

Mapping vegetarianism: A statistical analysis of the social and geographical factors underlying vegetarian diets in the North of the Netherlands

Abstract

This study concentrates on comprehending which are the most prominent factors on being vegetarian and on mapping the geographical distribution of vegetarians in the provinces of the North of the Netherlands. This research shows that social factors, such as the presence of a vegetarian partner or a vegetarian mother, are significantly correlated to vegetarianism. Personal factors, such as being a woman, highly educated, being on a same-sex partnership and having no child in the house are significantly highly correlated to being vegetarian. Likewise, some environmental factors are positively correlated to vegetarianism, such as living in highly urbanized areas. Finally, vegetarianism has a non-random distribution in space, tending to cluster on specific areas (especially in the vicinity of populous cities). There is evidence, however, of unmapped cultural factors that may be associated with vegetarianism that could be discussed in further research.

1. Introduction:

Recently, vegetarian related diets have been gaining a lot of societal and scientific attention across the world for its role in dealing with the climate crisis (The Guardian UK, 2019) and its impact on health (Hancox, 2018). In the 2019's IPCC's (The Intergovernmental Panel on Climate Change) special report on Climate Change and Land, for instance, highlighted the importance of a major shift to vegetarian and vegan diets to reduce greenhouse gas emissions and reduce the impacts of climate change (The Guardian UK, 2019). In the Netherlands, additionally, the Dutch Council for the living environment and infrastructure (RLI) released an extensive report strongly advising the Dutch government to revise its food policy by diminishing the presence of animal food products and migrating to a more vegetarian diet in order to reach a more

sustainable and healthy food system (RLI - Council for the environment and infrastructure, 2018).

This media attention is also reflected in an increase in the adoption of vegetarians in a diverse number of countries worldwide. In Great Britain, for example, according to a research by Ipsos in 2016, the number of vegans increased from *150,000 to 542,000 in the space of a decade (alongside a vegetarian population of 1.14 million – approximately 2% of the population)* (Hancox, 2018); In Brazil, on the other hand, 14% of the population declares themselves as vegetarians, according to the latest research done by IBOPE in 2018 (G1, 2018), representing a 100% increase of vegetarianism on the metropolitan areas from 2012 to 2018; Lastly in the USA, the number of consumers that identified as vegans have increased by 600% from 2014 to 2017, according to GlobalData (Forgrieve, 2019).

At first look, this vegetarian trend seems to be also booming in the Netherlands. According to the food consumption survey organized by RIVM (RIVM, 2018), the percentage of interviewees that followed a plant-based diet changed between 2007 to 2014, from 1,1% to 4,4%. Additionally, the quantity of meat per day decreased 8% in this period, whereas, legumes consumption rose 8% and nuts and fruits rose 9%. This trend also seems to resonate in the market: Meat and dairy substitutes had a 27.4% increase in sales in the first period of 2018 (Renesen, 2018) and ABN Amro expects the market to grow by 8% in 2019 (*ibidem*).

Even though there is a wide range of academic studies about the positive health impact of adopting a vegetarian diet (Chiu *et al*, 2018; Tonstad *et al*, 2013; Satija *et al*, 2016; Fraser *et al*, 2014; Tai Le and Sabaté, 2014; Buckingham, 2018), and the benefits of the diet to the environment (Carus, 2010; Scarborough, 2014; Berners-Lee, 2012), there are few studies, principally in the Netherlands, that concentrate on the demographic and environmental factors that influence vegetarianism or the geographical distribution of vegetarianism within space. Understanding the characteristics of those who are adopting a vegetarian diet and the factors that influence them is fundamental to amplify the reach of vegetarianism and to understand important social aspects of the rising plant-based diets. Mapping vegetarianism through space within a region is also necessary to understand the spatial and

agglomeration correlations with vegetarianism and avoid false assumptions on the distribution of vegetarians across space. Some common-sense assumptions about the spatiality of vegetarianism, such as being only concentrated in urban areas or big cities, have to be scientifically examined through a geodata-driven approach.

Considering this broader scenario, this research aims to understand the social, spatial and demographic factors that influence vegetarian diets in the North of the Netherlands and map how it is geographically distributed through the northern region. The North of the Netherlands provides an interesting scenario for understanding the distribution of vegetarianism since it has a diversity of types of urban and rural agglomerations and can provide insights on how vegetarianism is distributed away from big conurbations and metropolitan areas (such as the Randstad).

The research will make use of the existing data about dietary patterns and social variables available in the Lifelines databank. The lifelines research is an innovative “bio-bank” (Lifelines.nl, 2019) aggregating a diversity of information of different categories, such as lifestyle, health, personality, working and living environment, and biological samples. Also, as the Lifelines data provide geo-tagged data, it is also possible to analyze the geographical dispersion of vegetarian diets through the Northern region.

2. Literature review:

a. The definition of vegetarianism: conceptualizations and interpretations.

Generally, a vegetarian is defined as someone who follows a diet free from red meat, poultry, and fish (Ruby, 2002). However, there is no accepted single definition of vegetarianism and, in practice, there are many interpretations and different ways of ‘being vegetarian’ (*ibidem*). In fact, the term ‘vegetarian’ has stirred confusion among the scientific community (Weinsier, 2000) due to its imprecise conceptual nature. For example, if someone declares themselves as vegetarians, but occasionally eat chicken, should they be considered a vegetarian? To decipher the origin of the misconception,

there are two important concepts that need to be further explained: I. dietary pattern and II. identity.

I. Dietary pattern: 'I have a plant-based diet'

Using the term vegetarian as a single way to describe one's dietary habits is a common notion among nutritional academic research (Weinsier, 2000) and the general public. Vegetarianism is, nevertheless, an umbrella term that encompasses a variety of diet types that reject meat and animal products at different levels. Beardsworth and Keil (1992) define vegetarianism as a "*continuum of categories, measuring the progressive degree to which animal foods are avoided*" (Ruby, 2002, p. 142). In that sense, the scientific literature, aiming to specify the different forms of vegetarianism, use other qualifying terms, such as pescovegetarian and ovolactovegetarian (Weinsier, 2000). Due to its imprecise nature and non-nutritional connotations, Weinsier (2000), then, recommends nutritional researchers to avoid using the term 'vegetarian'. He then suggests the use of the term 'plant-based' diets when referring to the eating pattern based on the increase of plant foods and the decrease of animal derivatives. The term 'plant-based', concurrently, has been adopted by the market as a way to describe animal-free foods and diets, gaining *momentum* in the media and society recently (Ramanathan, 2019).

II. Identity: 'I am vegetarian'

Even though a great part of the academical research is focused on the diet *per se*, it is important to understand that vegetarianism goes far beyond individual dietary choices: it is embedded with beliefs, values and *an organizational structure and an ideology that looked very much like a social movement* (Maurer, 2002, pg 12). In fact, vegetarianism is, most of the times, part of personal and social identity, playing a significant role in people's daily lives and sociability (Ruby, 2002; Rosenfeld, 2018). Rosenfeld and Burrow (2018) suggest that vegetarianism is part of a bigger "dietarian identity" that describes the way people relate and identify with food. Notwithstanding, vegetarianism surpass a simple dietary choice, it is a complex concept *per se*, since it is part of a set of beliefs, personal identities, and social interactions.

Even though identity and dietary pattern many times converge, evidence suggests that these are different constructs that can differ in practice (Rosenfeld & Burrow, 2018; Ruby, 2002). From this perspective, people that consider themselves vegetarians can occasionally have 'non-vegetarian' diets and vice-versa. For example, one study discovered that *among women physicians in the United States: although 8% of participants identified themselves as vegetarian, only 5% reported having eaten no meat, poultry, or fish in the week before the survey* (Ruby, 2002, p.142). Indeed, this inconsistency can be found in many studies among vegetarians across the literature (Ruby, 2002) and obligates the researcher to be careful when delimiting the respective vegetarian sample.

b. Studying vegetarians: common themes and influencing factors

Most of the current published studies either focus on identifying the health impact of a vegetarian diet (Fraser *et al*, 2014; Dagnelie, 2003; Löwik *et al*, 1990) or in understanding the motivations and attitudes towards vegetarianism (Mullee *et al*, 2017; Radnitz *et al*, 2015; Rosenfeld, 2018). Regarding health, the studies identify that vegetarians have lower BMI and lower levels of cholesterol (Key *et al*, 2006; Fraser *et al*, 2014), lower odds of developing diabetes, hypertension, and obesity (Fraser *et al*, 2014), and lower mortality from ischaemic heart disease risks (Dagnelie, 2003, Löwik *et al*, 1990). Concerning motivation, even though, animal rights are the most traditional motivation for vegetarianism, other motivations have recently gained strength, such as Health, Environmental protection, and Spirituality (Radnitz *et al*, 2015; Mullee *et al*, 2017).

Furthermore, there is also some significant research about the factors that influence the adoption and adherence to vegetarianism. First of all, conscious factors linked to the informed decision on becoming vegetarian may have an influence, such as the strength and type of motivation/beliefs. Rosenfeld (2018) stated that *becoming vegetarian* may be predominantly about beliefs regarding food; whilst Radnitz discovered that, when compared to general vegans motivated by health, 'ethical vegans' *have adhered to* a plant-based diet for a longer time (2015). Secondly, other external factors different from the decision itself may have a role in influencing the predisposition of someone becoming or enduring on vegetarianism. Jabs and Colleagues (1998) stated

that 3 main factors were determinant to maintaining vegetarianism: I. **personal factors**, II. **social networks**, and III. **environmental resources**.

I. Personal factors

Individuals factors related to the individual's internal values and personalities, such as its demographic characteristics (gender, race, age, etc.) seem to increase the likelihood of being vegetarian. Regarding values, studies suggest that high scores in altruistic values increased the notion that vegetarianism is beneficial to health, the environment and animals (Kalof *et al*, 1999; Dietz *et al*, 2010). Furthermore, evidence suggests that there is a link between vegetarianism and political orientation, which in general, vegetarianism tended to be negatively associated with right-wing ideologies and conservatism (Allen *et al*, 2000; Neumark *et al*, 1997). Additionally, being more attached to traditionalist values decreased the perception that vegetarianism is beneficial (*ibidem*) and vegetarians were also less likely to endorse hierarchical domination and placed more importance on emotional states than non-vegetarians (Allen *et al*, 2000). Some studies also pointed out the influence of personality on vegetarianism, and more specifically the Big Five (also known as the OCEAN model) personality traits in it (Pfeiler & Eglof, 2018). The Big Five is one of the most influential models for describing personality and it characterizes individuals into 5 general personality traits considering universal patterns of thoughts, feelings, and actions (Keller and Siegrist, 2015). Openness seemed a common trait positively correlated to vegetarianism (Pfeiler & Eglof, 2018; Goldberg & Strycker, 2002), agreeableness and conscientiousness also seem to be in some studies positively correlated to vegetarianism, whilst extraversion and neuroticism show inconsistent association with it (Keller and Siegrist, 2015; Mottus *et al*, 2012; Kessler *et al*, 2016). Regarding the influence of demographics on vegetarianism, Gender, age, and socioeconomic status are the factors that correlate the most in previous research (Pfeiler & Eglof, 2018). Being female, younger and highly educated are factors that are commonly positively correlated to vegetarianism (Pfeiler & Eglof, 2018; Allen *et al*, 2000; Hoek *et al*, 2004). Another interesting line of thought on the influences on vegetarianism is the association between meat and masculinity (Love & Sulikowski, 2018; Browarnik, 2012; Adams, 2016). Meat is generally seen as a symbol of virility and power for men (Love &

Sulikowski, 2018), whilst, vegetarianism is seen as a relatively female trait (Browarnik, 2012). In fact, the association of meat-eating with the male-oriented dominant capitalist culture has been discussed among vegan feminists scholars (Adams, 2016) and highlight vegetarianism as an act of resistance against any forms of exploration of senescent beings (Nibert, 2013).

II. Social Networks

Even though there is not plenty of literature about the social factors that influence vegetarianism, there are some studies regarding the influence of the inner social circle in becoming vegetarian, and the importance of the vegetarian community in the reaffirmation of one's vegetarian identity. The social network of vegetarians can have either a positive or a negative influence on the adoption and endurance of being vegetarian. Freeland and colleagues (1986) observed that vegetarians, generally, had a strong support network system, composed by family and fellow vegetarian friends, which positively reinforced their commitment to vegetarianism. On the other hand, the influence of others in one's vegetarianism may also be a problematic issue faced in daily life, since managing the relationship with family and non-vegetarians can generate social tensions especially in events involving food (Jabs *et al*, 1998). The negative bias and attitudes towards vegetarianism from omnivore acquaintances can also be a challenge for vegetarians in confronting social norms and committing to their beliefs (MacInnis and Hodson, 2017; Merriman & Wilson-Merriman, 2009; Adams, 2016). In that sense, 'labeling' themselves as vegetarians provides a way for them to identify and relate to other vegetarians, building a social network and identity that may aid them in these distressing social situations (Jabs *et al*, 1998). Additionally, being part of a vegetarian movement also plays its part in people's identity. Haenfler and colleagues (2012) conceptualized vegetarianism as a part of the concept of "Lifestyle movements" and, as such, focus on provoking a social change achieved by collective individual actions and based on the construction of a morally cohesive personal identity. In a broader scenario, the 'collective identity' of vegetarianism, reinforced by vegetarian organizations, helps to motivate people to act on their beliefs and to promote the group interests (Maurer, 2002). Thus, the more a person identifies with the

collective identity, the more he/she is bounded by its expectations and the stronger his/her personal vegetarian identity becomes.

III. Environmental resources

There is very little research on the environmental factors that influence vegetarianism, such as the effect of rural and urban characteristics and the dispersion/agglomeration of vegetarians. On one of the few studies, Natrajan & Jacob (2018) focus on vegetarianism in modern India and discover some geographical effects on vegetarianism. First of all, there was little variation between rural and urban settings on vegetarianism, however, mega-cities in India tend to have a much smaller concentration of vegetarians than other urban or rural areas. Also, the study shows that the distribution of vegetarianism in India is extremely unequal: Northern and western Indian states have a high incidence of vegetarians (some with more than 75% of the population), while southern and eastern states have a low incidence of vegetarianism (some with less than 5% of the population). The researchers conclude that, even though caste and religion can partially explain the distribution, intrinsic regional factors may influence vegetarianism in India, such as the agro-ecological availability of foods and cultural politics. Dutch researchers (Hoek *et al*, 2004), on the other hand, discovered a different scenario for vegetarians in the Netherlands: the more urbanized the place of residence was, the more likely the person is to be vegetarian (*ibidem*). This difference might be explained by the different cultural role that vegetarianism occupies in western societies compared to the eastern counterparts: while in the west, vegetarianism is gaining strength on the modern society due to contemporary issues, in India it is attached to traditional and religious values.

Even though there are no studies that highlight the influence of clustered vegetarian establishments on the adoption of vegetarianism, there are some studies that see a correlation between vegetarian venues, agglomeration, and gentrification (Humphreys and Matti, 2018; Glaeser *et al*, 2018). Vegetarian restaurants, in particular, seem to be a highly localized type of venue (Humphreys and Matti, 2018), which means that they tend to agglomerate in a specific region within a city. On the other hand, vegetarian restaurants also tend to hold a correlation with neighborhood demographic change and indicatives of gentrification (Glaeser *et al*, 2018). These indicatives of the spatial dimension of

vegetarianism still have to be further researched, however, it might indicate a bigger spatial influence on vegetarianism.

Regarding the geographical distribution of vegetarianism in Western countries, no significant study was found so far, although, there are some studies regarding the geographical distribution of dietary patterns in general throughout regions (Dekker *et al*, 2018). Therefore, the geographical influence on vegetarianism in Western Society remains unknown.

3. The research methodology: conceptualizing vegetarianism and data analysis

a. Lifelines database and study sample

For this specific study, the Lifelines biobank was chosen as the main database source to gather information about vegetarianism in the Northern part of the Netherlands. The Lifelines is a multi-generational cohort study with over 167.000 participants mostly from the northern parts of the Netherlands (Lifelines.nl, 2019) that intends to be a detailed study of human health and aging processes. The biobank is comprehended by a vast range of personal information about the participants: their medical history, blood tests, nutritional information, physical activity, geocodes, socio-demographic factors, personality and quality of life.

From the 167.000 participants, 152.662 are adults (18+ years old people), in which there is a majority of women (approximately 58%) and adults between 18-65 y.o (140.000). The lifelines sample is generally representative of the population living in the Northern provinces (Dekker *et al*, 2018) and participants were invited to be part of the research through their general practitioner, family indication or via self-register in the Lifelines website. As Lifelines contains detailed information about people's dietary habits, it is a viable source for a study about vegetarianism.

b. The conceptual model: what is the definition of vegetarianism that should be used?

As previously defined (see chapter 2.a), there are two ways to generally define vegetarianism: as a dietary pattern and as an identity. In other words, defining vegetarians as someone who "eats vegetarian" or "identify as vegetarian". These two

definitions may apparently be similar, but they are identified in a quantitative scenario through different criteria. Dietary patterns are most commonly identified in academia through Frequent Food Questionnaires (FFQ), which question participants about the ingestion of specific foods along a period of time (Borges *et al*, 2015). Additionally, there are two clusters of vegetarian diets which are normally investigated through FFQ: either a plant-based diet (or vegan diets) or an ovolactovegetarian diet (Weinsier, 2000). On the other hand, vegetarian identity is normally obtained by self-identification questions inquiring about the dietary identity of the participants (Rosenfeld & Burrow, 2018), even though there are much more sophisticated and precise ways to capture the vegetarian identity, such as the Unified model of vegetarian identity (UMVI) of Rosenfeld & Burrow (*ibidem*).

For this current study, these two definitions correspond to two different sets of questions: The Food Frequency Questionnaire (FFQ) and the self-declared dietary identity question. The FFQ is a self-administered questionnaire comprehending the frequency of ingestion of 111 food items over the last month (4 weeks) (Dekker *et al*, 2018) and the specific amount of each item ingested. Therefore, to delimit the ovolactovegetarian dietary pattern, for instance, is possible to separate the participants that did not ingest meat or fish in the last month, whilst, to delimit the vegan dietary pattern it is possible to cluster participants that did not ingest any animal derivatives in the last month. On the other hand, the self-declared dietary identity question consisted of an inquire of whether the participants follow a specific diet during the last month and if the response was positive, the participant could indicate which type of diet he/she followed (which vegetarian and vegan were alternatives he could choose). As there is no question regarding the specific vegetarian identity of the participant on the dataset, this self-declared question can be used as a proxy for the vegetarian identity, since it expresses the willingness of someone to follow an ovolactovegetarian diet or a vegan diet.

For this study, it was chosen to define vegetarians through a two-folded definition, in which, both identity and dietary pattern are considered on the definition of what a vegetarian is. In that sense, a vegetarian is defined as someone that identifies as a vegetarian and, in fact, eats vegetarian. By “eating vegetarian”, it is considered all participants that did not eat meat, fish or any other animal flesh in the last month (in that

way, ovo-lacto vegetarians and vegans are joined together in the category). In practice, this means that all people who identified as vegetarians (see table 1) are filtered by their dietary pattern in the last month and people that ate some kind of meat in the last month are excluded from the vegetarian group. This results in two different groups: one vegetarian that only includes people that did not eat any kind of meat in their diet the last month and also declares to follow a vegetarian diet and the non-vegetarian that do not identify as vegetarians and/or ate some kind of meat the last month. In numbers, this corresponds to 1.142 that classified as vegetarians (0,92% of the sample) and 122.987 of non-vegetarians (99,08% of the sample)¹.

This vegetarian variable is chosen because the vegetarian group can potentially represent those people with a stronger bond to vegetarianism, since they are connected to vegetarianism through both identity and dietary pattern. Therefore, it is expected to statistically observe with more clarity the effects of the factors on being vegetarian. It is important to notice that throughout this study, the chosen identity & diet vegetarians will be referred simply as vegetarians, since all further analysis is based on this chosen concept of what a vegetarian is.

Table 1: Number/Percentage of participants that self-identify as vegetarians and did not eat animal meat in the last month.

	Total Sample	People that self-identify as vegetarians	People that did not eat any animal flesh last month	People that self-identify as vegetarians and did not eat any animal flesh last month
N	128933	5.810	1.246	1.142
%	100%	4,68%	0,97%	0,92%

¹ The total number of participants in the sample was reduced from 152.662 participants to 128.933 participants due to exclusions of unrealistic caloric intake as it is presented further on the article.

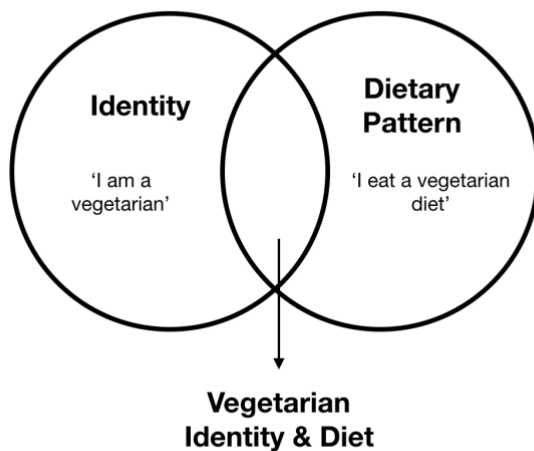


Figure 1: Vegetarian types scheme

c. Statistical analysis

As previously discussed, this research will focus on detailing vegetarian's social and geographical characteristics and mapping the factors that can explain vegetarianism in the Netherlands. In order to accomplish this final goal, 3 main statistical approaches will be applied to the data:

I. Descriptive approach:

In order to briefly describe the main characteristics of vegetarians, descriptive statistics, such as the means and distribution graphs, will be applied in order to better expose data particularities.

II. Inferential approach:

Aiming to make bigger assumptions out of the analyzed data, inferential techniques, such as multivariate logistic regression, will be used. The main goal of the multivariate logistic regression is to understand, at the individual level, which are the personal, social and environmental factors that can influence vegetarianism. This method was chosen because it provides a more comprehensive and integrated view on the

characteristics that are more influential on differentiating vegetarians from non-vegetarians. The criteria of inclusion of the variables is established by considering the influential aspects (personal, social and environmental factors) mapped in the literature review as the main reference (detailed table of variables in Annex). Additionally, there are four variables that need a more detailed explanation of the given transformations and treatment.

II.a. Family ties

As an inter-generational study, Lifelines has detailed information about family members of many participants, such as partner, parents and children. For this study, the dietary patterns of these familiars were checked and a variable was created signaling if they followed a vegetarian diet or not.

II.b. Personality

In order to measure personality traits, Lifelines adopted the NEO-PI method of assessing personality. This method is popularly known as the 'Big Five personality traits', namely measuring the traits: neuroticism, extraversion, conscience, agreeableness, and openness. In the lifelines database, however, there are only elements to test two out of the five big traits (Neuroticism, and Conscience). Even though many authors in Literature reinforce the significance of Openness and Agreeableness to vegetarians, there are not sufficient elements to elaborate a variable of it.

II.c. *Caloric Intake + Nutrients*

Through the food frequency questionnaire (FFQ), participants were able to fill out the frequency of the food they ingested in the last month, indicated in days per week and the number of items consumed each time (Dekker *et al*, 2018). Having this in mind the Lifelines team estimated the daily number of calories and nutrients that each person ingested, having the 2006 Dutch food composition as the reference nutritional table. For this specific study, to correct for errors in food intake in the FFQ questionnaire that may affect the vegetarian dietary pattern results, implausible energy intake values were excluded, such as defined by Dekker and colleagues in their Lifelines study (men <800 or >4200 daily calories and women <600 or >3500 daily calories). This resulted in n= 128.933 participants. The caloric

intake is, therefore, used as a filter variable which can certify that realistic dietary answers are being given (and not as an independent variable).

II.d. *Neighborhood codes*

In order to further elaborate a geographical analysis, the relative proportion of vegetarian per neighborhood was generated. Neighbors with less than 10 participants were excluded from the geographical analysis in order to preserve representativeness and confidentiality. Also, as the geographical analysis is focused mainly on the 3 provinces of the North of the Netherlands (Drenthe, Friesland, and Groningen), participants that lived in other regions were excluded from the geographical analysis². It is important to highlight that these exclusions are considered only on the geographical analysis part, since all participants were considered for the regression analysis. This resulted in a total of N= 1350 neighborhoods. The neighborhood codes were also fundamental on the regression analysis's phase of joining environmental variables obtained in other official statistical databases (that will be further on explained) to the lifelines dataset, such as urbanity levels³, the average income of the neighborhood (Centraal Bureau voor de Statistiek, 2014) and '*partij voor de dieren*' votes per municipality (Verkiezingsuitslagen.nl, 2012).

It is important to notice that due to variables with missing values and database corrections, the number of participants in the sample for the final regression diminished from approximately 152 thousand cases to 100 thousand cases (table 1).

Table 1: Table displaying the evolution of the sample total number due to missing values and database corrections.

	Full sample	Reduced database	Final dependent variable	personal factors							social factors				Environmental factors	
		Exclusion of unrealistic dietary values	Vegetarians (identity + diet)													
processes	Full sample			gender	Age tiers	Education	Relationship status	Living with children	consciousness	partner	father	mother	child	urbanity	Votes for PvdD	Average income (neighborhood)
sample number	152662	128933	124129	124129	124129	123549	123549	123549	111581	111581	111581	111581	111581	111581	101986	99722
sample reductions	0	23729	4804	0	0	580	0	0	11968	0	0	0	0	0	9595	2264

² The Lifelines database is focused on the northern provinces, there were still some participants that lived in other provinces. This may due to the fact that they have moved from the northern provinces or still have a general practitioner based on the region.

³ The adopted urbanity levels are defined by CBS as having address density as the main reference.

III. Geographical approach:

Firstly, with the goal to map how vegetarians spread through space, the percentage of vegetarians was displayed into a map of the northern provinces of the Netherlands, using neighborhood and regional codes (*buurt* and *gemeente* geographical levels more specifically) as the key geographical reference. Secondly, a Global Moran's I test was executed to check if there is evidence for a global spatial auto-correlation. Additionally, a Getis OrdGi* Hotspot Analysis was performed with the aim to determine if there was any spatial clustering logic of vegetarians in the region. Finally, a spatial analysis of the residuals of the logistic regression previously done was performed in order to understand regional variation not explained by the variables in the model (Dekker *et al*, 2017). All the analysis was made using *ArcMap Desktop* 10.5.1.

III.a. Hotspot Analysis & Global Moran's I

A Global Moran's I test is a global parameter for the measurement of spatial autocorrelation (Zhang *et al*, 2008) and useful to first identify if there is a non-random clustering pattern. In the *buurt* level, the Global Moran's Index was highly significant ($p \text{ value} < 0.001$) with a value of 0,086359 and a positive z score (6,547), which means the spatial distribution of high values and low values in the dataset were more spatially clustered than what would be expected if underlying spatial processes were random (Pro.arcgis.com, 2019). Moreover, a Hotspot analysis is a geostatistical technique used to identify these significant non-random patterns in space (Hart & Zandbergen, 2014) by spatially distributing a specific variable in relation to its neighbors. More specifically, each case receives a weighted average considering its initial value and the distance of nearby neighbors (Dekker *et al*, 2017). Therefore, these weighted averages can be interpreted as z scores that represent high concentrations (hotspots) and low concentrations (cold-spots) of a specific variable, which in the case of this study is vegetarians. For the vegetarian Hotspot, the *buurt* level was chosen as the spatial unit in which the tool would be performed because it is the smallest geographical level available and it enables a more specific analysis to be done. In order to optimize the tool, the distance band chosen was determined by firstly performing an incremental spatial autocorrelation tool to understand which was the

peak distance in which there is a spatial autocorrelation. For the *buurt* level, there was a significant autocorrelation at the distance band 9.5 km with an inverse Euclidean distance weighting.

III. b. Spatial analysis of the logistic regression residuals

Calculating the residuals of the results of the logistic regression may be used to understand if there are other explain local specificities or variables that are disregarded from the initial regression. In order to generate this analysis, the neighborhood (*buurt*) means of the residuals were calculated and aggregated by the *buurt* level. Thereupon, the residuals of each neighbourhood were plotted at the map displayed in four different intervals.

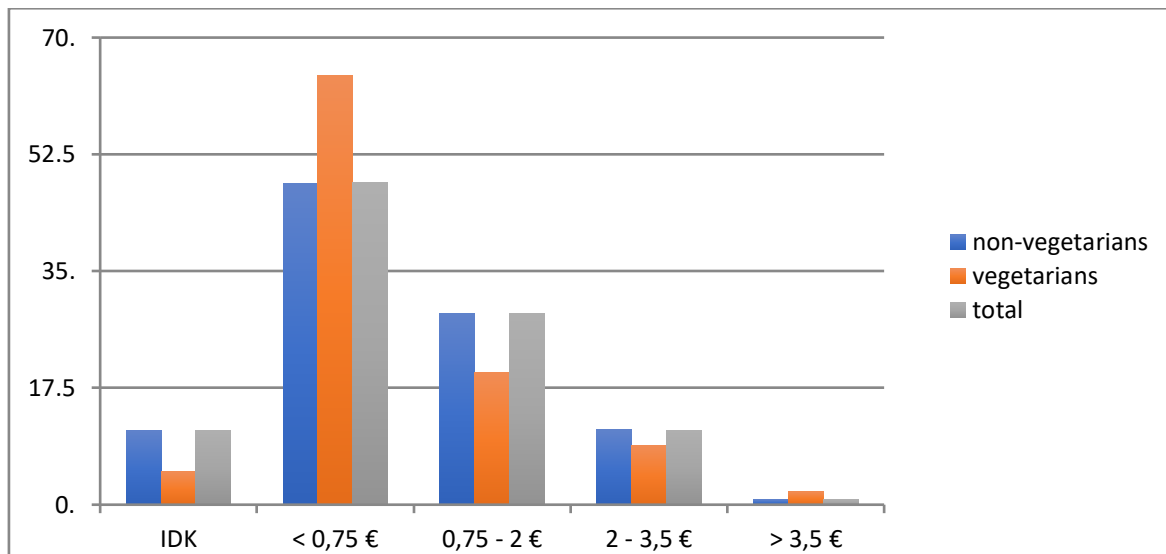
4. Results:

4a. Descriptive statistics: understanding the social demography of the vegetarian type.

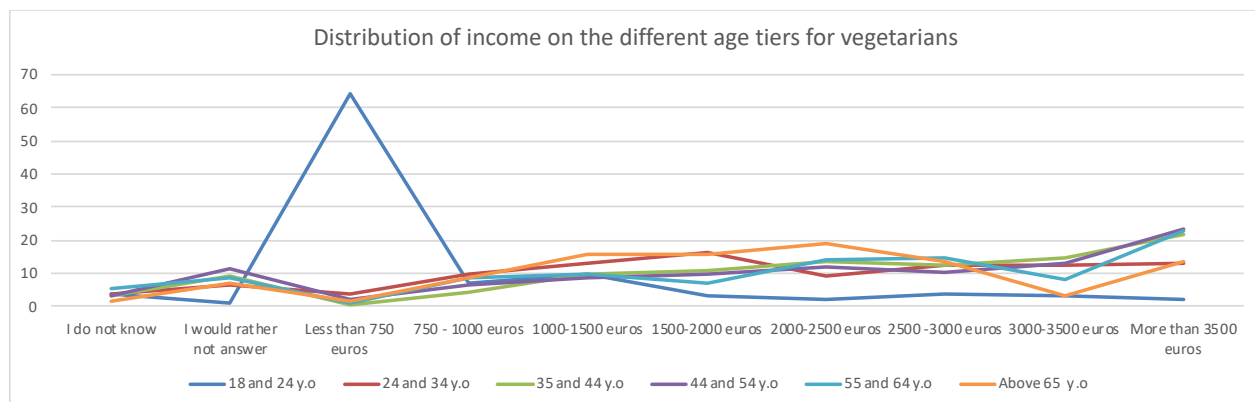
Having a first look in the overall descriptive demographics of vegetarians, it is possible to understand some important characteristics of the sample. The first point is that there are 1.142 vegetarians in the sample, which represent only 0,92% of the sample. This percentage of vegetarians in the study is considerably lower than the estimated results of the latest market research studies for 2014 (RIVM, 2018), but can be attributed to the strict definition of vegetarian adopted and the higher focus of the Lifelines sample in the northern provinces of the country that may have smaller representativeness of vegetarians than other eastern provinces. As an example, from the few participants that are from the provinces of North Holland and Utrecht, the percentage of vegetarians per province is considerably

higher than average, 2,87% and 2,35% respectively. From the provinces of the North, however, Groningen has the higher percentage of vegetarians (1,11%) and Drenthe the lowest (0,77).

When it comes to gender, age, and education, vegetarians are slightly younger, more highly educated and with more presence of females than males. Income, on the other hand, requires a different interpretation. Vegetarians seem to be more present in the two extremes of the monthly income tiers: 25,01% of vegetarians earn less than 1500 euros (significantly higher than the 15,56% of the sample), however, 18,05% of them earn higher than 3500 euros (slightly higher than the sample average of 16,14%). This may be partially due to the fact that the 18-24 age period is higher in vegetarians than in the sample and in this age period, the income is significantly lower than in other life stages (as it can be seen in graph 2). Curiously, younger vegetarians (18-24) seems to have a significantly lower income than younger people in general, however, for other older age groups, this difference seems to diminish. The slightly higher percentage of vegetarians that earn more than 3.5k euros may be due to the fact that they are more highly educated than non-vegetarians.



Graph 1: Distribution of income of vegetarians and non-vegetarians of the 18-24 cohort (x1.000 euros)



Graph 2: Distribution of income of vegetarians across the different age groups.

Regarding behavioral variables, it is possible to observe that vegetarians have higher percentages of same-sex partnership and of people that live in households without children. Additionally, the increased value of missing values/no partner for vegetarians might indicate that a higher percentage of vegetarians are single when compared to non-vegetarians⁴. Concerning the social factors, it is interesting to note that vegetarians in general have proportionally more vegetarian family members (partners, mother, father and children) than non-vegetarians: whilst only 0,53% of non-vegetarians have at least one family member that is vegetarian, 14,36% of vegetarians have a family member that is also vegetarian (table 2). As this variable was created solely considering the family members of the interviewees registered in the research, the amount of missing values is considerably higher.

Table 2: Percentage of vegetarians/non-vegetarians with at least one member of the family that is a vegetarian.

	No member from the family is vegetarian	At least one member of the family is vegetarian	missing values
not vegetarian	36,31%	0,53%	62,87%
vegetarian	13,57%	14,36%	72,07%
sample	36,39%	0,65%	62,95%

⁴ In the questionnaire, people could skip the question if it was non-applicable to their reality. This may suggest that they do not have a partner, however, cautiousness is needed to make this assumption as this variable also aggregates other types of missing values, such as absent answers and non-valid responses.

Finally, vegetarians lived in richer and more densely urban environments than non-vegetarians and are more present in the provinces of North Holland, Utrecht and Groningen than average. It is also interesting to observe that vegetarians lived in neighborhoods in which the *Pvdd* (*Partij voor de Dieren*) had a slightly higher percentage of votes.

Table 3: Descriptive statistics of vegetarians

variable	Sample	vegetarians	non-vegetarians	variable	Sample	vegetarians	non-vegetarians
N	124,129	1142	122987	<u>Personality variables</u>	mean	mean	mean
%	100%	0,92%	99,08%	Conscientiousness index	3,33	3,4	3,33
<u>Gender</u>	%	%	%	<u>Have a vegetarian partner</u>	%	%	%
Man	41,21%	22,85%	41,79%	Yes	0,21%	8,06%	0,13%
Woman	58,79%	77,15%	58,21%	No	36,58%	14,36%	36,78%
<u>Age</u>	%	%	%	Missing or no partner	63,22%	77,58%	63,05%
18-24	6,24%	9,02%	6,33%	<u>Have a vegetarian mother</u>	%	%	%
25-34	16,51%	24,08%	16,58%	Yes	0,11%	3,06%	0,08%
35-44	26,18%	25,57%	26,27%	No	16,60%	18,83%	16,58%
45-54	28,70%	26,01%	28,67%	Missing	83,29%	78,11%	83,34%
55-64	14,48%	10,25%	14,31%	<u>Have a vegetarian father</u>	%	%	%
65+	7,87%	5,08%	7,83%	Yes	0,04%	1,05%	0,03%
<u>Education</u>	%	%	%	No	11,68%	13,05%	11,67%
No education	0,47%	0,00%	0,47%	Missing	88,28%	85,28%	88,31%
Primary education	1,84%	1,14%	1,85%	<u>Have at least one vegetarian child</u>	%	%	%
Lower or preparatory education	13,03%	4,29%	13,12%	Yes	0,33%	3,85%	0,30%
Lower general secondary education	13,51%	8,14%	13,56%	No	19,34%	7,97%	19,44%
Intermediate vocational education	30,38%	18,48%	30,50%	Missing or no child	80,33%	88,18%	80,26%
Higher general secondary education	8,78%	13,75%	8,74%	<u>Urbanity levels of the neighborhood</u>	%	%	%
Higher vocational education	23,59%	35,64%	23,48%	Very strong urbanity	5,52%	14,71%	5,44%
University	6,12%	16,11%	6,03%	Strong urbanity	6,88%	9,46%	6,86%
other education	1,85%	2,10%	1,85%	Moderate urbanity	14,17%	13,92%	14,17%
missing values	0,42%	0,35%	0,42%	Weak urbanity	20,54%	15,41%	20,59%
<u>Income tier</u>	%	%	%	No urbanity	43,86%	32,57%	43,97%
I do not know	3,74%	3,54%	3,70%	Missing values	9,02%	13,92%	8,98%
I would rather not answer this	11,02%	8,23%	10,78%	<u>Mean Votes for Pvdd of the neighborhood</u>	mean	mean	mean
Less than 750 euros	4,15%	7,52%	4,20%	Mean Votes for Pvdd of the neighborhood	4,04%	4,35%	4,04%
750 - 1000 euros	3,08%	6,99%	2,95%	<u>Average annual income per inhabitant of the neighborhood (x1.000 euros)</u>	mean	mean	mean
1000 - 1500 euros	8,33%	10,53%	8,11%	Average income per inhabitant of the neighbourhood (x1.000 euros)	20,76	21,01	20,76
1500 - 2000 euros	12,61%	10,97%	12,55%	<u>Provinces</u>	%	%	%
2000 - 2500 euros	12,58%	11,33%	13,51%	North Holland	0,34%	1,07%	0,32%
2500 - 3000 euros	14,71%	11,50%	14,83%	Flevoland	0,2%	0,39%	0,20%
3000 - 3500 euros	12,65%	11,33%	12,89%	Utrecht	0,19%	0,49%	0,18%
More than 3500 euros	16,14%	18,05%	16,48%	South Holland	0,16%	0,10%	0,15%
<u>Partnership type</u>	%	%	%	Gelderland	0,28%	0,49%	0,27%
Have a straight partnership	85,09%	72,59%	85,21%	Noord Brabant	0,05%	0%	0,05%
Have a same-sex partnership	1,17%	4,47%	1,14%	Zeeland	0,01%	0%	0,01%
Missing or do not have a partner	13,74%	22,94%	13,65%	Limburg	0,01%	0%	0,01%
<u>Live with their offspring (children)</u>	%	%	%	Overijssel	1,16%	1,36%	1,14%
Yes	50,76%	37,04%	50,08%	Drenthe	30,57%	26,53%	30,68%
No	48,85%	62,52%	48,72%	Friesland	37,93%	33,43%	38,02%
missing values	0,39%	0,44%	0,39%	Groningen	29,09%	36,15%	28,96%

4b. Regression results (socio-demographics): personal factors and social networks

In order to analyze the factors that may influence vegetarianism, a multiple logistic regression is performed using the binary variable of being vegetarian as the dependent variable and three main influence factors of are chosen explanatory variables: personal, social and environmental factors. Four models are presented (table 5), each considering the inclusion of different variables: the first one is built only considering gender, age and education; the second one includes other personal factors; the third one considers social and personal factors; and the final and full model aggregates personal, social and environmental factors.

Personal factors

Traditional demographic factors, such as gender, age and education had a significant role in determining vegetarianism for the sample. As predicted by the literature, gender played an important role in the logistic regression. In the full model, for instance, women had almost three times the odds of being vegetarian compared to men ($p < 0,01$). Additionally, the coefficients for education were also significant in most cases: highly educated people had greater odds to be vegetarian than the lower educated. In general, people that attained an university degree had higher odds of being vegetarian than those who attained an intermediate degree ($p < 0,01$), whilst, those having lower or preparatory vocational educational had lower odds of being vegetarian than those that attained an intermediate degree ($p < 0,05$). Regarding age, an interesting effect is observed when the different regression models are compared. In the first model, the younger age tier, between 18-24 years old, had a significantly positive effect in vegetarianism, when compared to the reference category of 35-44 years old ($p < 0,05$). However, when other personal variables were added in the second model (namely, personality and living situation variables), the age tier of 18-24 had a significant negative effect on vegetarianism ($p < 0,10$) and the age tier of 55-64 years old also decreased the odds of being vegetarians ($p < 0,01$), when

compared to the intermediate age range of 35-44 years old. Additionally, as there is a high correlation between the lowest income range and the 18-24 years old age tier, the variable for individual income was excluded from the regression model in order to avoid multicollinearity.

Another meaningful factor for vegetarianism was the family composition and living status of the participants. Having children living in the house, generally, had a negative effect on the odds of being vegetarian ($p < 0,01$). Additionally, having a same-sex partnership increased the odds of being vegetarian generally by 3 times when compared to straight relationships ($p < 0,01$) in all the built models.

Finally, regarding the personality traits tested, it is possible to observe that conscientiousness proved to be a significant factor for vegetarianism, having a negative effect on being vegetarian (the higher the person scored in the conscientiousness, the lower the odds of her being vegetarian). Neuroticism, on the other hand, was left out of the regression model as it had a high correlation with the conscientiousness index. This discrepancy with the available literature may be attributed to the fact that not all five personality traits were included in the regression (because of database limitations) and this may influence on the regression results.

Social factors

One of the biggest influences in differencing vegetarians from omnivorous was the relationship between family ties and vegetarianism. Of all the tested familiar relationships, having a vegetarian partner has proved to be the most determining factor on the correlation with vegetarianism, greatly increasing the odds of being a vegetarian, when compared to non-vegetarian partners ($p < 0,01$). The second most important factor is the maternal influence, since having a vegetarian mother significantly increases the odds of being vegetarian ($p < 0,01$) compared to non-vegetarian mothers. The paternal influence, on the other hand, seems to have a weaker effect than the mother's, but still have a positive effect on vegetarianism ($p < 0,01$). Finally, the positive correlation with vegetarian offspring (children above

18 years old) is not that strong as the mother's but seems higher than the father's ($p < 0,01$).

Environmental factors

Considering environmental factors, urbanity is one of the factors that is most associated with vegetarianism. Mainly, the higher the urbanization of the neighborhood the participant lives, the higher the odds of being vegetarian. As an example in the final model, living on a very strongly urbanized increased the chances by approximately 30% compared to a moderate urbanized neighborhood ($p < 0,05$), whilst living on a non-urban (rural) environment had a negative effect on vegetarianism decreasing the odds by approximately 20% ($p < 0,05$). The average annual income per inhabitant of the neighborhood also had a significant effect on being vegetarian. Mainly for every 1.000 euros of increase in the average annual neighborhood income, the chance of being vegetarian increased by 2% ($p < 0,1$).

Finally, the political orientation of the "gemeente" level may also play a role in being vegetarian. As an example in the final model, the percent of votes that a "gemeente" received for the self-proclaimed vegan party of the Netherlands (partij voor de dieren) significantly increased the odds of being vegetarian. For each percent of votes increase in the *gemeente* level, the chance of being vegetarian increased by 8% ($p < 0,1$). This can be seen as a proxy for the effects of political activism of vegetarian organizations in a city, in that sense, the bigger the activism, the bigger the chances of being vegetarian in the region.

Table 5: Logistic Regression models of vegetarian (as opposed to not being vegetarian) – displayed as odd ratios. Legend of table: * = $p < 0,1$; ** = $p < 0,05$; *** = $p < 0,01$.

Dependent variable (vegetarians) X Independent variables	Model 1: Dependent variable (vegetarians) X gender, age and education	Model 2: Dependent variable (vegetarians) X personal factors	Model 3: Dependent variable (vegetarians) X personal + social factors	Model 4: Dependent variable (vegetarians) X personal + social + environmental factors (full model)
<u>N</u>	123.549	123.549	111.581	99.722
<u>Pseudo R2</u>	0,0472	0,0618	0,131	0,1356
<u>Model significance (chi2)</u>	0,000	0,000	0,000	0,000
<u>Personal factors</u>				
<u>Gender (ref. male)</u>				
Female	2,43*** (2,11 - 2,80)	2,44*** (2,1-2,82)	2,79*** (2,39 - 3,26)	2,91*** (2,45-3,46)
<u>Age tiers (ref. 35 -44 y.o)</u>				
18-24 y.o	1,34** (1,06 - 1,70)	0,77** (0,59 - 0,99)	0,77** (0,59-1,02)	0,79 (0,58-1,08)
24-34 y.o	1,31*** (1,10 - 1,54)	0,97 (0,81-1,16)	0,95 (0,78-1,14)	0,95 (0,77 - 1,17)
45 - 54 y.o	1,02 (0,87 - 1,2)	0,96 (0,82 - 1,14)	0,96 (0,81 - 1,14)	0,94 (0,78-1,14)
55-64 y.o	0,91 (0,73 - 1,14)	0,61*** (0,48 - 0,77)	0,67*** (0,52 - 0,88)	0,70** (0,51 - 0,95)
Above 65	0,92 (0,68 - 1,22)	(empty)	(empty)	(empty)
<u>Education (ref. intermediate education level)</u>				
No education	(empty)	(empty)	(empty)	(empty)
Primary education	1.08 (0,61 - 1,9)	0,92 (0,45 - 1,88)	1 (0,49 - 2,06)	1,18 (0,57-2,43)
Lower or preparatory education	0,62*** (0,45 - 0,85)	0,56*** (0,4 - 0,8)	0,62*** (0,43 - 0,88)	0,65** (0,45 - 0,94)
Lower general secondary education	1 (0,78 - 1,28)	1,01 (0,78 - 1,32)	1,04 (0,8-1,35)	1,11 (0,84 - 1,47)
Higher general secondary education	2,4*** (1,94 - 2,97)	2,3*** (1,85 - 2,87)	2,25*** (1,8-2,81)	1,99*** (1,55 - 2,54)
Higher vocational education	2,52*** (2,13 - 2,98)	2,51*** (2,11 - 2,99)	2,36*** (1,97-2,81)	2,12*** (1,74 - 2,57)
University	4,60*** (3,76 - 5,62)	4,23*** (3,43 - 5,23)	3,75*** (3,04-4,66)	3,2*** (2,5 - 4,09)
other education	1,86*** (1,22 - 2,87)	1,84*** (1,16 - 2,9)	1,72** (1,06 - 2,78)	1,51 (0,87 - 2,6)
missing education	1,47(0,54 - 3,99)	1,23 (0,34 - 4,43)	0,98 (0,24 - 4,05)	1,04 (0,24 - 4,46)
<u>Relationship type (ref. heterosexual partnership)</u>				
Same-sex partnership		3,06*** (2,27 - 4,13)	2,95*** (2,16 - 4,02)	2,98*** (2,1 - 4,21)
missing answer or no partner		1,36*** (1,16 - 1,6)	1,26*** (1,06 - 1,48)	1,22** (1,02 - 1,47)
<u>Live with children (yes is the reference category)</u>				
No		1,95*** (1,68 - 2,3)	1,83*** (1,57 - 2,13)	1,69*** (1,42 - 2)
missing value		2,37* (0,88 -6,4)	1,73 (0,58 - 5,18)	1,79 (0,58 - 5,5)
<u>Personality variables</u>				
Conscientiousness (personality trace)		0,79*** (0,68 - 0,92)	0,84** (0,72 - 0,97)	0,83** (0,7-0,98)

<u>Social factors</u>				
<u>Vegetarian partner (ref. omnivorous partner)</u>				
Yes			144,6*** (102,46 - 204,07)	141,02*** (97,32 - 204,34)
Missing or no partner registered in the sample			1,99*** (1,65 - 2,4)	1,79*** (1,46 - 2,18)
<u>Vegetarian Father (ref. omnivorous father)</u>				
Yes			5,33*** (2,02 - 14,95)	5,53*** (1,85 - 16,52)
Missing or no father registered in the sample			1,28** (1,03 - 1,59)	1,27** (1 - 1,6)
<u>Vegetarian mother (ref. omnivorous mother)</u>				
Yes			22,67*** (13,94 - 36,97)	24,13*** (14,27 - 40,8)
Missing or no mother registered in the sample			1,08 (0,88 - 1,31)	1,07 (0,86 - 1,32)
<u>Vegetarian offspring above 18 y.o (ref. omnivorous child)</u>				
Yes			15,89*** (9,45 - 26,74)	16,94*** (9,73 - 29,46)
Missing or no offspring registered in the sample			1,68*** (1,27 - 2,33)	1,66*** (1,22 - 2,27)
<u>Environmental factors</u>				
<u>Urbanity levels (moderate urbanity as the reference category)</u>				
very strong urbanity				1,35** (1,03 - 1,77)
strong urbanity				1,14 (0,88 - 1,5)
weak urbanity				0,8* (0,63 - 1,01)
no urbanity				0,83* (0,68 - 1,02)
<u>Average annual income per inhabitant of the neighborhood (x1.000 euros)</u>				
				1,02* (1 - 1,04)
<u>Percentual votes for the Party for the animals (Pvdd) in the "gemente" level</u>				
				1,08* (0,99 - 1,17)
constant		0,005	0,001	0,0006

4c. An ecological analysis: The geographical distribution of (identity & diet) vegetarians

Initially, when plotting the percentage of vegetarians on the Northern Netherlands provinces map (figure 2 and 3), it is possible to already observe some important points. The first noticeable point is that the percentage of vegetarians in most of the biggest cities of the North of the Netherlands is significantly higher than in other predominantly rural regions. Specially Groningen *gemeente* has a high concentration of vegetarians (2,2%), followed by Leeuwarden and Meppel *gemeente* which also concentrate a percentage of vegetarians significantly higher than the study's average (0,92%). However, other highly populated cities (even more populous than Meppel), such as Assen and Emmen, did not have significant high values. In fact, the Emmen surroundings, along with eastern Groningen and a great part of Friesland, had very low percentages of vegetarians (from 0% to 0,42%). Another interesting pattern is the difference between the concentration of vegetarians in the surroundings of the two biggest cities in the Northern provinces. Different from Groningen, Leeuwarden seems surrounded by *gemeenten* with lower concentrations of vegetarians, whilst the vegetarian's concentration surrounding Groningen is higher and more dispersed through the province (figure 2). That may be due to cultural food differences between the two provinces or could also indicate a bigger influential role of the city of Groningen in its region.

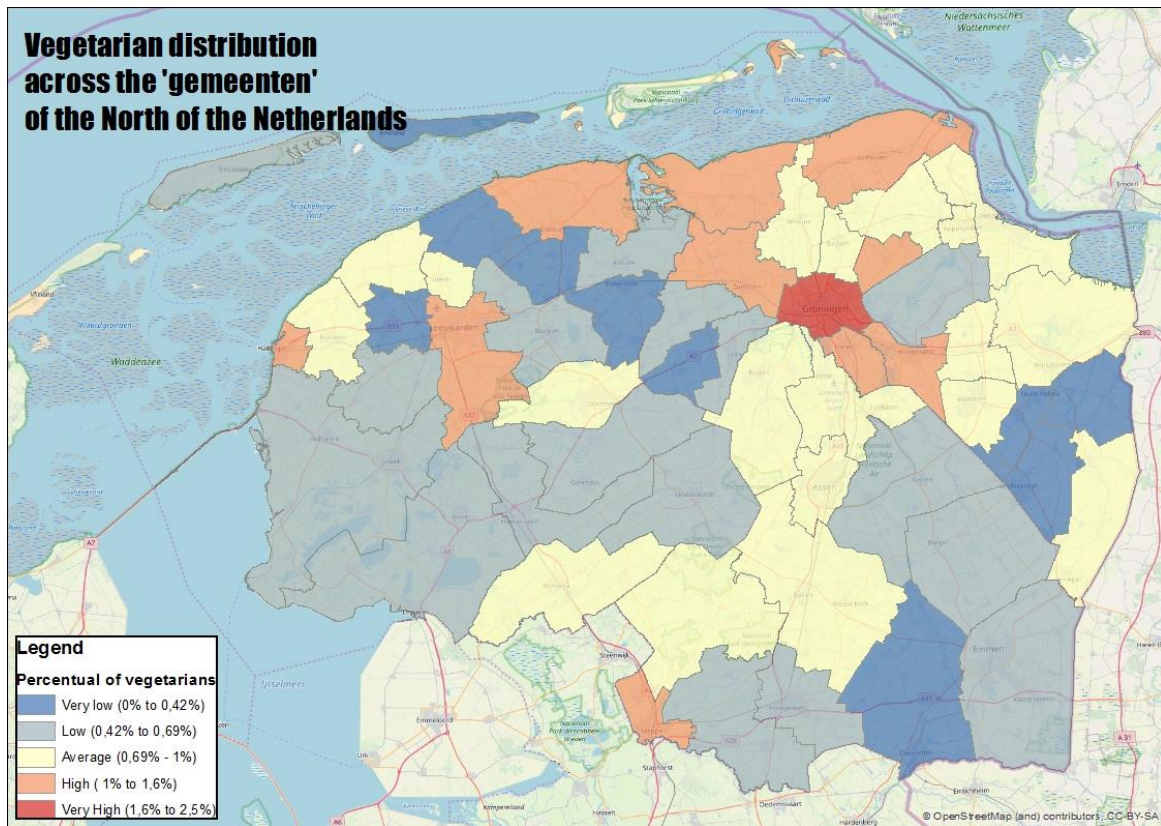


Figure 2: The spatial distribution of the percentage of vegetarians in the *gemeente* level of the Northern Netherlands.

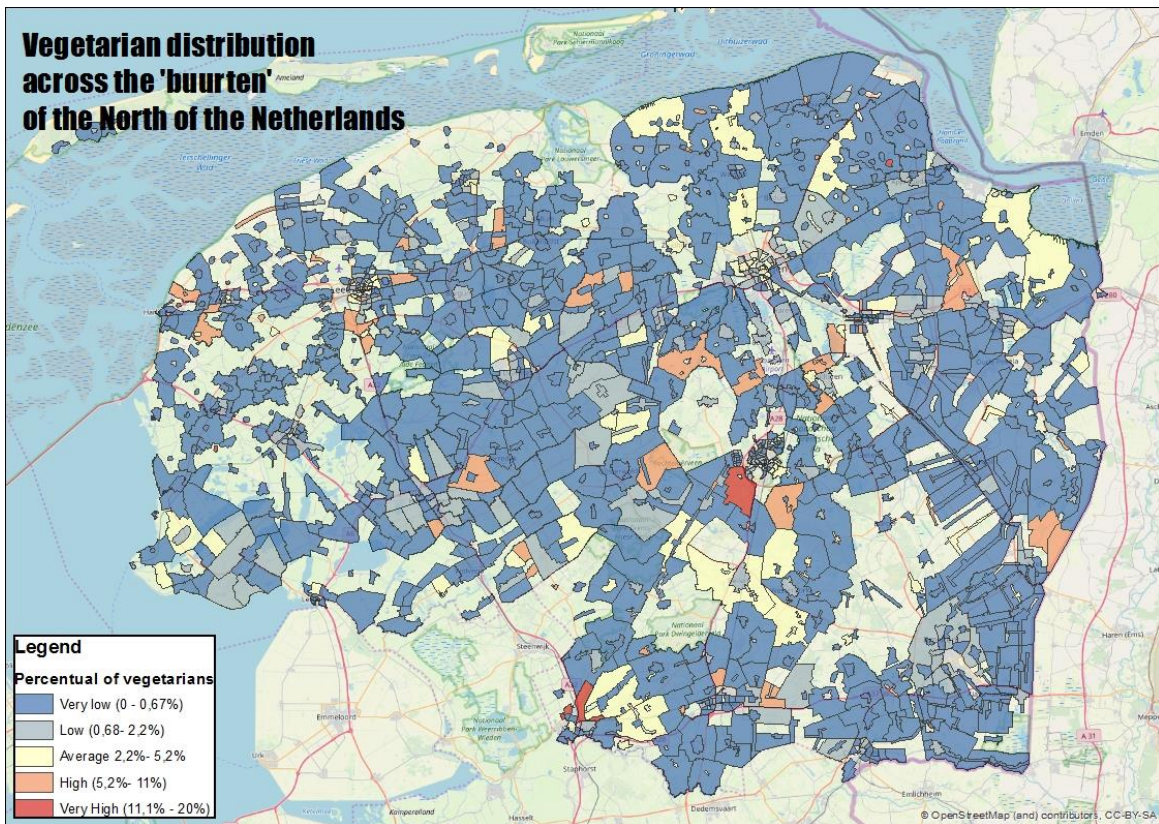


Figure 3: The spatial distribution of the percentage of vegetarians in the *gemeente* level of the Northern Netherlands.

Taking a closer look at the distribution of vegetarianism inside the city of Groningen, it is possible to perceive that the clustering and differentiation happen even within a city. The regions close to the city center and northern neighbors (close to Zernike campus) tend to have a higher concentration of vegetarians than neighbors on the south and on the outskirts of the city (Figure 4). One hypothesis for this phenomenon is that the proximity to university buildings and the city center may have an influence on the concentration of vegetarians in the region - something yet to be further scientifically explored.

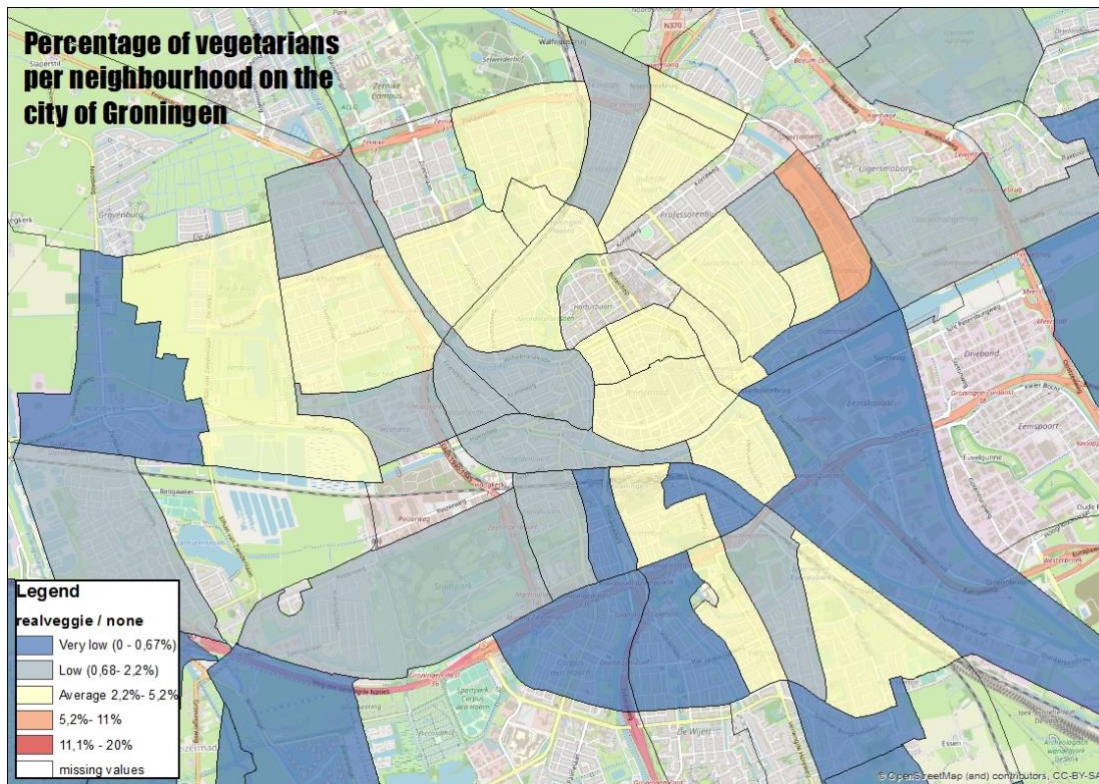


Figure 4: The spatial distribution of the percentage of vegetarians in the *buurt* level around Groningen city.

Regarding the spatial autocorrelation analysis, the first important point is that the distribution of vegetarianism across the northern provinces is not at random, and there is a spatial autocorrelation logic present, as shown in the results Global Moran's I test (better explained in section 3c). As it can be seen in the Hotspot Analysis (figure 5), there are 4 main places where a high/low spatial clustering take place (Hot/cold spots). The first one is the region surrounding the city of Groningen (the biggest city in the northern region), which encompass the biggest and most significant hotspot for vegetarianism in the northern provinces. The second one is in the region surrounding the city of Leeuwarden, which also encompass a significant hotspot area for vegetarianism, but less significant and dispersed than Groningen. The third hotspot is in the surroundings of the city of Assen, which have a more dispersed clustering pattern towards the suburbs of the city. Finally, there is a significant cold spot in the southeast part of Drenthe, near the city of Emmen and extending towards the german border. It is important to state, however, that due to the amount of missing neighbors surrounding some important areas (like

Groningen and Leeuwarden), an interference in the clustering of hotspots may have occurred (exaggerating the dimension of each hotspot). Considering the shown patterns, it is highly likely that vegetarianism in the Northern Netherlands has a strong spatial differentiation between urban scenarios.

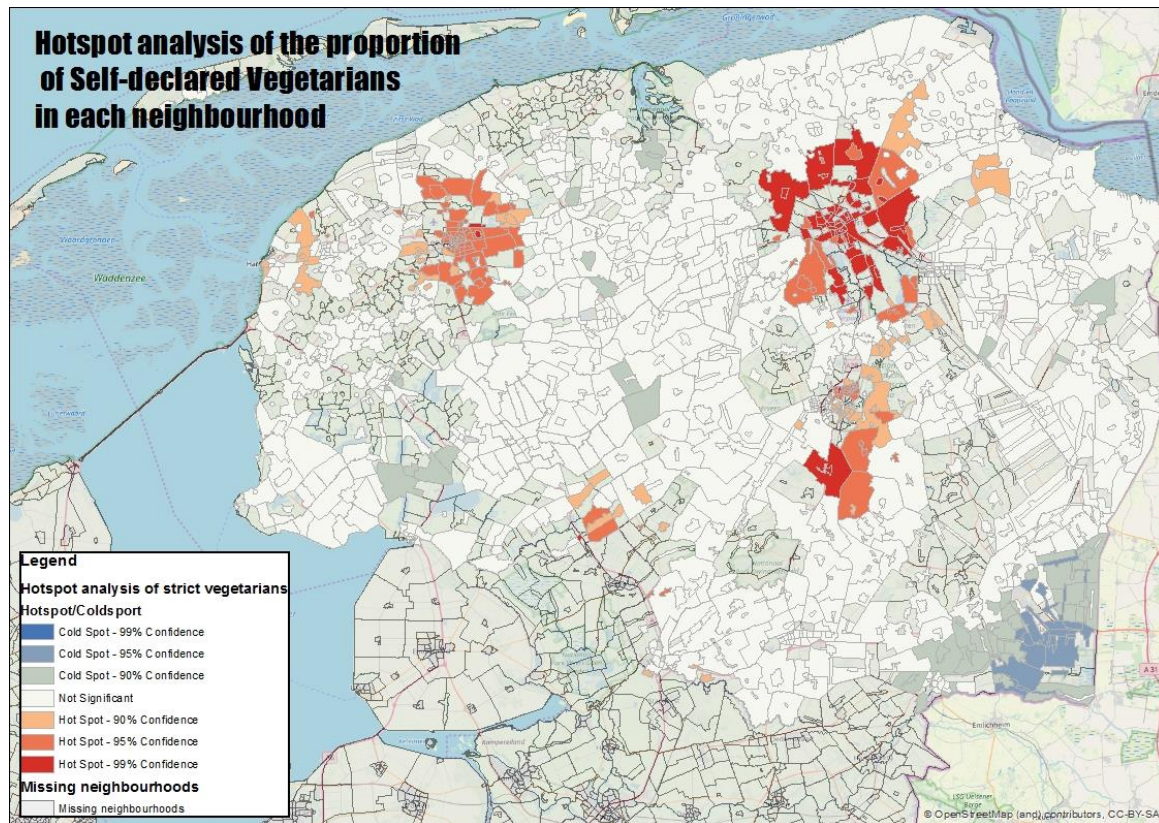


Figure 5: Hotspot analysis of the vegetarian distribution

Finally, considering the geographical distribution of the logistic regression residuals, it is possible to map if there are regional influences that are not being successfully predicted. As it can be seen in Figure 6, most of the areas have residuals of the northern region have a low difference between the observed and predicted values (between -0,1% and 0,1%), however, in the neighborhoods on the proximity of Leeuwarden, Groningen and Meppel the predicted values tend to have a higher difference from the observed values. This higher deviation indicates that there are other unconsidered variables which may have regional influence vegetarianism in these urban areas.

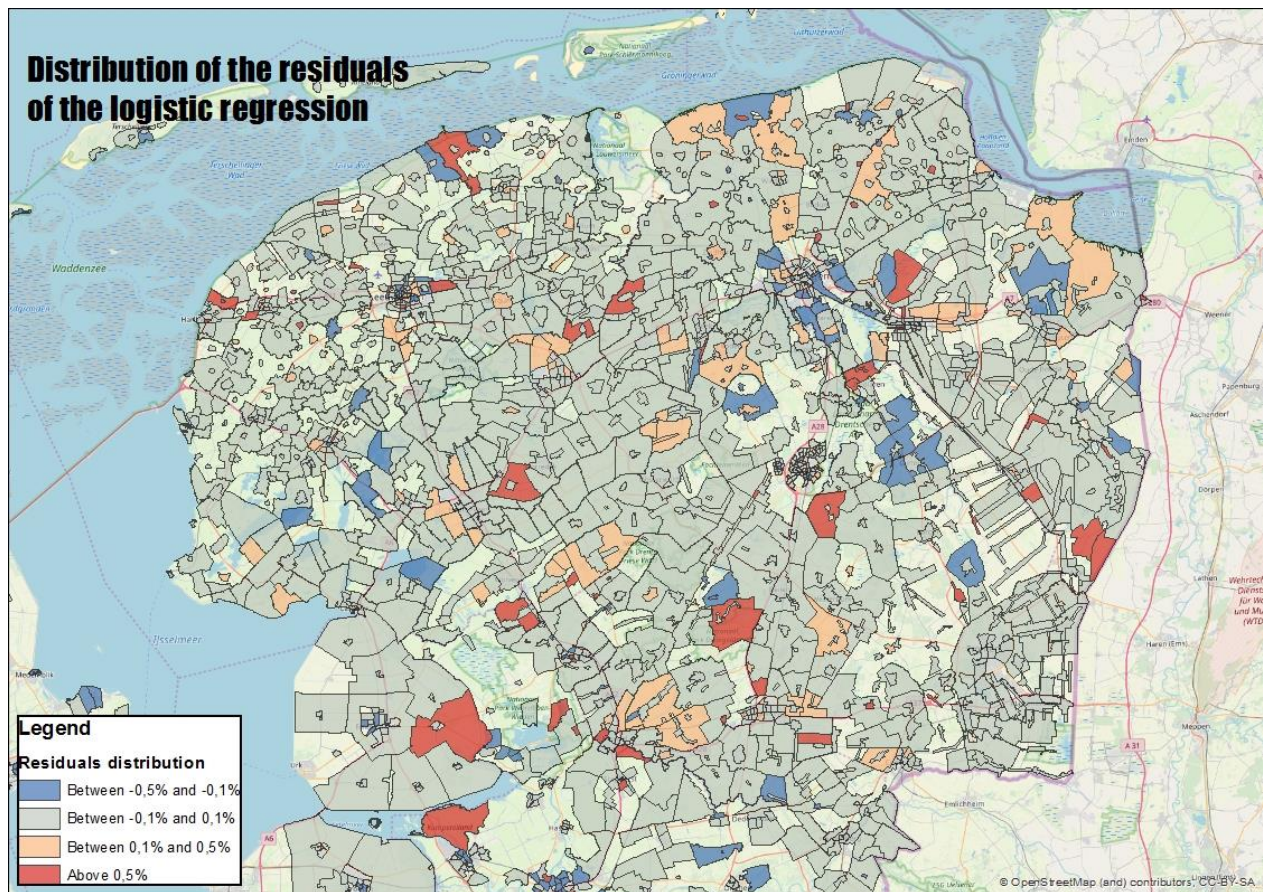


Figure 6: Geographical distribution of the logistic regression residuals.

5. Discussion & Conclusion

Despite the personal motivation to become vegetarian, this research has shown that there are external and internal factors that are associated with being vegetarian. More specifically, there are three main factor types that are correlated with vegetarianism: personal, social and environmental factors. From these three, social factors seem the one most influential, in which the association of the partner and the mother are the strongest factor. The maternal influence in eating may relate to the importance that the mother traditionally has on determining the food inside the house and her role in trying to incorporate new dietary habits in the family (Visser, 2016). It is interesting to see that the biggest association derives from the partner, possibly the person that the participant shares most of the household food with and deeply involved in household decisions. This

may indicate that (physically) closer relationships are more important on the adoption and endurance regarding vegetarianism. Therefore, social capital and more specifically bonding capital (McCann, 2013) may indicate the importance of a strong cohesive group on the practice of vegetarianism. In that sense, stimulating meaningful relationships between vegetarians and their close ones seems to be a useful strategy for disseminating vegetarianism.

Regarding the personal factors, education, gender, and family characteristics seem to be also important. It is interesting to observe that among the traditional demographics, gender and education seems to be the most correlating factors, refuting initially the preconception that vegetarianism might be just a youth-specific trend (Rowland, 2018). Alternatively, the high influence of same-sex partnership and gender may be due to vegetarianism characteristics of resistance against the established social norms and to the meat-male-oriented society. The liberal image vegetarianism has may lead social minorities to be keener on adopting it. It is important to notice that as vegetarianism grows in society, this core personal vegetarian profile might change, as different people adopt vegetarianism and the movement drifts away from a closed niche movement.

Finally, from the mapped environmental factors, urbanity and the average income of citizens are the most associated factors, both positively impacting vegetarianism. The significant impact of environmental factors indicates that geography matters to vegetarianism, having a role in people's adoption and endurance to vegetarianism. In that sense, it is safe to hypothesize that effects of agglomeration/clustering (previously discussed in the literature review) are also beneficial to vegetarians: the denser and richer the place is, the more vegetarians can benefit from clustered services and products targeted for them. The higher vegetarian concentration within the biggest cities may suggest that vegetarians benefit from clustering and agglomeration economies (McCann, 2013), as vegetarians share resources (such as restaurants, organizations and specialized food venues) that are scarce in less urban settings. Another hypothesis that may explain the clustering around cities is Richard Florida's creative class hypothesis (Florida, 2014), in which creative and innovative people tend to cluster in urban centers with a bigger cultural diversity, stimulating entrepreneurship and highly specialized venues. In a multicultural and commercially diverse city, vegetarians can find specialized

establishments to frequent and cultural events to attend. This high vegetarian specialized niche might influence vegetarians to live there and inspire more people to adhere vegetarianism. This hypothesis is reinforced when it is possible to observe that areas which vegetarians are prevalent are spatially correlated between each other and may cluster in some regions, even within cities. The different patterns around Groningen, Leeuwarden, and Emmen indicates that the local dynamics and regional culture have a role in the spread of vegetarianism across other regions. Vegetarian 'deserts' (places with a low spatial concentration of vegetarians) may offer resistance on the adoption of vegetarianism in these regions, since social and environmental factors are important to the overall adoption of vegetarianism.

Even though this research provides insights on influential factors, there are some limitations, which could be further explored in new studies. The first point is the inclusion of other possible influential factors, such as personal political orientation, values regarding nature and animals and the full spectrum of the Big Five personality traits. The absence of the other 3 personality traces in the questionnaire may obliterate the importance that personality has on being vegetarian. The second point is a more specific focus on adoption and persistence on being vegetarian. As this study's dependent variable is a binary vegetarian variable defining if the person is or isn't vegetarian), some important factors may have a different influence when considering a more specific variable such as 'adoption' or 'abandon' of vegetarianism. Understanding the difference between the factors that may lead someone to adopt or abandon vegetarianism might generate useful insights for creating food policies and strategies. A multi-method approach considering qualitative inputs and different quantitative methodologies (such as working with a longitudinal database) can generate even more qualified insights regarding how and why these factors are correlated to vegetarianism. Finally, as this study's time period finishes in 2014, it is fundamental to understand if these factors still play a role in more recent years. As reported by the media, the vegetarian trend intensified in 2013/14 and different factors might have a bigger influence on the latest vegetarian trend.

In conclusion, this study intended to show how vegetarianism is a complex multi-layered subject that is affected by a range of influence spheres, such as social relationships, the environment people live and the different lifestyles and identities. Even

though vegetarianism may structurally differ from other dietary patterns, it may serve as an inspiration for food policymakers and scholars to scientifically approach a dietary pattern in a different manner. In order to generate more effective and engaging policies, it is necessary to consider the different dynamics and factors that could influence a dietary pattern. Representing the distribution of the different dietary patterns in space can serve as a fundamental analytical tool that shows hidden spatial relationships, and not just a visual resource.

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Annex:

Table 1: Description and source of all variables used in the regression analysis.

Variables

Variables	Description	Source
Personal factors		
Gender	Gender of the participant (male/female)	Lifelines database (Baseline assessment)
Age tiers	Age group the participant was part of (calculated from the age declared in the baseline assesment)	Lifelines database (Baseline assessment)
Relationship type	The nature of the relationship the participant had (straight / homosexual). This was calculated based on the information available about the participants partner	Lifelines database (Baseline assessment)
Education	The highest level of education attained by the participant as declared in the lifelines baseline assessment. The missing value for education were added as an alternative.	Lifelines database (Baseline assessment)
Live with children	A variable that determines if the participant still lives with their children in the same household. For this variable the options " my children" and my partner's children were merged. The missing values were added as an alternative.	Lifelines database (Baseline assessment)
Personality variables	A variable created having the wide set of personality questions based on the 'Big Five' conceptual model. The coding of these variables were executed using the Lifelines guidelines.	Lifelines database (Baseline assessment)
Social factors		
Vegetarian partner	A variable that determine for people that have a partner also participating in the research if the partner is also vegetarian (based on the established criteria)	Lifelines database (Baseline assessment)

Variables

Variables	Description	Source
<u>Vegetarian Father</u>	A variable that determine for people that have a father also participating in the research if the father is also vegetarian (based on the established criteria)	Lifelines database (Baseline assessment)
<u>Vegetarian mother</u>	A variable that determine for people that have a mother also participating in the research if the mother is also vegetarian (based on the established criteria)	Lifelines database (Baseline assessment)
<u>Vegetarian offspring above 18 y.o</u>	A variable that determine for people that have children also participating in the research if any of his/her children is also vegetarian (based on the established criteria)	Lifelines database (Baseline assessment)
Environmental factors		
<u>Urbanity levels</u>	The level of urbanity of the neighbourhood the participant lived, as determined by NIDI	2014's CBS's Wijk- en Buurtkaart.
Number of inhabitants on the neighborhood	Number of inhabitants on the neighborhood the participant lived as determined by NIDI	2014's CBS's Wijk- en Buurtkaart.
Average annual income per inhabitant of the neighborhood (x1.000 euros)	The Average annual income per inhabitant of the neighborhood (x1.000 euros) as determined by NIDI	2014's CBS's Wijk- en Buurtkaart.
Percentual votes for the Party for the animals (Pvdd) in the "gemente" level	The percentual votes for the Party for the animals (Pvdd) in the "gemente" level on the House of representatives election of 2012	Kies Raad (election results of the house of representatives in 2012)