Food store environment examination – FoodSee: a new method to study the food store environment using wearable cameras

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Abstract:

Introduction: Food environments shape food behaviours and are implicated in rising rates of obesity worldwide. Measurement of people's interactions with food stores is important to advance understanding of the associations between the food environment and in-store behaviour. This paper describes a new method, Food Store Environment Examination (FoodSee) to measure people's interaction with the food store environment in a feasibility study focused on convenience stores and children.

Methods: One hundred and sixty-eight randomly selected children (aged 11–13 years) recruited from 16 randomly selected schools in Wellington, New Zealand, used wearable cameras for 4 days that recorded images every 7 s. The study was conducted from July 2014 to June 2015. All images of convenience stores and service stations, and a sample of images from supermarkets, were evaluated to determine the feasibility of assessing food availability and marketing. The outcomes of interest assessed were: food product availability, placement, packaging, branding, price promotion, purchases and consumption.

Results: Thirty-seven children (22%) visited a convenience store or service station at least once during the study period. In total, there were 65 visits to 34 different stores. Seven hundred and nineteen images revealed the in-store environment. Of those, 86.1% were usable and able to be analysed for the outcomes of interest.

Conclusions: The FoodSee methodology provides a promising new method to study people's interaction with the in-store food environment. The evidence generated will be valuable in understanding and improving the food store environment within which people shop, and will contribute to efforts to address obesity globally.

Keywords: food availability, food marketing, childhood obesity, consumer nutrition environment, wearable cameras

Introduction

Obesity rates are rising significantly across the globe (1). As a result, researchers have measured the impact of the food environment on health and dietary patterns (2–5). While cross-sectional and longitudinal studies have had varied results (6),

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there is increasing evidence of an association between the community nutrition environment (the type, availability and accessibility of food outlets) and dietary intakes and behaviour (7,8).

There has also been growing attention from researchers towards understanding the consumer nutrition environment and how the availability, product assortment, price, promotion and placement of food within a store influence dietary factors (3,9,10). The food environment has changed over time with access to most food outlets increasing (11) and the rise of large supermarket chains dominating the food supply chain in many countries (12). Supermarkets can facilitate a greater variety of healthier food choices to consumers than other food stores, however they can also increase the purchase of energy-dense, nutrient-poor foods by allowing extra shelf space for these foods, selling them at low prices or placing them at the checkout and end-of-aisle displays (13,14).

Convenience stores present a food environment that is 'BMI unhealthy' in that most of the food available is highly processed, energy-dense, nutrient-poor snack food (15,16). The presence of convenience stores within neighbourhoods has been linked to lower-quality diets, especially for low-income individuals in the United States (8,17). Food purchases made at convenience stores contribute significantly to total daily energy and sugar intake among urban school children. In one US study, the most frequently purchased items were sugar-sweetened beverages, candy and snack foods, which were often inexpensive (18). Within retail outlets, the cash register area is a place where impulse-purchasing decisions are made, a feature that has been exploited in convenience stores by the placement of unhealthy foods (chocolate, confectionary, salty snacks) by the cash register (19).

The in-store environment of convenience stores is complex. Studies have used a range of methods and tools to measure such environments, the choice being dependent on the aspect of the store that is being measured (3). Methods range from checklists that measure key indicator products such as fruit, vegetables and snack foods (20), or measuring the ratio of shelf length of healthy to unhealthy food in-store (21). Food purchase is normally measured by collecting receipts from participants (22). To explore consumer behaviour in-store, qualitative methods have been used including key informant interviews (21,23) and focus groups with children (24). Such studies typically introduce participant recall and social desirability bias (25). To our knowledge, no studies have objectively examined people's interaction with the food store environment.

Wearable cameras are a relatively novel research tool, and their utility to enhance existing dietary assessment methods has been tested with adult participants with promising results (26,27). The feasibility of using wearable cameras as a mechanism to understand food purchasing and consumption behaviour among teenage participants was assessed by Cowburn and colleagues (22). This study used multiple data-collection methods including wearable cameras, GPS, participant interviews, food and drink purchase consumption diaries, and an audit of food outlets located near schools (22). As the researchers were interested in quantifying food purchase and consumption rather than the consumer food environment, images from the inside of food stores were not analysed. However, the researchers suggested it would be worthwhile examining the feasibility of using image data to measure the food store environment in future studies, an aim of the present study.

This paper describes a new method to measure people's interaction with the food store environment, Food Store Environment Examination (FoodSee). Image data from wearable cameras worn by children generated from the Kids'Cam study (28) were analysed for the food store environment of convenience stores. The primary purpose of this paper is to describe the method, its development and feasibility for community-based nutrition research.

Methods

Study design

FoodSee is an ancillary study of Kids'Cam, a cross-sectional observational study of 168 children (aged 11–13 years) in the Wellington region of New Zealand (28). Data were collected from July 2014 to June 2015. Participants wore a wearable camera and a GPS unit on lanyards around their necks. The camera captured a 136° image of the scene ahead approximately every 7 s, and the GPS unit captured latitude and longitude coordinates every 5 s. Children understood the purpose of the research as 'to study the world in which children live' but were

blinded to the Kids'Cam study aim to measure children's exposure to food marketing (29). Ethical approval was given by the University of Otago Human Ethics Committee (Health) (13/220) to study any aspect of the world that children live in (28). A detailed analysis of the in-store food and beverage marketing was not conducted given its complex nature and multiple marketing occurrences; rather, it was simply coded as 'in-store marketing'. Further details of the methodology for Kids'Cam is published elsewhere (28,29).

In FoodSee, all children's images previously coded as 'convenience store' or 'service station' in the primary Kids'Cam study were re-examined, and the images of the in-store environment coded. Service stations were included as they were used by the children in a similar manner to a convenience store. A sample of images previously coded as supermarkets was also assessed. Manual coding of images was performed using a protocol to guide content analysis (30). Images were excluded from the analysis if they were blurred, or a significant portion of the image was blocked.

Protocol

A FoodSee study protocol was developed, piloted and refined. To do this, two researchers (CM and MS) reviewed the images and scoped the information that could be generated from the images. Issues resolved included agreement on the unit of measurement, which was finalised as each visit a child had to a food store. A visit began with the first in-store image, and concluded with the final in-store image. Another consideration was whether to count the total number of product categories or the individual items of food and beverages in each image, and whether to count items as accurately as possible or to estimate the count to the nearest 10 items. It was decided to count both product category and the items within a category as accurately as possible.

Coding schedule

The following outcomes of interest were identified and defined in relation to FoodSee:

The 'consumer food environment' refers to the conditions customers encounter when entering a store, including price, availability, promotion and nutritional information (3). 'Food availability' refers to the adequacy of the supply of food (31). This was measured by counting the 'food and drink items' in the photos and classifying them by product category and the total number of individual food items present. Each food or beverage item was only coded once per convenience store encounter. For example, the initial photo picturing the item was coded as 'available' and subsequent images containing the same item were noted as 'previously coded'.

The product categories were based on those used in the Kids'Cam food marketing study and extended to reflect the uniqueness of the in-store environment (29). For example, the category 'confectionary' was separated into confectionary packets, single serve confectionary (e.g. confectionary that is 10c or 20c per individual item), lolly mixtures (individual candy grouped into bags) and chocolate. All foods were classified as either recommended (core) or not recommended (non-core) based on the World Health Organization Regional Office for Europe Nutrient Profiling Model (32). This model was chosen as it categorises food as eligible or ineligible to be marketed to children.

'Food position' refers to the proximity of a food product (33). The images in the study were from a camera worn at a child's chest height. Therefore, images where products were at the forefront in the image, displayed at a child's eye level or within easy reach of them were coded as 'accessible'. Items on high shelves or behind a counter were coded as 'inaccessible'.

Marketing was defined as:

> any form of commercial communication or message that is designed to, or has the effect of, increasing recognition, appeal and/or consumption of particular products and services. It comprises anything that acts to advertise or otherwise promote a product or service (34, p.9).

In-store marketing includes on shelf displays at checkouts, pay points and end of aisles in supermarkets, special offers and pricing incentives. Glanz *et al.*, discuss food marketing relating to product, price, placement and promotion (35). In this study, food products were coded as discussed above. In addition,

Table 1. Summary of coding schedule.

Setting	*Marketing medium*	*Product category non-core*	*Placement*	*Behaviour*
Convenience store	Product	Confectionary (packet)	Fridge	Purchased
Service station	Packaging	Single serve confectionary	Freezer	Consumed
Supermarket	Price promotions	Lolly mixture	Display fixture	
		Sugary drinks and juices	Manufacturer-supplied display fixture	
		Iced confectionary	High shelf/wall	
		Chocolate	Counter with cash register	
		Fast food	Behind counter	
		Snack foods	Under counter	
		Cookies, cakes and pastries	Counter bench (side)	
		Milk product (non-core)		
		Other: non-specified – frozen potato products, dips		
		Processed meats		
		Product category core		
		Milk and milk products		
		Water		
		Breads and cereals		
		Fruit and vegetables		
		Meat and alternatives		
		Mixed meals		

if the item was packaged this was coded, and if a product had a visible price promotion, it was coded as 'price promotion'. Other examples of promotion codes were 'manufacturer-supplied displays' and 'signs'. See Table 1 for the codes used and Figure 1 for an example of an image from a convenience store, and an example of coding for this image.

'Food purchase' was coded when a purchase transaction occurred in exchange for a food or drink item. This included exchanges at shop counters and tills. Food purchase coding noted whether the purchase was by the child themselves, or a peer.

'Consumption' was coded when a sequence of images revealed a food or drink item being consumed. An eating or drinking episode was initiated by the presence of a food or drink item. The participant handling the food or drink item and/or a decrease in the amount of food or level of the drink in images followed this. See Figure 2 for an image sequence example of food purchase and consumption.

Coding of image data

An Excel spreadsheet (available upon request) was developed to enable the systematic coding of each image. To add context, field notes were recorded in the spreadsheet. For each image, the participant identification number, date and time of photo, and image identification number were recorded. In order for a food or drink item to be coded, the coder had to clearly identify the type of food or beverage product, for example 'chocolate' or 'sugary drink'. For an image to be coded for marketing, the logo, brand name or registered trademark needed to be clearly identified so that 50% of the image could be seen by the coder.

Each food store visit was treated as a separate item for analysis. The coding enabled calculation of the total number of food items observed in one visit to a food store, and the healthfulness of those items.

Category	Products (n)	Items (n)	Package	Position Arms Reach	Where in shop?	Promotion Branded Display	Signs (n)	Price Promotion
Confectionary Single Serve	8	20	Yes	Yes	Counter Bench (Side)	0	0	0
Lolly Mixture	3	11	No	Yes	Counter Bench (Side)	0	0	0
Chocolate	13	35	Yes	Yes	Counter Bench (Side) Manufacturer Supplied Display Fixture	2	2	6

Figure 1. Example image from convenience store.

Quality control

To ensure accuracy, the coding of two coders (CM and MS) was tested for inter-coder reliability. A score of 90% concurrence with model answers on a test dataset of two convenience store image sequences (n images = 10) was achieved before coding could commence. Where there was a discrepancy, the codes were discussed and the schedule was refined accordingly.

Results

Images from 37 children from the main dataset revealed the inside of a convenience store or service station. In total, there were 65 visits, with some children visiting a convenience store more than once during their 4-day data-collection period. Each visit consisted of 11 images, on average, which took approximately 1 hour to code. The total coding time was 65 hours. This value assumes an understanding of the coding procedure, such as food categories and data entry. Further, coding time was reduced because images from convenience stores had already been identified in the Kids'Cam study. However, scrolling through the photos to find exposure to food stores can be easily done as multiple images can be viewed at once and long periods of time are spent at home or school.

To test the feasibility of the FoodSee method, other food settings images from a sample of three supermarkets were also analysed. The total coding

Figure 2. Image sequence food purchase and consumption.

time differed depending on the length of time spent in a supermarket and therefore the total amount of images per encounter. Convenience store visits tended to be of short duration (2–3 min) whereas one trip to the supermarket could take over 30 min. However, as supermarket product categories are organised in aisles, coding was simpler than for convenience stores, where many different products and types of products are crowded together in a compact space. The prices of products were clearly visible and the placement of products at ends of aisles or at the checkout was also identifiable through the image data. It was also possible to code for purchase and consumption.

The images were practical for assessing the outcomes of interest studied: food availability, marketing, food purchase and consumption. Of the 719 images captured in a convenience store or service station, 620 (86.2%) were usable. Few images were excluded due to blurriness, blockage or the coder being unable to clearly detect the food products in the image. Images were mostly of high quality and it was possible to count both categories of products as well as the number of individual items within a category. The placement of a camera around a child's neck enabled a sense of what is within a child's reach in a store within their reach. Other marketing features, such as the use of semiotics on packaging or promotional displays were all easily visible in the data. In some images, children were exposed to multiple products and marketing stimuli, such as 100 individual chocolate bars, in branded displays with prominent price marketing.

Discussion

This paper reports on a novel approach to study people's interaction with the food store environment, using wearable cameras as data-collection instruments.

The methodology has several advantages to previous methods. As the participants were blinded to the food store environment analysis, it was possible to gain an objective measure of their behaviour. The objective and unobtrusive method overcame the participant recall and social desirability bias of previous methods (25). This method enabled both food availability and marketing to be assessed, whereas previous studies have required multiple methods such as NEM-S (food availability) (20) and the Gro-Promo tool (food marketing) (36).

While this study focused on measuring children's interaction with the food store environment of convenience stores and service stations, the method could also be used to assess the food store environment of a supermarket, as demonstrated by the high usability of images captured during the three supermarket visits. While supermarkets are generally categorised as BMI-healthy in food environment research (37) there is some evidence that the food sourced from supermarkets by young people, for example, is not necessarily healthy (38) and that supermarket promotional activities include a high percentage of unhealthy foods (39). The image data provide spatial information on people's exact location within the supermarket that could be mapped in geographic information systems to facilitate micro-spatial analysis. Micro-spatial analysis can highlight people's movement through a supermarket, as well as the location of features of interest and the exact location at the time of exposure. This further supports the content analysis, as was done for alcohol marketing in another ancillary study to Kids'Cam (40). Further more, while children were the participants in this study, it is a method that could also be used with adults (41).

Although we believe this study provides robust data on the use of wearable cameras to study people's interaction with the convenience store environment, it has some limitations. Some food purchases may have been missed in the data collection. In future studies this could be validated by collecting receipts, however, by doing so, participants would no longer be blinded to the study's objectives. As this method is reliant on where the person goes in-store it may not fully capture all food available or marketed, however the method enables an individual measure of actual food availability rather than using food stores as a proxy. While coding the images manually took time, it should be noted that the method does not require researcher time to visit food stores as in existing methods such as NEM-S(20).

Conclusions

The FoodSee methodology provides a promising new method to study people's interaction with the food environment in food stores. The evidence generated will be valuable in understanding and improving the environments in which people shop for food, and contribute to efforts to address obesity globally.

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Authorship

CM, MS and LS conceived the idea and developed the study protocol. CM and MS developed the coding schedule. LS, MS, MB and TC collected the data. LS provided overall leadership of the research. All authors contributed to the manuscript and approved the final version.

Ethical standards disclosure

Ethical approval was given by the University of Otago Human Ethics Committee (Health) (13/220) to study any aspect of the world that children live in. All participating children, parents and schools signed written consent to participate in the study.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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