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Temptation at every corner: exploring public perceptions of food cues and policy support for governmental food cue regulation in outdoor public spaces

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Abstract

Background Unhealthy visual food cues in outdoor public spaces are external drivers of unhealthy diets. Food cues are visible situations associated with food-related memories. This study aimed to gain insight into the (un)healthy food cues residents notice in outdoor public spaces in Dutch municipalities. It also aimed to explore residents' perceptions of food cues' influence on eating behaviour to gain insight into the acceptability of food cues and support for governmental food cue regulation.

Methods An exploratory study was conducted among 101 adults who photographed outdoor visual food cues in their municipality and answered survey questions about the food cues using a bespoke app ('myfoodenvironment'). Participant and food cue characteristics were analysed. Associations between those characteristics, perceived influence on eating behaviour, acceptability of food cues and support for regulation were analysed.

Results Participants took 461 photographs of food cues. Most food cues visualised food (73.8%), 54.4% of which showed only unhealthy food. Food cues photographed by participants with a high level of education and those located near a food service outlet were more often perceived as stimulating others to eat compared to those photographed by participants with a middle education level and located near a food store or along the road (Fisher's exact test: $p < 0.001$ and $p = 0.001$, respectively). For most photographs, participants found the presence of food cues acceptable and were opposed to governmental cue regulation. However, when food cues visualised healthy food, they were more likely to be found acceptable than when visualising unhealthy food (χ^2 (4; $N = 333$) = 16.955; $p = 0.002$). Besides, when food cues visualised unhealthy food, participants were less likely to oppose governmental regulation of those types of cues, than when visualising healthy food (Fisher's exact test: $p = 0.002$).

Conclusions Unhealthy food cues in outdoor public spaces were predominantly photographed by the participants. Yet, for most photographs, participants found the food cues acceptable and opposed governmental food cue regulation, although acceptance was higher for healthy food cues and opposition was lower for unhealthy food cues. These findings can serve as input for policymakers to develop governmental food cue regulations that may gain public support.

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Keywords Outdoor food cue, Food environment, Governmental regulation, Public support, Ecological momentary assessment

Background

Global public health challenges such as a high prevalence of overweight, obesity, and diet-related chronic diseases are urgent and mainly caused by unhealthy diets, consisting of energy-dense and nutrient-poor foods that are high in sugar, salt and saturated fat [1]. Dietary patterns are influenced by numerous factors, among which the food environment is very important [2–4]. Contemporary food environments are characterized by the omnipresence of unhealthy, energy-dense foods, for instance through the pervasiveness of unhealthy food within stores [5, 6], unhealthy food outlets [7, 8] and marketing for unhealthy food [9, 10]. As such, public health experts have suggested (local) governments implement policies to encourage the creation of healthy and sustainable food environments [11–13].

While regulating the availability and promotion of unhealthy food *within* stores is outside the jurisdiction of municipalities, the type and number of food outlets and outdoor food marketing in public spaces may be regulated through local policies in the Netherlands [14]. Public spaces have been defined by the United Nations (UN) as 'all places publicly owned or of public use, accessible and enjoyable by all for free and without a profit motive' (UN-Habitat, 2018, p.9). It includes streets (e.g. avenues, sidewalks, galleries, bicycle paths, squares), open public spaces (e.g. parks, playgrounds, gardens), public facilities (e.g. public libraries, public sports facilities) and markets. In this study, the term 'outdoor public spaces' is used to refer to streets and open public spaces. According to the UN, local governments are responsible for the provision of adequate outdoor public spaces and can develop policies to plan, design, protect and manage these spaces [15]. However, in contemporary outdoor public spaces, people are exposed to a variety of food outlets, billboards, displays, advertisements, etc., often not in favour of supporting a healthy diet [16–18]. To illustrate, a review of real-life studies on the prevalence and impact of visual food cues in outdoor public spaces, with a specific focus on food marketing, showed that almost a quarter of outdoor marketing was for food, and the majority of the food marketed was unhealthy (mean of advertised food that was unhealthy across studies = 63%) [18].

Exposure to food in outdoor public spaces creates so-called 'visual food cues', defined as visible cues or situations associated with food-related memories such as food advertisements, food displays, etc. [19]. Experimental studies have shown that especially visual food cues depicting unhealthy, tasty, energy-dense food (through words or images), trigger a rapid response and increase people's desire for the depicted food [20–22]. Besides, exposure and reactivity to unhealthy food cues (visual, olfactory, real food) has been found to increase eating behaviour in children and adults [23]. People with eating disorders and obesity show functional disturbances in the neural responses when visual food cues are perceived, which may lead to inappropriate eating responses [22, 24]. However, these insights are primarily derived from laboratory and experimental settings, which do not account for the visual food cues that individuals encounter in real life [22, 25–27]. People may encounter a variety of visual food cues in outdoor public spaces, some of which are not considered as food marketing, such as non-branded food images (not considered as marketing due to the absence of a brand, e.g. image of a food product pasted on a supermarket window). Currently, there is a scarcity of studies in natural settings and a limited understanding of how citizens perceive visual food cues (extending beyond food marketing) in their natural environments [16, 17, 28, 29].

In addition to that, we lack insights into the perceived acceptability of visual food cues in outdoor public spaces and whether citizens support local governmental regulations. In recent years, public health experts have called for marketing restrictions targeting alcohol and unhealthy food in outdoor public spaces, such as bus shelters, intending to improve public health [9, 10]. A few countries are already experimenting with regulating exposure to unhealthy food marketing in outdoor public spaces [28]. For example, London has implemented a policy restricting advertisements for unhealthy food on its public transport network, which has led to reductions in purchasing of these types of foods [29, 30]. In the Netherlands, the city of Amsterdam has banned unhealthy food marketing directed at children in the metro [31]. Also, the municipality of Rhenen in the Netherlands rejected a permit for a large fast-food chain due to protests from residents) [32–35]. Nevertheless, globally, the implementation of such policies remains scarce [29, 36–38]. This can be explained by a lack of political will and public support, two common barriers to the implementation of food policies, as evidence alone is not enough to generate food policy change (e.g. politicians may be hesitant to implement policies for which they fear rejection from the public) [39].

Therefore, this study addresses these gaps by using Ecological Momentary Assessment (EMA), a method that collects real-time data in everyday settings. EMA allows to assess the specific food cues individuals encounter as they go about their daily routines. EMA can also capture people's perceptions of the food cues as experienced in context, offering deeper insights into how these cues are perceived [40]. By focusing on real-time exposure and perception, this study aimed to gain insight into the food cues noticed by residents in outdoor public spaces across eight municipalities in the Netherlands. The study also aimed to explore how these food cues are perceived to stimulate consumption, their acceptability, and their suitability for regulation by governmental policies, while differentiating by demographic characteristics such as age, education level, gender, and weight status of individuals encountering these cues in daily life.

Methods

Setting and context

The study took place in May and June 2023, in the region Foodvalley (circa 355,000 inhabitants in 2022) in the Netherlands, which comprises eight municipalities: Barneveld, Ede, Nijkerk, Rhenen, Renswoude, Scherpenzeel, Veenendaal and Wageningen [41]. In general, these municipalities are characterized by a predominantly conservative and Christian political orientation, except for Wageningen, which has a more progressive and green political outlook [42]. The Social Sciences Ethics Committee of Wageningen University granted permission for this study. This research was part of a larger project to monitor and improve local food environments in the Region Food Valley (Regio Deal Food Valley); however, the findings may be relevant for other municipalities in high-income countries.

Participants and study procedure

A previously developed EMA smartphone app [43] was adapted for this study as the 'MyFoodEnvironment app' (MijnEetomgeving app) and was used to gather insights into the outdoor food cues noticed by residents, their perceived effect on eating behaviour, the acceptability of food cues for residents and residents' opinion on governmental food cue regulation. The app was pilot-tested beforehand by $n=15$ residents to ensure comprehension of the questions. As a result, some questions were simplified and the starting screen was adapted to be more self-explanatory.

An external research panel organisation (Flycatcher Internet Research B.V.) supported in the recruitment of participants. Using their existing panel, consisting of a representative sample of the Dutch population [44], they invited inhabitants of the eight municipalities in the region Foodvalley who met the inclusion criteria to participate in this study ($N=1742$). Panel members approached were aged between 25 and 65 years old and spoke Dutch fluently. Moreover, they had to own a smartphone on which the app could be installed, with outdoor internet access (e.g. 3G), a camera and a global positioning system (GPS) function.

Participants received written instructions by email about the study procedure (what to do, which timeline, defining key terms, where to find additional information, whom to contact for questions). They could also access the study website with additional information relating to the study and the app (e.g. definition of food cues, instructions to log in on the app, instructions to take pictures with the app, etc.). After registering, participants filled in a digital baseline questionnaire regarding their demographic characteristics (e.g. municipality of residence, gender, age, highest obtained education level). Participants received a financial compensation of 10 euros when completing the study, including taking at least five photographs, answering all corresponding questions and filling in the baseline questionnaire.

Participants were asked to take at least five photographs of outdoor food cues they noticed in the municipality where they lived. Food cues were introduced as 'visual triggers in outdoor surroundings that prompt thoughts of eating or drinking. These can include billboards, brand or supermarket logos, delivery scooters, restaurants, images of food or displays'. They were encouraged to take these photographs within two weeks as they went along their daily life during the study period of May–June 2023. Besides, participants received a weekly reminder to take photographs once they had registered for the study and as long as they had not taken five photographs, for a maximum of 4 weeks. For each photograph participants took, they answered several questions to gain insight into their perception of each food cue's influence on eating behaviour, the acceptability of these types of food cues and their opinion on governmental food cue regulations. Participants could email the research team for questions during the entire study period. In total, 101 (5.8%) participants agreed to participate, provided written informed consent and took at least one photograph of an outdoor food cue. A total of 461 outdoor food cues were photographed and analysed based on their characteristics (Fig. 1). Yet, the evaluations of participants were missing for five food cues as the answers were not saved by the app, and therefore, 456 cues were analysed for the demographic differences (Fig. 1).

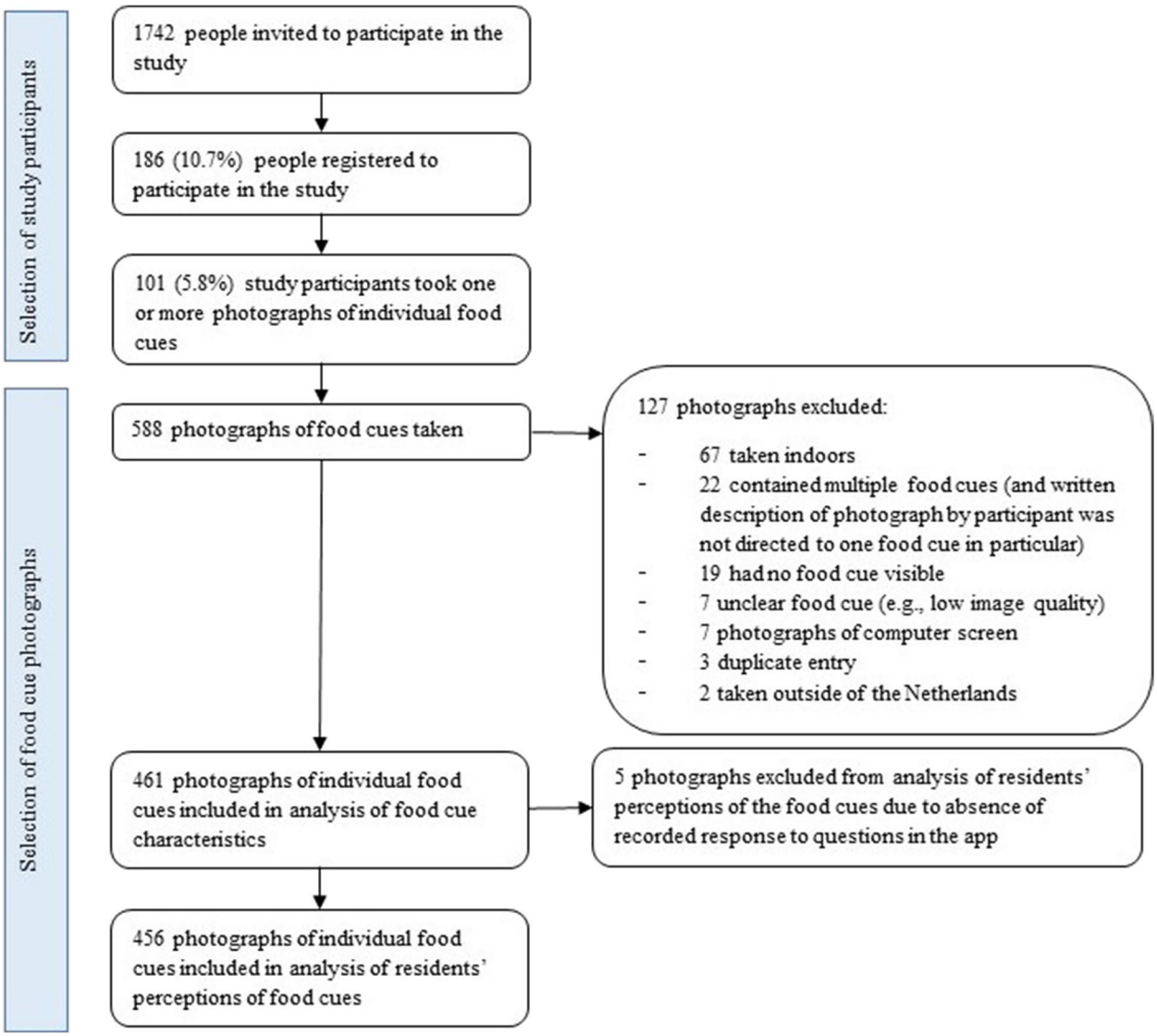

Fig. 1 Examples of food cues photographed by participants

Measures

Visual food cue characteristics

After taking a photograph, participants were asked to answer six multiple choice questions about the food cue. The first question was about the setting of the food cue: 'Where are you taking this photograph?' Response options were 'Outside' followed by 'near a shop; near a food service outlet; at the market; near a train station; at a tram/bus stop; near a petrol station; near a sport facility; alongside the road; and somewhere else, namely…'. The second question was an open question asking the participant to describe the food cue: 'Describe in one or two sentences the food cue that you photographed'. The answer to this question was used to determine which cue the participants had in mind when taking the photograph, in case several food cues were visible on the photograph. Photographs that contained several food cues and for which it was not clear which food cue the participant had in mind (i.e. description of several food cues or no description) were excluded.

The third and fourth questions were about how often the participant thought these types of food cues would influence him/her or others to eat: 'How often do you think these types of food cues stimulate you/others to eat?' A scale from one to five was used, with the following response options: never (1), rarely (2), sometimes (3), often (4), always (5); and I don't know. The fifth question was about whether they found those types of food cues

acceptable: 'Do you find it acceptable to see these types of food cues here?' A scale from 1 to 3 was used, with the following response options: yes, I find it acceptable here (1); neutral (2); no, I find it unacceptable here (3) I don't know. The last question was about whether they thought those types of food cues should be banned by the government: 'Do you think the government should ban these types of food cues?' A scale from one to three was used, with the following response options: no, the government should not ban these types of food cues (1); neutral (2); yes, the government should ban these types of food cues (3); I don't know. Please see Additional file 1 (Table S1) for a complete overview of the questions in the app.

The questions regarding the perceived impact of food cues on eating behaviour, the acceptability of food cues and the support for governmental regulation of the photographed visual food cues were phrased for 'these types of food cues' to be able to generalise the answers of participants to similar food cues. To analyse the data, the five-scale responses were modified into three-scale responses (never or rarely (1); sometimes (2); often or always (3)) for the questions 3 and 4 in the app (Additional file 1, Table S1). Also, the top three settings of food cues photographed by participants (outside, near a food store; outside, near a food service outlet; along the road) remained as such, whereas the category 'other settings' regrouped the other settings of food cues photographed by participants (at a tram/bus stop, at a petrol station, at the market, at a train station, at a sport facility, other).

Participant characteristics

The baseline questionnaire was used to determine the demographic characteristics of participants: gender (female/male/other), age (open question, dichotomised by researchers based on median age of 44.0 for data analysis), municipality of residence (multiple choice question with the eight participating municipalities), education level (multiple choice questions with different levels of education, categorised by researchers into 'low': primary education, first 3 years of general and pre-university secondary education, prevocational secondary education, lower secondary vocational training and assistant's training; 'middle': upper secondary education, basic vocational training, vocational training, and middle management and specialist education; or 'high education level': associate degree programmes, higher education, bachelor programmes, 4-year education at universities of applied sciences, master degree programmes at universities of applied sciences and research universities, and doctoral degree programmes at research universities [45]), and body mass index (calculated by researchers based on open question about weight and length).

Data analysis

Descriptive statistics were used to analyse the demographic characteristics of participants and characteristics of the food cues photographed, including the setting of the photograph (App question 1).

Two researchers (SP and TW) coded the photographed food cues in Microsoft Excel independently. The researchers determined the type of food cue visible (free-standing sign; signboard; poster/banner/sticker; painted building/wall; merchandising products; food on display; food sculpture (3D); vehicle; other) (see Additional file 2, Table S2 for definitions and examples of types of food cues), the type of food outlet (supermarket; full-service restaurant; quick-service restaurant; supermarket delivery platform; meal delivery platform; specialty food store; other outlet), what type of visual or textual representation was used for the food cue (photography of food; graphic representation of food; logo or branding; text (not branding); food on display), and whether a food product (food or beverage) was visible on the food cue (yes; no). Uncertainties were discussed with four researchers (FR, MP, SD, TW), until consensus was reached.

For photographs with a visible food product, additional steps were taken to code these food products. Visible food products were categorised by food group using the Dutch Food Composition Database (NEVO) [46] (see Additional file 3, Table S3). The researchers also coded the visible food products based on healthiness using the 'Wheel of Five' of the Netherlands Nutrition Centre, which is a translation of the Dutch nutrition guidelines by the Dutch Health Council [47]. A product was labelled as healthy if it was included in the 'Wheel of Five' and labelled unhealthy if it was not included in the 'Wheel of Five' [47]. If the product was an assembled dish, which was not listed in the 'Wheel of Five', the Healthy Meal Index was used to obtain an indication of the healthiness of meals, which is a tool developed by Poelman et al. (2021), inspired by the work of Kasper et al. (2016) and created based on the 'Wheel of Five' [5, 48]. Finally, it was determined whether all food products visible on the food cue were unhealthy, healthy or a mix of healthy and unhealthy products.

Regarding the visibility of food products, the products had to be clearly distinguishable in case of visual representations and refer to a specific product (e.g. donuts, ice cream) in case of textual representations. Broad food terms (e.g. lunch, snacks, drinks), descriptions of food products which were part of a brand name (e.g. Pizza Hut, Dunkin Donut), and visual representations of food products that were part of a logo (e.g. the logo of the quick-service restaurant 'Burger King' represents a hamburger) were not considered as visible food products. As such, they were excluded from above mentioned analyses

of visible food products on the food cues (not coded based on food group, nor coded based on healthiness).

As the number of photographs taken per participant varied (1 to 16), Chi-square or Fisher's exact tests (when Chi-square test assumptions not met) were conducted to test the associations between participants' demographic characteristics and the number of photographs taken per participant. These tests were also conducted to test the associations between each question about perceptions of the food cue (impact on eating behaviour, acceptability and support for governmental regulation) and the number of photographs taken per participant. Subsequently, descriptive statistics were used to analyse the perceived impact of food cues on eating behaviour, the acceptability of food cues and the support for governmental regulation of the photographed visual food cues. A Chi-square test was used to test the association between participants' perception of the impact of food cues on their eating behaviour and that of others. Chi-square tests or Fisher's exact tests (when Chi-square test assumptions not met) were conducted to test the associations between perceived impact of food cues on eating behaviour, acceptability of food cues, and support for governmental regulation (App questions 3 to 7) and demographic (gender, age, education level, body mass index (BMI)) as well as food cue characteristics (setting of food cue, visibility of food product on food cue, healthiness of food product when visible on food cue). Data were analysed with IBM SPSS Statistics, version 28.0.1.1.

Results

Food cues by demographic characteristics

The 461 food cues included in this study were photographed by 101 participants. The median of the number of photographs taken per participant was 6 (interquartile range = 3.5; range 1–16). The majority of food cues photographed were taken by women (73.5%) and participants with a higher educational level (66.2%). The majority of food cues (40.1%) were photographed in the largest municipality of the region (Ede), see Table 1. There was no significant association found between the number of photographs taken per participant and the demographic characteristics of participants (see Additional file 4, Table S4).

Table 1 Food cues by demographic characteristics of participants

	N **(%) or mean (SD)**
Food cues (total)	461 (100)
Photographed by:	
Female participants	339 (73.5)
Male participants	122 (26.5)
Younger participants (25–44)	212 (46.0)
Older participants (45–65)	249 (54.0)
Age	46.0 (10.9)
Participants residing in:	
Municipality of Barneveld	75 (16.3)
Municipality of Ede	185 (40.1)
Municipality of Nijkerk	60 (13.0)
Municipality of Rhenen	33 (7.2)
Municipality of Renswoude	3 (0.7)
Municipality of Scherpenzeel	24 (5.2)
Municipality of Veenendaal	68 (14.8)
Municipality of Wageningen	13 (2.8)
Participants with a high education level	305 (66.2)
Participants with a middle education level	141 (30.6)
Participants with a low education level	15 (3.3)
Participants with a healthy weight (18.5–24.9)	208 (45.1)
Participants with overweight (25.0–29.9)	159 (34.5)
Participants with obesity (> 30.0)	94 (20.4)

Food cues photographed by participants in outdoor public spaces

Most of the 461 photographed visual outdoor food cues were located near a food store ($N=158$, 34.3%), a food service outlet (124, 26.9%) or along the road ($N=106$, 23.0%) (Table 2). Most photographed food cues included free-standing signs ($N=146$, 31.7%) (Fig. 2a), posters, banners or stickers ($N=114$, 24.7%) (Fig. 2b), and signboards ($N=88$, 19.1%) (Fig. 2c). The majority of photographed food cues were produced by a food outlet ($N=415$, 90.0%), which were mainly quick service restaurants ($N=126$, 30.4%) (Fig. 2d), specialty stores ($N=119$, 28.7%) (Fig. 1a and c), and supermarkets ($N=93$, 22.4%) (Fig. 2b). Visual food cues were represented through photographs of food ($N=214$, 46.4%) (Figs. 2a–c), logos or brand names only ($N=114$, 24.7%) (Fig. 2d), or as graphic representation of food ($N=49$, 10.6%) (Fig. 2e) (Table 2).

Most of the photographed food cues depicted a food product ($N=340$, 73.8%), while no food products were visible on 26.2% of the photographs ($N=121$, e.g. only a logo or brand). When a food product was visible, 54.4% ($N=185$) of the food cues depicted only unhealthy food products whereas 26.2% ($N=89$) showed only (a) healthy food product(s); 19.4% ($N=66$) showed a mix of healthy and unhealthy food products (Table 2). The food products that were most represented on the food cues were candy, chocolate, ice cream ($N=65$, 14.1%), fast-food meals and snacks ($N=62$, 13.4%) and non-alcoholic beverages ($N=49$, 10.6%) (Additional file 3, Table S3).

Perceived behavioural impact of the food cues

Food cues were more frequently perceived as often or always affecting *others'* eating behaviour (38.8%) compared to *their own* behaviour (14.5%), (χ^2 (4;

Table 2 Setting, type, producer, written or visual representation, and healthiness of food cues photographed by participants

	***N* (%)**
Setting of food cue	
Outside, near a food store	158 (34.3%)
Outside, near a food service outlet	124 (26.9%)
Along the road	106 (23.0%)
Other setting (e.g. bus stop, market, petrol station, train station)	73 (15.9%)
Type of food cue	
Free standing sign	146 (31.7%)
Poster/banner/sticker	114 (24.7%)
Signboard	88 (19.1%)
Food on display	42 (9.1%)
Food sculpture (3D)	33 (7.2%)
Vehicle	32 (6.9%)
Other type	3 (0.7%)
Merchandising products	2 (0.4%)
Painted building/wall	1 (0.2%)
Producer of food cue	
Food outlet, of which:	415 (90.0%)
Quick service restaurant	*126 (30.4%)*
Specialty food store (e.g. greengrocer, bakery, ice cream shop)	*119 (28.7%)*
Supermarket	*93 (22.4%)*
Full-service restaurant	*39 (9.4%)*
Other outlet (e.g. farm store, petrol station store)	*32 (7.7%)*
Meal delivery platform	*4 (1.0%)*
Supermarket delivery platform	*1 (0.2%)*
Non-food outlet (e.g. drugstore)	12 (2.6%)
Food industry	28 (6.1%)
Other (e.g. municipality, private individual)	6 (1.3%)
Written or visual representation of food cue	
Photograph of food	214 (46.4%)
Graphic representation of food (e.g. illustration, sculpture)	49 (10.6%)
Logo or other branding	114 (24.7%)
Text (not branding)	42 (9.1%)
Food on display	41 (8.9%)
Healthiness of visible food product(s) on food cue	
Food product(s) visible, of which:	340 (73.8%)
Only unhealthy food product(s) visible	*185 (54.4%)*
Only healthy food product(s) visible	*89 (26.2%)*
Mix of (un)healthy food product(s) visible	*66 (19.4%)*
No food product visible	121 (26.2%)

$N=444)=103.312$; $p<0.001$). A few sociodemographic differences were observed. Food cues photographed by older participants were more frequently perceived as stimuli that would often or always encourage them to eat (18.5%), compared to food cues noticed by younger participants (10.1%) (Fisher's exact test: $p=0.006$) (Table 4). No significant differences were found between education level regarding the effect of food cues on the eating behaviour of the participants themselves. However, food cues photographed by participants with a high education level were more often perceived as food cues that would often or always stimulate others to eat (45.3%), compared to those

Fig. 2 The photographed food cues represent from left to right: **a** free-standing sign with an advertisement for alcoholic beverages, **b** poster in a bus shelter with an advertisement for fruit, **c** signboard with an advertisement for chicken, **d** signboard with a fast-food chain logo, **e** food sculpture of French fries

photographed by participants with a middle education level (25.5%) (Fisher's exact test: $p < 0.001$) (Table 4).

Differences between the food cue characteristics and perceived impact on eating behaviour were observed. Food cues located near a food service outlet were more often identified by participants as influencing others to eat often or always (50.8%), compared to those located near a food store (34.8%) or along the road (30.2%) (Fisher's exact test: $p = 0.001$). Food cues on which only unhealthy food was visible (47.0%) were more often identified by participants as often or always stimulating others to eat, compared to those on which only healthy food was visible (24.4%) (Fisher's exact test: $p = 0.002$) (Table 5).

Perceived acceptability of food cues

For 79.6% of the photographed food cues, participants indicated that these types of cues were acceptable to be present in outdoor public spaces (Table 3). The acceptability of the photographed food cues did not differ significantly based on gender, age, education level or BMI (Table 4). However, food cues located near a food store (87.3%) were more often identified as acceptable by participants than those located in other settings (67.6%) (Fisher's exact test: $P = 0.018$). Besides, food cues on which only healthy food was visible were more often identified by participants as acceptable (93%), compared to those visualising only unhealthy food (71.4%) (χ^2 (4; $N = 333$) = 16.955; $p = 0.002$) (Table 5).

Table 3 Participants' perception of food cues' influence on eating behaviour, acceptability, and support for governmental regulation

Questions about perceived impact of food cues on eating behaviour, acceptability of food cues and support for governmental regulation of food cues	Responses	Response percentages per photographed food cue	Mean (SD)
3. How often do these types of food cues stimulate you to eat? *(Scale 1–3)*	(1) Never or rarely (2) Sometimes (3) Often or always I don't know	34.3% 49.9% 14.5% 0.2%	1.8 (0.7)
4. How often do you think these types of food cues stimulate others to eat? *(Scale 1–3)*	(1) Never or rarely (2) Sometimes (3) Often or always I don't know	9.8% 47.7% 38.8% 2.6%	2.3 (0.6)
5. Do you find it acceptable to see these types of food cues here? *(Scale 1–3)*	(1) Yes, I find it acceptable here (2) Neutral (3) No, I find it unacceptable here I don't know	79.6% 11.7% 6.7% 0.9%	1.3 (0.6)
6. Do you think the government should ban these types of food cues? *(Scale 1–3)*	(1) No, the government should not ban these types of food cues (2) Neutral (3) Yes, the government should ban these types of food cues I don't know	79.0% 13.7% 5.4% 0.9%	1.25 (0.5)

Table 4 Associations between responses to questions about perceived impact of food cues on eating behaviour, acceptability of food cues and support for governmental regulation of food cues, and demographic characteristics of participants

	Photographs taken by men	Photographs taken by women	Photographs taken by participants aged 25–44	Photographs taken by participants aged 45–65	Photographs taken by participants with low education level	Photographs taken by participants with middle education level	Photographs taken by participants with high education level	Photographs taken by participants with BMI corresponding to healthy weight	Photographs taken by participants with BMI corresponding to overweight	Photographs taken by participants with BMI corresponding to obesity
How often do these food cues stimulate you to eat? *N* (%)										
Never or rarely	41 (33.6%)	117 (35.0%)	85 (41.1%)[a]	73 (29.3%)[b]	4 (26.7%)	59 (41.8%)	95 (31.7%)	74 (36.5%)	56 (35.2%)	28 (29.8%)
Sometimes	59 (48.4%)	171 (51.2%)	100 (48.3%)[a]	130 (52.2%)[a]	7 (46.7%)	64 (45.4%)	159 (53.0%)	100 (49.3%)	84 (52.8%)	46 (48.9%)
Often or always	21 (17.2%)	46 (13.8%)	21 (10.1%)[a]	46 (18.5%)[b]	4 (26.7%)	17 (12.1%)	46 (15.3%)	29 (14.3%)	18 (11.3%)	20 (21.3%)
I don't know	1 (0.8%)	0 (0.0%)	1 (0.5%)[a]	0 (0.0%)[a]	0 (0.0%)	1 (0.7%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	0 (0.0%)
Statistical tests	*Fisher's exact test: p = 0.331*		*Fisher's exact test: p = 0.006*		*Fisher's exact test: p = 0.126*			*Fisher's exact test: p = 0.295*		
How often do you think these food cues stimulate others to eat? *N* (%)										
Never or rarely	14 (11.5%)	31 (9.3%)	24 (11.6%)	21 (8.4%)	3 (20.0%)[a,b]	25 (17.7%)[b]	17 (5.7%)[a]	18 (8.9%)	22 (13.8%)	5 (5.3%)
Sometimes	49 (40.2%)	171 (51.2%)	96 (46.4%)	124 (49.8%)	5 (33.3%)[a]	71 (50.4%)[a]	144 (48.0%)[a]	99 (48.8%)	77 (48.4%)	44 (46.8%)
Often or always	54 (44.3%)	125 (37.4%)	80 (38.6%)	99 (39.8%)	7 (46.7%)[a,b]	36 (25.5%)[b]	136 (45.3%)[a]	83 (40.9%)	53 (33.3%)	43 (45.7%)
I don't know	5 (4.1%)	7 (2.1%)	7 (3.4%)	5 (2.0%)	0 (0.0%)[a,b]	9 (6.4%)[b]	3 (1.0%)[a]	3 (1.5%)	7 (4.4%)	2 (2.1%)
Statistical tests	*Fisher's exact test: p = 0.145*		*Fisher's exact test: p = 0.523*		*Fisher's exact test: p < 0.001*			*Fisher's exact test: p = 0.118*		
Do you find it acceptable to see these types of food cues here? N (%)										
Yes, I find it acceptable here	93 (76.2%)	274 (82.0%)	167 (80.7%)	200 (80.3%)	13 (86.7%)	119 (84.4%)	235 (78.3%)	164 (80.8%)	125 (78.6%)	78 (83.0%)
Neutral	15 (12.3%)	39 (11.7%)	27 (13.0%)	27 (10.8%)	2 (13.3%)	13 (9.2%)	39 (13.0%)	28 (13.8%)	18 (11.3%)	8 (8.5%)
No, I find it unacceptable here	12 (9.8%)	19 (5.7%)	12 (5.8%)	19 (7.6%)	0 (0.0%)	8 (5.7%)	23 (7.7%)	8 (3.9%)	15 (9.4%)	8 (8.5%)
I don't know	2 (1.6%)	2 (0.6%)	1 (0.5%)	3 (1.2%)	0 (0.0%)	1 (0.7%)	3 (1.0%)	3 (1.5%)	1 (0.6%)	0 (0.0%)
Statistical tests	*Fisher's exact test: p = 0.239*		*Fisher's exact test: p = 0.666*		*Fisher's exact test: p = 0.762*			*Fisher's exact test: p = 0.238*		

Table 4 (continued)

	Photographs taken by men	Photographs taken by women	Photographs taken by participants aged 25–44	Photographs taken by participants aged 45–65	Photographs taken by participants with low education level	Photographs taken by participants with middle education level	Photographs taken by participants with high education level	Photographs taken by participants with BMI corresponding to healthy weight	Photographs taken by participants with BMI corresponding to overweight	Photographs taken by participants with BMI corresponding to obesity
Do you think the government should ban these types of food cues? *N* (%)										
No, the government should not ban these types of food cues	100 (82.0%)	264 (79.0%)	162 (78.3%)	202 (81.1%)	13 (86.7%)	112 (79.4%)	239 (79.7%)	168 (82.8%)	123 (77.4%)	73 (77.7%)
Neutral	12 (9.8%)	51 (15.3%)	31 (15.0%)	32 (12.9%)	2 (13.3%)	22 (15.6%)	39 (13.0%)	24 (11.8%)	25 (15.7%)	14 (14.9%)
Yes, the government should ban these types of food cues	8 (6.6%)	17 (5.1%)	12 (5.8%)	13 (5.2%)	0 (0.0%)	4 (2.8%)	21 (7.0%)	10 (4.9%)	8 (5.0%)	7 (7.4%)
I don't know	2 (1.6%)	2 (0.6%)	2 (1.0%)	2 (0.8%)	0 (0.0%)	3 (2.1%)	1 (0.3%)	1 (0.5%)	3 (1.9%)	0 (0.0%)
Statistical tests	*Fisher's exact test: p = 0.269*		*Fisher's exact test: p = 0.883*		*Fisher's exact test: p = 0.244*			*Fisher's exact test: p = 0.581*		

Each superscript letter denotes a subset of categories whose column proportions do not differ significantly from each other at the 0.05 level

Table 5 Associations between responses to questions about perceived impact of food cues on eating behaviour, acceptability of food cues and support for governmental regulation of food cues, and food cue characteristics

	Setting of food cue: outside, near a food store	Setting of food cue: outside, near a food service outlet	Setting of food cue: along the road	Setting of food cue: other	Food product(s) visible on photograph	No food product visible on photograph	All food visible: healthy	All food visible: unhealthy	All food visible: mix of healthy and unhealthy
How often do these food cues stimulate you to eat? *N* (%)									
Never or rarely	50 (31.6%)	44 (35.5%)	35 (33.0%)	29 (42.6%)	119 (35.4%)	39 (32.5%)	27 (31.4%)	65 (35.1%)	27 (41.5%)
Sometimes	81 (51.3%)	62 (50.0%)	58 (54.7%)	29 (42.6%)	163 (48.5%)	67 (55.8%)	43 (50.0%)	92 (49.7%)	28 (43.1%)
Often or always	27 (17.1%)	18 (14.5%)	13 (12.3%)	9 (13.2%)	53 (15.8%)	14 (11.7%)	16 (18.6%)	27 (14.6%)	10 (15.4%)
I don't know	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.5%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	1 (0.5%)	0 (0.0%)
Statistical tests	*Fisher's exact test: p = 0.528*				*Fisher's exact test: p = 0.521*		*Fisher's exact test: p = 0.823*		
How often do you think these food cues stimulate others to eat? *N* (%)									
Never or rarely	15 (9.5%)[a,b]	3 (2.4%)[b]	19 (17.9%)[a]	8 (11.8%)[a]	29 (8.6%)	16 (13.3%)	13 (15.1%)[b]	8 (4.3%)[a]	8 (12.3%)[a,b]
Sometimes	84 (53.2%)[a]	55 (44.4%)[a]	53 (50.0%)[a]	28 (41.2%)[a]	164 (48.8%)	56 (46.7%)	48 (55.8%)[a]	84 (45.4%)[a]	32 (49.2%)[a]
Often or always	55 (34.8%)[a]	63 (50.8%)[b]	32 (30.2%)[a]	29 (42.6%)[a,b]	132 (39.3%)	47 (39.2%)	21 (24.4%)[b]	87 (47.0%)[a]	24 (36.9%)[a,b]
I don't know	4 (2.5%)[a]	3 (2.4%)[a]	2 (1.9%)[a]	3 (4.4%)[a]	11 (3.3%)	1 (0.8%)	4 (4.7%)[a]	6 (3.2%)[a]	1 (1.5%)[a]
Statistical tests	*Fisher's exact test: p = 0.001*				*Fisher's exact test: p = 0.274*		*Fisher's exact test: p = 0.002*		
Do you find it acceptable to see these types of food cues here? *N* (%)									
Yes, I find it acceptable here	138 (87.3%)[a]	97 (78.2%)[a,b]	86 (81.1%)[a,b]	46 (67.6%)[b]	267 (79.5%)	100 (83.3%)	80 (93.0%)[b]	132 (71.4%)[a]	55 (84.6%)[a,b]
Neutral	15 (9.5%)[a]	17 (13.7%)[a]	10 (9.4%)[a]	12 (17.6%)[a]	40 (11.9%)	14 (11.7%)	4 (4.7%)[b]	29 (15.7%)[a]	7 (10.8%)[a,b]
No, I find it unacceptable here	4 (2.5%)[a]	8 (6.5%)[a,b]	10 (9.4%)[a,b]	9 (13.2%)[b]	26 (7.7%)	5 (4.2%)	2 (2.3%)[b]	21 (11.4%)[a]	3 (4.6%)[a,b]
I don't know	1 (0.6%)[a]	2 (1.6%)[a]	0 (0.0%)[a]	1 (1.5%)[a]	3 (0.9%)	1 (0.8%)	0 (0.0%)[a]	3 (1.6%)[a]	0 (0.0%)[a]
Statistical tests	*Fisher's exact test: p = 0.018*				*Fisher's exact test: p = 0.607*		*χ2 (4; N = 333) = 16.955; p = 0.002*		
Do you think the government should ban these types of food cues? N (%)									
No, the government should not ban these types of food cues	137 (86.7%)	93 (75.0%)	86 (81.1%)	48 (70.6%)	264 (78.6%)	100 (83.3%)	77 (89.5%)[b]	129 (69.7%)[a]	58 (89.2%)[b]
Neutral	16 (10.1%)	22 (17.7%)	13 (12.3%)	12 (17.6%)	48 (14.3%)	15 (12.5%)	6 (7.0%)[b]	36 (19.5%)[a]	6 (9.2%)[a,b]
Yes, the government should ban these types of food cues	4 (2.5%)	8 (6.5%)	7 (6.6%)	6 (8.8%)	21 (6.3%)	4 (3.3%)	3 (3.5%)[a]	17 (9.2%)[a]	1 (1.5%)[a]
I don't know	1 (0.6%)	1 (0.8%)	0 (0.0%)	2 (2.9%)	3 (0.9%)	1 (0.8%)	0 (0.0%)[a]	3 (1.6%)[a]	0 (0.0%)[a]
Statistical tests	*Fisher's exact test: p = 0.072*				*Fisher's exact test: p = 0.622*		*Fisher's exact test: p = 0.002*		

Each superscript letter denotes a subset of categories whose column proportions do not differ significantly from each other at the 0.05 level

Support for governmental regulation to ban food cues

For 79.0% of the cues, participants stated that the government should not ban them from outdoor public space (Table 3). Participants' opinion on a governmental regulation of the food cues did not differ significantly based on gender, age, education level or BMI (Table 4).

However, when food cues only visualised unhealthy food, participants less often indicated that they were opposed to governmental regulations to ban those food cues (69.7%), compared to food cues on which only healthy food was visible (89.5%) or a mix of healthy and unhealthy food was visible (89.2%) (Fisher's exact test: $P=0.002$) (Table 5).

There was no significant association found between the number of photographs taken per participant and their responses to four questions in the app regarding the perceived impact of food cues on eating behaviour, the acceptability of food cues and the support for governmental regulation of the photographed visual food cues (see Additional file 5, Table S5).

Discussion

This study showed that foods depicted on cues that were photographed were primarily unhealthy (54.4%) and most frequently included candy, chocolate, ice cream; fast-food meals and snacks; or non-alcoholic beverages (e.g. sugar-sweetened beverages, juice, syrup). Participants perceived that their photographed food cues had a greater influence on others' eating behaviour than on their own. Next, for most food cues, participants indicated that their presence was acceptable, although this was less likely when all food visible was unhealthy compared to healthy or when food cues were located at other settings (e.g., tram/bus stops, market, train station, sport facility) compared to near a food store. Besides, for most food cues, participants were *opposed* to governmental regulations. However, when food cues only visualised unhealthy food, participants less often indicated that they were opposed to governmental regulations to ban those food cues, compared to food cues on which only healthy food was visible or a mix of healthy and unhealthy food was visible.

A quarter of the food cues noticed by participants in their municipality showed a logo or brand name only, without a visual representation of actual foods. This is in line with a study conducted in New Zealand on children's exposure to brand marketing, which found that children were exposed to a mean of 111 (88–140) food and beverages marketing brands per 10-h day across diverse settings (homes, schools, food venues, retail, streets, etc.) [49]. However, previous studies on the prevalence of food marketing in outdoor public spaces have reported a lower prevalence of brand only advertisements. In a study conducted in the UK, no brand-only advertisements were identified [50], while brand-only advertisements constituted 5% of all outdoor food advertisements in a study conducted in New Zealand [51] and another one conducted in Australia [52]. The higher prevalence of food cues with only a logo or a brand name in this study may be due to the larger scope of the study (food cues as opposed to food marketing). Studies focusing on outdoor marketing may, for instance, exclude front-of-store signs, with the logo of the store. However, adults' and children's eating behaviour are known to be influenced by branding [25, 26, 53]. Given these findings, municipalities developing outdoor food marketing regulations should consider not only visual representations of food products but also the role of branding, as it also serves as a significant food cue for participants in this study [28, 54].

In line with the phenomenon referred to as the third-person effect [55, 56] which suggests that people tend to believe that others are more influenced by media messages than they are themselves, we observed that participants in our study thought the food cues stimulated others more to eat than they did themselves. This was predominantly observed for food cues near food service outlets and food cues representing unhealthy foods. People tend to acknowledge the influence of contextual factors on the behaviour of others while they deny the influence of these factors on their own behaviour [55, 56]. This third-person effect is facilitated by two main factors: judgements of message desirability (i.e. the third person effect is more pronounced when the message is perceived as undesirable) [57, 58] and perceived social distance between oneself and others (i.e. the third person effect is more pronounced when the others are more socially distant or share less characteristics with oneself) [59]. Interestingly, food cues noticed by older participants (45–65 years) were more likely to be perceived as affecting individual eating behaviours than those photographed by younger participants (25–44 years). It could be argued that older participants have memories of food environments less polluted by unhealthy food cues than those being younger who have only been exposed to contemporary, largely unhealthy food environments [60, 61]. Moreover, food cues noticed by participants with a middle educational level were more often seen as *not* affecting others' eating behaviour than food cues noticed by participants with a higher educational level. This is in line with findings from Bridger (2023) indicating that people with a lower socioeconomic tended to attribute poor health to behavioural causes, whereas people with a higher socioeconomic position attributed poor health to structural causes [62]. It might also be one of the explanations why those with lower education levels are less in favour of policies to ban food marketing as strategy compared to those with higher education levels [63].

Food cues observed by participants were largely perceived as being acceptable to be present in the outdoor public spaces of their municipality. An explanation might be that people have become used to seeing these food cues in their environment. A qualitative study exploring

participants' opinion on outdoor food cues and their perceived food environment found that some participants thought food cues were an integral part of the street sceneries (Wopereis TM, Roman KJ, Djojosoeparto SK, Poelman MP: Voicing residents' perception of (commercial) food cues in outdoor public spaces: a photovoice study, under review). Besides, previous experimental studies have shown that cues embedded in the living environment can convey a social norm, meaning that environmental cues can guide people's food choices and food intake [64, 65]. Hence, people seem to have become used to the omnipresence of visual food cues in their environment, to such a point that they find them acceptable and see them as an integral part of their living environment, despite the negative influence unhealthy food cues may have on their eating behaviour.

In line with being accepted in public spaces, for the majority of food cues, participants indicated that they were opposed to governmental regulations, regardless of their education level, age and gender. This is contrary to prior research that observed that women, older people and people with a high education level tend to be more favourable to governmental regulations to promote a healthy food environment (e.g. to ban advertising of unhealthy food) [63, 66]. However, the reluctance shared by most participants for the implementation of policies banning the food cues in this study is in line with prior studies. People tend to be opposed to food policies that impose restrictions (like banning food cues), while being more in favour of food policies that provide incentives or information [63]. Another explanation might be related to the rather politically conservative character of the area where the study was conducted. The majority of food cues were photographed by participants residing in municipalities where the ruling political parties primarily consisted of conservative and Christian parties [42]. These political parties have been recognized for their opposition to restrictive policies compared to more progressive political parties and may be an explanatory factor of the study outcomes. To illustrate, 67% of Amsterdam inhabitants (a progressive area) were in favour of banning fast food outlets from public spaces to improve public health [67]. Moreover, these findings highlight an important challenge for policymakers aiming to reduce environmental drivers of unhealthy diets, as policies that address these drivers tend to include more restrictive policies [11, 63]. Lack of public support is often an important barrier to food policy implementation [39].

Local municipalities might benefit from incorporating insights form citizens when designing and implementing policies with a restrictive character because designing public policies with its users enables the latter to contribute their knowledge and experiences, leading to more suitable policies, and possibly increased public support [68]. Moreover, public health researchers could put more effort into sharing their research evidence with people at the grassroots and civil society organisations to increase public support and facilitate the implementation of structural policies for public health (e.g. unhealthy food cue regulations) [39, 69].

Strength and limitations

This study has notable strengths. First, food cues were photographed and assessed by the participants in real time within their natural environments. This allows to reduce recall bias, increase the ecological validity of the study outcomes and study micro processes influencing behaviour in real-world contexts [40]. Moreover, a broad definition of food cues was incorporated, allowing to grasp a broader picture of outdoor visual food cues that go beyond a stricter definition (e.g. that of food marketing). This study comes also with some limitations. First, the food cues resulted from a sample that included a relatively high number of women with a high educational level. In addition, our recruitment may have resulted in selection bias, which is however a well-known phenomenon in this type of research, in which more health-conscious people may tend to volunteer more frequently in nutrition research. Moreover, only food cues of eight municipalities in the Netherlands were assessed, limiting its generalizability to the entire country.

Second, participants varied in the number of photographs taken, so the evaluated food cues do not provide a representation of all food cues noticed by the participants. The perception of some participants may be under- or overrepresented in the sample. In addition, the independence of values assumption was not always met for the statistical tests conducted because some photographs were taken by the same participants. Care should be taken when interpreting data, as results from the statistical tests might have been under- or overestimated due to this lack of independence.

Recommendations for research and practice

Given that scholars have suggested the use of subjective and objective measures to obtain a comprehensive characterisation of the influence of the food environment on diet [70–72], we recommend the implementation of regular subjective and objective monitoring of the exposure to food cues in outdoor public spaces. This is paramount to inform and evaluate future policies restricting unhealthy food cues. Although traditional nutrition research often excludes alcohol, treating it more as a substance than a food item, it could be beneficial to include it in such a monitor as alcoholic beverages affect health [73] and accounted for

3.5% of the photographed cues. Alcohol forms a common component of the Western diet and is intertwined with dietary habits and social eating practices [74]. Therefore, monitoring alcoholic beverages within the context of nutrition research may provide a more comprehensive understanding of improving public health nutrition.

Future research could investigate whether there is an association between people's perceptions of the influence of food cues on eating behaviour and their opinions on the acceptability of food cues and governmental regulations. This would allow to gain a deeper understanding of the factors influencing public opinion on the presence of food cues and governmental regulation, including the opposition to governmental regulation. Finally, while food cue regulations may contribute to a healthier food environment, encouraging healthy eating behaviour, more measures are needed. An integrated approach, combining diverse measures targeting the physical, socio-cultural, political and economic aspects of the food environment, is essential to create healthy food environments that encourage healthy eating behaviour [3].

Conclusions

In conclusion, this study showed that foods depicted on cues that were photographed were primarily unhealthy and participants perceived that their photographed food cues had a greater influence on others' eating behaviour than on their own. The presence of visual food cues was considered acceptable, and participants were generally opposed to governmental food cue regulations. Nevertheless, unhealthy food cues were perceived as less acceptable, and there was somewhat less opposition to the regulation of unhealthy food cues compared to healthy ones. Policymakers considering the implementation of food cue regulations, as well as health professionals advocating for structural policies improving food environments, should be aware of these citizen perceptions that may stand in the way of these efforts. Alternatively, they might seek strategies to engage citizens' perceptions and ideas in policy design and advocacy strategies.

Abbreviations

BMI	Body mass index
EMA	Ecological momentary assessment
GPS	Global positioning system
SD	Standard deviation
UN	United Nations

Supplementary Information

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Additional file 1: Table S1. Questions and answers in the 'Myfoodenvironment' app. Shows the questions participants had to answer in the 'Myfoodenvironment' app, including possible responses to these questions they could choose from.

Additional file 2: Table S2. Type of food cues (based on the work by (Mackay et al., 2017) and own field work prior to the study). Shows definitions and examples of the classification used for the types of food cues.

Additional file 3: Table S3. Categories of food groups visible on the food cues. Shows the categories used to code the food and drinks visible on the food cues into food groups.

Additional file 4: Table S4. Associations between responses to questions 3 to 6 and the amount of photographs taken per participant. Shows statistical analyses conducted to test associations between responses to questions 3 to 6 from the app and the amount of photographs taken per participant.

Additional file 5: Table S5. Associations between demographic characteristics of participants and the amount of photographs taken per participant. Shows statistical analyses conducted to test associations between demographic characteristics of participants and the amount of photographs taken per participant.

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Authors' contributions

TW, FC, MP conceptualised the study, TW, FC, MP, SD, EdV developed the questionnaire used in the app for this study. SP led the participant recruitment process and managed the data collection process. TW and SP coded the data and TW analysed the data. FC, MP, SD, and EdV were consulted whenever needed during the data coding and analysis. They also reviewed and edited the manuscript, while TW and MP wrote the original draft. All authors read and approved the final manuscript. All authors agree both to be personally accountable for their own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Approval for the study was granted by the Social Sciences Ethics Committee of Wageningen University. All participants provided their written informed

consent for this study. In addition, participants agreed to the privacy statement regarding the collection, use and processing of personal data through the mobile application.
The Social Sciences Ethics Committee of Wageningen University granted permission for this study on 8 July 2021.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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