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Demand for healthier and higher-priced processed foods in low-income communities: Experimental evidence from Mexico City

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ABSTRACT

Diets in Mexico, like many countries, have changed dramatically in recent decades, with increased consumption of processed foods being a major factor. Research suggests that unhealthy diets in low-income communities reflect limited access to healthy foods, combined with high costs and limited knowledge. Weak demand signals from these communities likely disincentivise the food industry from delivering healthier, often costlier, options. This paper explores the potential to market healthy processed foods to these areas. We elicited willingness to pay (WTP) for healthier but relatively more expensive processed foods in low-income communities of Mexico City. We implemented a BDM mechanism to elicit WTP, with half of the participants randomly receiving information regarding nutritional content and health benefits. Results suggested that WTP was considerable among low-income groups but higher among higher-income groups within these communities. While, in general, providing nutrition and health information did not influence WTP, it was effective for those with strong preferences for the processed food category used in the study. WTP was highest among females and younger consumers, those who had a small family and children below 12 years in the household.

1. Introduction

Over the past decades, much of the world has experienced a nutrition transition characterised by strong shifts from traditional diets composed of whole foods (e.g., legumes, fruits and vegetables, whole grains) to a “Western diet” rich in saturated fats (especially from animal sources), added sugars and salt, and processed foods (Ford, Patel, & Venkat-Narayan, 2017; Popkin & Gordon-Larsen, 2004). The associated public health challenges are rising rapidly in developing countries (Popkin, 2014; Popkin, 2015), with Latin America and the Middle East and North Africa being the most obese regions (Popkin & Reardon, 2018). Factors influencing the growth of overweight and obesity are linked to food systems transformations, which were facilitated by five major drivers: income growth, policy liberalisation, infrastructure improvement, urbanisation and the rise of rural nonfarm employment (Popkin & Reardon, 2018). Despite these challenges, research on urban consumer food preferences in these countries remains relatively scarce (Blare, Donovan, & del Pozo, 2017).

The food industry has been challenged to become more involved in the promotion of healthier diets worldwide (WHO, 2018). Voluntary efforts by food companies to enhance processed foods’ quality and reduce caloric content seem to be focused on high-income rather than in low- and middle-income countries (Popkin et al., 2012). As a result, healthy processed food alternatives are mainly available in higher-income small niche markets in certain countries (Popkin & Reardon, 2018). At the same time, low-income communities tend to have easy access to unhealthy food products and limited access to healthy alternatives as compared to richer areas in the same regions (Cummins et al., 2010; Hamelin, Beaudry, & Habicht, 2002; Pérez-Ferrer et al., 2019). Additionally, budget constraints (Bai, Alemu, Block, Headey, & Masters, 2020; Waterlander et al., 2018), limited knowledge (Sandvik, Nydahl, Kihlberg, & Marklinder, 2018) and the overvaluation of sensory attributes like taste (Mancino, Guthrie, & Just, 2018) discourage healthy choices among disadvantaged groups. These barriers disincentivise local retailers to offer healthy foods in these areas, as they would provide them if sufficient demand is perceived from low-income consumers

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(Andreyeva et al., 2010).

Access to understandable information may support healthy food uptake (Mancino et al., 2018), as disadvantaged consumers may find it easier to identify healthy alternatives (Sandvik, Nydahl, Kihlberg, & Marklinder, 2018). Well-designed information strategies have guided behaviour changes in other domains like energy conservation (Delmas, Fischlein, & Asensio, 2013) and public health (Stead et al., 2019). Recent evidence in developing countries has shown that low-income consumers are willing to pay a premium for quality and nutritious foods, wherein nutrition information about the product positively influenced its valuation (Chege, Sibiko, Wanyama, Jager, & Birachi, 2019). In light of such evidence, consumers in low-income areas that are willing to purchase healthier foods may be negatively affected by lack of availability in their residential neighbourhood (Van Ham, Boschman, & Vogel, 2018).

Mexico represents a remarkable case in the nutrition transition (Popkin et al., 2012), where greater availability of relatively low-cost unhealthy processed foods has significantly contributed to aggravate its associated health problems (Giuntella, Rieger, & Rotunno, 2020). Over the last three decades the purchases of these foods have doubled, while those for healthier and less processed options have gradually declined (Marrón-Ponce, Tolentino-Mayo, Hernández-F., & Batis, 2019). Likely factors that have contributed to the increase in uptake of these foods are the rise of advertisement by large processing companies, particularly for ultra-processed foods; volume discounts and promotions from these companies to retailers, and women increasingly working outside home, which has reduced cooking time and has made convenience foods (e.g., ready-to-heat, ready-to-eat) more appealing (Popkin & Reardon, 2018).

Processed wheat and maize products (e.g., pasta, flours, breads, cookies, tortillas, breakfast cereals) are the most prominent category in the Mexican food retail. Altogether, these products represent 33% of the production of processed foods (PROMEXICO, 2018) and contribute to 40% of the total energy intake of the population (Marrón-Ponce, Flores, Cediel, Monteiro, & Batis, 2019). They are not only major sources of energy, but also of essential proteins and micronutrients, and diverse non-nutrient bioactive food components (Poole, Donovan, & Erenstein, 2020). Their substantial contribution to achieving nutrient adequacy comes at a relatively low-cost (Bai et al., 2020). Traditionally, the Mexican diet has included high consumption levels of maize tortillas and other types of maize-based products (Dunn, Serna-Saldivar, Sanchez-Hernandez, & Griffin, 2008; INEGI, 2017). However, several factors like gains in consumer purchasing power and rising maize prices, have led to a gradual transition towards processed wheat products, including bread (Afeiche, Taillie, Hopkins, Eldridge, & Popkin, 2017; Juarez & Harrison, 2018; Popkin & Reardon, 2018). Products like baguette and packaged breads are substitute goods for tortillas in low- and middle-income groups (Retes-Mantilla, Torres-Sanabria, & Garrido-Roldan, 2013)¹. Nonetheless, the most popular varieties within these breads exhibit low fibre content, while at the same time, the Mexican population consumes a limited diversity (Rivera-Dommarco et al., 2018) and likely insufficient amount of high-fibre whole grains (Popkin & Reardon, 2018). Therefore, the intake of high-fibre bread varieties will support improved nutrition, and offer positive metabolic and health effects (CIMMYT, 2017; Poole et al., 2020).

The transition towards processed wheat products is more evident in large metropolitan areas such as Mexico City (Torres, 2007). Mexico City has a sophisticated food processing and retail environment with the presence of multinationals, and the continuous expansion of large supermarket chains and convenience stores (Pérez-Ferrer et al., 2019). Accordingly, 66% of its population's food consumption comes from

processed and packaged sources (Popkin, 2017). A recent study found that only 1 out of 10 processed wheat and maize products available in food retail outlets in Mexico City were healthy, while this proportion was lower in the low- than in high-socioeconomic status areas analysed (Marrón-Ponce et al., 2020). In low-income *peri-urban* areas, nearly half of the healthy processed wheat and maize portfolio was unavailable, whereas the usage of nutrition and health information in the packaging was less frequent (Fernández-Gaxiola et al., 2020). Processed wheat retailers have a limited scope particularly in the *peri-urban* neighbourhoods where lower-income households tend to locate (Torres, 2007).

This research examines willingness to pay (WTP) for healthy and higher-priced variants of processed foods in *peri-urban* Mexico City. Our case study focused on the demand for packaged bread. We employed non-hypothetical methods to elicit consumers monetary valuations, a common tool to analyse the potential uptake of healthy foods (Batte, Hooker, Haab, & Beaverson, 2007; Janssen & Hamm, 2012; Sriwaranun, Gan, Lee, & Cohen, 2019). In addition, we tested the effect of providing consumers with nutrition and health information on product valuations. This work complements a supply-side analysis of the diversity of processed foods in Mexico City, conducted together with the International Maize and Wheat Improvement Centre (CIMMYT) (Fernández-Gaxiola et al., 2020; Marrón-Ponce et al., 2020). Our goal was to shed light on potential demand and pathways that could facilitate the purchases of an expanded availability of healthy products in low-income communities.

The next section presents the hypotheses of the research. Section 3 describes our methodology and empirical approach. Then, we analyse the main findings regarding the potential uptake of healthy processed foods in the study area. Section 5 discusses the main results and implications for the food industry. The last section provides concluding remarks.

2. Hypotheses

Three overarching hypotheses guided this research, which are laid out below.

Hypothesis 1. *Low-income consumers are willing to pay market prices for healthy variants of processed foods (H1).*

The standard perception is that price limits the purchase of healthier food items, especially for low-income consumers (Waterlander et al., 2018). Yet, evidence from Africa, Asia and Latin America has shown that lower-income rural and urban consumers are willing to pay for nutritious foods at market prices (Biol, Meenakshi, Oparinde, Perez, & Tomlins, 2015; Chege et al., 2019; De Groot et al., 2017). However, these studies framed the development problem in terms of micronutrient deficiencies, and thus, they focused on WTP for enhanced nutritional quality through biofortification, fortification or composite products of lower-cost staple foods. In this paper, we attempt to deepen our understanding of market engagement by lower-income consumers to processed foods with a better nutritional profile in terms of macronutrients and ingredients (e.g., lower calories, fat, sodium and sugar; higher in protein and fibre) and a relatively higher price. As dietary choices are related to household-level characteristics like education and income (Allcott et al., 2019; Mancino et al., 2018; Ver Ploeg & Wilde, 2018), it is plausible that this hypothesis may particularly hold in wealthier developing country's urban areas such as Mexico City.

Hypothesis 2. *In low-income peri-urban communities, higher-income consumers have a higher WTP for healthy variants of processed foods than lower-income consumers (H2).*

There is a high degree of social mix in the periphery landscape of developing countries' metropolitan areas (Monkkonen, Comandon, Montejano-Escamilla, & Guerra, 2018) that needs to be acknowledged to shed more light on potential business opportunities. It is common that *peri-urban* areas include predominately low-income groups, often engaged in the informal sector, but also higher-income groups working in formal jobs, typically commuting to the main urban centres. In addition to the potential demand among low-income consumers, we

¹ Baguette refers to a minimally processed white bread that is low in fibre content and called *bolillo* in Mexico. In their estimations, the cited authors grouped *bolillo* with other traditional white breads (e.g., *telera*).

anticipated a substantial demand from those with higher income. Higher disposable income among the latter group may imply a more diverse diet, including healthier processed foods, thus leading to potentially higher WTP. Assuming the latter argument holds, social-interactive mechanisms (e.g., social contagion, collective socialisation) at the neighbourhood level (Duncan, Connell, & Klebanov, 1997; Galster, 2012; Leventhal & Brooks-Gunn, 2000) may incentivise lower-income consumers to mimic their higher-income and own group neighbours' behaviour. Causal evidence within this literature has revealed that even after controlling for neighbourhood selection, place of residence still influences individuals' outcomes (Van Ham, Boschman, & Vogel, 2018).

Hypothesis 3. *The provision of nutrition and health information increases consumers' WTP (H3).*

Economic theory predicts that information aids agents to make rational choices aligned with their preferences and needs. Hence, individuals with a knowledge deficit will increase their valuation of healthy processed foods when receiving the signal that these products are favourable for their diet and overall health. Based on a meta-analysis of the existing literature on WTP for unprocessed and processed foods that are beneficial for health (i.e., functional foods), Dolgoplova and Teuber (2018) estimated that health claims generally resulted in positive marginal valuations. Similar results were found in WTP experiments for products bearing nutritional claims (De-Magistris & López-Galán, 2016). As nearly all this literature related to processed products is concentrated in developed regions, we attempted to provide evidence to see if this holds in a developing country context.

3. Materials and methods

Fieldwork was conducted in the north-eastern Mexico City from September 2nd to October 4th, 2019. We selected six data collection sites (see Fig. 1), as detailed below. In five out of six locations, we collected data for up to three days to reduce the risk of spillover effects. For logistics and safety reasons, however, we collected data in one of the locations for a total of eleven days in three different weeks. Data collection took place between 9 am and 4 pm during twenty weekdays. Participants who engaged in the study signed consent forms, and the project's protocol was approved by CIMMYT's Institutional Research

Ethics Committee.

3.1. Data collection sites

To determine the research locations, we used venue-based sampling. In order to target low-income segments, we selected densely populated municipalities that were considered to have high or very high levels of marginalisation according to the Index of Urban Marginalisation elaborated by the National Population Council (CONAPO). This index includes ten indicators covering four dimensions: education, health, housing conditions, and asset ownership. Within these municipalities, we purposely selected six sites where we were likely to encounter many primary shoppers. All sites were in areas with high levels of marginalisation, but to ensure encountering both poor and less poor people, we made sure to include sites in areas surrounded by areas with medium-level marginalisation. The selected sites were in a central square, a shopping mall, and locations in streets close to schools in the municipalities of Chimalhuacán, Chicoloapan and Texcoco.

3.2. Participants

Our sample consisted of 472 persons who purchased household grocery on a regular basis. A team of seven researchers approached passers-by to participate in the study. Female respondents comprised roughly 69% of the sample (Table 1). While women were more prevalent in our sample than in the population, this reflects that they are typically the primary grocery shoppers. Likewise, average age (41) was higher than in the general population as we only interviewed adults. Although interviews occurred during working hours, a high percentage of interviewees (68%) had engaged in a remunerated activity in the previous month. Perhaps an important share were informally employed given that they were outside during these hours. This does not necessarily suggest a biased sample, as the rate of informal employment is high at around 50% in Mexico City. The majority of respondents (86%) were classified in the lower-income categories (see Table 2). Based on Table 2 data and information on household sizes, we found that at least 76% of the interviewees lived in a household with an income below the urban poverty line (MXN 3,091/USD 158 per person).

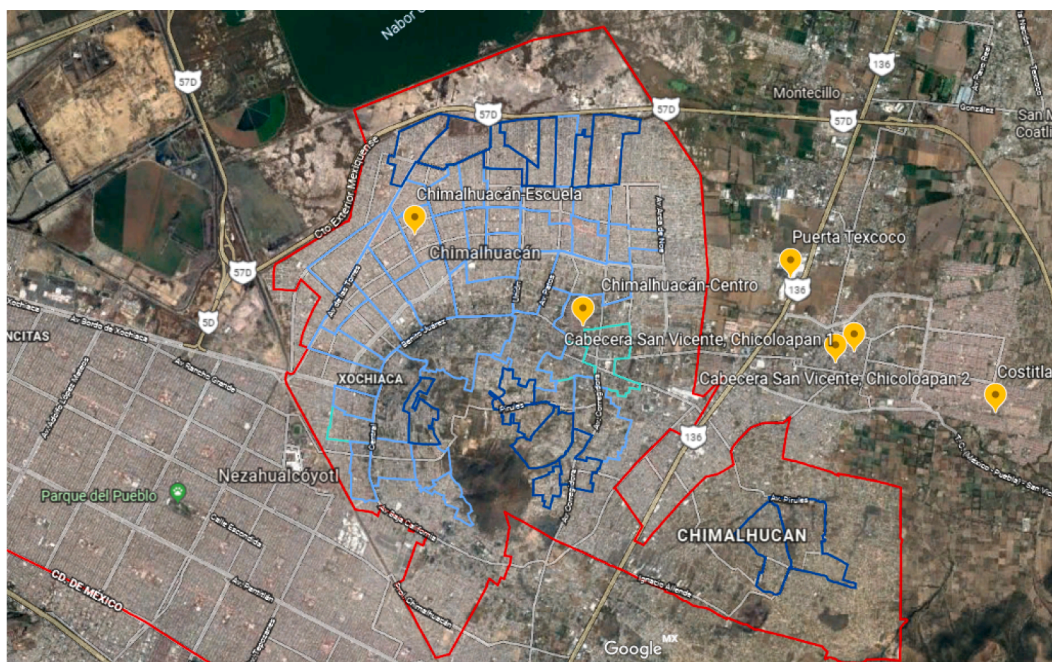


Fig. 1. Data collection sites shown as yellow spots. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 1
Descriptive statistics in the sample and selected Mexico's areas.

Variable	Sample				Mean in selected areas		
	Mean (1)	Std. Dev. (2)	Min (3)	Max (4)	National (5)	Mexico City ⁵ (6)	Municipalities in the sample ⁶ (7)
<i>Basic demographics</i>							
Female	0.69	0.46	0	1	0.51	0.52	0.52
Age (years) ¹	41.22	14.94	18	85	28.92	30.55	27.00
Remunerated activity ²	0.68	0.47	0	1	0.63	0.64	0.65
HH size	4.19	2.01	1	15	3.93	3.83	4.06
Children < 12 yr. ³	0.57	0.50	0	1	0.59	0.54	0.65
In partnership ⁴	0.65	0.48	0	1	0.65	0.61	0.67
<i>Education</i>							
None	0.02	0.14	0	1	0.08	0.04	0.04
Primary	0.49	0.50	0	1	0.56	0.49	0.58
Secondary	0.33	0.47	0	1	0.18	0.23	0.23
Tertiary	0.15	0.36	0	1	0.18	0.24	0.15

Notes: ¹ Weighted average in columns 5 and 6; and median values' average in column 7. ² Includes the unemployed in columns 5, 6 and 7. ³ Includes households with children until 14 years in columns 5, 6 and 7. ⁴ Includes married and living together. ⁵ 2010 Average in Mexico City and the State of Mexico. ⁶ 2015 Average in *Chicoloapan*, *Chimalhuacan* and *Texcoco*. Source: Columns 5, 6 and 7 are own elaboration with data from (INEGI, 2011) and (INEGI, 2016).

Table 2
Sample size by household monthly income level.

Category	Income level (MXN)		Freq.	Percent	Cum.
	Min	Max			
Very low	0	2,500 (1 28)	91	19.28	19.28
Low and middle-low	2,501	11,000 (5 62)	317	67.16	86.44
Middle-high and above	11,001	More	64	13.56	100.00
Total			472	100.00	

Notes: Amounts in USD in parentheses (Ex. Rate 19.6 MXN/USD).

68% of the participants had consumed packaged bread in the previous week. The majority of participants (60%) had consumed both packaged bread and its substitute baguette. It was more common to consume baguette but not packaged bread (28%) than the other way around (8%). Packaged bread was purchased at least every other week by nearly 80% of the sample.

3.3. Products

We selected two high-fibre bread products based on information provided by Marrón-Ponce et al. (2020). These authors calculated nutrition scores for processed wheat and maize products in retail outlets in selected parts of Mexico City, following the Pan American Health Organization's Nutrient Profile Model (PAHO, 2016). They classified the products in five levels of healthiness based on their calories, sugar, saturated fat, sodium, protein and fibre content. We focused on products in the healthiest category, that had a cost above the conventional options, and were unavailable and likely unknown in the researched zones. According to the classification 17 out of 53 packaged breads were rated in the desired category. From the shortlisted options we selected two that: a) had the traditional sandwich-like slice; b) had a colour that was appealing to consumers in the area (not black) and signalling healthiness (not white); c) were not readily available in the research zones; and d) were not of the same brand. Focus groups and visits to supermarkets in well-off districts informed this decision-making process.

The selected breads were (see Fig. 2): 1) Canadian Bagels and 2) Oroweat 12 Grains. To focus less on brands and more on a set of products chosen to test our hypotheses, we will refer to them by their package colours as green and red, respectively. These breads were richer in protein and fibre and had less sodium content than a standard and highly consumed white packaged bread, which translated into a higher nutrition score (see Table 3, last column). Switching consumption from white bread to the selected breads would thus contribute to healthier diets.

Bread prices collected from different retail outlets (e.g., supermarkets, independently owned grocery stores, corner stores and



Fig. 2. Packaged bread varieties.

convenience stores) were obtained from Marrón-Ponce et al. (2020) to compute mean values. The green bread fetched an average price of MXN 44 (USD 2.25) and tended to be sold only in supermarkets in higher-income areas of Mexico City. The red bread had an average price of MXN 49 (USD 2.51) and was available in most types of retailers including supermarkets, even in a couple of these in the periphery of the study area. However, only a few participants in focus groups and during data collection were aware of its existence. The costs of these products were at least 35% above the mean cost of the most frequently consumed bread products (i.e., white bread MXN 33 (USD 1.66)).

3.4. Experimental design

We used a Becker-DeGroot-Marschak (BDM) auction-type mechanism to estimate WTP, where half of the participants were randomly selected to receive information about the positive health aspects of the selected food items. BDM auctions are relatively easy to implement and incentive-compatible, which increases the chance of respondents revealing their true WTP, thus potentially reducing hypothetical bias (Skuzza, McCracken, & Ellis, 2015). They do not require gathering groups of people, as opposed to other commonly used methods such as Vickery second price auctions. While BDM auctions have been shown to generate less accurate results than more complex alternatives (Lusk & Rousu, 2006), a recent study suggests they yield similar results when participants are experienced in making market purchases of the product (Banerji et al., 2018).

Three focus groups were organised in the area to inform and validate our research design. These provided insights on the local context and

Table 3
Nutrition profile of the study’s packaged breads and the conventional option.

Packaged bread	Protein (per 100 gr.)	Fibre	Kcal	Sat. fat	Carbs	Sugar	Sodium	Nutrition score*
Green	8.8	9.6	252.0	0.4	56.4	4.4	404.0	3
Red	11.8	4.7	287.1	0.9	49.4	7.1	376.5	2
Conventional (white)	6.8	0.0	246.6	0.3	50.7	6.8	439.2	-4

Notes: * Values shown with opposite sign with respect to standard methodology to reflect that a higher score means that the product is healthier. It is the weighted sum of the nutrition indicators shown in the table, where protein and fibre are favourable components that increase the score; while total fat, saturated fat, carbohydrates, sugar and sodium are unfavourable components that reduce the score. Source: own estimations based on data from [Marrón-Ponce et al. \(2020\)](#).

helped to refine the survey modules and BDM protocol. The final design of the survey tools had the following elements and order:

- 1. Background information:** Participants provided information on basic demographics, family food consumption behaviours regarding bread and maize tortilla products, and stated the time of their last meal, which helped to control for level of hunger.
- 2. Nutrition and health information** (treatment group only): The enumerators explained to treated participants that both breads were high in fibre, low in fat, and high in whole grains content; and that a diet rich in fibre and whole grains reduces the risk of constipation and colon cancer (see exact wording and materials in Annex B of the [supplementary information](#)). We employed succinct non-technical wording, as suggested in the literature ([Hellyer, Fraser, & Haddock-Fraser, 2012](#)).
- 3. Sensory evaluation:** Participants tasted a piece of each bread variety and rated seven attributes using a visual scale (see materials and protocol in Annex B of the [supplementary information](#)), where the tasting order was random.
- 4. Mood:** Participants responded to questions about their levels of hurriedness, tiredness and stress.
- 5. Training:** Before the auction, participants engaged in a practice round, where we used didactic charts that outlined the auction implementation process. Contrary to the actual auction in which participants received real money, we gave participants toy coins in the practice round to avoid cash-in-hand effects ([Morawetz, De Groote, & Kimenju, 2011](#)). The practice round was designed to ensure that individuals were aware of the implications of over-bidding or underbidding, thus making it more plausible that they bided equal to their real valuation of the product.
- 6. Grocery expenses:** Question about weekly grocery expenses.
- 7. Auction fee:** An endowment of MXN 60 (USD 3.06) was given to each auction participant, which was enough to cover the market price of either of the breads used.
- 8. Bidding:** Each participant was asked to bid for a package of each of the two bread options, and their bids were recorded.
- 9. Selection of binding option:** One of the bread options was randomly selected for the auction.
- 10. Auction result:** A random sale price was drawn from a bag with a set of five values distributed around market prices of the study’s products. The distribution was unknown to participants. If the bidding price was greater than or equal to the sale price, the participant got the product and the change after paying the sales price; otherwise, the participant did not get the product and kept the auction fee (see materials and protocol in Annex C of the [supplementary information](#)).
- 11. Knowledge acquisition questions** (treatment group only): After the experiment, we asked information recipients two questions to test knowledge acquisition. These questions were multi-select multiple choice, where the first was about the breads’ nutritional content, and the second covered the health risks mentioned in point two.
- 12. Income sources:** At the end of the interview, respondents provided information about their household’s monthly income, and

whether their family received remittances and government financial support.

We asked all questions, with the exception of those related to knowledge acquisition and income sources, before the auction in anticipation that respondents might lose interest in continuing the interview after the auction. We did not foresee significant bias in the experiment due to these questions as they were unrelated to WTP.

3.5. Estimation strategy

We treated our data as a panel with two observations per subject, one for each bread. Hausman tests indicated that the random-effects estimator was preferred over the fixed-effects estimator. The full specification used for the estimations of the WTP of person *i* for bread variety *j* is therefore as follows:

$$WTP_{ij} = \alpha + \beta Info_i + \sum_{k=1}^K \delta_k X_i^k + \sum_{m=1}^M \gamma_m Sen_{ij}^m + \sum_{n=1}^N \varphi_n Bread_i^n + \vartheta Red_{ij} + \theta (Info_i \times Red_{ij}) + \sum_{o=1}^O \omega_o Z_i^o + c_s + m_e + \eta_i + \epsilon_{ij}$$

Where:

- *Info_i*: dummy variable that takes the value of 1 if the individual is treated with the nutrition and health information, 0 otherwise.
- *X_i^k*: sociodemographic covariates. 1) Demographics: female, dummy variable equal to 1 if female, 0 otherwise; age in years; partnership status, dummy variable equal to 1 if the participant has a partner (e.g., married or living together), 0 otherwise; secondary education, dummy variable equal to 1 if completed secondary school or a higher level, 0 otherwise; remunerated activity, a dummy variable equal to 1 if the individual generated an income in the previous month, 0 otherwise; children dependency ratio, equal to the number of children below 12 years of age divided by household size; and household size. 2) Income categories: low and middle-low, equal to 1 if monthly household income between MXN 2,501–11,000, 0 otherwise; and middle-high and above, equal to 1 if monthly household income above MXN 11,000, 0 otherwise.
- *Sen_{ij}^m*: sensory attributes with scores ranging from 1 to 7, which were (i) taste (ii) appearance and (iii) size. We only selected three out of seven attributes to avoid multicollinearity problems.
- *Bread_iⁿ*: bread consumption variables, which included: (i) existence of dietary restrictions related to bread, dummy variable equal to 1 if bread purchases are restricted due to the health condition of a respondents’ family member, 0 otherwise; (ii) frequency of consumption of packaged bread, dummy variable equal to 1 if packaged bread is purchased on a weekly basis, 0 otherwise; and whether baguette, a common substitute of packaged bread, was consumed (dummy variable equal to 1 if consumer had a baguette on the previous week, 0 otherwise).
- *Red_{ij}*: Red bread variety, dummy variable equal to 1 if referring to the red bread, 0 if referring to the green bread.

- Z_i^j : set of additional control variables, which included: (i) level of hunger, dummy variable equal to 1 if time from last meal is less than three hours, 0 otherwise; (ii) level of rush, dummy variable equal to 1 if not in a hurry, 0 otherwise; (iii) level of tiredness, dummy variable equal to 1 if not tired, 0 otherwise; (iv) stress level past month, equal to 1 if very worried about affording grocery expenses in the past month, 0 otherwise; (v) other income sources, to include remittances (dummy variable equal to 1 if received remittances from other region or abroad, 0 otherwise) and government benefits, (equal to 1 if received a benefit from the government, 0 otherwise); and (vi) bid in the practice round to capture revealed preferences information. Variables i-iv were measured as median splits of continuous variables and typically influence WTP (Morawetz et al., 2011).

- m_e : enumerator fixed-effects.
- c_s : data collection site fixed-effects.
- η_i : individual random-effects in the residual term.
- ϵ_{ij} random error term.

In contrast with similar WTP studies (Chege et al., 2019; Hellyer et al., 2012; Teuber, Dolgoplova, & Nordström, 2016), we did not choose a Tobit specification, as did not have bids with a value of zero. As packaged bread and baguette tend to be substitute goods, we employed a heterogeneity analysis based on the consumption preferences for these two products. We used Stata 15 for statistical analyses.

4. Results

4.1. Balance checks and enumerator bias

There were a few imbalances between the treatment groups at 5% (i.e., female, level of hunger) and 10% (i.e., in partnership, income low and middle-low) levels of significance (see Table A1 in the supplementary information). As an additional balance check, we performed a joint test of orthogonality, by estimating a probit regression of the treatment variable against the sociodemographics, bread preferences, mood and hunger level, and other income sources. Through this test we could not reject the null hypothesis that all the regression coefficients are simultaneously equal to zero ($\text{Prob} > \chi^2 = 0.187$), which suggests that both treatment groups are comparable in terms of a large set of characteristics.

The team of enumerators was relatively homogeneous: five out of seven were between 24 and 26 years old. In addition, the eldest enumerator (i.e., the supervisor, aged 34) interviewed only two respondents. The key difference was their gender with four female and three male enumerators. Female interviewers were somewhat more likely to interview respondents that were older, had a higher-income, were not in a hurry and under less stress (see Table A2 in the supplementary information). Through a joint test of orthogonality estimated as above, we rejected the null hypothesis of equal participant pools ($\text{Prob} > \chi^2 = 0.032$). Hence, enumerators' sex influenced the sample composition.

In our regression analyses, we provide specifications that control for sociodemographics, bread preferences, mood and hunger level, and other income sources of the respondents, and enumerator fixed effects.

4.2. Sensory analysis

Both breads were generally well-liked, with scores around 5 and above in all categories, based on a 1–7 scale (Table 4). The red bread was significantly preferred across all the measured attributes. Especially taste and texture were rated higher, mainly due to the green bread regularly judged as tougher and drier. This may be driven by the fact that the red bread has three times more ingredients than the green bread (27 vs 10), including taste enhancers and a higher sugar content (7.1 vs 4.4 gr/100gr). Additionally, as reflected by its highest scores, this bread possessed visual attributes that consumers found attractive, such as

Table 4
Sensory attributes' descriptive statistics by bread type.

Attribute	Bread type				Means diff. [†]
	Red		Green		
	Mean	Std. Dev.	Mean	Std. Dev.	
Smell	5.88	1.05	5.13	1.23	0.75***
Taste	6.11	1.02	4.98	1.38	1.13***
Texture	5.96	1.07	4.86	1.46	1.09***
Appearance	6.22	0.94	5.36	1.30	0.86***
Colour	6.14	1.00	5.51	1.21	0.63***
Size	6.39	0.86	5.76	1.22	0.63***
Thickness	6.29	0.95	5.61	1.28	0.68***

Notes: [†] Paired t-test on equality of means. * p < 0.1, ** p < 0.05, *** p < 0.01.

whole grains sprinkled on the top of the loaf. The information treatment did not affect the sensory evaluations (see Table A3 in the supplementary information).

4.3. Willingness to pay

The average valuations for the green and red products were 27% and 23% below their respective market prices (see Table 5). Our data also revealed that 14% and 18% of the participants were willing to pay the market prices or above for the green and red breads, respectively. In Fig. 3, we observe that a substantial share of participants had a WTP around MXN 40, which is just below market prices. The most frequently offered bids were close to the price of the conventional white packaged bread (MXN 33).

4.3.1. Demand among low-income consumers

The distribution of bids for the lower-income categories (i.e., very low, low and middle-low) exhibits a similar pattern to the whole sample (Fig. 3). The average bid for these categories was below the cost of the green and red products between 28 and 31% and 24–27%, respectively (Table 5). Furthermore, the proportions of valuations at least at market prices were 10–14% for the green bread and 12–17% for the red bread (see Figs. 4a and 4b). Half of these participants were willing to pay a premium with respect to the cost of the conventional option, particularly for the red variety for which the average premiums were between 10 and 15%. Thus, we found evidence to partially support H1: A non-negligible part of low-income consumers were willing to pay market prices for healthy variants of processed foods.

4.3.2. Incorporating higher-income consumers

Ceteris paribus, consumers who formed part of households in the middle-high and above income category were willing to pay MXN 5.5 more than those with very low income (see Table 7). They were also willing to pay more than the low- and middle low group ($\text{Prob} > \chi^2 = 0.028$). Within this category, 20% and 33% of the bids were equal or greater than the market prices of the green and red breads, respectively (see Figs. 4a and 4b). This provides evidence in favour of H2: Higher-income consumers in low-income communities have a higher WTP for healthy variants of processed foods than lower-income consumers.

Table 5
Bids by income level and bread type.

Category	Bread type			
	Red		Green	
	Mean	Std. Dev.	Mean	Std. Dev.
Very low	35.79	10.12	30.31	9.89
Low and middle-low	37.30	10.34	31.78	9.87
Middle-high and above	43.75	9.59	35.50	10.46
All sample	37.89	10.46	32.00	10.04

Notes: Amounts in MXN (Ex. Rate 19.6 MXN/USD).

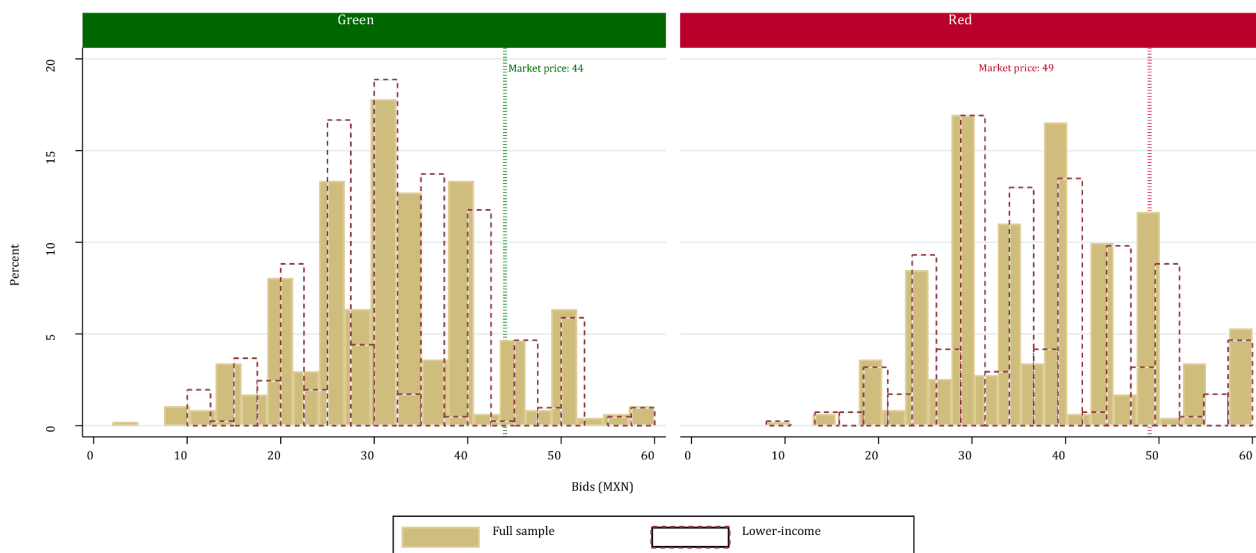


Fig. 3. Distribution of bids for the full sample and lower-income categories by bread type.

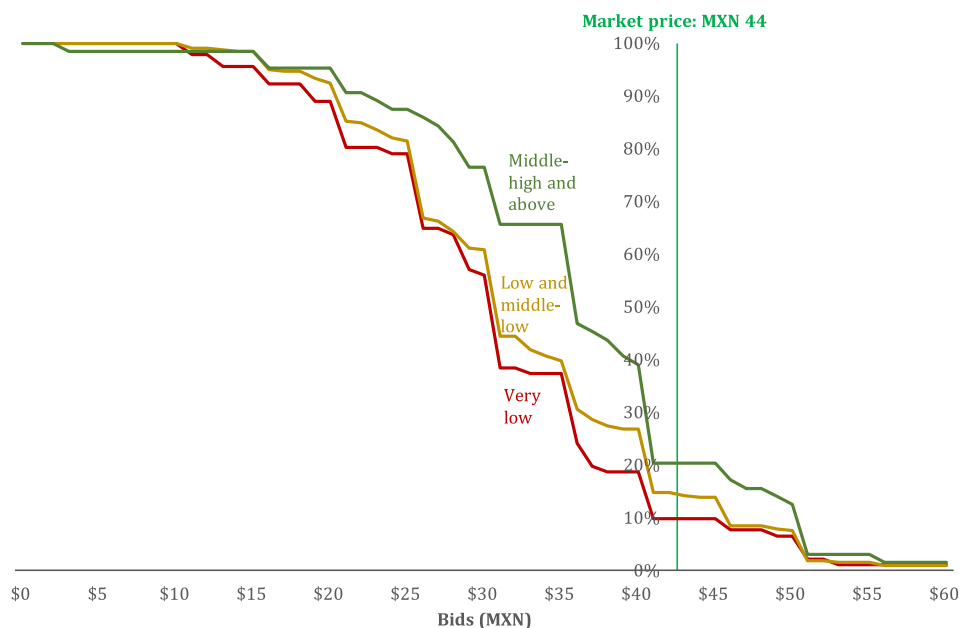


Fig. 4a. Cumulative distribution of bids by income level for the green bread. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4.3.3. The role of nutrition and health information provision

Before eliciting WTP, we provided a random selection of participants with facts about fat, sugar and whole grains content, as well as about prevention of health risks. This information did not influence their valuations of healthy packaged bread for the whole sample, nor by bread type (see Table 6, columns 9 and 10; and Table 7). This result is robust to the inclusion of a large set of individual controls and location and enumerator fixed effects. Most of the respondents (75%) remembered at least one component in the information provided, especially fibre content. We did an explorative analysis to test for sub-group differences based on bread preferences. We divided our sample in three groups: those that did not consume packaged bread, those that consumed

packaged bread and its close substitute baguette, and those that consumed packaged bread but not baguettes². We found that information effectively increased WTP for the latter group, which we expect to have the highest consumption of packaged bread (see Table 8). The increase was equivalent to 0.82 SD and did not differ between the two bread types. The coefficient remained significant even after controlling for multiple hypothesis testing using the false discovery rate adjustment (Anderson, 2008). This result needs to be interpreted with caution as it is

² 17 participants that did not consume any of the breads were excluded from this analysis given the small sample.

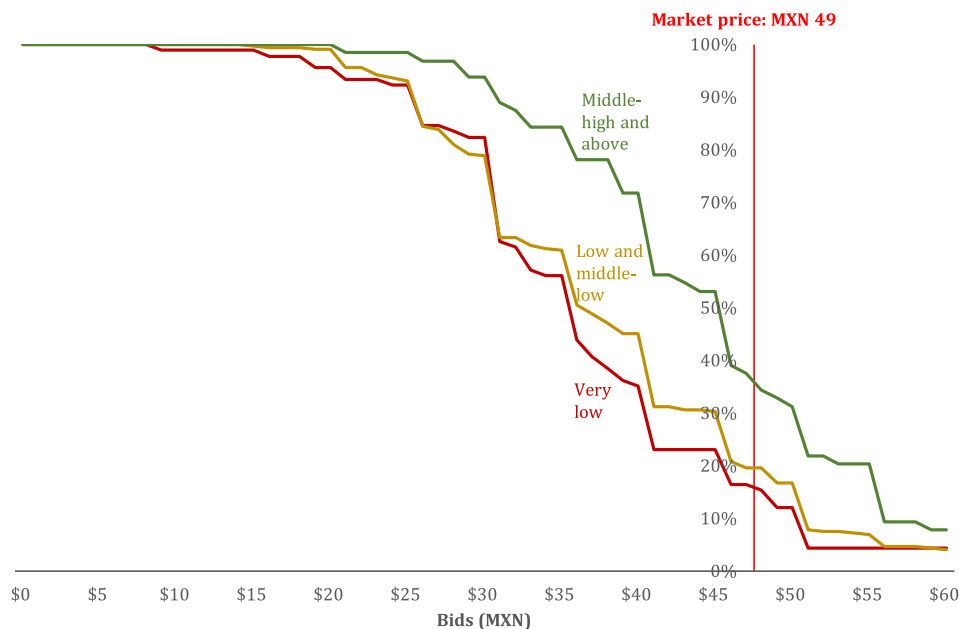


Fig. 4b. Cumulative distribution of bids by income level for the red bread. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 6
Summary statistics of bids by treatment group and bread type.

Sample	Treatment				Control				p-value [†]	
	Mean (1)	Std. Dev. (2)	Min (3)	Max (4)	Mean (5)	Std. Dev. (6)	Min (7)	Max (8)	(9)	(10)
All	34.80	10.70	8	60	35.08	10.63	2	60	0.681	0.565
Green bread	31.60	9.75	10	60	32.39	10.33	2	60	0.395	0.379
Red bread	38.00	10.68	8	60	37.78	10.26	14	60	0.822	0.924

Notes: [†]p-value in column 9 is based on t-test on equality of means between groups; while p-value in column 10 is based on Wilcoxon ranksum test for equality of distributions.

based in a relatively small sample³. Hence, H3 partially holds in our study: the provision of nutrition and health information increases WTP only for specific consumer segments.

The lack of observed impact for the whole sample could in theory have been caused by diffusion of treatment if early participants in the treatment group shared their new knowledge with acquaintances who later became untreated participants. This was especially a risk for the area where we spent eleven days in total, compared to two or three in the others. As a robustness check, we re-estimated WTP excluding observations from the location where we stayed for longer. The treatment effect remained statistically insignificant. We therefore do not think that the lack of impact is caused by diffusion of treatment.

4.3.4. Main characteristics that explain willingness to pay

Women were willing to pay more than men for healthy packaged bread, on average MXN 2.9 more (see column 7, Table 7). Older people had a lower WTP. On average, a person 20 years younger would pay MXN 1.5 more. Households with more family members exhibited significantly lower WTP. Although only significant at 10% level, individuals living in households with a higher share of children had a higher WTP. A higher score in terms of taste increased WTP, on average,

³ We confirmed this result with a larger sample (156) by adding the same group of consumers from another study that we ran simultaneously. The latter had the same research design, the only difference was an additional treatment that was expected to decrease WTP, but did not alter the effect of information.

MXN 1.4 more per additional point provided. Its magnitude was larger than the coefficients for appearance ($Prob > \chi^2 = 0.070$) and size ($Prob > \chi^2 = 0.018$), which yielded a higher WTP too: MXN 0.8 and MXN 0.5, respectively. As mentioned above, the red bread was especially well rated by its taste, which goes hand in hand with participants willing to pay MXN 3.2 more than for the green variety on average. Participants who had consumed baguette in the previous week were willing to pay MXN 2.6 less than those who had not.

5. Discussion

The portfolio of healthy processed foods is limited in low-income urban communities of developing countries (Fernández-Gaxiola et al., 2020; Pérez-Ferrer et al., 2019). From the private sector perspective, reluctance to sell healthier, but more expensive, foods in these areas likely reflects a perception of there being insufficient demand. However, this paper shows that a considerable share of low-income consumers in our sample from three peri-urban municipalities of Mexico City were willing to pay market prices for such foods, after they had the opportunity to feel, smell, and taste them. Half of these consumers valued the products at a price higher than the most popular and unhealthier alternative in the market. While the average overvaluation ranks below the premiums in similar studies in developing and developed regions (see Fig. 5), it points towards an interest in paying more for healthier varieties. Furthermore, we showed that peri-urban areas comprised higher-income shoppers with their associated higher demand for these

Table 7
Regression analysis on willingness to pay.

Dependent variable	Willingness to pay (MXN)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Information	0.038 (0.862)	-0.228 (0.852)	-0.228 (0.840)	-0.035 (0.825)	0.043 (0.854)	-0.389 (0.892)	0.009 (0.862)
<i>Demographics</i>							
Female		2.776*** (0.953)	3.178*** (0.949)	3.147*** (0.929)	3.013*** (0.946)	3.013*** (0.946)	2.912*** (0.918)
Age		-0.066** (0.032)	-0.059* (0.031)	-0.080*** (0.030)	-0.069** (0.031)	-0.069** (0.031)	-0.073** (0.030)
In partnership		1.684* (0.905)	1.478* (0.890)	1.235 (0.886)	1.460* (0.884)	1.460* (0.884)	1.097 (0.861)
Above secondary education		0.618 (0.937)	-0.283 (0.981)	-0.152 (0.970)	-0.106 (0.978)	-0.107 (0.979)	-0.029 (0.936)
Remunerated activity		0.902 (0.915)	0.631 (0.896)	0.598 (0.884)	0.789 (0.895)	0.790 (0.895)	0.519 (0.901)
Children < 12 yr. dependency ratio		1.084 (1.666)	0.904 (1.519)	1.848 (1.430)	2.296* (1.380)	2.296* (1.381)	2.427* (1.362)
Household size		-0.629*** (0.228)	-0.605*** (0.222)	-0.626*** (0.223)	-0.502** (0.214)	-0.502** (0.214)	-0.464** (0.209)
<i>Income level</i>							
Low and middle-low			1.453 (1.097)	1.834* (1.074)	1.891* (1.067)	1.889* (1.068)	2.806*** (1.085)
Middle-high and above			5.970*** (1.560)	6.001*** (1.506)	5.534*** (1.579)	5.534*** (1.580)	5.548*** (1.543)
<i>Sensory analysis</i>							
Taste				1.468*** (0.215)	1.458*** (0.214)	1.448*** (0.214)	1.440*** (0.213)
Appearance				0.771*** (0.247)	0.796*** (0.247)	0.801*** (0.247)	0.768*** (0.249)
Size				0.461* (0.273)	0.461* (0.274)	0.464* (0.276)	0.549** (0.274)
<i>Bread preferences</i>							
Bread dietary restrictions					1.414 (1.093)	1.414 (1.093)	0.912 (1.093)
Purchases pack. bread frequently					-1.002 (0.847)	-1.002 (0.847)	-0.976 (0.843)
Consumed baguette last week					-2.813** (1.171)	-2.813** (1.172)	-2.602** (1.144)
Red bread variety		5.886*** (0.358)	5.886*** (0.358)	3.269*** (0.368)	3.259*** (0.369)	2.839*** (0.473)	3.248*** (0.372)
Information*Red bread variety						0.867 (0.655)	
Constant	33.120*** (1.381)	31.249*** (2.721)	29.502*** (2.789)	15.335*** (3.026)	15.155*** (3.405)	15.379*** (3.396)	16.524*** (3.988)
<i>Controls</i>							
Location fixed effects	yes	yes	yes	yes	yes	yes	yes
Mood and hunger level	no	no	no	no	yes	yes	yes
Others [†]	no	no	no	no	yes	yes	yes
Enumerator fixed effects	no	no	no	no	no	no	yes

Notes: GLS random-effects estimations and observations equal to 944 in all columns. Robust standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. † Include other income sources and bids in the auction's practice round.

Table 8
Regression analysis on willingness to pay by bread consumption preferences.

Dependent variable	Willingness to pay (MXN)					
	Consumption in the previous week: Baguette & packaged bread		No packaged bread		Only packaged bread	
	(1)	(2)	(3)	(4)	(5)	(6)
Information	0.138 (1.081)	-0.435 (1.130)	0.301 (1.778)	0.059 (1.883)	8.788*** (3.154)	8.073** (3.655)
p-value	0.898	0.700	0.866	0.975	0.005	0.027
FDR q-value	1.000	1.000	1.000	1.000	0.016	0.089
Red bread variety	3.666*** (0.504)	3.098*** (0.652)	2.301*** (0.664)	2.066** (0.874)	4.280** (1.728)	3.755* (2.131)
Information*Red bread variety		1.145 (0.834)		0.475 (1.193)		1.390 (3.738)
Constant	14.284*** (4.298)	14.449*** (4.296)	5.263 (7.024)	5.525 (6.986)	-12.452 (23.234)	-11.514 (23.161)
Covariates [†]	yes	yes	yes	yes	yes	yes
N	570	570	266	266	74	74

Notes: GLS random-effects estimations in all columns. Robust standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. FDR q-values calculated according to Anderson (2008). † Include variables for demographics, income level, sensory attributes, bread preferences, location fixed effects, mood and hunger level, other income sources and bids in the auction's practice round.

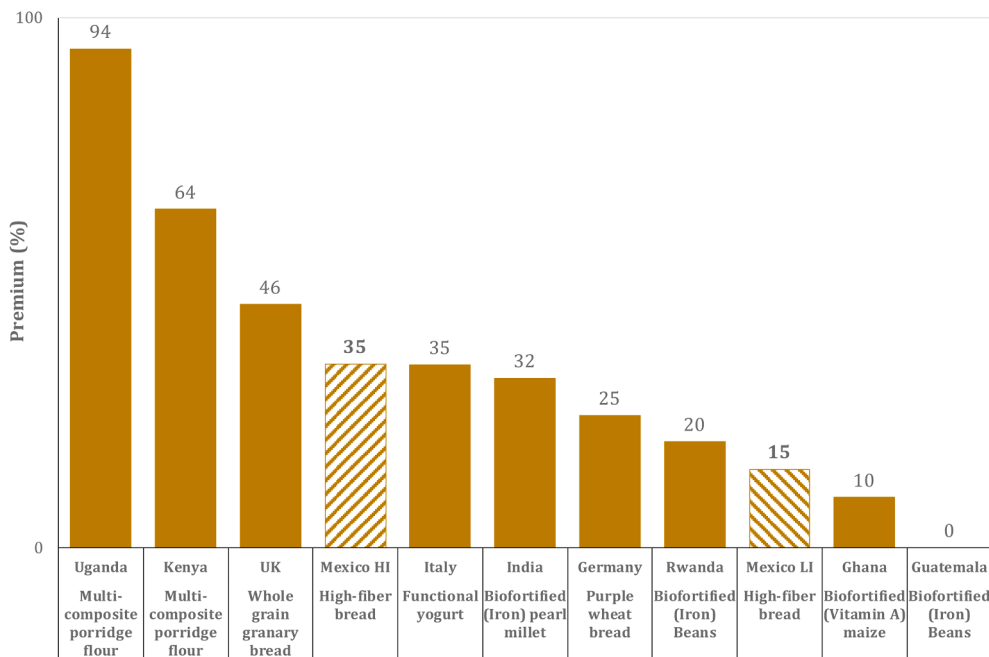


Fig. 5. Estimated premium for selected food items in developing and developed countries. Notes: LI means lower-income, which corresponds to the low and middle-low income category. HI means higher-income, which corresponds to the middle-high and above income category. Premiums correspond to the percentage change of the product's WTP with respect to the valuation (cost) of the conventional alternative in the same food category. For each country, we took the highest estimated premium for the treated group in studies eliciting WTP with auctions. For Italy, organic yogurt had the highest premium, but we excluded it as its main feature mainly concerned attributes other than health (e.g., ethics, environmental). Source: (Birol et al., 2015; Chege et al., 2019; Hellyer et al., 2012; Teuber, Dolgopolova, & Nordström, 2016; Vecchio et al., 2016).

healthy foods. Their premium with respect to the cost of conventional breads is comparable to premiums for similar processed foods in developed countries (see Fig. 5). Over time, demand is likely to increase further through the influence of neighbour peers that purchase these products, as well as the diffusion of social norms and higher-income neighbours serving as role models (Galster, 2012). Therefore, combining consumers across all income categories, there is enough potential demand in these communities to justify making such healthy varieties available.

We tested whether nutrition and health messaging increased WTP for healthier processed foods. In general, we found no effects of this type of information. As pointed out in focus groups, perhaps people already identified the products used in our study as healthy, so the information provided had no additional effect. This interpretation was previously mentioned in similar WTP studies elsewhere (Chege et al., 2019; Mialon, Clark, Leppard, & Cox, 2002). Nonetheless, we discovered that health and nutrition messages were effective for participants with stronger preferences for the processed food used in our experiment. This result echoes recent consumer behaviour research, which states that information is useful only for those who have certain motivations for the product that is being promoted (Van Kleef & Van Trijp, 2018). Nutrition information tends to be effective for enriched staple foods that are highly consumed by low-income populations (Chege et al., 2019). This may apply to upgraded versions of traditional products in Mexico that are cheap and less processed, but lower in fibre content (e.g., baguette). Thus, for relatively less consumed products personalized information for specific consumer segments is a potential business strategy (Delmas et al., 2013; Stead et al., 2019).

In general, we can explain WTP along the following lines: it tends to be higher for consumers who are female, younger, form part of a family with less members, and are members of households with a higher share of children below 12 years. Women in particular are a potential target group for businesses, a finding consistent with the WTP literature (Szakály, Kovács, Pető, Huszka, & Kiss, 2019). Predominantly younger participants in focus groups showed a high level of dissatisfaction with conventional white packaged breads and were willing to save money to buy healthier options at least every other week. On the sensory side, participants substantially valued the product more if they liked its taste, appearance and size. Taste in particular is a key feature influencing food choices and preferences (Bruschi, Teuber, & Dolgopolova, 2015; Teuber,

Dolgopolova, & Nordström, 2016) especially for low-income consumers who usually face greater cognitive and affective burdens (Just & Gabrielyan, 2018; Mancino et al., 2018). Therefore, taste offerings and an attractive appearance may aid substantially to raise awareness about new healthy varieties and those already offered that are relatively unknown to shoppers in low-income areas (e.g., red bread).

The study presents some important limitations. First, our sample was non-random. We have no reason to believe that this biased our results, but this can only be tested by replicating the experiment in more locations and with different selection procedures. Second, auction fees may have had an upward influence on bidding behaviours, if they were perceived as windfall gains (Skuzza et al., 2015). However, these effects have been shown to be small, especially among knowledgeable subjects (Banerji et al., 2018) like primary shoppers. Third, although we substantially limit overstating of WTP by using non-hypothetical methods (List & Gallet, 2001) we cannot rule out that our respondents showed higher WTP than they would in a real-life situation to create a favourable impression on the enumerators. However, we expect this social desirability bias to be specifically relevant for respondents in the information treatment, and in general we do not find this treatment to have a significant effect on WTP. This suggests that overstating of WTP may have been limited. Fourth, diffusion of treatment is a potential concern. We think this risk is limited, as the research took place in very busy locations with a lot of environmental noise, and we told participants to avoid sharing details of the interview. In addition, we stayed only a few days in all but one location, and the results hold also when excluding the latter location from the sample.

6. Conclusions

This research unveiled potential for healthy foods demand within a vast processed food category, in low-income communities of one of the largest metropolitan areas in the world. Altogether, the joint valuations of low- and high-socioeconomic status shoppers from the area account for a sizable business opportunity for processors and food retailers of expanding their menu of healthy products to these zones. In this context, the interplay of social and sensory aspects may facilitate the uptake of these foods. Our results are based on an upper-middle income country and a specific processed food category. Hence, replications of our concept in different developing regions and with other processed food

categories are warranted. At the same time, providing information is an effective strategy to promote healthier product purchases among specific market segments.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodqual.2021.104362>.

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