The mismatch between observational measures and residents' perspectives on the retail food environment: a mixed-methods approach in the Heart Healthy Hoods study

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Abstract

Objective: To gain a deeper understanding of the retail food environment by investigating similarities and differences between objective measures and residents' perspectives.

Design: The study incorporated Geographic Information System (GIS)-based measures, in-store surveys and the results from a larger photovoice project. We combined these data using a convergent parallel mixed-methods approach.

Setting: We conducted this study in a low-income neighbourhood in Madrid (Spain) in 2016.

Subjects: We assessed healthy food availability, accessibility and affordability using GIS-based measures and in-store audits. We also analysed the photographs and discussions from twelve participants who engaged in a photovoice project on their food environment.

Results: Quantitative results depicted a widely served and highly accessible retail food environment, in which supermarkets scored highest in terms of healthy food availability (36·5 out of 39) and 98·9 % of residents could access a healthy food store within a walking travel distance of less than 15 min. Qualitative results showed that participants preferred small local businesses over supermarkets, and revealed built environment obstacles for elderly residents. They also highlighted how the socio-economic context constrained residents' food choices.

Conclusions: People's experienced retail food environment is different from the one quantitatively analysed. Results show the potential of using a mixed-methods approach to enrich food environment research and enhance public health interventions.

The rising obesity epidemic is associated with non-communicable diseases such as CVD, diabetes and hypertension[1]. Tackling unhealthy dietary patterns requires designing effective preventive strategies that consider the retail food environment as a mass influence shaping individual food choices and diet-related health outcomes[2–4]. Understanding how individuals perceive and interact with their food environment is key to addressing this public health issue[5–8].

Despite acknowledgment of its influential role, evidence is limited about whether residents' conceptualization of their retail food environment correlates with the one as defined by researchers[7,9–11]. Previous studies have highlighted the need for understanding the perceptions on the food environment[12–14]. Qualitative methods can extend existing quantitative research by providing an in-depth understanding of residents' perspectives[15,16]. Using a mixed-methods research approach, we focused on a research question that calls for real-life contextual understandings and multilevel perspectives[16]. By means of using both objective neighbourhood-level measures and subjective perceptions, we may gain a more comprehensive understanding of how the food environment influences residents' diets[14,17].

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In our mixed-methods study, we aimed to evaluate the retail food environment in a low-income neighbourhood by: (i) objectively assessing it through Geographic Information System (GIS)-based measures and in-store audits; (ii) analysing residents' perspectives through participants' photographs and discussions; and (iii) studying similarities and differences found between objective and residents' results.

Methods

The present mixed-methods study is part of the Heart Healthy Hoods project (hhhproject.eu), which studies how social and physical characteristics affect residents' cardiovascular health in the city of Madrid (Spain)[15].

Study design

The present study was multidisciplinary, involving university-based researchers (epidemiologists, geographers and anthropologists), public health practitioners from the Madrid Public Health Institute and residents from a low-income neighbourhood. It incorporated GIS-based measures, in-store surveys and the results from a larger photovoice project[18].

We aimed to address the extent to which the objective neighbourhood-level measures and residents' perceptions converged; therefore, we followed a mixed-methods approach[16]. We used a convergent-parallel design[16], intending to merge concurrent quantitative (observational audits) and qualitative data (residents' photographs). In this type of design, data are collected in parallel and independently, analysed separately, and then combined to compare and contrast both sets of data and results[16].

Setting

We conducted the study in the low-income neighbourhood of Los Rosales in the Villaverde district of Madrid (Spain). According to Madrid Municipal Registry 2016 data, Los Rosales comprises a population of 36 215 residents of great ethnic diversity (24·8 % of foreign-born residents v. 19·3 % in Madrid). It is a low-income urban neighbourhood, where 28·7 % of residents have a low educational level (highest level of education being high school or less), compared with 6·8 % in Madrid. The unemployment rate is 18·7 %, in comparison to Madrid's rate of 10·2 %[19].

Participants

We used a purposive sampling strategy to engage participants and based recruitment on residence location. We invited adults who: (i) had lived in the neighbourhood for more than 1 year; (ii) spoke Spanish; (iii) had no impediment to manage a digital camera; and (iv) agreed to attend five group discussion sessions. Public health practitioners facilitated participants' recruitment and retention. They used multiple recruitment strategies (e.g. distributing

information sheets, conducting brief presentations in different neighbourhood associations).

We selected a sample size of twelve to fourteen participants, based on Wang's recommendations and previous photovoice projects of other researchers[20,21]. Finally, twelve adult residents agreed to participate. All of them completed informed consents, image release forms and a brief sociodemographic questionnaire.

We divided them into two small discussion groups, one group with the six female residents and the other group with the six male residents, to capture gender differences and to give women the opportunity to express their opinions in an environment free from the power pressure of men. Participants (n 12) had a mean age of 58·7 years (range 51–72 years) and most of them (n 8) were the primary food purchaser in their family/household. Seven participants did not have a high school diploma and only one had a college degree. Four participants had a monthly household income of <1200€ and three of them were unemployed.

Objective assessment

Using quantitative methods, we assessed: (i) the community food environment, in terms of number, type of and access to food stores in the neighbourhood; and (ii) the consumer food environment, in terms of availability of healthy foods within food stores.

To examine the community food environment, we obtained data on all licensed food stores within the neighbourhood from Madrid City Council in May 2015. We verified these food stores by direct auditing. Food store categorization was based on the size and range of food options available at the food store[15]. We classified them as: (i) supermarkets (corporate-owned 'chain' food stores with several employees and cash registers, including discounters); (ii) small specialized stores (greengrocers, fishmongers, butchers, bakeries, etc.); (iii) chain convenience stores (food stores with a limited selection of foods and with long opening hours); or (iv) corner stores (small food stores with long shopping hours, generally owned by ethnic minorities)[15]. We also identified existing public or street markets. Then, we created a GIS database integrating all food stores located in Los Rosales. We performed a density analysis by census section, to identify areas with a greater availability of healthy food. Census sections are the smallest administrative area available in Spain, which include a population of approximately 1500 residents.

To ascertain the consumer food environment, two trained researchers conducted in-store audits from May to June 2015. We used an adapted version from the Nutrition Environment Measurement Survey of Stores (NEMS-S), which has been previously tested for validity and reliability and has been widely used or adapted[22]. The NEMS-S examines the availability of healthy options v. less-healthier options over eleven food categories,

following the most typical food items according to an American diet[23]. We were interested in reflecting Spanish eating patterns, so we added some food items (e.g. fish) while excluding others (e.g. hot dogs) from the original survey. Our final measure comprised eleven food groups: (i) fruits; (ii) vegetables; (iii) nuts; (iv) non-alcoholic beverages; (v) bread, cereals and baked goods; (vi) milk, dairy products and eggs; (vii) oil and butter; (viii) rice and pasta; (ix) legumes; (x) meat and meat products; and (xi) fish.

Out of the 114 food stores present in the neighbourhood, we conducted in-store audits in a random sample of half of them. Out of these fifty-seven food stores, we could not perform audits in twenty-five of them, due to being permanently closed (*n* 19) or the manager's refusal (*n* 6). In-store audits lasted a mean of 7·13 min (SD 4·03; range 2–17 min). The outcome of the NEMS-S survey is a Healthy Food Availability Index (HFAI), developed as a 'market basket' of groceries, which awards points based on the presence of all categories of this market basket and additional points for healthier versions of those foods[24]. We computed the HFAI score for each food store, with a minimum possible survey score of 0 and a maximum possible score of 39. We categorized healthy food availability into high, medium or low using the natural Jenks break optimization method, which classifies features using natural breaks in data values[25,26]. This method, also known as the goodness of variance fit, was used to reduce the variance within classes of healthy food availability and to maximize the variance between classes[25,26].

Finally, we assessed objective potential pedestrian access using a street network analysis, which represents the spatial relationships between locations by a time or distance cost along the shortest-travel path. All street network data came from the Spanish National Geographic Institute at 1:1000 scale. We measured the length for each street segment to calculate the impedance value, and estimated an average speed of 4·5 km/h (2·8 miles/h) to calculate three intervals of potential pedestrian access to each food store with a high HFAI score (>22 points) and within a travel time of 5, 10 and 15 min[27,28]. We managed all objective information with ArcGIS 10.1 (ESRI Inc., Redlands, CA, USA).

Residents' perspectives

Photovoice is a participatory action research method grounded in feminist and educational theory, as well as in the practice of photographic documentary and community work[29,30]. Photovoice objectives are to use participants' photographs and narratives, emerging from small group session discussions, to assess their community resources and problems, while stimulating critical reflection to advocate community change[31,32]. As intended by Freire's empowerment education conception[33,34], we involved residents in a project where they initiated a process of critical reflection by discussing and analysing their local

food environment through photography[18] . According to Freire, 'dialogue can enhance reflection, understanding and action through a process of walking toward together while questioning'[33].

Following Wang's methodology, each photovoice group met for five small group discussion sessions (between March and June 2015), which were held weekly and lasted for 2 h[20,30,32]. In the initial meeting, we explained the project aims and encouraged participants to 'take pictures of all the features related to the food environment in your neighbourhood over the next week'. In session 1, a professional photographer gave out digital cameras and conducted a 1 h photography workshop on basic photography. He provided technical assistance and advice on taking photographs, and addressed the ethical implications of taking photographs with participants[35,36]. They signed consent forms related to the photovoice project, and were instructed to ask for permission and obtain consent from any person they photographed. Participants were asked to grant permission to publish and use their photographs, and to return the digital cameras once the project finished.

Sessions 2 to 4 consisted of small group discussions, where we discussed each selected participant-produced photograph. These sessions were moderated by a university-based researcher and a public health practitioner, who used the SHOWED mnemonic method to guide the group discussions on why participants took that photograph and what it meant to them[30,34]. The SHOWED includes five questions: What do you See here? What is really Happening? How does this relate to Our lives? Why does this problem or strength Exist? What can we Do about it?[20,30,34]. Group sessions took place at the Health Promotion Center in Villaverde, were audio recorded and transcribed verbatim. During session 5, participants chose the photographs they wanted to be used in the dissemination activities (e.g. scientific publications, photobook, etc.) resulting from the project. Finally, we gathered all participants together in a meeting where we gave each participant a personal portrait (taken by the professional photographer). In this meeting, researchers and participants decided together the future steps regarding the project communication strategy.

Following Wang and Burris' guidelines, we carried out a participatory data analysis, where participants were the ones who sorted their photographs into categories[30]. First, each participant selected one or two of their photographs (the ones they thought best reflected their neighbourhood food environment). During the small group discussion sessions, they critically discussed each photograph and identified categories arising from the group discussions. Facilitators intervened only to involve everyone. Finally, participants organized together their photographs into eleven categories. These categories were then grouped into three themes by the co-authors, using the deductive analytical strategy of successive

approximation, a method 'of qualitative data analysis in which the researcher repeatedly moves back and forth between the empirical data and abstract concepts or theories'[37,38]. To enhance credibility and confirmability, these themes (with their accompanying categories, photographs and discussions) were later member-checked with participants, so that they could change anything they wanted (or preferred not to share)[36].

Results

First, we describe the objective retail food environment in the neighbourhood. Second, we describe the categories discussed by residents as relevant for their retail food environment. Third, we report differences and similarities across both quantitative and qualitative results.

Objective retail food environment

The community food environment included 114 food stores and one street market. In terms of types of food store, the neighbourhood was widely served by small specialized stores (59·4 %), whereas corner stores (34·4 %) and supermarkets (6·2 %) were less common.

Figure 1(a) displays the results from the in-store audits, showing the healthy food availability (HFAI) scores by store type. Supermarkets scored highest in terms of healthy food availability (36·5 out of 39), followed by corner stores (33·6 out of 39) and small specialized stores, which

scored the lowest (10·8 out of 39). Figure 1(b) depicts residents' pedestrian accessibility to food stores with high HFAI scores. It shows that 57·3 % of residents lived within less than 5 min from a high healthy food store, 88·4 % lived within less than 10 min and 98·9 % lived within less than 15 min.

Residents' perspectives on the retail food environment

Photovoice participants took eighty-five photographs and selected twenty-two to be discussed during the group discussion sessions. Through the participatory analysis, residents identified eleven categories related to their retail food environment, which were grouped into three themes: (i) 'community food environment'; (ii) 'social local influences'; and (iii) 'consumer food environment' (see Fig. 2).

In relation to the 'community food environment', participants highlighted availability-related aspects ('variety of food store types') and accessibility-related aspects ('poor access: built environment obstacles'). Four photographs served as triggers for discussion of these categories (see Fig. 3 for two examples).

While talking over the 'variety of food store types', residents agreed that small specialized stores were a positive asset of the community environment, which offered a wide variety of healthy foods: 'Neighbourhood food stores have lots of fruits and vegetables' (Javier, 51 years). They also highlighted the street market as another food store type offering them a wide variety of
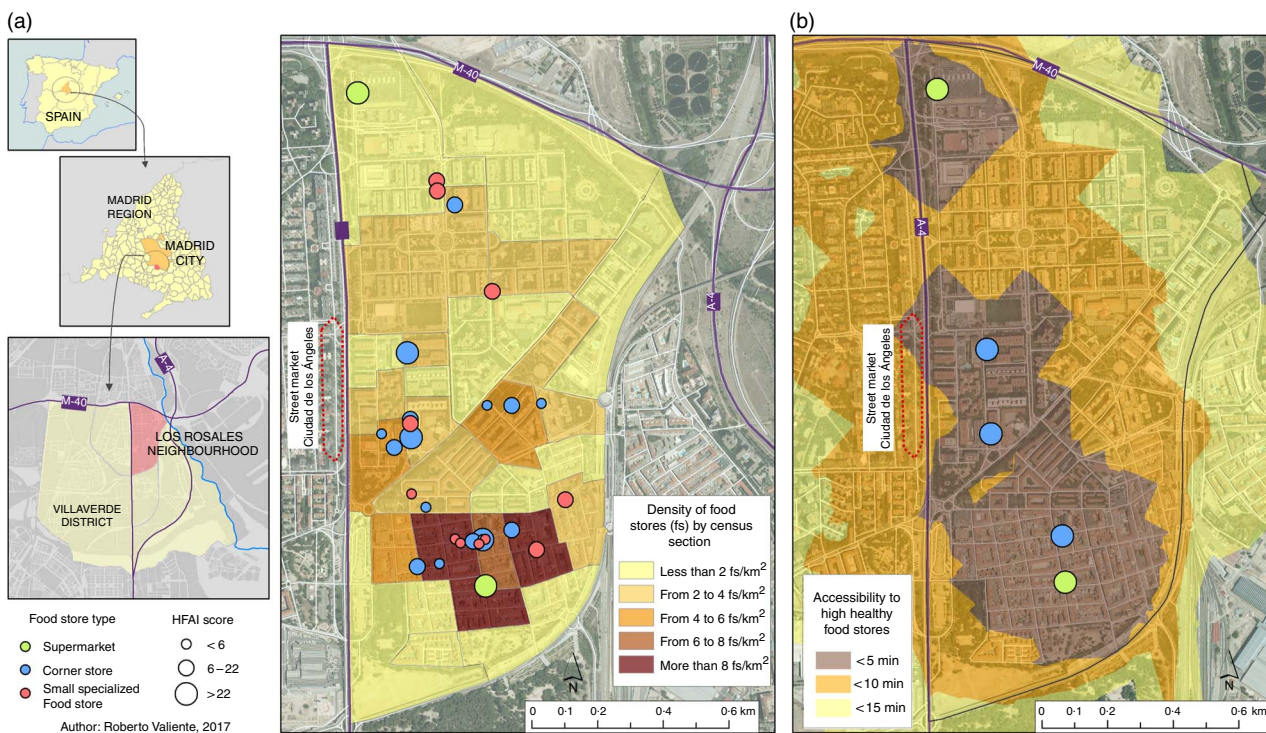

Fig. 1 Objective retail food environment in the low-income neighbourhood of Los Rosales in the Villaverde district of Madrid (Spain), 2016. (a) Healthy food availability scores (HFAI, Healthy Food Availability Index) by food store type and density of food stores by census section; (b) access by walking to food stores with a high availability of healthy foods
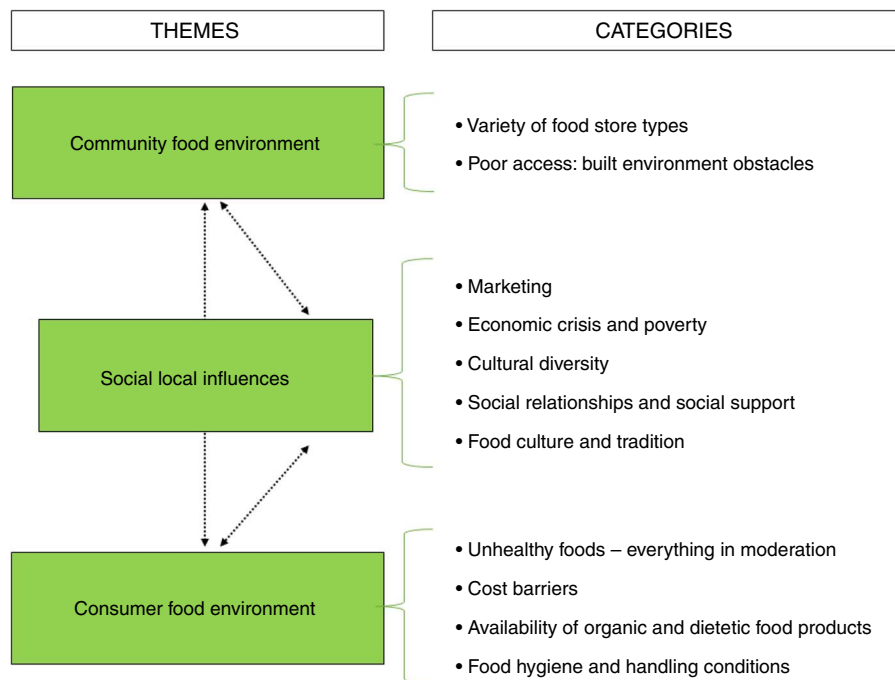
THEMES	CATEGORIES

Community food environment
- Variety of food store types
- Poor access: built environment obstacles

Social local influences
- Marketing
- Economic crisis and poverty
- Cultural diversity
- Social relationships and social support
- Food culture and tradition

Consumer food environment
- Unhealthy foods – everything in moderation
- Cost barriers
- Availability of organic and dietetic food products
- Food hygiene and handling conditions

Fig. 2 Residents' perspectives on their retail food environment, low-income neighbourhood of Los Rosales in the Villaverde district of Madrid (Spain), 2016. Participants generated eleven categories (right), which were grouped into three themes (left)

fresh foods. Supermarkets were sorted as a negative influence of the community environment. On the one hand, residents acknowledged that supermarkets also offer fresh fruits and vegetables (see Fig. 3(a)). On the other hand, they claimed that: 'We have to protect these [small specialized] stores against other retail types such as supermarkets, especially in terms of places where you can buy fresh food' (Pablo, 66 years). In relation to the category of 'poor access: built environment obstacles', residents highlighted the need to remove architectural barriers in the neighbourhood (Fig. 3(b)).

Four categories arose from participants' analysis related to their 'consumer food environment': (i) 'unhealthy foods – everything in moderation'; (ii) 'availability of organic and dietetic food products'; (iii) 'cost barriers'; and (iv) 'food hygiene and handling conditions within food stores'.

When discussing a photograph depicting a dish of chorizo, one participant explained: 'We are looking at products [a dish of chorizo] that are very appealing, awesome for the palate … but if you abuse of them, your cholesterol will go through the roof' (Armando, 69 years). Residents emphasized that the presence of unhealthy foods within food stores, bars and restaurants influenced their diets negatively. Still, they also defended the sporadic consumption of these unhealthy products. Participants depicted in their photographs how some food stores (e.g. bakeries) offered dietetic food products (e.g. foods with a reduced sugar content). However, they stressed their difficulties to afford these products: 'It's the same thing with the organic food shops, they sell very healthy products but they are quite expensive … quite expensive.

Very healthy, but not affordable' (Javier, 51 years). Hence, the category of 'cost barriers' was constantly present in their discussions. Figure 4 shows an example of how the wide availability of unhealthy foods and cost barriers influence residents' food choices.

Participants' analysis revealed another five emergent categories, which were grouped around the theme of 'social local influences': (i) 'marketing'; (ii) 'economic crisis and poverty'; (iii) 'cultural diversity'; (iv) 'social relationships and social support'; and (v) 'food culture and tradition'.

In relation to 'food culture and tradition' and 'social relationships and social support', residents highlighted that in the Spanish culture, 'the way we get in touch with each other is very connected to food' (Encarna, 59 years). In this context, one photograph portrayed 'a friends meeting having tapas on a terrace'. One participant claimed that 'eating together while gathering with friends improves the self-esteem' (Encarna, 59 years), and another also commented that 'it is very healthy to have some beers at the terrace with friends' (Rosa, 51 years). Through grocery shopping, residents socialized with others. Participants talked about the street market, the small specialized food stores, as well as also urban gardens, as neighbourhood spaces 'of great value, which improve our sense of belonging to the neighbourhood. These encounters may also serve as a social protection net against loneliness' (Encarna, 59 years). They also sorted the customer service of small specialized food stores as an important asset of the neighbourhood food environment, as shown in Fig. 5.

(a)

(b)

'A retired person is choosing fresh vegetables.'

'Men are getting increasingly involved in purchasing food and preparing meals.'

(Beatriz, 56 years)

'A ramp with a ridiculous incline and lots of difficulties.'

'We need to demand local policy makers to change it.'

(Ángel, 51 years)

Fig. 3 (a) Photograph: 'Grocery shopping at the supermarket'; category: 'variety of food store types'; theme: 'community food environment' (photographer: Beatriz, resident of Los Rosales, Villaverde). (b) Photograph: 'The access?'; category: 'poor access: built environment obstacles'; theme: 'community food environment' (photographer: Ángel, resident of Los Rosales, Villaverde)

'Even the elderly residents surrender to junk food, and that is very disturbing … for convenience, for looking for something cheaper … they make us fall into line. It is a quick and cheap way of going outside for lunch.'

(Beatriz, 56 years)

'I'm not saying that these [hamburgers] are healthy (…) but it's what people can afford to buy.'

(Sagrario, 44 years)

Fig. 4 Photograph: 'McDonalds'; category: 'unhealthy foods – everything in moderation'; theme: 'consumer food environment' (photographer: Beatriz, resident of Los Rosales, Villaverde)
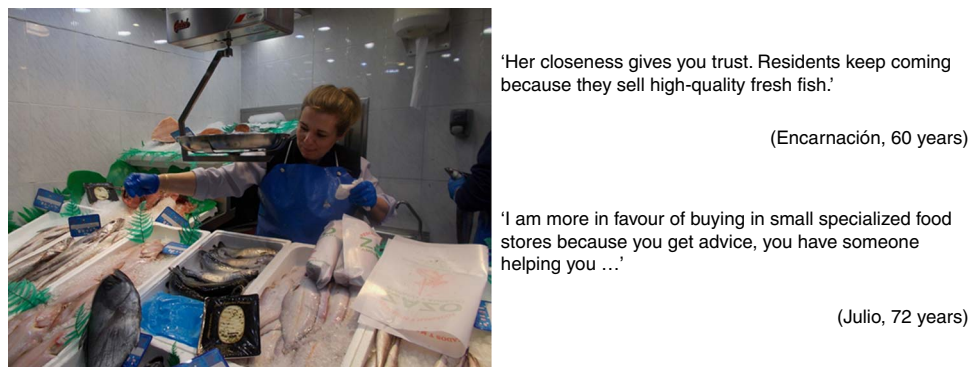

'Her closeness gives you trust. Residents keep coming because they sell high-quality fresh fish.'

(Encarnación, 60 years)

'I am more in favour of buying in small specialized food stores because you get advice, you have someone helping you …'

(Julio, 72 years)

Fig. 5 Photograph: 'My fish shop'; category: 'social relationships and social trust'; theme: 'social local influences' (photographer: Encarnación, resident of Los Rosales, Villaverde)

On the other hand, residents explained that supermarkets' marketing strategies focused on trying to seduce customers to make them buy more. Another salient category that residents revealed to be affecting their diets was poverty. Figure 6 illustrates the existing poverty (and food insecurity) in the neighbourhood, talked about as being a direct consequence of the economic crisis.
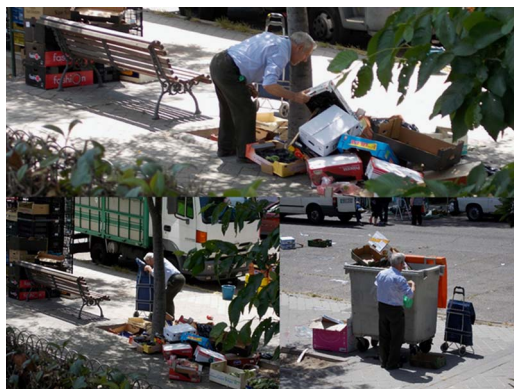
"It shows a sequence of photographs of an old neighbour in the street market. Once the food vendors are gone, he bows down to get food, and then you see that he is putting that food in his trolley … I think that he does not want his neighbours to find out. He is in extreme need. This man does not get any help besides from the garbage bin.'

(Sagrario, 44 years)

'There have been always the typical beggars. But now there are people from normal families, and you see them rummaging.'

(Julio, 72 years)

Fig. 6 Photograph: 'Elderly man grabbing food from the bin'; category: 'economic crisis and poverty'; theme: 'social local influences' (photographer: Sagrario, resident of Los Rosales, Villaverde)

Differences and similarities and across quantitative and qualitative results

In terms of the community food environment (type of and access to food stores in the neighbourhood), residents' perspectives were partially consistent with the quantitative assessment. In terms of variety of food stores, Fig. 1 showed a widely served neighbourhood. This was also recognized by participants, 'I think that we have many venues … and regarding small neighbourhood food stores … they are great. And there is a lot of variety in the neighbourhood, and lots of quality too!' (Encarnación, 59 years). Talking over the different food stores, another participant added 'in this neighbourhood we have everything' (Encarnación, 60 years). However, results diverged regarding accessibility. Figure 1 showed a neighbourhood in which 98·9 % of residents could access a healthy food store within a walking travel distance of less than 15 min. On the other hand, Fig. 3(b) served as a trigger photograph revealing existing built environment obstacles in the neighbourhood, which were discussed as being particularly determinant for the elderly residents: 'there used to be a ramp, but people complained because they slipped on the floor (…) it is like a slalom test for elderly neighbours now if they want to go grocery shopping there' (Ángel, 51 years).

Residents' perspectives on their consumer food environment were not consistent with the aforementioned quantitative findings either. Supermarkets scored highest in terms of healthy food availability (36·5 out of 39). However, they were sorted as a negative influence by residents. Residents discussed their lack of personalized customer service and their marketing strategies which they claimed lead customers to buy more than needed. Participants also stressed the wide presence of unhealthy foods they offered, 'there was this man in the supermarket, a man with considerable overweight, and he was in the prepared meals aisle, choosing what to buy. But almost everything were fried or battered foods, not very healthy' (Beatriz, 56 years).

On the other hand, small specialized stores, which scored the lowest in terms of healthy food availability

(10·8 out of 39), were viewed as healthy food sources. Residents emphasized their preference to do their grocery shopping in small local businesses over supermarkets (see Fig. 5). Small specialized stores were recognized as food stores they could rely on: 'the familiarity of the store-owners gives you confidence' (Encarnación, 60 years).

Discussion

In the present mixed-methods study we examined the retail food environment in the low-income neighbourhood of Los Rosales (Madrid, Spain), by combining both objective (observational audits) and subjective data (residents' photographs and discussions).

We found that residents experienced the retail food environment differently from what researchers analysed through GIS-based measures and in-store audits. Quantitative results showed a widely served and highly accessible retail food environment, where 98·9 % of residents could access a healthy food store within a walking travel distance of less than 15 min. Supermarkets scored highest in terms of healthy food availability (36·5 out of 39). However, residents shopped at small local businesses over supermarkets, because they placed higher trust in the workers and owners of this type of store. Moreover, participants highlighted many negative aspects related to supermarkets, such as their marketing strategies or their wide offer of unhealthy foods. These are key differences between the current study and previous research advocating for supermarkets to improve neighbourhood food environments. We also found that the socio-economic context constrained residents' diets, as previous research has also highlighted[11,39,40]. Cost barriers was an emergent category discussed in the group discussion sessions. Participants portrayed and discussed the existing food insecurity in the neighbourhood or their difficulties to afford healthy food products.

Previous studies have shown how retail food environments in Southern European cities differ widely from those

in Anglo-Saxon countries[28,41]. In the case of Spain, a study by Flavian *et al.* showed that the number of food stores per resident was three times higher in Spain compared, for instance, with the UK[42]. Moreover, food retailing activity in these Southern European cities is not so concentrated into big retail chains of supermarkets and small convenience stores (like in the USA), but more determined by specialized food stores[15,28,41,42]. In addition, it is important to consider that supermarkets offer healthy products as well as a wide range of unhealthy and ultra-processed foods[43]. Therefore, assumptions on whether certain types of food stores (e.g. supermarkets *v.* small specialized food stores) promote healthier food environments could introduce important biases in non-Anglo-Saxon settings[41]. These small food stores, and also the local street market, were talked about as being more than just food stores, rather as opportunity structures for socializing[44]. These results are consistent with previous studies which have stressed that local food environments are a highly complex phenomenon resulting from the interaction between multiple physical and social influences[3,9,40,42].

In the current study, our spatial analyses depicted the objective healthy food availability and accessibility in the neighbourhood, but could not explain the mechanisms through which food choices are made[45]. However, this lack of contextualization can be diminished with the input of qualitative methods, as in the present case with the photovoice methodology, which documents the lived food environment from a resident's perspective[36]. Residents captured social local influences less tangible to researchers. For instance, the importance of the 'customer–store owner relationships' would not have emerged without engaging in the photovoice process[36]. Thereby, the combination of different quantitative and qualitative methods allowed us to gain a more comprehensive understanding of the retail food environment.

Although conducting a photovoice project involves considerable effort, incorporating community-driven data allows researchers to better interpret and understand how contextual determinants of the retail food environment shape people's food choices[45]. Including citizens' perspectives into research is key to designing pragmatic interventions that have the greatest likelihood of success[46]. In the present case, understanding residents' perspectives on the retail food environment is critical to develop future effective interventions aimed at improving healthy eating. Residents' insights have revealed that public health interventions should promote small-sized neighbourhood stores, carrying fruits, vegetables and fresh products. Further, public health interventions aimed at supporting these stores may help support the local economy, increase socialization between residents, and even contribute to enhance pedestrian environments[15,47]. Moreover, food environment interventions need to be more context-specific and to encourage community participation to increase their likelihood of success.

As in previous studies, using photovoice methodology also proved particularly useful to create a critical dialogue to advocate for community change[29,31,48]. In order to stimulate policy change, we developed a dissemination strategy to communicate results to the scientific community, society and relevant local policy makers[36]. Our aim was that researchers, practitioners and residents worked as equal partners, so that participants were involved in all dissemination and outreach activities. Participants chose the final photographs they wanted to be included in the photobook and in the photographic exhibition of the project, which has been shown in four different settings in Madrid and, very importantly, in the European Parliament. The printed and free downloadable photobook (https://hhhproject.eu/wp-content/uploads/2016/12/161214_Photobook_print_27x22mm.pdf) includes the photographs selected by the participants and their discussions. We also edited a video (https://www.youtube.com/watch?v=VIiFggKzVas) and a website (https://hhhproject.eu/photovoice/) including an interactive cartographical application with both objective and participant-generated results (http://www.geogra.uah.es/PHHotovoiceMap/photovoice.html). Further, we organized two different citizen science meetings, where participants, researchers and local policy makers came together and discussed study results to design and implement several food policy initiatives in the neighbourhood.

Our study presents several limitations that should be taken into account. First, we recognize that the small sample size of participants and our purposive sampling design may limit generalizability. However, as Catalani and Minkler noted in their literature review focusing on the use of photovoice in public health research, our sample size is appropriate for photovoice projects[21]. Second, we acknowledge that food stores are not the only food source in the retail food environment. Food services (e.g. fast-food restaurants or bars) may contribute substantially to residents' dietary patterns, but were not assessed quantitatively in the current study.

Our study also presents a number of strengths. First, we collected a large amount of original data from different data sources. Second, the community was engaged in all aspects of the research process, helping us to learn from residents' experiences. Third, there is concordance of timing between the quantitative data collection and participant-produced photographs and discussions, which prevents us from finding discrepancies between results that might be attributable to variations in time (for instance, food store closures between the objective data collection and the photovoice project process).

Conclusions

The present study reveals that people's experienced retail food environment is different from the one conceptualized

by researchers. Studying the mismatch across different elements of the retail food environment (in terms of type and availability of and access to healthy foods in the neighbourhood) allowed us to understand more comprehensively how it influences where (and how) residents do their grocery shopping.

Our results show the potential of using a mixed-methods approach to reveal key contextual determinants that can be difficult to assess by quantitative methods, and yet may be crucial to enrich food environment research and for designing effective public health interventions to improve the neighbourhood food environment.

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