Health & Place 81 (2023) 103009

Contents lists available at ScienceDirect

Health and Place

journal homepage: www.elsevier.com/locate/healthplace

Who uses what food retailers? A cluster analysis of food retail usage in the Netherlands

Jody C. Hoenink [a,b,*], Milou Eisink [c], Jean Adams [a], Maria G.M. Pinho [b,d], Joreintje D. Mackenbach [b,c]

[a] MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Box 285 Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge CB2 0QQ, UK
[b] Upstream Team, www.upstreamteam.nl, Amsterdam UMC, the Netherlands
[c] Amsterdam UMC, Vrije Universiteit Amsterdam, Epidemiology and Data Science, Amsterdam Public Health Research Institute, De Boelelaan 1117, Amsterdam, the Netherlands
[d] Copernicus Institute of Sustainable Development, Department Environmental Sciences, Utrecht University, Utrecht, the Netherlands

ARTICLE INFO

Keywords:
Food supply
Dietary behaviors
Food environment
Exposure to food outlets
Residential environment

ABSTRACT

The aim of this study is to describe how individuals use different food retailers and how food retail usage varies according to socio-demographic and diet-related characteristics. A cross-sectional survey among Dutch adults (N = 1784) was used. Results from the Two-step cluster analysis indicated that there were five clusters of food retail users. Use of discount supermarkets, organic supermarkets, fast-food outlets, and restaurants contributed to clustering, but use of regular supermarkets, local food shops and whether food retailers were close to home or further from home did not. The clusters included mixed food outlet users, discount supermarket and restaurant users, fast-food and restaurant users, predominant discount supermarket users and supermarkets, fast-food and restaurant users. Participants in each cluster had their own characteristics especially in terms of socio-economic position and diet quality. Future studies need to consider further how food retail selection links physical exposure to the food environment and diet.

1. Introduction

Worldwide, rapid urbanisation and globalisation have led to environments where foods high in fat, salt and sugar are now increasingly easily accessible (Malik et al., 2013; Popkin, 2001). Indeed, several studies, including our own, have demonstrated significant changes in urban food environments in the last decade (Pinho et al., 2020; Hobbs et al., 2021; Maguire et al., 2015). These increases in access are paralleled by increases in consumption of fat, salt and sugar (Popkin, 2001).

Exposure to the food environment is usually defined in geographical terms, by measuring access to or availability of food retailers from a person's home address (Cobb et al., 2015; Caspi et al., 2012). However, reported associations between local food environments, dietary intake and obesity are inconsistent (Cobb et al., 2015; Caspi et al., 2012). Some studies show that exposure to less healthy food retailers (e.g. fast food restaurants and convenience stores) is associated with decreased dietary quality and increased risk of obesity (Burgoine et al., 2014; Gustafson et al., 2011), while most studies show null effects (Cobb et al., 2015; Poelman et al., 2018; Drewnowski et al., 2012; Block et al., 2011), and some even find that exposure to less healthy food retailers is associated with healthier diets (Cobb et al., 2015; Timperio et al., 2008).

Greater clarity on the influence of food environments on diet and health outcomes can help researchers identify strategies to improve health. Though it is possible that the local food environment does not influence diet and obesity, a limitation of the current literature base is that the assumptions underlying the exposure-outcome association remain largely untested. In operationalizing 'exposure' to the food environment, assumptions are made around the size and shape of the geographic unit of interest (e.g. in which directions and how far people travel to food retailers (Li and Kim, 2020)) and the interaction between

Abbreviations: SEP, Socio-economic position; US, United States; DHD15-index, Dutch Healthy Diet 2015 index; BIC, Bayesian Information Criterion; DNFCS, Dutch National Food Consumption Survey.

* Corresponding author. MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Box 285 Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge CB2 0QQ, UK.
E-mail address: Jody.hoenink@mrc-epid.cam.ac.uk (J.C. Hoenink).

https://doi.org/10.1016/j.healthplace.2023.103009
Received 16 September 2022; Received in revised form 27 February 2023; Accepted 13 March 2023
Available online 10 April 2023

individuals and their environment (e.g. how many and what food retailers are used) (Lytle, 2009). Individuals do not necessarily shop at the food retailers most proximal to their home, suggesting that there are reasons other than distance for choosing a food retailer (Drewnowski et al., 2012; Kerr et al., 2012). Also, food retail exposure not only takes place around the home environment, but also in work, school and recreational settings (Thornton et al., 2017). Caspi et al. (2012) conclude that 'a tremendously understudied aspect of food retail access is the utilization of food retailers by area residents'. Additionally, in an attempt to simplify a complex reality, researchers often resort to a dichotomization (e.g. healthy vs. less healthy) or selection (e.g. only fast-food outlets) of food retailers when considering the food environment (Cobb et al., 2015; Sacks et al., 2019). Because food retail exposure and use do not operate in a vacuum, simultaneous consideration of exposure to food retailers and their use is important (Lucan, 2015). Common metrics to capture the complexity of the food environment include the use of ratios and relative measures. However, the identification of clusters of food retail users may be preferable (Thornton et al., 2020).

Some previous studies assessed the assumptions underlying the exposure-outcome association by investigating the spatial locations of food purchasing behaviours (Kerr et al., 2012; Thornton et al., 2017). However, few previous studies have explored the clustering of food retail use in the general population (Carlson et al., 2002; Yenerall et al., 2020; Stern et al., 2015). An older study by Carlson et al. (2002) grouped consumers based on where they obtained their food and found nine clusters. The largest cluster including 49% of participants, consisted of those that purchased 93% of their food from supermarkets. Individuals in this cluster were older and had a lower socio-economic position (SEP) compared to individuals in the other clusters. Similarly, Yenerall et al. (2020) found that all six clusters of food retail use were dominated by retailers selling foods to cook at home (e.g. grocery stores and supermarkets). This study also found significant differences in terms of sociodemographic characteristics and taste preferences between clusters. The study by Stern et al. (2015) found three clusters (primary-grocery, primary-mass-merchandise and combination clusters). However, this study only included retailers conducive to food at home limiting generalizability to the wider food environment and total food intake (Yenerall et al., 2020). Furthermore, all of these studies were conducted in the United States (US) and none of these studies explored where food retail use took place or assessed the diet quality of the individuals in the different clusters. Usage of different types of food retailers could influence dietary quality, or individuals with healthier diets could choose to shop more frequently at certain types of food retailers (Minaker et al., 2016). Furthermore, as all studies were conducted in the US, these findings may not be generalizable to other countries.

The aim of this study was to enhance understanding of how individuals interact with the food environment by investigating the extent to which there are distinct clusters of food retailer use in the Netherlands. In addition, we aimed to investigate the socio-demographic and diet-related characteristics of individuals in each food retail cluster. As the total impact of the food environment includes food availability in various settings such as neighbourhoods surrounding home, work and travel paths, we distinguished between food retail use in the residential neighbourhood environment and further away.

2. Methods

This cross-sectional study used data from the 'Eet & Leef' study, which aimed to assess dietary intake and its determinants among the Dutch general population (aged 18–65 years). Full details of the study are described elsewhere (Hoenink et al., 2022; Mackenbach et al., 2022). Briefly, participants were recruited from the 20 largest urban cities in the Netherlands and were recruited online and via mail through a stepwise recruitment approach in 2019 (Mackenbach et al., 2022). Participants were included in the study if they were between the ages of 18 and 65 years and provided informed consent. Participants were excluded if they were not able to understand the Dutch language or did not have access to a computer with internet and an e-mail address. Instead of one long survey, participants were asked to complete three separate web-based surveys over a period of 2–3 weeks. Participants who completed all three surveys received a gift voucher of €7.50. In this analysis, we used data from the first survey containing questions on socio-demographics, psychosocial resources, lifestyle and health, snacking behaviours and perceptions of the food environment, and from the third survey on diet quality. No variables from the second survey were used in this study. In total, 2552 participants registered for the study, 1784 participants completed the first survey, 1659 completed the second survey and 1492 participants completed all three surveys. The study was approved by the Medical Ethics Review Committee.

Table 1
Questions, answering options and coding relating to food retail usage.

Question	Food retailers	Answer	Coding
1. Are the following retailers present in your area within a 10-min walk?	Regular supermarkets Organic supermarkets Discount supermarkets Specialist shops Fast-food outlets Restaurants	Yes, I go there regularly Yes, but I rarely go there No	User; within 10-min walk Non-user; within 10-min walk Non-user; further away from home
2. Do you use facilities while they are a bit further away	Regular supermarkets Organic supermarkets Discount supermarkets Specialist shops Fast-food outlets Restaurants	Yes No	User; further away from home Non-user; further away from home

2.1. Measures

2.1.1. Food retail use

Participants provided information on their use of six types of common food retailers in the Netherlands: regular supermarkets, organic supermarkets, discount supermarkets, specialist shops (e.g. bakery, greengrocer, butcher), fast-food outlets (e.g. local fast-food shops, McDonalds, Kentucky Fried Chicken, Burger King), and restaurants. Table 1 displays the questions and answer possibilities participants received that established food retail use and how these were coded in analysis. In total, twelve dichotomous variables were included relating to the use of the six food retailers within a 10-min walk or further away from home.

2.1.2. Socio-demographic characteristics

Several socio-demographic characteristics that have been linked to dietary behaviour (e.g. (Edvardsson et al., 2011; Rehm et al., 2015)) were assessed: age in years, sex (male/female), partner status (yes/no), number of children living in the household (regardless of age), educational level, occupation and income. Information on the SEP proxies educational level, occupation, and income have been previously published (Hoenink et al., 2022). Briefly, low educational level included those who completed no education, primary education, lower vocational education and general secondary education. Medium education included those who completed secondary vocational education or intermediate vocational education and high educational level included those who completed higher professional education (College/University). Occupation was classified using the ISCO08 (International Labour, 2012). Skill level 1 included occupations labelled as simple and routine

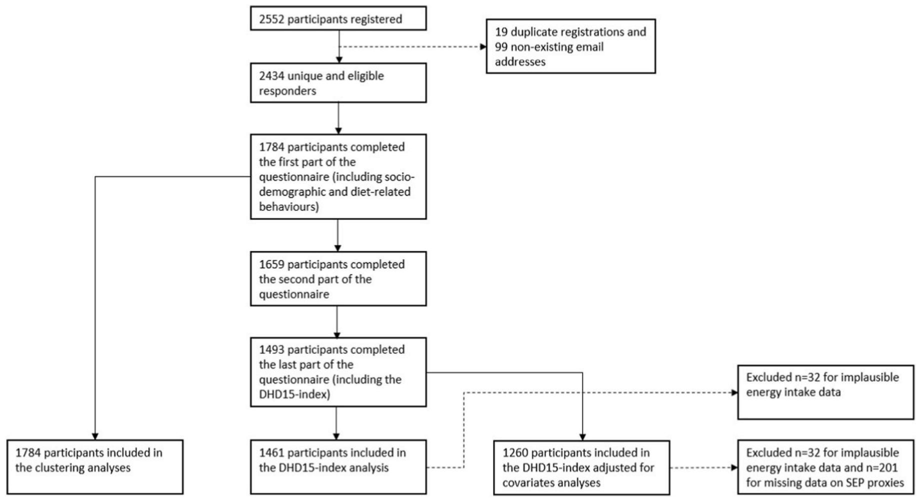

Fig. 1. Flow chart of participant inclusion in the Eet & Leef study and the current analyses.

physical or manual tasks. Skill level 2 occupations include tasks such as operating machinery. Skill level 3 are those that involve the performance of complex technical skills, and skill level 4 occupations require complex problem-solving, decision-making and creativity. Net monthly household income was assessed using the question 'What is your net household income (after tax deduction) per month' and included five answering options (ranging from €0-€1200 to more than €4000).

2.1.3. Diet-related behaviours

Behaviours that have been previously linked to diet quality were also assessed (Larson et al., 2016; Vandevijvere et al., 2019; Wolfson et al., 2020; Clifford Astbury et al., 2019; Pitts et al., 2018; Keeble et al., 2020). Participants were asked how frequently they consumed 10 different snack foods (Supplementary Table 1; e.g. candy, cookies and ice cream), cooked at home (Supplementary Table 2), ordered dinner online (Supplementary Table 2) and ordered groceries online (answer options ranging from never to 2x per week or more). Grocery shopping style was assessed by asking participants about whether they made a shopping list before doing the groceries, if they shopped for groceries once a week and if they decided beforehand what they are going to purchase within the store (Supplementary Table 3; on a 5-point Likert scale ranging from never to always). When describing the diet-related behaviours, answering categories with fewer participants were combined. Thus, the diet-related behaviours included were snacking frequency, cooking frequency, ordering dinners online, ordering groceries online and grocery shopping style.

2.1.4. Diet quality

Diet quality was assessed using the Dutch Healthy Diet 2015 index (DHD15-index). The DHD15-index and energy intake was measured using the 34-item Dutch Healthy Diet Food Frequency Questionnaire (De Rijk et al., 2021). The DHD15-index consist of fifteen components, namely vegetables, fruits, whole grain products, legumes, nuts, dairy, fish, tea, fats and oils, coffee, red meat, processed meat, sweetened beverages and fruit juices, alcohol and salt. Each component receives a score ranging from 0 to 10, on which a total score is calculated ranging from 0 (no adherence) to 150 (complete adherence). If participants had implausible energy intake levels (<500 kcal or >3500 kcal/day for women and <800 kcal or >4000 kcal/day for men (34)), their data were excluded from the analyses on diet quality (n = 32, 1.7%).

2.2. Statistical analyses

Descriptive statistics were performed for socio-demographic characteristics, diet-related behaviours and diet quality using frequencies and percentage, means with standard deviations or median with interquartile range as appropriate. A Two-Step cluster analysis was used to identify clustering of food retail use. The Two-Step cluster analysis is a hybrid approach which first uses a distance measure to separate groups and then a probabilistic approach (similar to latent class analysis) to choose the optimal subgroup model (Benassi et al., 2020). We used the Log-likelihood distance measure to group individuals in clusters based on their food retail usage (12 dichotomous variables) as this measure can be used on categorical variables. Descriptive statistics were performed to indicate the presence and usage of food retailers within the cluster solutions.

The number of clusters was determined automatically to reveal natural clusters, using the best combination of low Bayesian Information Criterion (BIC), high ratio of BIC changes and high ratio of distance measure. As it is possible that clustering problems occur in which the BIC continues to decrease as the number of clusters increases, the number of clusters was also checked manually by evaluating the changes in BIC and distance measure. This was done by using a relatively large BIC change and large Ratio of Distance Measures. The quality of the cluster solutions were manually determined using the silhouette measures of cohesion and separation, which measure the distance between clusters (score <0.25: no clustering, 0.26–0.50: weak clustering, 0.51–0.70: reasonable clustering, 0.71–1.00: strong clustering) (Kaufman and Rousseeuw, 2009). We used a distance measure between clusters of 0.51 as a cut-off to determine whether there was clustering or not. Additionally, predictor importance was evaluated (ranging from 0 to 1 where lower numbers indicate that the contribution of a food retail variable is less important to the cluster). A pre-determined stepwise approach was used to identify the best cluster solution. A-priori we specified that in the case of weak cluster quality (i.e. a distance measure lower than 0.51), food retail variables within a 10-min walk and those further away from home would be combined, thereby counting each type of food retailer only once instead of twice. Thus, if participants indicated use of a food retailer within a 10-min walk or further away from home, this participant was considered to use the food retailer. If low cluster quality was still present after this, we pre-specified that we would drop types of food retailers that had low predictor importance.

As cluster solutions can depend on data ordering, randomly ordering of the dataset is advised to verify the stability of the given cluster solution (Ibm: IBM Docs, 2021). As such, a sensitivity analysis was performed by creating three random variables that were used to sort the dataset in random order three different times. All cluster solutions were checked three times with the dataset in these three different random orders. In all three cases, this led to the same cluster solution as the main analyses.

Table 2
Sociodemographic characteristics and diet-related behaviours of the analytical (N = 1784).

Sociodemographic characteristics		n	Mean (SD), median (IQR) or n (%)
Age in years (SD)		1784	42.5 (13.7)
Gender (% women)		1784	1137 (63.7)
Partner (% yes)		1784	1182 (66.3)
Number of children living in the household (%)	0	1784	1054 (59.1)
	1		266 (14.9)
	2 or more		464 (26.0)
Educational level (%)	Low	1778	200 (11.2)
	Medium		574 (32.3)
	High		1004 (56.5)
Occupation (%)	Skill level 1	1665	54 (3.2)
	Skill level 2		537 (32.3)
	Skill level 3		326 (19.6)
	Skill level 4		748 (44.9)
Net monthly household income (%)	€0-€1200	1639	201 (12.3)
	€1200-€1800		195 (11.9)
	€1800-€2600		353 (21.5)
	€2600-€4000		489 (29.8)
	>€4000		401 (24.5)
Diet-related behaviours		**n**	**Mean (SD), median (IQR) or N (%)**
Median snacking frequency per week (IQR)		1784	8.6 (7.7)
How often do you (or your partner) cook at home?	6–7x a week	1784	1111 (62.3)
	3–5x a week		557 (31.2)
	2x a week or less		116 (6.5)
Do you sometimes purchase groceries online? (% yes)[a]		1784	494 (27.7)
How often do you order dinner online (% never)[a]		1784	648 (36.3)
Before I go grocery shopping, I (or my partner) make a grocery list (%)	Always	1784	629 (35.3)
	Very often		585 (32.8)
	Sometimes		274 (15.4)
	Rarely/never		296 (16.6)
I (or my partner) go to the grocery store approximately once a week (%)	Always	1784	287 (16.1)
	Very often		523 (29.3)
	Sometimes		292 (16.4)
	Rarely/never		682 (38.2)
I decide in the grocery store what I will purchase (%)	Always	1784	40 (2.2)
	Very often		296 (16.6)
	Sometimes		627 (35.1)
	Rarely/never		821 (46.0)
Diet quality		**n**	**Mean (SD)**
DHD15-index (SD)[b]		1461	96.3 (18.3)

Abbreviations: DHD15-index = Dutch Healthy Diet index 2015, SD = Standard deviation, IQR = Interquartile range.
[a] Participants that indicated to never do online grocery shopping or use meal delivery services were coded as 'no' or 'never', and those that indicated to do online grocery shopping or use meal delivery services 1–2x per year to almost every day were coded as 'yes'.
[b] DHD15-index Dutch Healthy Diet 2015 index (DHD15-index) score ranging from 0 to 150.

Differences between clusters with regards to socio-demographic characteristics, diet-related behaviours and diet quality were analysed using Chi-Squared tests (in the case of categorical variables), analyses of variance (ANOVA in case of normally distributed continuous variables)) or the Kruskal-wallis H test (in case of non-normally distributed continuous variables). In case of statistical significance (i.e. a p-value <0.05), post-hoc analyses were conducted (including the Tukey method for the ANOVA). The General Linear Model Univariate procedure was used to estimate and compare the mean DHD15-index of individuals in the food retail clusters adjusted for covariates (i.e. sociodemographic characteristics and diet-related behaviours). Complete case analyses were used (flow chart displayed in Fig. 1) and all analyses, including the Two-Step cluster analysis, were implemented in IBM SPSS Statistics (version 27.0) (IBM Corp. Released, 2020).

3. Results

In total, n = 1784 participants completed the first survey including information on participants' socio-demographics, psychosocial resources, lifestyle and health, snacking behaviours and perceptions of the food environment. Missing data was only found for the three SEP indicators. The analytical sample including dietary quality consisted of n = 1461 participants. Participant sociodemographic and diet-related characteristics are described in Table 2.

Fig. 2 illustrates that the most commonly used food retailer was the supermarket (used by 1716 or 96% of participants regardless of distance), followed by restaurants further from home and discount supermarkets further from home. In general, use of retailers further from home was more common than retailers within a 10 min walk (e.g. 20% of participants indicated they used organic supermarkets further from home whilst only 11% indicated that they used organic supermarkets within a 10-min walk). The only exception was for regular supermarkets.

3.1. Cluster profiles

Meaningful clustering was only found when the food retail variables within a 10-min walk and further from home were combined (i.e. food retail use closer to home and further from home was combined into a single measure of food retail use) and when regular supermarkets and specialist shops were excluded due to their low predictor importance. Thus, only use of discount supermarkets, organic supermarkets, fast-food outlets and restaurants were included in clusters. After manual determination, five clusters were found with a cluster quality of 0.75 and a lowest predictor importance of 0.45. Fig. 3 displays the use of food retailers within the five clusters. Despite not being used in the formation of the cluster variables, supermarkets and specialist shops were included in Fig. 2 to indicate that participants within all five clusters made regular use of supermarkets (90.7%–99.1%) and specialist shops (39–74%).

As shown in Fig. 3, all food retailers were represented in the *mixed food retail* cluster. The smallest cluster of n = 290 participants included participants that all used both discount supermarkets and restaurants, but neither organic supermarkets nor fast-food outlets. The *fast-food outlet and restaurant users* cluster included participants who all used restaurants, some used fast-food outlets and none used discount or organic supermarkets. The largest cluster (N = 421) included participants of whom most used discount supermarkets, and some used organic supermarkets and fast-food outlets; none used restaurants. The last *discount supermarket, fast-food outlet and restaurant users* cluster was characterized by all participants using fast-food outlets, restaurants and discount supermarkets and no participants using organic supermarkets.

3.2. Cluster differences

As shown in Table 3, age, having a partner, the number of children in the household, SEP proxies, snacking frequency, cooking frequency, ordering dinner, grocery shopping styles and diet quality all differed statistically significantly between clusters. The *mixed food retail* cluster was characterized by participants that had the highest mean age (45.2 ± 12.8), a high SEP as indicated by educational level, occupation and net household income, and had the highest DHD15-index (104.6 ± 16.0). Participants in the *discount supermarket and restaurant* cluster had a relatively high DHD15-index (99.0 ± 17.0), snacked least often per week (Med 7.5 IQR 7.4), and cooked most often (70.7%). Participants in the *fast-food outlet and restaurant users* cluster were the youngest (Mean

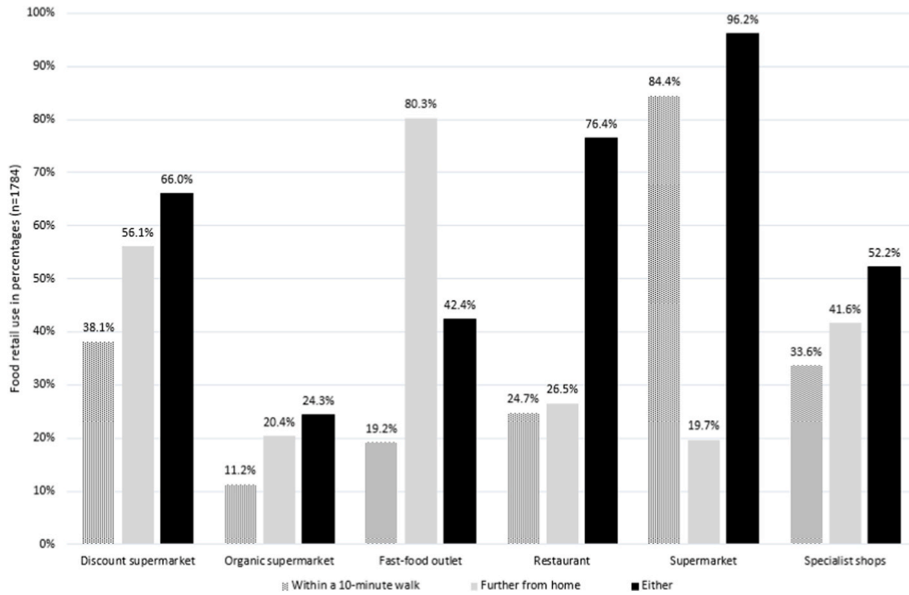

Fig. 2. Percentage of study population (N = 1784) who used food retailers within a 10-min walk, further away from home, and who used either options. As participants are able to shop at multiple food outlets in multiple areas, these percentages do not add up to 100%.

40.4 ± 13.2), most often had a partner (70.4%) and had the highest SEP (e.g. 69.1% had a high educational level). Participants in the *predominant discount supermarket users* cluster had the lowest SEP, had a lower DHD15-index (Mean 93.0 ± 19.3) and were less likely to have a partner (57.0%). Participants in the *discount supermarket, fast-food outlet and restaurant* cluster had the lowest DHD15-index (Mean 90.9 ± 17.6), the highest snacking frequency per week (Med 10.1 IQR 8.9), most often ordered dinner online (71.6%) and least often cooked 6 times per week (54.8%).

Table 4 shows the mean DHD15-index score in each cluster before and after adjustments for sociodemographic and diet-related characteristics. Adjustments for sociodemographic and diet-related characteristics decreased the mean DHD15-index score in all five clusters. For example, the mean DHD15-index for the *mixed food retail use* cluster was 104.6, which reduced to 93.7 after adjustments. Nevertheless, differences in DHD15-index between clusters remained approximately the same after adjustments. Participants in the *mixed food retail use* cluster had the highest diet quality while participants in the *discount supermarket, fast-food outlet and restaurant cluster* had the poorest diet quality.

3.3. Additional analysis

As we expected the cluster development to be based on a distinction between the use of food retailers within a 10-min walk (i.e. in the residential neighbourhood environment) and further away from home, we additionally investigated how the presence and use of food retailers within the residential neighbourhood was distributed among the clusters. The results of this additional analysis displayed in Supplementary Table 4 indicate that between 8% (supermarkets) and 66% (fast-food outlets) of participants stated that certain food retailers were present in their neighbourhood, but that they chose not to use them. Despite 80% of participants stating that there are specialist shops within a 10-min walk, only 34% of participants use these, while 42% of participants use specialist shops further away from home. Usage when being available varied between clusters, with higher percentages of non-use despite presence within a 10-min walk in clusters with no or low use of the food retailer. Results also indicated that the vast majority of participants (i.e. 73% or more) reported to have supermarkets, specialist shops, fast-food outlets and restaurants within a 10-min walk. Also, supermarkets were used both close to home as well as further away. Namely, 85% of participants used supermarkets within a 10-min walk and 80% used supermarkets further away. Fast-food outlets within a 10-min walk were often not used despite being present in the neighbourhood (between 42% and 78% of participants reported not using fast-food outlets within a 10-min walk).

4. Discussion

In this study we address an important gap in the food environment-food choice literature around the individual characteristics associated with food retail usage. We sought to understand to what extent there are distinct clusters of food retail use among Dutch adults. We identified five distinct clusters: 1) *mixed food retail users*, 2) *discount supermarket and restaurant users*, 3) *fast-food outlet and restaurant users*, 4) *predominant discount supermarket users,* and 5) *discount supermarket, fast-food outlet and restaurant users*. The distinction between the use of food retailers close to home and further away did not contribute to the final cluster solution. Furthermore, including supermarkets and specialty shops did not lead to meaningful clusters, likely because they were used by at least some proportion of participants in each cluster. As such, these food retailers were excluded from the final cluster solution. The five clusters consisted of individuals with varying sociodemographic and diet-related characteristics. For example, individuals in the cluster with the second highest diet quality (i.e. *discount supermarket and restaurant users*) generally had healthier diet-related behaviours in that they snacked the least, had the highest frequency of cooking 6–7x a week and most often did the grocery shopping for a week. The individuals in the *discount supermarket, fast-food outlet and restaurant users* cluster with the lowest diet quality, had the highest snacking frequency, a relatively low SEP and the lowest cooking frequency. Interestingly, whether or not a food retailer in the residential neighbourhood (i.e. within a 10-min walk from home) is used seems to be related to the type of food retailer.

The current study found that use of regular supermarkets was highly prevalent and therefore did not contribute to the clustering of food retail use. Similarly, previous US-based clustering studies found that most individuals, including those with strong preferences for supermarkets, also use a variety of additional food retailers (Carlson et al., 2002; Yenerall et al., 2020). Also, the study by Yenerall et al. (2020) found that the mixed food retail cluster consisted of participants with more children in the household and a higher income compared to the cluster dominated by superstores and supermarkets. While our *mixed food retail* cluster included participants with a relatively high SEP, it did not

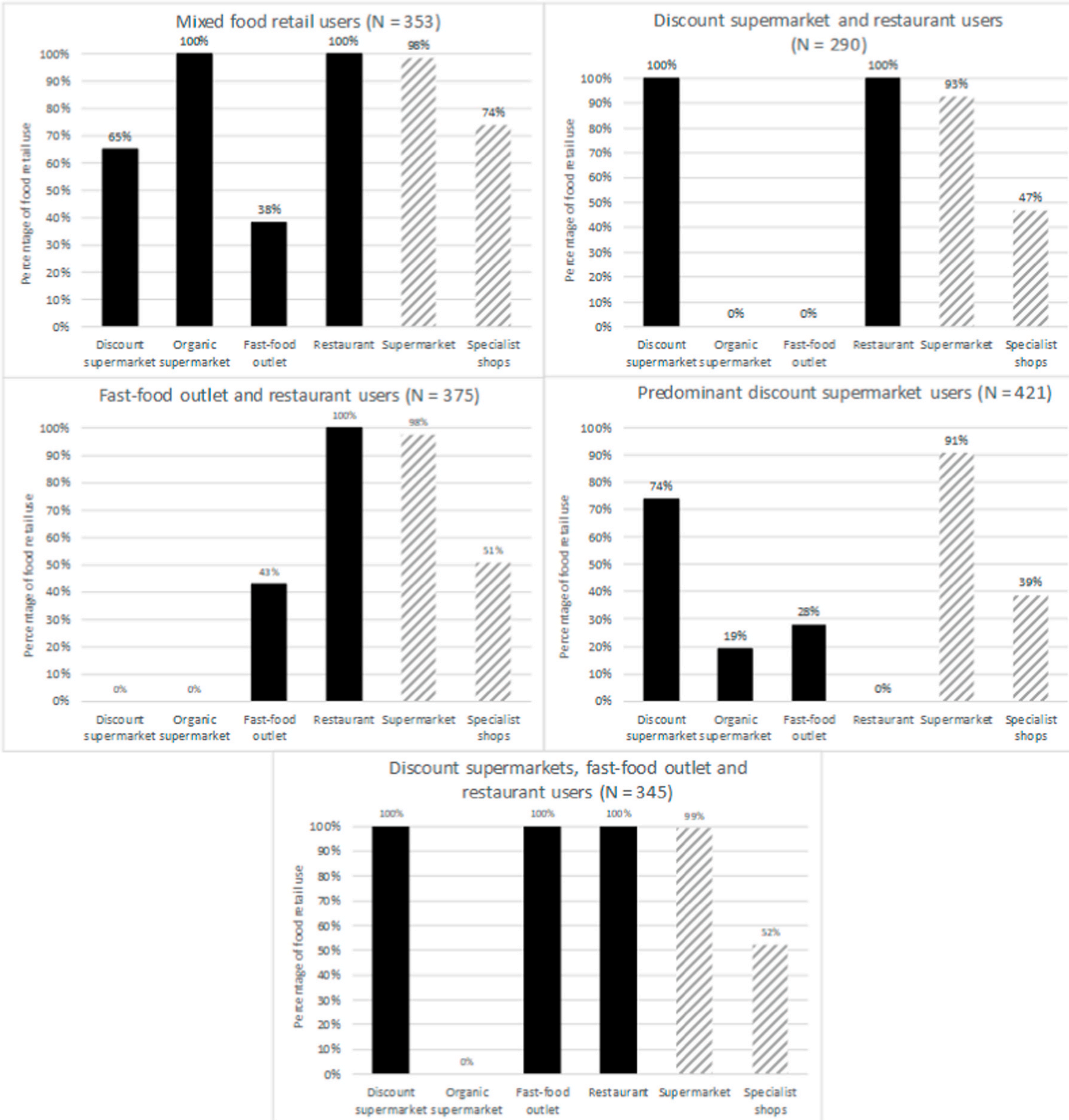

Fig. 3. Percentage of participants (N = 1784) in the clusters who used food retailers
Note: The striped bars represent the food retail variables that were not included in the two-step cluster analysis due to a low predictor importance. Nevertheless, as these food retailers are still used by the participants included in these clusters, they were also included in the figure.

necessarily differ in terms of presence of children in the household compared to for example the *discount supermarket and restaurant* cluster. Comparing clusters and the participant characteristics of the clusters with previous studies is difficult due to, among other factors, differences in the types of food retailers prevalent in different countries and considered in previous analyses. The different food retailers included in the studies are likely a result of contextual differences between the US and the Netherlands. Unlike the US, the Netherlands does not have superstores, and instead supermarkets are mostly distinguishable based on product price (e.g. discount vs regular), product range (e.g. regular vs discount) and product variety (e.g. organic/discount vs regular).

Previous research suggests that socio-demographic characteristics are associated with food retail use as well as distance traveled (Drewnowski et al., 2012; Kerr et al., 2012; Moore et al., 2009; Tan and Arcaya, 2020). For example, there is evidence to suggest that lower SEP is associated with more fast-food exposure, fast-food use, and (discount) supermarket use (Drewnowski et al., 2012; Kerr et al., 2012; Moore et al., 2009). Also, older age and being male is associated with use of discount supermarkets (Drewnowski et al., 2012). As such, the socio-demographic and diet-related characteristics of the current study population likely led to the discovery of these specific five clusters (Stern et al., 2015).

The specific clusters found in this study may not be generalizable to other contexts due to differences in sociodemographic characteristics, types of food retailers available as well as other factors such as culture. Nonetheless, the mere presence of food retail clusters as well as the other study results have important implications for future studies aiming to investigate the role of the food environment on diet and obesity. For example, our results suggest that clustering of food retail use is independently associated with diet quality since adjustments for socio-demographic and diet-related characteristics did not influence the ranking of participants' dietary quality across clusters. The comparatively high diet quality found in the *mixed food retail* cluster, in spite of few menu offerings from popular fast-food chains meeting the recommended dietary guidelines (Hearst et al., 2013), may be because the consumption of foods from fast-food outlets and restaurants are offset by

Table 3
Sociodemographic and diet-related characteristics of participants in clusters (N = 1784).

	Mixed food retail users (n = 353)	Discount supermarket and restaurant users (n = 290)	Fast-food outlet and restaurant users (n = 375)	Predominant discount supermarket users (n = 421)	Discount supermarket, fast-food outlet and restaurant users (n = 345)	Chi-value (df), F value (df) or H value (df)[g]
Socio-demographic characteristics						
Age in years (SD)	45.2 (12.8)[b,c,e]	42.2 (13.6)[a]	40.4 (13.2)[a,c]	43.9 (13.8)[c,e]	41.6 (13.5)[a,d]	8.5 (4)‡
Sex N (%) women	236 (66.9)	191 (65.9)	232 (61.9)	263 (62.5)	215 (62.3)	3.2 (4)
Partner N (%) yes	239 (67.7)[d]	199 (68.6)[d]	264 (70.4)[d]	240 (57.0)[a,b,c,e]	240 (69.6)[d]	21.7 (4)‡
Number of children in N (%)						
0 children	214 (60.6)	177 (61.0)	231 (61.6)	244 (58.0)	188 (54.5)	15.7 (8)#
1 child	62 (17.6)	34 (11.7)	61 (16.3)	61 (14.5)	48 (13.9)	
2+ children	77 (21.8)[b,c,d,e]	79 (27.2)[a,e]	83 (22.1)[a,e]	116 (27.6)[a,e]	109 (31.6)[a,b,c,d]	
Educational level in N (%)[f]						
Low	20 (5.7)	20 (6.9)	12 (3.2)	91 (21.7)	57 (16.5)	134.3 (8)‡
Medium	98 (27.9)	93 (32.2)	104 (27.7)	157 (37.5)	122 (35.4)	
High	233 (66.4)[d,e]	175 (60.8)[c,d,e]	259 (69.1)[b,d,e]	171 (40.8)[a,b,c,e]	166 (48.1)[a,b,c,d]	
Occupation in N (%)[f]						
Skill level 1	4 (1.2)	6 (2.2)	6 (1.7)	22 (5.8)	16 (5.0)	85.6 (12)‡
Skill level 2	82 (24.2)	82 (29.4)	84 (24.1)	160 (41.9)	129 (40.7)	
Skill level 3	69 (20.4)	63 (22.6)	64 (18.4)	69 (18.1)	61 (19.2)	
Skill level 4	184 (54.3)[b,d,e]	128 (45.9)[a,c,d,e]	194 (55.7)[b,d,e]	131 (34.3)[a,b,c]	111 (35.0)[a,b,c]	
Net monthly household income in N (%)[f]						
€0-€1200	23 (6.9)	23 (9.0)	24 (6.8)	92 (24.5)	39 (12.2)	143.3 (16)‡
€1200-€1800	40 (11.9)	20 (7.8)	31 (8.8)	61 (16.2)	43 (13.5)	
€1800-€2600	65 (19.4)	62 (24.2)	63 (17.8)	87 (23.1)	76 (23.8)	
€2600-€4000	100 (29.9)	89 (34.8)	109 (30.9)	94 (25.0)	97 (30.4)	
>€4000	107 (31.9)[b,d,e]	62 (24.2)[a,c,d]	126 (35.7) [b,d,e]	42 (11.2)[b,c,d,e]	64 (20.1)[a,c,d]	
Diet-related behaviours						
Median snacking frequency per week (IQR)	8.1 (7.6)[e]	7.5 (7.4)[c,e]	8.5 (7.5)[b,d,e]	7.8 (7.8)[c,e]	10.1 (8.9)[a,b,c,d]	37.8 (4)‡
How often do you (or your partner) cook at home?						
6-7x a week	231 (65.4)[b,e]	205 (70.7)[a,c,d,e]	226 (60.3)[b,e]	260 (61.8)	189 (54.8)[a,b,c,d]	22.3 (8)#
3-5x a week	102 (28.9)[b,e]	70 (24.1)[a,c,d,e]	124 (33.1)[b,e]	127 (30.2)	134 (38.8)[a,b,c,d]	
≤2x a week	20 (5.7)	15 (5.2)	25 (6.7)	34 (8.1)	22 (6.4)	
Do you sometimes purchase groceries online? (% yes)[1]	101 (28.6)	68 (23.4)	121 (32.3)	104 (24.7)	100 (29.0)	8.8 (4)
How often do you order dinner online (% never)[a]	213 (60.3)	176 (60.7)	277 (73.9)[a,b,d,e]	223 (53.0)[a,b,c,e]	247 (71.6)[a,b,c,d]	49.8 (4)‡
Before I go grocery shopping, I (or my partner) make a grocery list (%)						
Always	112 (31.7)	99 (34.1)	155 (41.3)	159 (37.8)	104 (30.1)	25.0 (16)
Very often	122 (34.6)	113 (39.0)	112 (29.9)	126 (29.9)	112 (32.5)	
Sometimes	61 (17.3)	40 (13.8)	51 (13.6)	60 (14.3)	62 (18.0)	
Rarely/never	58 (16.4)	38 (13.1)	57 (15.2)	76 (18.0)	67 (19.5)	
I (or my partner) go to the grocery store approximately once a week (%)						
Always	36 (10.2)[b,c,d,e]	59 (20.3)[a,c,d,e]	68 (18.1)[a,b]	66 (15.7)[a,b]	58 (16.8)[a,b]	52.2 (16)‡
Very often	98 (27.8)	81 (27.9)	114 (30.4)	112 (26.6)	118 (34.2)	
Sometimes	67 (19.0)[c]	50 (17.2)[c]	32 (8.5)[a,b,d,e]	80 (19.0)[c]	63 (18.3)[c]	
Rarely/never	152 (45.1)[b,e]	100 (34.5)[a,c,d,e]	161 (43.0)[b,e]	163 (39.7)[b,e]	106 (30.7)[a,b,c,d]	
I decide in the grocery store what I will purchase (%)						
Always	9 (2.5)[e]	4 (1.4)[e]	5 (1.3)[e]	9 (2.1)[e]	13 (3.8)[a,b,c,d]	34.5 (16)‡
Very often	57 (16.1)	44 (15.2)	68 (18.1)	75 (17.8)	52 (15.1)	
Sometimes	134 (38.0)[d,e]	103 (35.5)[d,e]	122 (32.5)[d,e]	131 (31.1)[a,b,c,e]	137 (39.7)[a,b,c,d]	
Rarely/never	153 (43.4)[d,e]	139 (47.9)[d,e]	180 (48.0)[d]	206 (49.0)[a,b,e]	143 (41.5)[a,b,c,d]	
DHD15-index (SD)[f]	104.6 (16.0)[b,c,d,e]	99.0 (17.0)[a,c,d,e]	95.3 (18.1)[a,b],[e]	93.0 (19.3)[a,b]	90.9 (17.6)[a,b,c]	26.1 (4)‡

Abbreviations: SD - Standard deviation, IQR - Interquartile range.
= p-value smaller than 0.05.
‡ = p-value smaller than 0.01.
[a] Statistically significantly different from mixed food retail cluster.
[b] Statistically significantly different from discount supermarket and restaurant cluster.
[c] Statistically significantly different from fast-food outlet and restaurant cluster.
[d] Statistically significantly different from predominant discount supermarket cluster.
[e] Statistically significantly different from discount supermarket, fast-food outlet and restaurant cluster.
[f] $n_{\text{educational level}} = 1778$, $n_{\text{occupation}} = 1665$, $n_{\text{net household income}} = 1639$, $n_{\text{DHD15-index}} = 1461$.
[g] Based on Chi-Squared tests (in the case of categorical variables), analyses of variance (ANOVA in case of normally distributed continuous variables)) or the Kruskal-wallis H test (in case of non-normally distributed continuous variables).

Table 4
General Linear Model results of the mean diet quality as measured by the DHD15-index of participants in the clusters adjusted for covariates.

	Mean (95%CI) DHD15-index		
	Model 0[f]	Model 1[g]	Model 2[g]
Mixed food retail users (n = 279)	104.6 (102.5; 106.7)[b,c,d,e]	97.6 (95.0; 100.2)[b,c,d,e]	93.7 (90.5; 96.9)[b,c,d,e]
Discount supermarket and restaurant users (n = 243)	99.0 (96.7; 101.2)[a,c,d,e]	93.2 (90.4; 95.9)[a,c,d,e]	88.9 (85.6; 92.3)[a,c,d,e]
Fast-food outlet and restaurant users (n = 317)	95.3 (93.3; 97.2)[a,b,e]	89.2 (86.7; 91.7)[a,b]	85.8 (82.7; 89.0)[a,b]
Predominant discount supermarket users (n = 344)	93.0 (91.1; 94.9)[a,b]	89.0 (86.7; 91.3)[a,b]	84.7 (81.6; 87.7)[a,b]
Discount supermarket, fast-food outlet and restaurant users (n = 278)	90.9 (88.9; 93.0)[a,b,c]	87.2 (84.8; 89.7)[a,b]	84.0 (81.0; 87.1)[a,b]

Model 0 is unadjusted, Model 1 is adjusted for sociodemographic characteristics (i.e. age, sex, partner, number of children, net household income, educational level and occupation), and model 2 is adjusted for both sociodemographic and diet-related characteristics.

[a] Statistically significantly different from mixed food retail cluster.
[b] Statistically significantly different from discount supermarket and restaurant cluster.
[c] Statistically significantly different from fast-food and restaurant cluster.
[d] Statistically significantly different from predominant supermarkets cluster.
[e] Statistically significantly different from discount supermarket, fast-food outlet and restaurant cluster.
[f] n = 1461.
[g] n = 1260 due to missing data in the SEP proxies. The cluster sizes are mixed food retail cluster n = 254, discount supermarket and restaurant cluster n = 204, fast-food outlet and restaurant cluster n = 282, predominant supermarkets cluster n = 278, discount supermarket, fast-food outlet and restaurant cluster n = 242.

healthier food purchases and consumption from organic supermarkets and specialist shops. Indeed, a recent report suggests that a popular organic supermarket chain in the Netherlands has a healthier product assortment compared to regular and discount supermarkets (Questionmark, 2020). Thus, shopping at the organic supermarket across the street may lead to healthier food purchases. However, individuals preferring healthier foods may be more likely to use a food retailer that provides these healthier foods (e.g. organic supermarkets). In other words, the relationship between environmental exposure and dietary behaviours is likely dynamic; with causation flowing in both directions and through positive or negative feedback loops (Cummins and Macintyre, 2006). It was not our aim to determine the direction of causation between food retail cluster use and diet quality, but rather to investigate if there is an association between the two. Future longitudinal and experimental studies should explore direction(s) of causation between food retail exposure/use and diet quality, and the potential feedback loops.

Another interesting finding was that despite food retailers being present in the residential neighbourhood, this did not necessarily imply that they were used (except in the case of regular supermarkets). For example, despite 85% of participants saying they had a fast-food outlet within 10-min walk, 66% of participants indicated that they did not use these, and 38% of participants stated that they used fast-food outlets further away from home. While the reporting of fast-food outlet use may be sensitive to social desirability bias, and fast-food outlets may be used near other settings where individuals spend a lot of time (e.g. the workplace), these results may also imply that people are selective in their use of food retailers, and again it is possible that the availability of a specific food retailer does not necessarily lead to use. It is likely that a combination of individuals' desire to consume foods and food retail characteristics lead to use of food retailers (Clary et al., 2017). The Netherlands is a highly dense country with excellent infrastructure (especially in urban areas where most participants were recruited). Due to this limited variation in proximity to food retailers (e.g. more than 73% of participants reported to have supermarkets, specialist shops, fast-food outlets and restaurants within a 10-min walk), it is possible that the willingness and opportunity to travel a bit further for a preferred food retailer, and other factors such as pricing (DiSantis et al., 2016; Chamhuri and Batt, 2009), food quality (Chamhuri and Batt, 2009), convenience, and family preferences (DiSantis et al., 2016) play important roles in food retail usage. Even in more rural areas/countries, residential exposure to food retailers may not lead to usage due to for example trip chaining (e.g. stopping at the supermarket between work and home) (Kerr et al., 2012; Sharkey, 2009).

The present study showed that people 1) use a variety of food retailers and 2), with the exception of supermarkets, generally do not use food retailers close to home. Our work thereby challenges the common methodological choice of using data on physical proximity to food retailers as a proxy of shopping behaviour as this might not be an accurate metric of exposure (especially in the Netherlands where there is little variation in proximity to food retailers). The finding that people do not necessarily use food retailers close to home (except for supermarkets) may partly explain the inconsistent associations between local food environments, dietary intake and obesity (Cobb et al., 2015; Caspi et al., 2012). While the current findings do not imply that the residential food environment does not influence food retail usage, it does highlight the need to incorporate food shopping patterns into future research and policy (Stern et al., 2015). To make progress in the food environment-behaviour literature, drivers of food retail use and its consequences on dietary behaviours and health must be untangled before placing too much policy focus on physical food retail exposure alone. For example, a supermarket may be available to those living around it, but they may not use that supermarket for a variety of reasons: because it is too expensive, because food shopping is done near the work environment and/or personal preferences (Drewnowski et al., 2012; Pitt et al., 2017). Thus, intervening on the physical location of food retailers only is unlikely to be sufficient for achieving substantial improvements in diet quality. Different interventions implemented simultaneously will likely lead to substantial diet quality improvements, such as offering lower prices for healthy relative to less healthy foods, restricting the marketing of unhealthy foods and promoting healthy foods (Stern et al., 2015).

The strengths and limitations of this study should be considered when interpreting the results. The first strength of the study is that, as far as we are aware, it is the first study to investigate clustering of food retail use outside the US. Furthermore, different types of supermarkets were differentiated, allowing for additional insights into mechanisms behind food purchases and diet quality (Drewnowski et al., 2012). A third strength is that robustness checks were performed on the cluster solution, which led to the same cluster solution both before and after the checks. Lastly, we included a relatively large sample size of participants recruited from different urban regions in the Netherlands, likely making our results generalizable to the population living in this area. Indeed, participant characteristics with regards to age, having a partner and number of children in the household are comparable to the study sample of the Dutch National Food Consumption Survey 2012–2016 (DNFCS) which recruited a representative sample of the Dutch population (Van Rossum et al., 2012). The DNFCS also found that approximately 50% of Dutch people live in an extremely or strongly urbanized region, making the current clustering results generalizable to almost half of the Dutch population. Nevertheless, as previously discussed, differences in contextual factors can hinder the generalizability of the clustering results to other areas in the Netherlands as well as other countries. A limitation includes the self-reported data which may be subject to social desirability bias, resulting in for example under reportage of dietary intake (Drewnowski, 2001). Also, while the current study findings may suggest that proximity is not an important distinguishing feature of food retail use, this cannot be inferred due to the crude nature of the proximity variable (i.e. within 10 min walk of home or further away). It also does not capture proximity from other locations (e.g. work (Thornton et al., 2017)). Other limitations include the fact that participants could only select from a list of six food retailers, that the proportion of daily or weekly food consumption from each food retailers was not measured and that only usage by participants themselves were reported (and not that of partners or housemates).

5. Conclusion

This study shows that Dutch adults use a variety of food retailers and that food retail use is clustered. Differences were found between participants in the clusters, in particular regarding their diet quality, SEP, snack intake, cooking frequency and meal delivery. Generally, use of food retailers further from home was more common than within the residential neighbourhood (except for supermarkets), indicating that the availability of a specific food retailer does not necessarily lead to use. It is important to understand the patterning of food retail usage, as it increases our understanding of the ways in which food environments influence food choices and obesity.

Ethics approval and consent to participate

The study complies with the Declaration of Helsinki and was approved by the Institutional Review Board of the VU University Medical Centre Amsterdam (OHRP: IRB00002911). Informed consent was obtained from all the participants before starting the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used during the current study are available from JDM on reasonable request.

Declaration of competing interest

The authors have no competing interests to declare.

Funding

The ‘Eet & Leef’ study, and the work of JDM, is funded by an*NWO VENI* grant on “Making the healthy choice easier – role of the local food environment” (grant number 451-17-032). During the start of the manuscript, JCH and JDM were further funded by the Netherlands Heart Foundation (Hartstichting) and the Netherlands Organisation for Health Research and Development (ZonMw) through the Supreme Nudge (CVON2016–04) project. JCH and JA are currently supported by the Medical Research Council [Unit Programme number MC_UU_00006/7]. The funders played no role in the design of the study, the collection, analysis, and interpretation of data, or the writing of the manuscript. For the purpose of Open Access, the authors have applied a Creative Commons Attribution (CC BY) licence to any Author Accepted Manuscript version arising.

Author contributions

JDM set up the ‘Eet & Leef’ study and collected the data. JCH and JDM developed the research question and plan. ME conducted the formal analyses and JCH drafted the manuscript. JCH, ME, JA, MGMP and JDM interpreted the results. All authors reviewed and edited the manuscript.

Acknowledgements

The authors would like to thank the participants for taking part in the ‘Eet & Leef’ study.

List of abbreviations

BIC = Bayesian Information Criterion
DHD15-index = Dutch Healthy Diet index 2015
DNFCS = Dutch National Food Consumption Survey 2012–2016
SEP = Socioeconomic Position
US = United States

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.healthplace.2023.103009.

References

Benassi, M., Garofalo, S., Ambrosini, F., Sant’Angelo, R.P., Raggini, R., De Paoli, G., Ravani, C., Giovagnoli, S., Orsoni, M., Piraccini, G., 2020. Using two-step cluster analysis and latent class cluster analysis to classify the cognitive heterogeneity of cross-diagnostic psychiatric inpatients. Front. Psychol. 11, 1085.

Block, J.P., Christakis, N.A., O’malley, A.J., Subramanian, S., 2011. Proximity to food establishments and body mass index in the Framingham Heart Study offspring cohort over 30 years. Am. J. Epidemiol. 174, 1108–1114.

Burgoine, T., Forouhi, N.G., Griffin, S.J., Wareham, N.J., Monsivais, P., 2014. Associations between exposure to takeaway food outlets, takeaway food consumption, and body weight in Cambridgeshire, UK: population based, cross sectional study. BMJ (Clinical research ed) 348, g1464.

Carlson, A., Kinsey, J., Nadav, C., 2002. Consumers’ Retail Source of Food: A Cluster Analysis, vol. 14, pp. 11–20.

Caspi, C.E., Sorensen, G., Subramanian, S.V., Kawachi, I., 2012. The local food environment and diet: a systematic review. Health Place 18, 1172–1187.

Chamhuri, N., Batt, P., 2009. Factors influencing the consumer’s choice of retail food store. Stewart Postharvest Review 5, 1–7.

Clary, C., Matthews, S.A., Kestens, Y., 2017. Between exposure, access and use: reconsidering foodscape influences on dietary behaviours. Health Place 44, 1–7.

Clifford Astbury, C., Penney, T.L., Adams, J., 2019. Home-prepared food, dietary quality and socio-demographic factors: a cross-sectional analysis of the UK National Diet and nutrition survey 2008–16. Int. J. Behav. Nutr. Phys. Activ. 16.

Cobb, L.K., Appel, L.J., Franco, M., Jones-Smith, J.C., Nur, A., Anderson, C.A.M., 2015. The relationship of the local food environment with obesity: a systematic review of methods, study quality, and results. Obesity 23, 1331–1344.

Cummins, S., Macintyre, S., 2006. Food environments and obesity—neighbourhood or nation? Int. J. Epidemiol. 35, 100–104.

De Rijk, M.G., Slotegraaf, A.I., Brouwer-Brolsma, E.M., Perenboom, C.W., Feskens, E.J., De Vries, J.H., 2021. Development and evaluation of a diet quality screener to assess adherence to the Dutch food-based dietary guidelines. Br. J. Nutr. 1–11.

DiSantis, K.I., Hillier, A., Holaday, R., Kumanyika, S., 2016. Why do you shop there? A mixed methods study mapping household food shopping patterns onto weekly routines of black women. Int. J. Behav. Nutr. Phys. Activ. 13.

Drewnowski, A., 2001. Diet image: a new perspective on the food-frequency questionnaire. Nutr. Rev. 59, 370–372.

Drewnowski, A., Aggarwal, A., Hurvitz, P.M., Monsivais, P., Moudon, A.V., 2012. Obesity and supermarket access: proximity or price? Am. J. Publ. Health 102, e74–e80.

Edvardsson, K., Ivarsson, A., Eurenius, E., Garvare, R., Nyström, M.E., Small, R., Mogren, I., 2011. Giving offspring a healthy start: parents’ experiences of health promotion and lifestyle change during pregnancy and early parenthood. BMC Publ. Health 11, 936.

Gustafson, A.A., Sharkey, J., Samuel-Hodge, C.D., Jones-Smith, J., Folds, M.C., Cai, J., Ammerman, A.S., 2011. Perceived and objective measures of the food store environment and the association with weight and diet among low-income women in North Carolina. Publ. Health Nutr. 14, 1032–1038.

Hearst, M.O., Harnack, L.J., Bauer, K.W., Earnest, A.A., French, S.A., Oakes, J.M., 2013. Nutritional quality at eight US fast-food chains: 14-year trends. Am. J. Prev. Med. 44, 589–594.

Hobbs, M., Mackenbach, J.D., Wiki, J., Marek, L., McLeod, G.F., Boden, J.M., 2021. Investigating change in the food environment over 10 years in urban New Zealand: a longitudinal and nationwide geospatial study. Soc. Sci. Med. 269, 113522.

Hoenink, J.C., Waterlander, W., Beulens, J.W., Mackenbach, J.D., 2022. The role of material and psychosocial resources in explaining socioeconomic inequalities in diet: a structural equation modelling approach. SSM-Population Health 17, 101025.

IBM Corp. Released, 2020. IBM SPSS Statistics for Windows, Version 27.0. IBM Corp, Armonk, NY.

Ibm: **IBM Docs - TwoStep Cluster Analysis**, 2021.

International Labour, O., 2012. International Standard Classification of Occupations. ISCO-08, Geneva.

Kaufman, L., Rousseeuw, P.J., 2009. Finding Groups in Data: an Introduction to Cluster Analysis. John Wiley & Sons.
Keeble, M., Adams, J., Sacks, G., Vanderlee, L., White, C.M., Hammond, D., Burgoine, T., 2020. Use of online food delivery services to order food prepared away-from-home and associated sociodemographic characteristics: a cross-sectional, multi-country analysis. Int. J. Environ. Res. Publ. Health 17.
Kerr, J., Frank, L., Sallis, J.F., Saelens, B., Glanz, K., Chapman, J., 2012. Predictors of trips to food destinations. Int. J. Behav. Nutr. Phys. Activ. 9, 58.
Larson, N.I., Miller, J.M., Watts, A.W., Story, M.T., Neumark-Sztainer, D.R., 2016. Adolescent snacking behaviors are associated with dietary intake and weight status. J. Nutr. 146, 1348–1355.
Li, J., Kim, C., 2020. Exploring relationships of grocery shopping patterns and healthy food accessibility in residential neighborhoods and activity space. Appl. Geogr. 116, 102169.
Lucan, S.C., 2015. Concerning limitations of food-environment research: a narrative review and commentary framed around obesity and diet-related diseases in youth. J. Acad. Nutr. Diet. 115, 205–212.
Lytle, L.A., 2009. Measuring the food environment: state of the science. Am. J. Prev. Med. 36, S134–S144.
Mackenbach, J.D., Hobbs, M., Pinho, M.G., 2022. Where do Dutch adults obtain their snack foods? Cross-sectional exploration of individuals' interactions with the food environment. Health Place 75, 102802.
Maguire, E.R., Burgoine, T., Monsivais, P., 2015. Area deprivation and the food environment over time: a repeated cross-sectional study on takeaway outlet density and supermarket presence in Norfolk, UK, 1990–2008. Health Place 33, 142–147.
Malik, V.S., Willett, W.C., Hu, F.B., 2013. Global obesity: trends, risk factors and policy implications. Nat. Rev. Endocrinol. 9, 13–27.
Minaker, L.M., Olstad, D.L., Thompson, M.E., Raine, K.D., Fisher, P., Frank, L.D., 2016. Associations between frequency of food shopping at different store types and diet and weight outcomes: findings from the NEWPATH study. Publ. Health Nutr. 19, 2268–2277.
Moore, L.V., Diez Roux, A.V., Nettleton, J.A., Jacobs, D.R., Franco, M., 2009. Fast-food consumption, diet quality, and neighborhood exposure to fast food: the multi-ethnic study of atherosclerosis. Am. J. Epidemiol. 170, 29–36.
Pinho, M.G.M., Mackenbach, J.D., den Braver, N.R., Beulens, J.J.W., Brug, J., Lakerveld, J., 2020. Recent changes in the Dutch foodscape: socioeconomic and urban-rural differences. Int. J. Behav. Nutr. Phys. Activ. 17.
Pitt, E., Gallegos, D., Comans, T., Cameron, C., Thornton, L., 2017. Exploring the influence of local food environments on food behaviours: a systematic review of qualitative literature. Publ. Health Nutr. 20, 2393–2405.
Pitts, S.B.J., Ng, S.W., Blitstein, J.L., Gustafson, A., Niculescu, M., 2018. Online grocery shopping: promise and pitfalls for healthier food and beverage purchases. Publ. Health Nutr. 21, 3360–3376.
Poelman, M., Strak, M., Schmitz, O., Hoek, G., Karssenberg, D., Helbich, M., Ntarladima, A.-M., Bots, M., Brunekreef, B., Grobbee, R., et al., 2018. Relations between the residential fast-food environment and the individual risk of cardiovascular diseases in The Netherlands: a nationwide follow-up study. European Journal of Preventive Cardiology 25, 1397–1405.
Popkin, B.M., 2001. The nutrition transition and obesity in the developing world. J. Nutr. 131, 871S–873S.
Questionmark: Superlijst Gezondheid 2020: Welke supermarkt maakt gezond de makkelijke keuze? pp. 62. Amsterdam: Stichting Questionmark:62.
Rehm, C.D., Monsivais, P., Drewnowski, A., 2015. Relation between diet cost and Healthy Eating Index 2010 scores among adults in the United States 2007–2010. Prev. Med. 73, 70–75.
Sacks, G., Robinson, E., Cameron, A.J., 2019. Issues in measuring the healthiness of food environments and interpreting relationships with diet, obesity and related health outcomes. Current obesity reports 8, 98–111.
Sharkey, J.R., 2009. Measuring potential access to food stores and food-service places in rural areas in the US. Am. J. Prev. Med. 36, S151–S155.
Stern, D., Robinson, W.R., Ng, S.W., Gordon-Larsen, P., Popkin, B.M., 2015. US household food shopping patterns: dynamic shifts since 2000 and socioeconomic predictors. Health Aff. 34, 1840–1848.
Tan, S.B., Arcaya, M., 2020. Where we eat is who we are: a survey of food-related travel patterns to Singapore's hawker centers, food courts and coffee shops. Int. J. Behav. Nutr. Phys. Activ. 17, 1–14.
Thornton, L.E., Crawford, D.A., Lamb, K.E., Ball, K., 2017. Where do people purchase food? A novel approach to investigating food purchasing locations. Int. J. Health Geogr. 16, 1–13.
Thornton, L.E., Lamb, K.E., White, S.R., 2020. The use and misuse of ratio and proportion exposure measures in food environment research. Int. J. Behav. Nutr. Phys. Activ. 17, 1–7.
Timperio, A., Ball, K., Roberts, R., Campbell, K., Andrianopoulos, N., Crawford, D., 2008. Children's fruit and vegetable intake: associations with the neighbourhood food environment. Prev. Med. 46, 331–335.
Van Rossum C, Buurma-Rethans E, Vennemann F, Beukers M, Brants HA, De Boer E, Ocké MC: **The Diet of the Dutch: Results of the First Two Years of the Dutch National Food Consumption Survey 2012-2016.** *RIVM Letter Report 2016-0082* 2016.
Vandevijvere, S., De Ridder, K., Fiolet, T., Bel, S., Tafforeau, J., 2019. Consumption of ultra-processed food products and diet quality among children, adolescents and adults in Belgium. Eur. J. Nutr. 58, 3267–3278.
Wolfson, J.A., Leung, C.W., Richardson, C.R., 2020. More frequent cooking at home is associated with higher Healthy Eating Index-2015 score. Publ. Health Nutr. 23, 2384–2394.
Yenerall, J., You, W., Hill, J., 2020. Beyond the supermarket: analyzing household shopping trip patterns that include food at home and away from home retailers. BMC Publ. Health 20, 1747.