia 208(1): 35–40.

[DOST-FNRI] Department of Science and Technology – Food and Nutrition Research Institute. 2013. 8th National Nutrition Survey. Retrieved from https://www.fnri.dost.gov.ph/index.php/nutrition-statistic/19-nutrition-statistic/118-8th-national-nutrition-survey

DUNN S, DATTA A, KALLIS S, LAW E, MYERS CE, WHELAN K. 2011. Validation of a food frequency questionnaire to measure intakes of inulin and oligofructose. European Journal of Clinical Nutrition 65: 402–408.

GONZÁLEZ-CARRASCOSA R1, GARCÍA-SEGOVIA P, MARTÍNEZ-MONZÓ J. 2011. Paper and pencil *vs* online self-administered food frequency questionnaire (FFQ) applied to university population: A pilot study. Nutrición Hospitalaria 26(6): 1378–1384.

HENRY JF, SHERWIN BB. 2012. Hormones and Cognitive Functioning During Late Pregnancy and Postpartum: A Longitudinal Study. Behavioral Neuroscience 126(1): 73–85.

HILL C, GUARNER F, REID G, GIBSON GR, MERENSTEIN DJ, POT B, MORELLI L, CANANI RB, FLINT HJ, SALMINEN S, CALDER PC, SANDERS ME. 2014. The International Scientific Association for Probiotics and Prebiotics consensus statement on the scope and appropriate use of the term probiotic. Nature Reviews Gastroenterology and Hepatology 11: 506–514.

HINTZMAN DL. 2010. How does repetition affect memory? Evidence from judgments of recency. Memory & Cognition 38: 102–115.

JENSEN RG. 1995. Handbook of Milk Composition. San Diego, CA: Academic Press Inc.

KENT K, CHARLTON KE. 2017. Development, validation and reproducibility of a food frequency questionnaire to measure flavonoid intake in older Australian adults. Nutrition and Dietetics 75(1): 106–116. DOI: 10.1111/1747-0080.12371.

KRALL EA, DWYER JT, COLEMAN KA. 1988. Factors Influencing Accuracy of Dietary Recall. Nutrition Research 8: 829–841.

KROL KM, KAMBOJ SK, CURRAN HV, GROSSMANN T. 2014. Breastfeeding experience differentially impacts recognition of happiness and anger in mothers. Scientific Reports 4: 706. DOI:10.1038/srep07006.

MACINTYRE UE, VENTER CS, VORSTER HH. 2000. A culture-sensitive quantitative food frequency questionnaire used in an African population: 1. Development and reproducibility. Public Health Nutrition 4: 53–62.

MARANGONI F, CETIN I, VERDUCI E, CANZONE G, GIOVANNINI M, SCOLLO P, CORSELLO G, POLI A. 2016. Maternal Diet and Nutrient Requirements in Pregnancy and Breastfeeding. An Italian Consensus Document. Nutrients 8: 629. DOI:10.3390/nu8100629.

MARTÍNEZ-VILLALUENGA C, CARDELLE-COBAS A, CORZO N, OLANO A. 2008. Study of galactooligoscahharide composition in commercial fermented milks. Journal of Food Composition and Analysis 21: 540–544.

MOSHFEGH AJ, FRIDAY JE, GOLDMAN JP, CHUG AHUJA JK. 1999. Presence of Inulin and Oligofructose in the Diets of Americans. Journal of Nutrition 129: 1470S–1411S.

MUIR JG, SHEPHERD SJ, ROSELLA O, ROSE R, BARRETT JS, GIBSON PR. 2007. Fructan and Free Fructose Content of Common Australian Vegetables and Fruit. Journal of Agricultural and Food Chemistry 55: 6619–6627.

MUIR JG, ROSE R, ROSELLA O, LIELS K, BARRETT JS, SHEPHERD SJ, GIBSON PR. 2009. Measurement of Short-Chain Carbohydrates in Common Australian Vegetables and Fruits by High-Performance Liquid Chromatography (HPLC). Journal of Agricultural and Food Chemistry 57: 554–565.

PAKSERESHT M, SHARMA S. 2010. Validation of a culturally appropriate quantitative food frequency questionnaire for Inuvialuit population in the Northwest Territories, Canada. Journal of Human Nutrition & Dietetics 23(S1): 75–82.

PAPAZIAN T, HOUT H, SIBAI D, HELOU N, YOUNES H, EL OSTA N, KHABBAZ LR. 2016. Development, reproducibility and validity of a food frequency questionnaire among pregnant women adherent to the Mediterranean dietary pattern. Clinical Nutrition 35: 1550–1556.

PERES CM, PERES C, MENDOZAA AH, MALCATAA FX. 2012. Review on fermented plant materials as carriers and sources of potentially probiotic lactic acid bacteria – With an emphasis on table olives. Trends in Food Science & Technology 26: 31–42.

PÉREZ-CORNAGO A, GONZALEZ MAM, CANELA MR, JAURRIETA I, CARLOS S, SAYON-OREA C, BES-RASTROLLO M. 2015. Prebiotic consumption and the incidence of overweight in a Mediterranean cohort: The Seguimiento Universidad de Navarra Project. American Journal of Clinical Nutrition 102: 1554–1562.

SHEEHY T, KOLAHDOOZ F, MTSHALI TL, KHAMIS T, SHARMA S. 2013. Development of a quantitative food frequency questionnaire for use among rural South Africans in KwaZulu-Natal. Journal of Human Nutrition and Dietetics 27: 443–449.

SHORI AB. 2016. Influence of food matrix on the viability of probiotic bacteria: A review based on dairy and non-dairy beverages. Food Bioscience 13: 1– 8.

SHU G, HUI Y, CHEN H, MI J, WANG Y. 2014. Effect of carbon sources including lactose, glucose and maltose on growth of *B. bifidum* in the extract of *Fructus tribuli.* Journal of Chemical and Pharmaceutical Research 6(4): 617–622.

TEUFEL NI. 1997. Development of culturally competent food-frequency questionnaires. American Journal of Clinical Nutrition 65(Suppl.): 1173S–1178S.

VAN LOO J, COUSSEMENT P, DE LEENHEER L, HOEBREGS H, SMITS G. 1995. On the presence of inulin and oligo-fructose as natural ingredients in the Western diet. Critical Reviews in Food Science and Nutrition 35: 525–552.

WENTZEL-VILJOEN E, LAUBSCHER R, KRUGER A. 2011. Using different approaches to assess the reproducibility of a culturally sensitive quantified food frequency questionnaire. South African Journal of Clinical Nutrition 24: 143–148.