


# Caretakers' perceptions and willingness-to-pay for complementary food in urban and rural Cambodia

Mulia Nurhasan<sup>1,2</sup>  | Rizal Adi Prima<sup>3</sup>  | Søren Bøye Olsen<sup>4</sup>  |  
Frank T. Wieringa<sup>5</sup>  | Marjoleine A. Dijkhuizen<sup>1</sup> | Chhoun Chamnan<sup>6</sup> |  
Nanna Roos<sup>1</sup> 

<sup>1</sup>Department of Nutrition, Exercise and Sports, University of Copenhagen, Copenhagen, Denmark

<sup>2</sup>Center for International Forestry Research (CIFOR), Bogor, Indonesia

<sup>3</sup>School of Economics, Finance and Marketing, RMIT University, Melbourne, Australia

<sup>4</sup>Department of Food and Resource Economics, University of Copenhagen, Frederiksberg, Denmark

<sup>5</sup>UMR-204 Nutripass, Institut de Recherche pour le Développement, IRD/UM/SupAgro, Montpellier, France

<sup>6</sup>Department of Fisheries Post-harvest Technologies and Quality Control, Fisheries Administration, Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia

## Correspondence

Mulia Nurhasan and Nanna Roos, Department of Nutrition, Exercise and Sports, University of Copenhagen, Rolighedsvej 26, 1958 Frederiksberg C, Denmark.  
Email: nro@nexs.ku.dk

## Funding information

Danida, The Ministry of Foreign Affairs, Denmark, Grant/Award Number: WinFood Project Grant 57-08-LIFE; The European Commission, Grant/Award Number: FP7 project SMILING-Project reference 289616; The Institut de Recherche pour le Développement (IRD), France; University of Copenhagen, Grant/Award Number: Scholarship for the PhD program; World Food Programme, Rome, Italy, Grant/Award Number: donated CSB++ for the study

## Abstract

Inadequate child nutrition during the first '1000 days' is widespread in Cambodia, resulting in a high prevalence of child malnutrition. Access to processed complementary food in packages (PCFP) may support caretakers in improving diet of young children. This study aimed to evaluate the caretakers' preferences and willingness-to-pay (WTP) for PCFP in Cambodia. The study was conducted in urban and rural settings, involving 520 caretakers with children aged 7–24 months in Phnom Penh (urban) and Prey Veng (rural). Four PCFPs were included: a commercial brand, a social-commercial brand, a worldwide distributed fortified complementary food aid product (CSB++) and an experimental fortified rice-and-fish-based PCFP developed in Cambodia (WF-L). Sensory analysis was conducted for all products, stated WTP was assessed for three products (excluding CSB++) and actual WTP experiment was conducted on WF-L only. Our results show that overall, WF-L was preferred by the rural participants over food aid CSB++. Further improvements in the organoleptic qualities of WF-L should focus on consistency and taste. The participants were, on average, willing to pay 1,667 Cambodian riel (KHR, \$0.4) and 1,192 KHR (\$0.3) in urban and rural settings, respectively, for 35 g of WF-L. We also found that despite being nutritionally inadequate, most participants considered homemade porridge to be healthier, more practical and preferred by the children. Therefore improving the quality of homemade foods merits urgent consideration. When applying PCFP in nutrition programmes as a supplementary option to homemade complementary foods, locally produced products could be a more viable supplementary option than global food aid.

## KEYWORDS

Cambodia, complementary food, field experiment, fish, market study, preference, willingness-to-pay

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

© 2021 The Authors. Maternal & Child Nutrition published by John Wiley & Sons Ltd.

## 1 | INTRODUCTION

Despite its economic progress, Cambodia is among the poorest countries in the world and the prevalence of undernutrition remains high. In 2014, 32% of children under 5 years were stunted and 10% were wasted (CDHS, 2015). Complementary feeding during the vulnerable period of transition from breastmilk to solid food is a concern as more than 70% of the children do not meet the recommendations for a minimum acceptable diet; thus, inadequate nutrition is widespread (Som et al., 2018).

The promotion of dietary diversity and improved complementary feeding is recognized as a key strategy to improve infant and child nutrition (Bhutta et al., 2013). The consumption of homemade complementary food exposes children to a broader range of different flavours and textures, which affects the development of dietary diversity, nutrient intake and quality, and infant growth (Mok et al., 2017). In Cambodia, the traditional complementary food is a watery rice porridge (*borbor*), either served plain or with some addition of vegetables, meat or fish. However, the nutrient composition and density of *borbor* is insufficient to meet the energy and nutrient requirements of infants and young children (Skau et al., 2014). Additionally, in vulnerable populations, caretakers often lack resources such as money, time and access to the nutrient-dense ingredients needed to prepare sufficient daily servings of nutritionally appropriate homemade complementary foods (Bruyeron, Denizeau, Berger, & Trèche, 2010).

Processed complementary food in packages (PCFP) is a supplementary option instead of the preparation of nutritionally optimal complementary foods at home. PCFPs are widely available as 'babyfoods' in high-income countries and they are increasingly entering the markets in low- and middle-income countries. PCFP is convenient by being practical, time saving and able to provide nutritionally balanced diets for infants and young children. In Cambodia, several brands of PCFP are available in supermarkets. Corn soy blend (CSB) products have been included in food baskets by the World Food Programme (WFP) all over the world for decades (WFP, 2012). Nutritionally improved versions of CSB (CSB+ and CSB++) were introduced by the WFP in Cambodia in 2008–2010 as part of a programme for improving maternal and child health (Skau et al., 2015).

The WinFood project in Cambodia aimed to develop a nutritious complementary food product based on locally sourced ingredients as a supplementary option to homemade complementary foods. The WinFood products were developed for experimental purposes and were semi-instant complementary food based on rice (similar to the traditional *borbor*) nutritionally enriched with dried, powdered small freshwater fish available from the highly productive aquatic environment of the Mekong River. A randomized intervention study that assessed the efficacy of WinFood formulas in comparison with CSB products showed that the WinFood-L (WF-L) version supported growth in a similar manner to CSB++ (Skau et al., 2015); thus, it was likely to have a positive impact on the omega-3 fatty acid status of nonbreastfed children (Nurhasan et al., 2018).

Food aid products were developed primarily for nutritional quality relative to cost and were not adjusted for cultural preferences

### Key messages

- When applying PCFP in nutrition programmes, locally produced PCFP could be a more viable option than global food aid.
- WF-L, a locally developed fortified rice-and-fish-based processed complementary food in packages (PCFP), was preferred by the rural participants over CSB++, a widely distributed PCFP aid.
- The participants were willing to pay for WF-L, and improving the consistency and taste will be the major factors in overall liking of WF-L.
- Despite being nutritionally inadequate, homemade complementary food was considered to be healthier, more practical and preferred by children over PCFPs.
- Thus, the improvement of homemade complementary foods should be the main strategy in complementary feeding programmes, and PCFP as supplementary option.

(Dijkhuizen, 2000). Locally developed and produced complementary food products that are nutritious, culturally accepted and affordable are potentially a more sustainable option than a temporary distribution of imported food aid products (Humphrey & Robinson, 2015; Rahaman & Khan, 2017). Furthermore, partnership with the private sector could potentially support a sustainable distribution channel of nutritious complementary food products in order to reach vulnerable communities not reached by public health interventions (Lybbert, 2011; Segrè et al., 2015).

When integrated within the product development process, sensory and consumer testing can potentially reduce the risk of product failure (Kemp, Hollowood, & Hort, 2011). This study aimed to evaluate the Cambodian caretakers' preferences and actual willingness-to-pay (WTP) for the locally produced fortified rice-and-fish-based PCFP product, WF-L, in comparison with a common commercial PCFP, a common social-commercial or hybrid PCFP, and the worldwide distributed food aid product, CSB++.

## 2 | MATERIAL AND METHODS

### 2.1 | Rationale for the method selection

Sensory evaluation is a scientific method used to evoke, measure, analyse and interpret the responses to products as perceived through the senses of sight, smell, touch, taste and hearing in a manner that is designed to minimize the potentially biasing effects of brand identity and other influences (Lawless & Heymann, 2010). The importance of sensory food science is based on the relevance of consumer perceptions to the acceptance and commercial success of foods and on the significance of food for human well-being and health (Tuorila &

Monteleone, 2009). The current practice in sensory science was formed over the last 50 years (Martens, 1999), and it will continue to be the ultimate method for evaluating product quality (Schiano, Harwood, & Drake, 2017).

The combination of sensory and WTP evaluations contributes to understanding the value of novel food products in a commercial context related to food choice (Combris, Bazoche, Giraud-Héraud, & Issanchou, 2009) and understanding whether sensory properties of the foods are significant in relation to the consumer's willingness to purchase and pay for the product (Aoki, Akai, Ujiie, Shimmura, & Nishino, 2019; Williamson, Lockshin, Francis, & Loose, 2016).

## 2.2 | Sites and subjects

Four urban communities in the Teuk Thla commune, Phnom Penh province, and 15 rural villages in the Smaong Khang Cheung and Kronyu communes, Prey Veng province, were selected to represent urban and rural settings in Cambodia. The urban and rural settings were selected to compare different food environments such as access to food and food markets, both of which potentially influence food choice (Dean & Sharkey, 2011). The fieldwork was conducted between July 2012 and February 2013.

'Caretaker' refers to any adult person caring for a child, either the mother or others. All caretakers in the selected sites with a child aged 7–24 months who reported that the child ate porridge on a daily basis were invited to join the study. The exclusion criteria were children with specific food allergies or intolerances, hepatic problems, a known infection at the time of the study entry, oral problems, cerebral palsy or obvious general health problems. All of the exclusion criteria were based on visual observations and/or the caretakers' information.

## 2.3 | Informal market survey for common complementary foods

The first step of the study was to identify the PCFPs available on the market, from which the brands could be selected for the sensory and WTP evaluations. First, we conducted an informal market survey in the four subdistricts of Phnom Penh (18–19 February 2012) and four subdistricts of Prey Veng (24–26 February 2012). Two trained staff members visited relevant stores (supermarkets, baby shops and convenience stores) and noted the brands sold in the stores in addition to the net weight (as listed on the package) and retail price. The survey identified the most available commercial brands and variants in the market.

## 2.4 | The food products

The following products were selected to be included in the sensory and WTP evaluations;

1. Commercial PCFP: the commercial PCFP product identified in the informal market survey as the most available commercial product in urban and rural Cambodia.
2. Hybrid PCFP: the social-commercial PCFP identified in the informal market survey, available in both urban and rural Cambodia.
3. CSB++: the nutritionally superior PCFP present in the food aid channel in Cambodia at the time of the study, distributed by WFP.
4. WF-L: the locally produced PCFP developed as a nutritious and culturally acceptable local product as part of the WinFood study that was conducted in 2010 in Prey Veng Province, Cambodia (Skau et al., 2015).

## 2.5 | Data collection process

The participants were invited to an outdoor site under temporary canopies or on health centre terraces. The study placed the interviewers in different consecutive booths to get answers on the following criteria: morbidity survey, the sensory study, stated WTP, socio-economic status, knowledge and familiarity with young child feeding and nutrition issues and experimental WTP. The flow of the study is presented in Figure S1.

### 2.5.1 | Sensory evaluation

To assess the product preferences of the caretakers of the young children, we applied the hedonic ranking test evaluation method. We presented the participants with a tray containing all four products, each in a small coded bowl with four small spoons on the side. The four products were randomly placed on each tray. The participants were invited to observe, taste, smell and touch the products. The staff asked the participants to rank their preference for taste, colour, odour, consistency, texture and overall preference consecutively. The participants placed the bowls in order of their preference and the staff wrote the code of each bowl in the corresponding ranking column of the questionnaire.

### 2.5.2 | Assessment of the stated WTP

The stated WTP was elicited using the open-ended contingent valuation (CV) method. This relies on directly asking the participants how much they would hypothetically be willing to pay for a product if it was made available to them. Stated WTP was elicited using this method for three of the PCFP products, namely, the 'Commercial', 'Hybrid' and WF-L. The participants were shown a PCFP presented in three different forms: (a) single use portion-unlabelled-closed-uniform-plain foil package of 35 g, (b) in an open container (powder) and (c) in a bowl, prepared and ready to eat. The participants were welcome to touch, smell or taste the food displayed. No additional information about the food was provided. The order of the three PCFP was randomized for each participant.

The stated WTP method is often criticized for its hypothetical bias. Because the question is purely hypothetical, the participants may for various reasons refrain from revealing their true WTP (see, e.g., Johnston et al., 2017). Following on from the work of Blumenschein, Blomquist, Johannesson, Horn, and Freeman (2008), a procedure was implemented to minimize the potential impact of hypothetical bias. The participants were first asked how much they would be willing to pay for the presented PCFP and the value stated was recorded as 'original stated WTP'.

The participants were then asked for the certainty level of their answer (absolutely, moderately, little or not certain). When the answer was 'absolutely certain', the original WTP interviewer moved on to ask for the stated WTP of the next PCFP. When the answer was other than 'absolutely certain', the participants were asked to state a price at which they would be certain to buy the product. This WTP was recorded as 'corrected stated WTP'. The respondents were allowed to express their unwillingness to pay for the PCFP or their indecisiveness when it came to paying for a certain PCFP, where their stated WTP would be recorded as zero.

### 2.5.3 | Assessment of the actual WTP of WF-L

Actual WTP was revealed using the Becker–DeGroot–Marschak (BDM) auction method (Becker, DeGroot, & Marschak, 1964). The BDM is an acknowledged method used to elicit the participants' preferences and WTP in the economic valuation literature (Breidert, Hahsler, & Reutterer, 2006). The BDM mechanism is constructed to ensure that the dominant strategy for the participants is to reveal their true preferences and values associated with the goods in question by penalizing both the over-and-underbidding of WTP (Lusk & Shogren, 2007). This ensures that there is incentive compatibility, which is considered to be a key condition for the elicitation of true preferences and WTP (Johnston et al., 2017). In this respect, the BDM mechanism thus obtained more valid estimates of WTP than the stated WTPs obtained using the CV method as it avoids hypothetical bias.

The BDM method was implemented only for the WF-L. WF-L was presented to participants in three different forms as described above for the stated WTP. The participants were invited to observe, touch, smell and taste the sample. The participants were given vouchers for *borbor* sold in their area. Every participant received 25 vouchers, each worth 100 Cambodian riel (KHR)<sup>1</sup> (~\$2 cents). The total value of the *borbor* vouchers was 2500 KHR (~\$0.60) for each participant. The participants were instructed that the vouchers were valid for buying *borbor* from a list of local sellers, in addition to the seller's picture and name being provided. Each of the participants confirmed that they knew at least one of the *borbor* sellers from the pictures and that they understood how the vouchers could be used as payment for *borbor* in their area.

First, the participant submitted a bid for a product of unknown price. The price was then determined by randomly selecting a lottery card from a jar with cards displaying different prices. If the submitted bid was greater than or equal to the determined price, *borbor* vouchers equal

to the determined price were exchanged for WF-L. If the submitted bid was lower than the determined price, no transaction took place, and all vouchers were kept by the participant. In this way, the participants revealed their actual WTP by exchanging *borbor* vouchers for WF-L.

The field staff explained the BDM method three times to the participants, twice as an exercise (with toys and sugar). The participants were also given opportunities to ask about the mechanism during the practice itself. The field staff took note of whether or not the participants understood the BDM mechanism before bidding for WF-L. Whether or not the participants understood the mechanism, the experimental WTP for WF-L was still performed. The respondents were allowed to express their unwillingness to pay for the PCFP and their actual WTP would be recorded as zero. The WTP values from participants who did not understand the bidding mechanism were treated as missing values.

### 2.5.4 | Socio-economic, knowledge and familiarity and word association surveys

The socio-economic and knowledge and familiarity surveys were conducted in the same booth using photo albums containing clippings of PCFPs (packages). They were showed when asking about their familiarity with PCFPs. Additionally, questions were asked about the caretaker's associations related to a set of words concerning food such as 'protein', 'carbohydrate' and 'rice' and whether the participants associated these words with 'good or healthy for children', 'bad or unhealthy for children' or 'never heard the word'. This restricted word association task proceeded to understand the participants' perception of the health association of words related to food and nutrition. Most of the enumerators were women in order to minimize the possible cultural discomfort of the female caretakers. The child dependents of the participants were provided with toys to play while waiting.

## 2.6 | Statistical analysis

For the sensory analysis, the preferences of individual groups were expressed as a median. The Friedman test was used to assess the differences in consumer preference between the four food groups and the Wilcoxon sign rank test was the post-hoc test. The Kruskal–Wallis test was used to understand the difference between the urban and rural areas for each sensory attribute of every complementary food. WTPs were expressed as mean and median.<sup>2</sup> Significance was declared as  $p < 0.05$ .

To show how strongly each sensory attribute influences the overall liking for each PCFP, a principal component analysis (PCA) biplot was used (Ngo, 2018). We summed the values of each food product and each sensory attribute. We then presented the results as a biplot with the PCFPs being the observation and the sensory attributes being the variables. The longer vector shows a higher variance, and vice versa. An angle smaller than 90° shows that the two attributes are positively correlated, a 90° angle shows an unlikely correlation

and close to 180° angle shows a negative correlation. The larger the projection of the PCFP on an attribute vector, the more that the PCFP deviates from the average of the attributes and vice versa (Kroonenberg, 2008; Ngo, 2018).

### 3 | RESULTS

The study involved 520 caretakers with a child between 7 and 24 months of age (233 in urban Phnom Penh and 287 in rural Prey Veng). The number of participants in each step of the study is presented in Figure S1.

#### 3.1 | Informal market survey of common complementary foods in Cambodia

In the informal market survey, the field staff identified 49 stores in the four districts of Phnom Penh and 23 stores in the four districts of Prey Veng where PCFPs were sold. The total number of stores visited was not recorded. The most commonly available PCFP in both Phnom Penh and Prey Veng was a global commercial brand. The average price of this brand and variant was \$4.70 in Phnom Penh and \$4.17 in Prey Veng per 350 gram package. We found only one social-commercial PCFP in the market, and on average, it was sold for \$0.18/sachet of 35 g. We selected these two products to represent the commercial and social-commercial/hybrid PCFPs in the Cambodian market. For the purpose of neutrality, this study does not reveal the name of the commercial and social-commercial brands and refers to the selected products (brand and variant) as 'Commercial' and 'Hybrid'. All PCFPs in this study were repacked in identical neutral packages.

#### 3.2 | Participants' characteristics

Table 1 summarizes the participants' characteristics for the socio-economic status, familiarity of PCFP and WTP questions. The median income and the number of children were the same between the households in the rural and urban areas, while more of the rural households were in the lowest income group. More urban participants had a higher level of education. There were more participants in the rural area who had paid jobs, and there were more households in the urban area whose main breadwinner of the family included the woman. Figure 1 shows the percentage of urban and rural participants who associated food-related words asked in the survey with what was good or healthy for the child.

#### 3.3 | Participants' preferences for complementary foods

The participants' ranking of PCFPs and the food attributes in the sensory evaluation are illustrated in Figure 2. Both the urban and rural

caretakers consistently preferred 'Commercial' (rank 1) to other products, followed by 'Hybrid' (rank 2). The participants generally ranked CSB++ and WF-L as rank 4 and rank 3 interchangeably, with WF-L being preferred by the rural participants over CSB++. The differences between the urban and rural area for each sensory attribute of the food is also shown in Figure S2.

#### 3.4 | Sensory attribute with the strongest association to overall preference

The sensory attributes were found to be positively correlated with each other. The attributes with the strongest correlation to overall liking were taste and consistency in the urban area and consistency, taste and odour in the rural area. For both urban and rural participants, colour and texture were the attributes with the weakest correlation to overall liking (Figure 2 and Table S1).

#### 3.5 | Stated WTP for 'commercial', 'hybrid' and WF-L

Initially, 100% of the urban participants were willing to pay for 'Commercial', 94.8% for 'Hybrid', and 69.0% for WF-L. After being asked how certain they were about their WTP and whether they would like to revise it, the percentage of the urban participants who were willing to pay changed to 99.6% for 'Commercial', 96.6% for 'Hybrid' and 78.9% for WF-L. The percentage of rural participants who were willing to pay for 'Commercial', 'Hybrid' and WF-L did not change, even after their certainty was assessed; 100% for 'Commercial', 97.9% for 'Hybrid' and 86.4% for WF-L.

Asking the respondents about their certainty of purchasing PCFP changed the average WTP but not the median. The average stated WTP after being asked for their certainty level (corrected WTP) for 'Commercial', 'Hybrid' and WF-L in the urban area was 3008 KHR, 2306 KHR and 1801 KHR consecutively. In the rural area, it was 3234 KHR, 2548 KHR and 2014 KHR. The medians of the stated WTP for 'Commercial', 'Hybrid' and WF-L in the urban area were 2000 KHR, 1500 KHR and 1000 KHR, and in the rural area, the medians were 2000 KHR, 2000 KHR and 1500 KHR (Figure S3).

#### 3.6 | Actual WTP for WF-L

Despite the extensive efforts to ensure that the participants understood the BDM mechanism as outlined in Section 2.5.3, 66 out of the 228 participants in the urban sample and eight out of the 285 participants in the rural sample did not understand the bidding mechanism. Among the participants who understood the bidding mechanism, 99.4% in the urban and 87.7% in the rural areas were actually willing to pay for WF-L. Among the urban participants, the descriptive mean and median of actual WTP elicited through the BDM auction were

**TABLE 1** Socio-economic characteristics of the participants by site and baseline bid

Socio-economic characteristics	n	Urban	n	Rural
HH income group (median in \$)	233	60–150	285	60–150
HH income group <\$60/month, n (%)	233	7 (3)	285	131 (46)
Have job, n (%)	233	143 (61.4)	282	278 (98.6)
Main breadwinner, n (%)				
Husband	232	151 (65.1)	285	243 (85.3)
Wife or husband and wife together		73 (31.5)		12 (4.2)
Literate, n (%)	233	193 (82.8)	285	172 (60.7)
Number of children (median)	233	2	285	2
Some secondary education, n (%)	233	190 (81.5)	285	172 (60.3)
Possession, n (%)				
Bike		99 (42.5)		213 (74.7)
Motorcycle	233	197 (84.5)	285	181 (63.5)
Car		19 (8.2)		6 (2.1)
Widest type of floor, n (%)				
Tile	233	155 (66.5)	285	10 (3.5)
Bamboo		8 (3.4)		253 (88.8)
Ground		18 (7.7)		22 (7.7)
Cooked/filtered source of drinking water, n (%)	233	230 (98.7)	273	195 (71.4)
Toilet, n (%)				
Own toilet (in or out house)		181 (77.7)		89 (31.2)
Shared toilet (public or personal)	233	50 (21.5)	285	56 (19.6)
In nature		2 (0.9)		140 (49.1)
Familiar with the following instant porridge brands, n (%)				
Cerelac		174 (74.7)		129 (46.1)
Celia		38 (16.3)		33 (11.8)
Gerber	233	21 (9.0)	280	38 (13.6)
Promina		66 (28.3)		36 (12.9)
Nutrihmer		209 (89.7)		118 (42.1)
Ever consumed instant porridge, n (%)				
Cerelac		65 (27.9)		60 (21.4)
Celia		5 (2.1)		9 (3.2)
Gerber	233	7 (3.0)	280	13 (4.6)
Promina		10 (4.3)		13 (4.6)
Nutrihmer		72 (30.9)		53 (18.9)
Exposure to commercials for instant porridge, n (%)				
Radio		0 (0)		87 (31.1)
TV		193 (82.8)		222 (79.3)
Mags	233	6 (2.6)	280	38 (13.6)
Poster		12 (5.2)		14 (5.0)
People talk		83 (35.6)		210 (75.0)
Never		16 (6.9)		10 (3.6)
Believe that the following is healthier, n (%)				
Instant porridge		37 (15.9)		74 (26.4)
Traditionally sold porridge	233	1 (0.4)	280	9 (3.2)
Homemade porridge		196 (84.1)		197 (70.4)

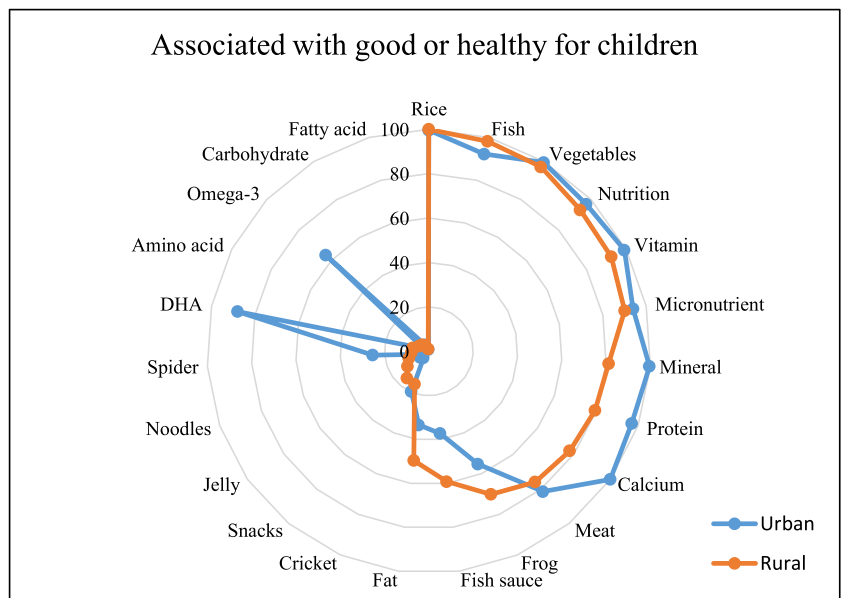
(Continues)

**TABLE 1** (Continued)

Socio-economic characteristics	n	Urban	n	Rural
Believe the following is more practical, n (%)				
Instant porridge		20 (8.6)		29 (10.4)
Traditionally sold porridge	233	50 (21.5)	280	20 (7.1)
Homemade porridge		164 (70.4)		232 (82.9)
Believe that the following is preferred by their child, n (%)				
Instant porridge		17 (7.3)		32 (11.4)
Traditionally sold porridge	233	28 (12)	280	65 (23.2)
Homemade porridge		189 (81.1)		185 (66.1)

Note: Including those who were excluded from the analysis for failing to understand the bidding mechanism; HH is an abbreviation for household.

**FIGURE 1** Percentage of participants associating food-related words with ‘bad or unhealthy’ for their children (the number of participants included in the analysis were 233 for urban and 282 for rural, except for the words ‘micronutrient’, ‘meat’, ‘snack’ and ‘jelly’ (n = 232) and ‘snack’ (n = 282) in urban and for the word ‘cricket’ (n = 280) in rural)



1667 KHR and 1500 KHR consecutively. Among the rural participants, the descriptive mean and median of the actual WTP were 1192 KHR and 1000 KHR. The distribution of the actual WTP for WF-L is shown in Figure 3.

**3.7 | Stated WTP vs actual WTP**

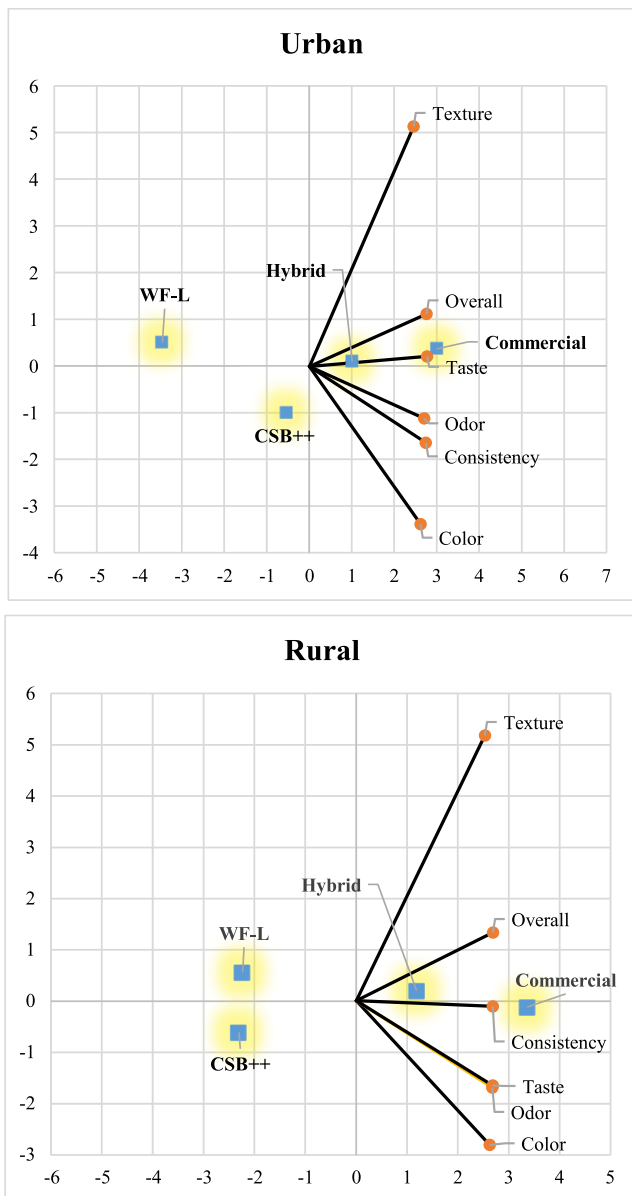
Our study found strong evidence of a hypothetical bias based on the CV estimation of WTP for WF-L. Figure 4 shows that most of the participants overstated their economic valuation. In the absence of hypothetical bias, the WTP results should be relatively congruent, reflected by the 45° line. Most of the participants appear to be below the 45° line, showing a tendency to report a higher stated WTP than the one revealed when actual transactions are involved in the BDM auction. Only 18% of our sample reported identical stated WTP and actual WTP. On average, the hypothetical WTP is 1.4 times greater than the actual WTP. This trend was similar among the urban and rural participants, but the urban participants showed less hypothetical bias.

**4 | DISCUSSION**

The sensory study showed that the experimental product, WF-L, was less preferred than the commercially available PCFP relative to CSB++. The WTP study showed that the participants were willing to pay for WF-L and that the WTP values were higher in the urban than rural settings.

**4.1 | Participants were not familiar with PCFP**

Our study showed that knowledge and familiarity with PCFP was not universal in both the urban and rural settings, although more of the urban participants were familiar with PCFPs than rural participants. Cerelac and Nutrihmer were the most familiar brands known by more than 74.7% of the participants in the urban area and 42.1% in the rural area, consumed by at least 27.9% of the urban and 18.9% of the rural participants, respectively. With a limited experience of PCFPs among the target consumers, the preference for PCFP in general could be expected to be low.



**FIGURE 2** Principal component (PC) analysis biplot (PC 1 and PC 2) of the sensory attributes of the PCFPs in urban and rural settings (for the urban participants, the first principal component (PC1) and the second (PC2) accounted for 93.14% and 5.85% respectively, explaining a total of 98.99% of the data variability. For the rural areas, the biplot explained 99.32% (PC1 = 96.22% and PC2 = 3.10%) of the total variability; the lengths of the attribute vectors are approximately proportional to the standard deviations of the attributes with exact proportionality if the fit is perfect (longer vector show higher variance, and vice versa). When the angle between the two PCFP vectors is small, they have similar response patterns to the attributes, and vice versa; Kroonenberg, 2008; Ngo, 2018)

Most of the urban and rural participants acknowledged that they were exposed to PCFP advertisements, especially on television. Interestingly, 31% of the rural participants but no urban participants were exposed to PCFP advertisements on the radio. ‘People talk’ in this study describes word-of-mouth or an informal source of information

received from other persons talking about or mentioning PCFP, PCFP brands or any related information regarding PCFP. This was also reported as a major source of information, especially among the rural participants.

Other than Cerelac and Nutrihmer, PCFP brands in Cambodia were poorly recognized. The finding shows that more than 80% of participants were exposed to PCFP advertisements and only two brands were widely recognized. This indicates that there would be room for a higher diversity of PCFP if they meet the consumers' preferences and competitive in price. It also indicates the challenges related to penetrating the Cambodian market for PCFP producers and a rationale for strengthening the homemade complementary food programmes in Cambodia.

## 4.2 | Participants were willing to pay for PCFP

The stated WTP for WF-L was higher in the rural than urban setting, even after adjusting for the participants' level of certainty of their stated WTP. When the participants were given the *borbor* vouchers to actually trade for WF-L in the BDM auction, the share of participants who were willing to buy was higher than in the stated WTP setting. However, the mean WTP value was lower. Using the average WTP of WF-L at the BDM auction, the participants' WTP for WF-L was 48 and 34 KHR/g in the urban and rural settings consecutively. The market price of ‘Commercial’ and ‘Hybrid’ both fall into the range shown by the WTP at the BDM auction.

Our findings confirm a pattern of urban participants being willing to pay more than the rural participants. While the presence of hypothetical bias questions the validity and usefulness of the stated WTP values, we note that the magnitude of this bias in our study is relatively small compared to previous studies (e.g., Kanya, Sanghera, Lewin, & Fox-Rushby, 2019; List & Gallet, 2001).

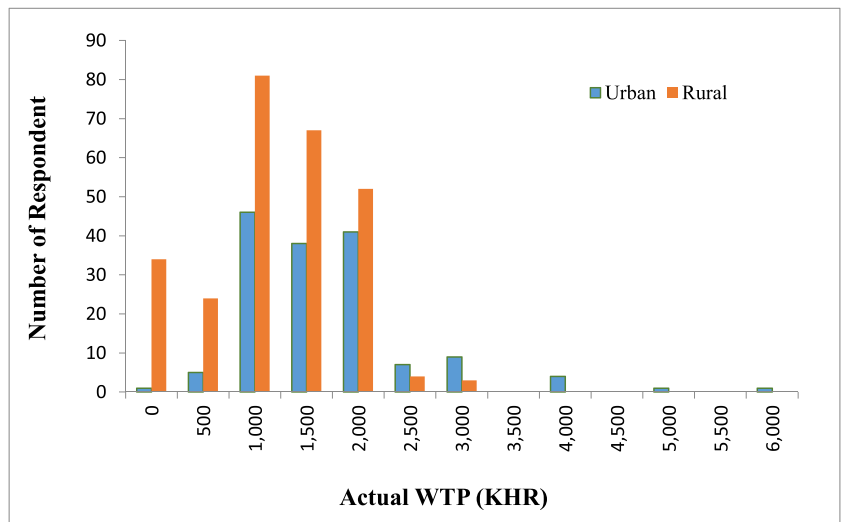
## 4.3 | The locally produced WF-L could be a more viable PCFP option than CSB++

The findings from the organoleptic assessment are aligned with the ranking of the average WTP values, with the ‘Commercial’ and ‘Hybrid’ products as the most preferred PCFPs in urban and rural settings. The two products available on the market have presumably been through an extensive product development process prior to going on the market. Overall, the novel product WF-L was equally preferred over a widely distributed food aid PCFP, CSB++. Moreover, WF-L supported growth in a similar manner to CSB++ (Skau et al., 2015) and thus was likely to have a positive impact on the omega-3 fatty acid status of nonbreastfed children (Nurhasan et al., 2018). The collective evidence suggests that the tested pilot version of locally produced WF-L could be a more viable PCFP option than CSB++.

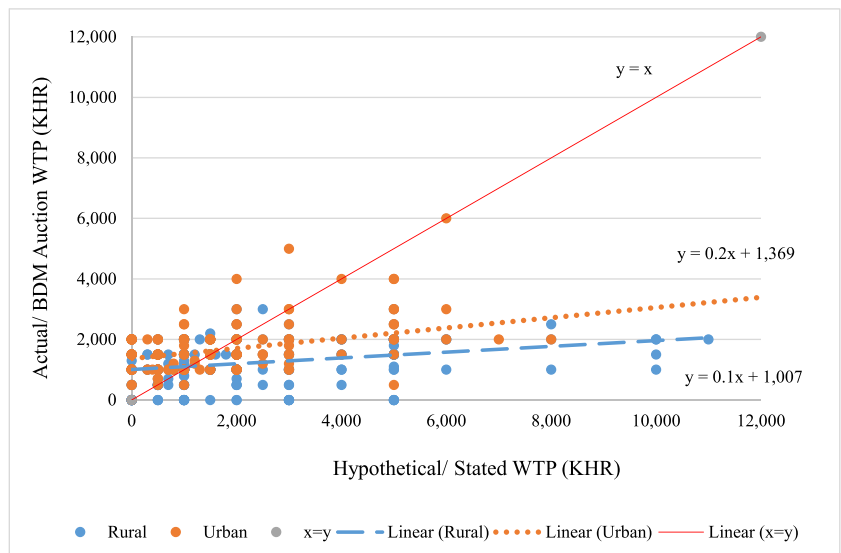
In a rural setting, the participants preferred WF-L to CSB++ for its texture and overall organoleptic properties. This indicates a



**FIGURE 3** Actual WTP for WF-L in urban and rural Cambodia (actual willingness to pay 0 [zero] shows the number of respondents who were unwilling or indecisive to pay for WF-L)



**FIGURE 4** Actual versus hypothetical WTP of WF-L (actual WTP showing the values where non-bidders are treated as WTP = 0 KHR and the participants who did not understand the bidding mechanism were treated as missing values [excluded]. The line of  $y = x$  shows an ideal nonbias WTP between actual and hypothetical. To avoid visual clutter, one observation was left out of the graph, namely, 20 000 KHR, a hypothetical/stated WTP for an urban respondent)



potential for WF-L to be further developed as a PCFP for the 91% of Cambodia's poor households living in rural areas (ADB, 2014). Nevertheless, in order to have a significant impact on child nutrition on a national level, WF-L development needs to meet the local preferences better. Taste and consistency were found to be the most important sensory attributes. WF-L and other future PCFPs developed for the Cambodian market should consider taste and consistency as the most important attributes for potential consumers. As all of the sensory attributes are positively correlated, an improvement of any of the sensory attributes will increase the preference for PCFP.

Although incorporating the preferences of the target consumers in the early stages is a critical success factor in new product development (van Kleef, van Trijp, & Luning, 2005), this step has largely been ignored in the process of developing food aid products. This causes poor compliance with programmes that target food-insecure populations. A successful example of using small fish as a high-quality protein source in nutrition programmes in Cambodia was demonstrated by the development of a fish-based ready-to-use therapeutic

food (RUTF) product (Sigh, Roos, Sok, et al., 2018; Sigh, Roos, Chamnan, et al., 2018). The RUTF, which is in the form of crispy wafer with fortified fish paste, was developed after this study was completed. It is now manufactured locally under the trademark name Nutrix, and it was procured by the Ministry of Health for the treatment of severe acute malnutrition (UNICEF, 2018).

#### 4.4 | Homemade complementary foods perceived as healthier, more practical and preferred

Many of the participants in both urban and rural settings perceived that the porridge they make at home is healthier, more practical and preferred by their children. This finding will be useful when designing a nutrition strategy in view of the insufficient preparation of healthy complementary meals in Cambodia. A study conducted in Prey Veng found that the average portion size of egg, fish or pork added to *borbor* was only 8–16 g/day for egg, 3–23 g/day for fish and

3–18 g/day for pork (Skau et al., 2014). This showed that although animal-source foods such as fish and fish products were available from the surrounding aquatic environment, the inclusion in the traditional complementary food of infants and young children was insufficient to provide the required nutrients. Improving the quality of homemade foods certainly merits urgent consideration.

Caretakers typically categorized complementary foods as healthy and unhealthy, which is an important consideration when they are choosing what to feed their children with (Matvienko-Sikar et al., 2018). Understanding the parental perception concerning what is associated with healthy and unhealthy provides a valuable tool in the development of strategies to reach the targets of the nutrition programmes (Buckton, Lean, & Combet, 2015). In our study, the participants' perception of the words related to the commonly consumed diet such as rice, fish and vegetables were largely associated with 'good' or 'healthy' for their child. Unique traditional animal source foods, namely, frog, fish sauce, spider and crickets, were associated with being good or healthy for their children by fewer participants than fish and meat. This indicates that the caretakers are possibly more reluctant to feed their children with Cambodian unique sources of animal protein.

Nutrition words, such as vitamin, micronutrient, protein, mineral, calcium and even DHA and Omega-3 were associated as good or healthy by more of the urban than rural participants. This indicates a different exposure to nutrition information between the urban and rural participants. Interestingly, although the high consumption of ultra-processed snacks in urban (Pries et al., 2016a) and rural Cambodia (Brown, 2017) was a concern, the words related to ultra-processed snacks, namely, jelly and snacks, had unhealthy associations according to more than 80% of both urban and rural participants. A similar pattern was shown in Nepal where ultra-processed snacks were perceived as unhealthy but the caretakers commonly fed them to their children because of the child's preference, the ease of preparation and the ease of feeding (Sharma et al., 2019).

This finding suggests that parental familiarity and the perception of homemade complementary foods can relate to the strength of the nutrition education provided and behavioural change interventions to improve homemade complementary foods in Cambodia. Such a programme could be more efficient when embedded in an agriculture project (Reinbott et al., 2016) or if organized in a way to utilize community-based participation (Reinbott & Jordan, 2016). Additionally, the language used to communicate the nutrition message influenced the effectiveness of the public health nutrition strategy (Buckton, Lean, & Combet, 2015). Without an effective communication strategy, the attempted nutrition programmes using PCFP often failed (McGuire, 2000). Hence, our findings on food-related words being associated with healthy and unhealthy should be considered when designing the communication strategy of both programmes involving homemade foods and PCFP.

Inadequate complementary feeding practices involve various underlying reasons (Bhutta et al., 2013). Hence, implementing diverse interventions, both market and nonmarket based, will broaden the chance to tackle the various issues of complementary feeding. The

lessons learned from other studies suggest that it is challenging to persuade mothers to feed their children with PCFP more than once a day (Bruyeron, Denizeau, Berger, & Trèche, 2010). This could make interventions with PCFP suboptimal. Other studies also show that albeit positively affecting subsequent growth, the consumption of fortified infant foods reduced dietary diversity (Diana et al., 2017) while the consumption of homemade complementary food was associated with higher dietary diversity (Mok et al., 2017). Our finding that homemade complementary foods are preferred by mothers resonates with the recommendation that the improvement of homemade complementary foods should be the main strategy in complementary feeding programmes with PCFP as a supplementary option. Furthermore, when applied in the context of food aid programmes, locally produced PCFP can potentially be an equally if not better option than CSB++.

Care should be taken concerning the risk of supporting PCFPs as a market-based intervention for malnutrition issues (Robinson, 2016), especially on the violation of marketing ethics and the risk of unfair marketing practices, as has happened before in Cambodia (Champeny et al., 2016; Hou et al., 2019; Pries et al., 2016b). Policy makers should develop nutrition policies and programmes aimed at ensuring a fair and demonstrable dietary impact on the children vulnerable to malnutrition.

## 4.5 | Strengths and limitation of the study

This study is among the first to test the preferences and WTP for novel PCFPs relative to the products already available in Cambodia. The strengths of our study lie in several aspects. First, the coverage of urban and rural caretakers represents the diversity of the socio-economic states and the rate of malnutrition in Cambodia. The study is therefore informative and supports the diversification of the nutrition strategies required to reach both urban and rural caretakers. Second, our results are consistent with the previous findings from other studies, indicating the robustness of the methodology. Various studies found that the actual WTP is usually lower than the stated WTP. This gap is referred to as hypothetical bias (List & Gallet, 2001; Loomis, 2011). This is also evident in our study and underlines the importance of using experimental setups that measure actual WTP in these types of setting. The ranking in the stated WTP among the three PCFPs was consistent with the ranking of the overall sensory assessment of the participants. This is also in line with the previous findings (Combris, Bazoche, Giraud-Héraud, & Issanchou, 2009).

Our study also has limitations. First, the WF-L tested was not yet optimally refined while the other products were fully developed. WF-L could be optimized further regarding the attributes that could have changed the perception and judgement of the product users (Bublitz, Peracchio, & Block, 2010). Second, in order to identify PCFP in the market, the total number of stores visited in the informal market survey was not recorded. Third, the number of participants who did not understand the bidding game was substantially higher in the urban area. Fourth, the study was conducted in 2012. Although we

included CSB++ as the PCFP distributed through food aid channels, its distribution in Cambodia was discontinued in 2014. This makes the specific information embedded in CSB++ in this study less relevant to the specific Cambodian context. However, the CSB++ is still distributed widely in other parts of the world, sometimes as SuperCereal Plus (WFP, 2013). This represents global food aid that is not developed based on the local diet. Therefore, our findings might serve as reference for future studies to encourage more local-based food aid around the world.

## 5 | CONCLUSION

Our study aimed to evaluate the Cambodian caretakers' preferences and actual willingness-to-pay (WTP) for locally produced fortified rice-and-fish-based PCFP and WF-L in comparison with a common commercial PCFP, a common social-commercial PCFP and the widely distributed food aid product, CSB++. Our results show that overall, WF-L was preferred by the rural participants over food aid CSB++ and the participants were willing to pay for it. However, in order to compete with the other PCFPs available in the Cambodian market, WF-L needs to undergo further improvements in terms of its organoleptic qualities, especially consistency and taste.

Despite being nutritionally inadequate, most of the participants considered homemade porridge to be healthier, more practical and preferred by their children. In order to decrease the prevalence of childhood malnutrition in Cambodia, improving the quality of homemade complementary foods certainly merits urgent consideration. As inadequate complementary feeding practices involve different underlying reasons, implementing diverse interventions will broaden the chance to tackle the various issues of complementary feeding. Our study suggests that when applying PCFP in nutrition programmes, locally produced fortified rice-and-fish-based PCFP could be a more viable supplementary option in terms of homemade complementary foods compared with global food aid.

## ACKNOWLEDGMENTS

We thank our collaborating partners in Cambodia: Reproductive and Child Health Alliance, World Food Programme and Institut de Recherche pour le Développement. We would also like to thank staff at DFPTQ, Teuk Thla Health Center in Phnom Penh and Kamchay Mear Hospital in Prey Veng for their generosity and openness in providing venues and assistance during the study. Most importantly, we are grateful for the participants' time, willingness and curiosity to join the study. This study was funded by the following: The University of Copenhagen, Denmark; Danida, The Ministry of Foreign Affairs, Denmark through the 'WinFood' project (Grant 57-08-LIFE); The European Commission through the FP7 project 'Sustainable Micronutrient Interventions to Control Deficiencies and Improve Nutritional Status and General Health in Asia' (SMILING-Project reference 289616); The Institut de Recherche pour le Développement (IRD), France; CSB++ was donated by the World Food Programme, Rome, Italy.

## CONFLICTS OF INTEREST

There are no relevant disclosures pertaining to funding or conflict of interest issues.

## CONTRIBUTIONS

MN contributed and took lead of all stages of the study (design, field implementation, data collection, data analysis, data interpretation, and drafting the manuscript); RAP contributed in all stages of the study (design, field implementation, data collection, data analysis, data interpretation, and drafting the manuscript); SBO contributed in study design, data analysis, data interpretation and drafting the manuscript; FTW, MD and CC contributed in study design and field implementation; NRO contributed in study design, data interpretation and drafting the manuscript. All authors have approved the final manuscript.

## ORCID

Mulia Nurhasan  <https://orcid.org/0000-0002-3307-284X>

Rizal Adi Prima  <https://orcid.org/0000-0002-8125-2263>

Søren Bøye Olsen  <https://orcid.org/0000-0002-1278-3749>

Frank T. Wieringa  <https://orcid.org/0000-0002-6010-355X>

Nanna Roos  <https://orcid.org/0000-0002-9733-9523>

## ENDNOTES

- <sup>1</sup> All \$ in the study expressed USD, and it is a common unofficial market currency in Cambodia; \$1 was valued at around 4000–4200 KHR at the time of the study and it is still valued at around the same rate at the time of the submission of the manuscript; the Cambodian currency hardly changed beyond this range in the last 10 years.
- <sup>2</sup> For the analysis, the values from the participants who did not respond to a question were considered as missing only for the particular variable associated with that question.

## REFERENCES

- ADB. (2014). Cambodia: Country poverty analysis 2014 (Publication Stock No. RPT146839). Mandaluyong City, Philippines: Asian Development Bank (ADB). Retrieved from <https://www.adb.org/sites/default/files/institutional-document/151706/cambodia-country-poverty-analysis-2014.pdf>
- Aoki, K., Akai, K., Ujiie, K., Shimmura, T., & Nishino, N. (2019). The impact of information on taste ranking and cultivation method on rice types that protect endangered birds in Japan: Non-hypothetical choice experiment with tasting. *Food Quality and Preference*, 75, 28–38. <https://doi.org/10.1016/j.foodqual.2018.11.021>
- Becker, G. M., DeGroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Behavioral Science*, 9, 226–232. <https://doi.org/10.1002/bs.3830090304>
- Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., ... Black, R. E. (2013). Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *The Lancet*, 382, 452–477. [https://doi.org/10.1016/S0140-6736\(13\)60996-4](https://doi.org/10.1016/S0140-6736(13)60996-4)
- Blumenschein, K., Blomquist, G. C., Johannesson, M., Horn, N., & Freeman, P. (2008). Eliciting willingness to pay without bias: Evidence from a field experiment. *The Economic Journal*, 118, 114–137. <https://doi.org/10.1111/j.1468-0297.2007.02106.x>
- Breidert, C., Hahsler, M., & Reutterer, T. (2006). A review of methods for measuring willingness to pay. *Innovative Marketing*, 2(4), 8–32.

- Retrieved from. <https://michael.hahsler.net/research/misc/InnovativeMarketing2006.pdf>
- Brown, A. L. (2017). Consumption of packaged foods and sugar-sweetened beverages and the associations with undernutrition among 24-month old Cambodian children. (Master's thesis, University of California). eScholarship. Retrieved from <https://escholarship.org/uc/item/2p62k7g1>
- Bruyeron, O., Denizeau, M., Berger, J., & Trèche, S. (2010). Marketing complementary foods and supplements in Burkina Faso, Madagascar, and Vietnam: Lessons learned from the Nutridev program. *Food and Nutrition Bulletin*, 31(2 Suppl), S154–S167. <https://doi.org/10.1177/15648265100312S208>
- Bublitz, M. G., Peracchio, L. A., & Block, L. G. (2010). Why did I eat that? Perspectives on food decision making and dietary restraint. *Journal of Consumer Psychology*, 20, 239–258. <https://doi.org/10.1016/j.jcps.2010.06.008>
- Buckton, C. H., Lean, M. E., & Combet, E. (2015). 'Language is the source of misunderstandings'—Impact of terminology on public perceptions of health promotion messages. *BMC Public Health*, 15(1), 579. <https://doi.org/10.1186/s12889-015-1884-1>
- CDHS. (2015). Cambodia demographic and health survey 2014. Phnom Penh, Cambodia and Rockville, Maryland, USA: National Institute of Statistics, Directorate General for Health, and ICF International. Retrieved from <http://www.dhsprogram.com/pubs/pdf/FR312/FR312.pdf>
- Champeny, M., Pereira, C., Sweet, L., Khin, M., Ndiaye Coly, A., Sy Gueye, N. Y., ... Huffman, S. L. (2016). Point of sale promotion of breastmilk substitutes and commercially produced complementary foods in Cambodia, Nepal, Senegal and Tanzania. *Maternal & Child Nutrition*, 12, 126–139. <https://doi.org/10.1111/mcn.12272>
- Combris, P., Bazoche, P., Giraud-Héraud, E., & Issanchou, S. (2009). Food choices: What do we learn from combining sensory and economic experiments? *Food Quality and Preference*, 20, 550–557. <https://doi.org/10.1016/j.foodqual.2009.05.003>
- Dean, W. R., & Sharkey, J. R. (2011). Rural and urban differences in the associations between characteristics of the community food environment and fruit and vegetable intake. *Journal of Nutrition Education and Behavior*, 43, 426–433. <https://doi.org/10.1016/j.jneb.2010.07.001>
- Diana, A., Mallard, S. R., Haszard, J. J., Purnamasari, D. M., Nurulazmi, I., Herliani, P. D., ... Houghton, L. (2017). Consumption of fortified infant foods reduces dietary diversity but has a positive effect on subsequent growth in infants from Sumedang district, Indonesia. *PLoS ONE*, 12(4), e0175952. <https://doi.org/10.1371/journal.pone.0175952>
- Dijkhuizen, P. (2000). Processed complementary foods in the World Food Programme. *Food and Nutrition Bulletin*, 21(1), 62–64. <https://doi.org/10.1177/156482650002100110>
- Hou, K., Green, M., Chum, S., Kim, C., Stormer, A., & Mundy, G. (2019). Pilot implementation of a monitoring and enforcement system for the international code of marketing of breast-milk substitutes in Cambodia. *Maternal & Child Nutrition*, 15, e12795. <https://doi.org/10.1111/mcn.12795>
- Humphrey, J., & Robinson, E. (2015). Markets for nutrition: What role for business? *IDS Bulletin*, 46, 59–69. <https://doi.org/10.1111/1759-5436.12144>
- Johnston, R. J., Boyle, K. J., Adamowicz, W., Bennett, J., Brouwer, R., Cameron, T. A., ... Scarpa, R. (2017). Contemporary guidance for stated preference studies. *Journal of the Association of Environmental and Resource Economists*, 4(2), 319–405. <https://doi.org/10.1086/691697>
- Kanya, L., Sanghera, S., Lewin, A., & Fox-Rushby, J. (2019). The criterion validity of willingness to pay methods: A systematic review and meta-analysis of the evidence. *Social Science & Medicine*, 232, 238–261. <https://doi.org/10.1016/j.socscimed.2019.04.015>
- Kemp, S. E., Hollowood, T., & Hort, J. (2011). *Sensory evaluation: A practical handbook*. West Sussex: John Wiley & Sons. <https://onlinelibrary.wiley.com/doi/book/10.1002/9781118688076>
- Kroonenberg, P. M. (2008). *Applied multiway data analysis*. New Jersey: Wiley & Sons. Retrieved from. <https://doi.org/10.1002/9780470238004.app2>
- Lawless, H. T., & Heymann, H. (2010). *Sensory evaluation of food: Principles and practices*. New York: Springer Science & Business Media. <https://doi.org/10.1007/978-1-4419-6488-5>
- List, J. A., & Gallet, C. A. (2001). What experimental protocol influence disparities between actual and hypothetical stated values? *Environmental and Resource Economics*, 20, 241–254. <https://doi.org/10.1023/A:1012791822804>
- Loomis, J. (2011). What's to know about hypothetical bias in stated preference valuation studies? *Journal of Economic Surveys*, 25, 363–370. <https://doi.org/10.1111/j.1467-6419.2010.00675.x>
- Lusk, J. L., & Shogren, J. F. (2007). *Experimental auctions: Methods and applications in economic and marketing research (quantitative methods for applied economics and business research)*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9780511611261>
- Lybbert, T. J. (2011). Hybrid public-private delivery of preventative lipid-based nutrient supplement products: Key challenges, opportunities and players in an emerging product space. *SCN News*, 39, 32–39. Retrieved from. [http://www.unscn.org/files/Publications/SCN\\_News/SCNNEWS39\\_10.01\\_high\\_def.pdf](http://www.unscn.org/files/Publications/SCN_News/SCNNEWS39_10.01_high_def.pdf)
- Martens, M. (1999). A philosophy for sensory science. *Food Quality and Preference*, 10(4–5), 233–244. [https://doi.org/10.1016/S0950-3293\(99\)00024-5](https://doi.org/10.1016/S0950-3293(99)00024-5)
- Matvienko-Sikar, K., Kelly, C., Sinnott, C., McSharry, J., Houghton, C., Heary, C., ... Kearney, P. M. (2018). Parental experiences and perceptions of infant complementary feeding: A qualitative evidence synthesis. *Obesity Reviews*, 19(4), 501–517. <https://doi.org/10.1111/obr.12653>
- McGuire, J. (2000). The essential role of communication in behavioural change. *Food and Nutrition Bulletin*, 21(1), 81–83. <https://doi.org/10.1177/156482650002100114>
- Mok, E., Vanstone, C., Gallo, S., Li, P., Constantin, E., & Weiler, H. (2017). Diet diversity, growth and adiposity in healthy breastfed infants fed homemade complementary foods. *International Journal of Obesity*, 41(5), 776–782. <https://doi.org/10.1038/ijo.2017.37>
- Ngo, L. (2018, June 18). How to read PCA biplots and scree plots [Blog post]. Retrieved from <https://blog.bioturing.com/2018/06/18/how-to-read-pca-biplots-and-scree-plots/>
- Nurhasan, M., Roos, N., Skau, J. K., Wieringa, F. T., Friis, H., Michaelsen, K. F., ... Lauritzen, L. (2018). Effect of complementary food with small amounts of freshwater fish on whole blood n-3 fatty acids in Cambodian infants age 6–15 months. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, 135, 92–101. <https://doi.org/10.1016/j.plefa.2018.07.002>
- Pries, A. M., Huffman, S. L., Mengkheang, K., Kroeun, H., Champeny, M., Roberts, M., & Zehner, E. (2016a). High use of commercial food products among infants and young children and promotions for these products in Cambodia. *Maternal & Child Nutrition*, 12, 52–63. <https://doi.org/10.1111/mcn.12270>
- Pries, A. M., Huffman, S. L., Mengkheang, K., Kroeun, H., Champeny, M., Roberts, M., & Zehner, E. (2016b). Pervasive promotion of breastmilk substitutes in Phnom Penh, Cambodia, and high usage by mothers for infant and young child feeding. *Maternal & Child Nutrition*, 12, 38–51. <https://doi.org/10.1111/mcn.12271>
- Rahaman, M. M., & Khan, N. A. (2017). Making international aid effective: An agenda for aligning aid to social business. *Development and Policy Review*, 35, O96–O117. <https://doi.org/10.1111/dpr.12319>
- Reinbott, A., & Jordan, I. (2016). Determinants of child malnutrition and infant and young child feeding approaches in Cambodia. In H. K. Biesalski & R. E. Black (Eds.), *Hidden hunger: Malnutrition and the first 1,000 days of life: Causes, consequences and solutions* (Vol. 115, pp. 61–67). Basel: Karger Publishers.
- Reinbott, A., Schelling, A., Kuchenbecker, J., Jeremias, T., Russell, I., Kevanna, O., ... Jordan, I. (2016). Nutrition education linked to

- agricultural interventions improved child dietary diversity in rural Cambodia. *British Journal of Nutrition*, 116(8), 1457–1468. <https://doi.org/10.1017/S0007114516003433>
- Robinson, E. (2016). Can nutrition be packaged and sold? The contradictions of a development policy debate. *World Development Perspectives*, 2, 1–4. <https://doi.org/10.1016/j.wdp.2016.06.004>
- Schiano, A., Harwood, W., & Drake, M. (2017). A 100-year review: Sensory analysis of milk. *Journal of Dairy Science*, 100(12), 9966–9986. <https://doi.org/10.3168/jds.2017-13031>
- Segrè, J., Winnard, K., Abrha, T. H., Abebe, Y., Shilane, D., & Lapping, K. (2015). Willingness to pay for lipid-based nutrient supplements for young children in four urban sites of Ethiopia. *Maternal & Child Nutrition*, 11, 16–30. <https://doi.org/10.1111/mcn.12022>
- Sharma, N., Ferguson, E. L., Upadhyay, A., Zehner, E., Filteau, S., & Pries, A. M. (2019). Perceptions of commercial snack food and beverages for infant and young child feeding: A mixed-methods study among caregivers in Kathmandu Valley, Nepal. *Maternal & Child Nutrition*, 15, e12711. <https://doi.org/10.1111/mcn.12711>
- Sigh, S., Roos, N., Chamnan, C., Lailou, A., Prak, S., & Wieringa, F. T. (2018). Effectiveness of a locally produced, fish-based food product on weight gain among Cambodian children in the treatment of acute malnutrition: A randomized controlled trial. *Nutrients*, 10(7), 909. <https://doi.org/10.3390/nu10070909>
- Sigh, S., Roos, N., Sok, D., Borg, B., Chamnan, C., Lailou, A., ... Wieringa, F. T. (2018). Development and acceptability of locally made fish-based, ready-to-use products for the prevention and treatment of malnutrition in Cambodia. *Food and Nutrition Bulletin*, 39(3), 420–434. <https://doi.org/10.1177/0379572118788266>
- Skau, J. K., Touch, B., Chamnan, C., Chea, M., Unni, U. S., Makurat, J., ... Roos, N. (2015). Effects of animal source food and micronutrient fortification in complementary food products on body composition, iron status, and linear growth: A randomized trial in Cambodia. *The American Journal of Clinical Nutrition*, 101, 742–751. <https://doi.org/10.3945/ajcn.114.084889>
- Skau, J. K., Touch, B., Chamnan, C., Wieringa, F. T., Dijkhuizen, M. A., Roos, N., & Ferguson, E. L. (2014). The use of linear programming to determine whether a formulated complementary food product can ensure adequate nutrients for 6-to11-month-old Cambodian infants. *American Journal of Clinical Nutrition*, 99, 130–138. <https://doi.org/10.3945/ajcn.113.073700>
- Som, S. V., Prak, S., Lailou, A., Gauthier, L., Berger, J., Poirot, E., & Wieringa, F. T. (2018). Diets and feeding practices during the first 1000 days window in the Phnom Penh and North Eastern districts of Cambodia. *Nutrients*, 10, 500. <https://doi.org/10.3390/nu10040500>
- Tuorila, H., & Monteleone, E. (2009). Sensory food science in the changing society: Opportunities, needs, and challenges. *Trends in Food Science & Technology*, 20(2), 54–62. <https://doi.org/10.1016/j.tifs.2008.10.007>
- UNICEF. (2018). New fish-based ready-to-use-therapeutic food to treat children with severe acute malnutrition in Cambodia [Press release]. Retrieved from <https://www.unicef.org/eap/press-releases/new-fish-based-ready-use-therapeutic-food-treat-children-severe-acute-malnutrition>
- van Kleef, E., van Trijp, H. C., & Luning, P. (2005). Consumer research in the early stages of new product development: A critical review of methods and techniques. *Food Quality and Preference*, 16, 181–201. <https://doi.org/10.1016/j.foodqual.2004.05.012>
- WFP. (2012). Nutrition at the World Food Programme: Programming for nutrition-specific interventions [Digital editions version]. World Food Programme (WFP). Retrieved from [https://www.fao.org/fileadmin/templates/cfs/Docs1415/Events/CFS\\_NERWS\\_2015/CFS\\_NERW\\_WFP\\_Programming\\_Nutrition\\_Specific.pdf](https://www.fao.org/fileadmin/templates/cfs/Docs1415/Events/CFS_NERWS_2015/CFS_NERW_WFP_Programming_Nutrition_Specific.pdf)
- WFP. (2013). Managing the supply chain of specialized nutritious foods. World Food Programme (WFP). Retrieved from <https://reliefweb.int/sites/reliefweb.int/files/resources/wfp259937~1.pdf>
- Williamson, P. O., Lockshin, L., Francis, I. L., & Loose, S. M. (2016). Influencing consumer choice: Short and medium term effect of country of origin information on wine choice. *Food Quality and Preference*, 51, 89–99. <https://doi.org/10.1016/j.foodqual.2016.02.018>

## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Nurhasan M, Prima RA, Olsen SB, et al. Caretakers' perceptions and willingness-to-pay for complementary food in urban and rural Cambodia. *Matern Child Nutr*. 2021;17:e13130. <https://doi.org/10.1111/mcn.13130>