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Master Thesis

MSc Population Studies

An exploration of geographical differences in prevalence of obesity: A local perspective on the individual and environmental influences on obesity in the province of Groningen

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Abstract

The growing obesity epidemic asks for a multi-sited approach to understand the underlying factors influencing this phenomenon. Data showed that the percentage of people with obesity within the province of Groningen is relatively high and on the local level, the percentage of people with obesity is highest in the eastern part within the province. Small-scale research could help developing targeted policy implications that could contribute to the health improvement of the population. Furthermore, the inclusion of both compositional and contextual variables in quantitative research adds to existing literature. The objective of this research is to explore and analyse the main underlying compositional and contextual factors that influence the occurrence of obesity in the province of Groningen. This was done by visualizing data gathered through the Health Survey (2016) in the Netherlands with the use of ArcGIS and through logistic and multi-level analyses for both males and females. Outcomes showed that individual characteristics of the population are stronger predictors of obesity than the environmental factors. Age, health-status and socio-economic status are significant for both males and females and are considered as most important. Furthermore, the variation between municipalities was low regarding the environmental variables implicating that, on a local level, the environmental characteristics do not add significantly to the spatial variation. Additionally, the significance and size of the explanatory predictors of obesity differ between males and females. These outcomes confirmed the complex and unique character of studying lifestyle related issues as obesity and asks for the acknowledgement of the complex intrinsic nature of lifestyle related issues regarding policy making.

Keywords: Health, Lifestyle, Obesity, Local, Composition, Context, Groningen

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List of abbreviations

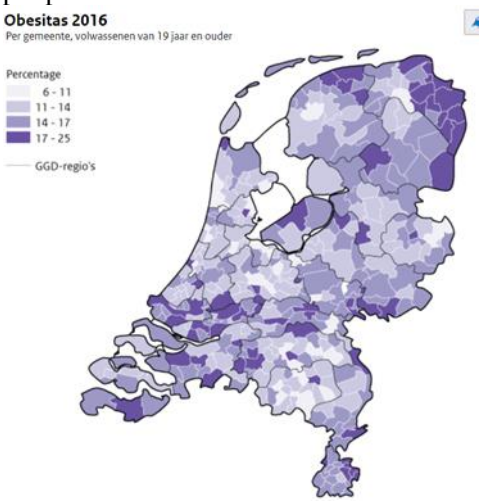
BMI	Body Mass Index
CBS	Central Bureau for the Statistics
GGD	Gemeentelijke Gezondheidsdienst *(Municipal Health Services*)
GIS	Geographic Information System
Havo	Hoger Algemeen Voortgezet Onderwijs *(higher general secondary education)*
HBO	Hoger Beroepsonderwijst *(Higher Vocational Education)*
LBO	Lager Beroepsonderwijs (*low vocational education*)
Mavo	Middelbaar Algemeen Voortgezet Onderwijs (*lower general secondary education)*
MBO	Middelbaar Beroepsonderwijs *(intermediate vocational education)*
NCD	Non-Communicable Diseases
RIVM	Rijksinstituut voor Volksgezondheid en Milieu *(Netherlands National Institute for Public Health and the Environment)*
SES	Socio-economic Status
VWO	Voortgezet Wetenschappelijk Onderwijs *(Pre-University Education)*
WO	Wetenschappelijk Onderwijs *(University-level Programme)*

1. Introduction

1.1 Societal relevance

Obesity has reached epidemic proportions globally, with at least 2.8 million people dying each year as a result of being overweight or obese (World Health Organization, 2017). Worldwide, the number of people with obesity has nearly tripled since 1975 and Europe is currently, with 15.9%, the region with the second-highest obesity prevalence (Eurostat, 2016). In the Netherlands, in 1990 around five percent of the adult population was considered obese and in 2017 this number had increased to nearly fifteen percent which is almost as high as the average within Europe (Volksgezondheidszorg, 2017). In the rapport concerning the outcomes of the health survey conducted by the municipal health services (GGD), the Central Bureau for Statistics Netherlands (CBS) and the RIVM, the regional differences between prevalence of overweight and obesity are quite visible and existent (GGD Groningen, 2016). Furthermore, when comparing the province of Groningen to the Netherlands as a whole, there seems to be a high percentage of people with obesity in the north-eastern part of the country (Figure 1.1). This difference between the north-eastern part and the other areas within the province is often made when referring to geographical health differences within Groningen. It is expected that the causes of this high occurrence of obesity and generally worse health status are rooted in the context of ageing, lack of needs to realise a healthy lifestyle and relatively low socio-economic status compared to the other parts of the province (Castelijns & Kalverboer, 2009). However, scientific research has not yet been done towards these factors in this region and on, generally, the health differences on such a local level. Therefore, to gain a more scientific insight concerning the factors that influence this difference in prevalence of overweight and obesity within the Province of Groningen could help policy makers to develop targeted policy implications that could contribute to the health improvement of the population living in the area. Furthermore, this local focus is desired since decentralization of social policy from the national government to local governments has taken place and more information and indicators of health on a local level is needed (Volksgezondheidszorg, 2019). Therefore, this research will focus on overweight and obesity and factors that could play a role in influencing the regional differences within the province of Groningen.

Figure 1.1: Obesity prevalence of adult people in the Netherlands 2016



Source: GGD, CBS & RIVM, Gezondheidsmonitor Volwassenen en Ouderen,

1.2 Academic relevance

Previous research concerning the geographical differences in obesity prevalence focussed mainly on the differences on large-scale areas as the European region (Vidra, 2019) or on predictors of obesity within one specific area (Putrik et al. 2015). Furthermore, qualitative research has been conducted by Sanne Visser (2016) in the north-eastern part of the Province of Groningen which focussed mainly on the cultural background of the people living in the area concerning their nutritional habits and the relation to overweight and obesity. Unknown however remains what the most influential factors are that could explain regional differences on the local scale and which individual, or environmental characteristics are the most important predictors of obesity when performing quantitative research. In this research, a specific region on a relatively small geographical scale will be the focus of analysis. This local approach could help to identify what the main implications of obesity are when looking at regions within a small area instead of comparing nations which often already have multiple differences regarding culture and landscape characteristics. This study of individual and additional environmental

factors influencing the prevalence of overweight and obesity on a local, regional, scale, could fill the gap between large-scale theories and small-scale practice.

1.3 Research objective

The objective of this research is to explore and analyse which compositional and contextual factors are most important regarding the influence on the prevalence of obesity and could explain the geographical differences on a local scale. In this study, the focus will be on data on the individual and environmental factors that could explain the relatively high differences in prevalence of obesity within the province of Groningen.

1.4 Research questions

To elaborate upon the research objective, three research questions are carried out focussing on both individual and environmental characteristics:

1. What is the current regional pattern of obesity occurrence within the province of Groningen?
2. Which individual characteristics of the population are most influential regarding the geographical differences in prevalence of obesity?
3. Which environmental characteristics contribute to the geographical differences in prevalence of obesity?

1.5 Structure of the thesis

After the introduction, in the second chapter the relevant theories related to health differences and obesity prevalence are discussed. Furthermore, previous literature regarding the influences on obesity, regional differences in Europe and regional differences within Groningen are elaborated upon. Based on these theories and literature a conceptual model and hypotheses are formulated. In the third chapter, the data is, and methods used in this research are discussed in relation to ethical issues and the setting. The fourth chapter presents the results of the analyses which will be discussed in chapter five. In this last chapter of the thesis, the results are related to the literature and theories discussed in chapter two, the data is evaluated, and policy recommendations are made.

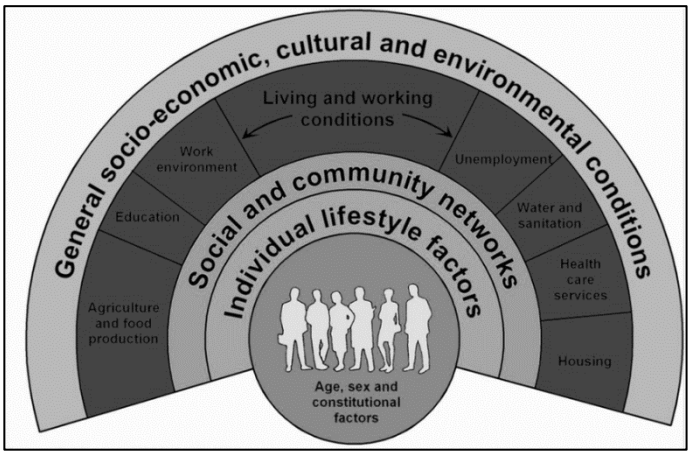
2. Theoretical Framework

2.1 Relevant theories

2.1.1 Individual and environmental determinants of health

The basis for this research is situated in the relationship between health and place. Specifically, the relationship between obesity prevalence in relation to the characteristics of individuals who live in places with, in return, their own characteristics. The characteristics of the individuals could be referred to as compositional whereas the characteristics of the environment could be considered contextual factors (Collins et al. 2017). A theory regarding the influences related to this relationship between individuals, places and health-outcomes is supported by the main determinants of health scheme as illustrated by Dahlgren & Whitehead in 1991 (figure 2.1). It is a scheme in which the main influencers on health are illustrated as a set of layers on top of each other. These layers represent different factors on different levels that could influence health. These determinants could also be categorized based upon contextual or compositional characteristics. Age, sex and constitutional factors relate to demographic, compositional characteristics and the lifestyle factors, social networks and factors related to an individual's socio-economic status are the less fixed compositional characteristics. The environmental conditions mentioned in the model, as mentioned in the outer layer, refer to characteristics of a place, the contextual factors. This division between compositional and contextual factors is important since they ask for different policy implications and research strategies. Compositional approaches focus on the influence of the individual's personal characteristics on her/his health status whereas contextual approaches stress the influence of the social (including local) context (Jen et. al., 2009). Therefore, factors as age, gender, individual socio-economic status, physical activity and education could be labelled as 'compositional' and factors as neighbourhood socio-economic status, social networks, housing and health care services availability could be labelled as contextual.

Figure 2.1: Model of the determinants of Health



Source: Dahlgren and Whitehead (1991)

2.1.2 Interaction between individual and environment: The theory of structuration

To study the differences between areas regarding health issues, the structuration theory as proposed by the sociologist Anthony Giddens (1984) could provide a theoretical basis and support for the need to take both individuals and contexts into account when studying issues related to social phenomena. Giddens proposes a dialectical approach towards geographical patterns in health between the structure of an area and the agency within that area and supports the argument that individual agency interacts with the social and economic structure of the 'locale' in his theory of structuration. This theory of structuration emphasizes the importance of the interaction between individuals with their specific characteristics and their socio-geographical context (Curtis, 2004). According to Giddens, this theory argues that: 'in the social sciences, all explanations will involve at least implicit reference to both the purposive, reasoning behaviour of agents [individuals] and to its intersection with constraining and enabling features of the social and material contexts of that behaviour' (Giddens, 1984 p.179). In the context of this research, some environmental, neighbourhood-level characteristics could influence the prevalence of obesity over residents' behaviour, but it is through the practice of the residents that a structure exists, making the relationship between environment and individuals a complex one.

Furthermore, the activities of individuals are performed by individuals on a local, small scale within a small-time framework of on a larger scale in a larger time framework, the lifecycle. Therefore, we could not disconnect the individual from the context in which he or she lives in and we should include both the compositional and contextual factors when doing research to social phenomena, especially when including the aspect of geography. Furthermore, time-space distinction partly exists through allocative, natural environment resources and technologies and goods that are produced and authoritative sources which include the administrative structures, human mutual associations and the organization of life chances and opportunities (Curtis, 2004). How these allocative and authoritative resources are ordered constrain or enable life paths of individuals. The nation states are the 'power containers' in which this ordering takes place, and where the ordering of the resources between different social classes and groups are situated. Furthermore, these area factors of health inequality may operate at different scales. Therefore, the probability that a factor has an effect on a health-related issue, as obesity, can also depend on whether the area-effects differs enough to have a significant influence on the spatial variation.

2.1.3 Geographical inequalities: composition and context

Health inequality is prevalent when the chances of having a bad or good health are not evenly distributed among groups of people (Shaw et al., 2002). However, variations in health-statuses within populations do not necessarily represent inequalities. This is only the case when those variations are patterned by specific characteristics of the population (McCarthy, Collins & Mackenzie, 2013). In health-studies, the division between compositional and contextual effects is most often used to explain observed differences in health between places. These compositional and contextual differences refer, respectively, to the kinds of people that live in a place or to the different characteristics of these places (Macyntire & Ellaway, 2003). Compositional variables are defined as those relating to the socio-demographic characteristics of individuals living in a certain place, such as age, sex, ethnicity, employment status, and income (Collins et al, 2017).

Geographical differences in health could also be partly explained by characteristics of the social and built environment. These contextual characteristics refer to indicators on the area level such as the services available, whether the area is considered rural or urban, environmental pollution, sport facilities and less tangible features as social cohesion or crime (Shaw et al. 2002). In the developed world, spatial variation in health at different geographical scales is often related to income inequalities between areas. Added to this, the relative situation, e.g. the deprivation of surrounding areas, may also have an additional effect on a person's health (Boyle et al. 2004). Karvonen and Rimpelä (1996) named three channels through which the socio-regional context can influence health behaviours. These 'channels' refer to the way in which the contextual characteristics might influence the health differences of a population:

1. The diffusion effect: The diffusion effect implies that a health behaviour, for example an unhealthy diet, diffuses among population through social exchange. In this case, context refers to a societal process.
2. Global effect: The global effect takes place when characteristics of the socio-regional context might influence the whole population. These characteristics could be norms of a community, shared knowledge etc.
3. Subcultural effect: A subcultural effects is prevalent in a situation when an individual's behaviour is shaped by a subculture of the context. E.g. in a school/work environment. In other words, if the social patterning of health behaviours is determined by socio-regional context a subcultural effect is observed.

Assumed is, when composition explains the geographical variation in an entirely correct manner, there are no effects of the environment in which a person lives over their individual characteristics. Then we will be able to predict and explain area differences with the knowledge of the population characteristics in that area (Shaw et al. 2002). However, it is not that straightforward. There is an

ongoing debate in modelling relationships between health and other area variables related to compositional and contextual variables. According to Boyle et al (2004), the general approach is to take account of the socio-economic characteristics of the population first before drawing conclusions about contextual effects.

2.1.4 The obesity epidemic: The nutrition transition

Worldwide, obesity is a growing problem with multiple consequences, negatively, for the individuals as well as for societies. Together with the increase in the number of people with obesity, there has been a change in the way the world's population shops and eats. Whereas most of the populations in the period around WWII consumed much of their diet in home-cooked forms, with lots of vegetables and animal source foods, now it seems that the task of cooking has vanished from households and fresh foods towards the consumption of packaged and processed foods (Popkin, 2017). Popkin mentions that the world faces more obesity and diet-related noncommunicable diseases (NCDs) than in the past and currently, most countries face higher mortality from those NCDs than from undernutrition and infectious diseases. The different stages a population experiences considering the access to food is what Popkin calls the 'Nutrition transition'. It can be thought of as the different stages that a population will go through as their access to food evolves from the hunter gatherer (life)style foods through to health-conscious pre-packaged meals (Popkin, 2018). The first stage is characterized by the collection of food sources that are high in carbohydrates and fibres and hunted by the population. The stage requires an active lifestyle and obesity is rare, because food is difficult to come by. The stage followed by the hunter-gatherer stage is 'famine'. The number of food sources are drastically reduced and unequal access to food often leads to an increase in inequality regarding social status. As a reaction, societies develop and organise, they are able to plan and control food, which leads to the third stage of the nutrition transition. In this stage, there is a lot of food available and modern technology is linked with the easier lifestyle and increased interest in leisure activities related to the desire to lounge (Popkin, 2018). The last stage, in which the obesity epidemic is rising, is characterized by reduced activity at work and increased nutrition-related noncommunicable diseases. The population has easy access to unhealthy foods and at the same time they transition to a sedentary lifestyle. The obesity epidemic is caused by the transition into this last stage and the NCDs are associated with it.

2.2 Previous studies on obesity and regional differences

2.2.1 Literature on influences obesity

Multiple studies have been conducted to explore the influences of different factors on obesity prevalence. However, explanations for the emerging epidemic as well as its socio-spatial distribution have proven more elusive (Witten & Pearce, 2007). Whereas some researches focus mainly on compositional factors as age and gender, others do focus on neighbourhood characteristics as the availability of health-care services and sports-facilities. Harrington and Elliot (2009) stress the importance of taking into account neighbourhood characteristics when doing research towards the influences of obesity. They conducted single- and multilevel analyses in Canada where they sought to determine the relative contributions of individual- and area level factors to the development of overweight and obesity. The outcomes showed that variation in BMI is influenced by both characteristics of neighbourhoods and characteristics of the people within the neighbourhood. Most of the variation in the outcomes was due to individual-level, compositional, differences rather than differences between neighbourhoods. But it should be mentioned that there were significant differences concerning adult BMI between neighbourhoods, which supports other studies that suggest that individual level factors alone cannot explain variation in obesity prevalence across space (Harrington & Elliot, 2009). Area-level variables they used were the neighbourhood income as a proxy for neighbourhood socio-economic deprivation, percentage of people living in a rental home as a proxy for neighbourhood socio-cultural environment and rural areas as a proxy for the physical environment of a neighbourhood.

Other studies show that the socio-economic status on the individual level has a substantial influence on the probability of getting obesity, but this differs between sub-groups of the population with specific individual characteristics. Research conducted in the United States by Robert and Reither (2004) found that black women have, on average, a BMI-score that is three points higher than non-black women after controlling for socio-economic status. However, this did not account for men. They propose that, because their evidence for women suggest that determinants of obesity are multiple and multilevel, the research towards the topic also requires a multi-faceted approach. Another study that reports that there are differences between males and females, is the research conducted by Bell et. al. (2014). They focussed on the gender specific associations of objective and perceived neighbourhood characteristics with BMI and found that there were significant differences between males and females. Among women, greater objective neighbourhood deprivation was independently associated with higher BMI after 2 years. They suggested that public efforts to reduce obesity among community-dwelling older women may benefit most from addressing objective residential characteristics, over and above subjective perceptions. Additionally, related to health-status, research shows that the social determinants of health might have different effects for males and females. Moreover, ways in which age and the social determinants contribute to the poorer health status of women compared with men varies between groups of countries (Hosseinpoor et al., 2012). Curtis (2004) mentions that gender differences in health, associated with the socially constructed roles and social positions occupied by men and women, should be distinguished from sex differences due to biological differences.

A study that focusses on health differences on the local, municipal level, is the cross-sectional study in the Dutch municipality 'Maastricht' (Putrik et al., 2015). They explored whether overweight and obesity were associated with the physical and social environment at neighbourhood level by using multinomial regressions. Their main reason for focussing on neighbourhood instead of individual characteristics was that 'while many interventions have been developed to address obesity at an individual level, these are not able to control the emerging obesity pandemic. In a view of this growing consensus, it has been suggested that approaches that target community (as opposed to individual) risk factors could add to traditional individual-based obesity interventions.' (Putrik et al., 2015, P.1039). They assumed that selection would mostly occur among age, which is, according to Apostolopoulou et al. (2012), because of the fact that the amount of physical activity decreases with age and therefore the BMI will rise. Putrik et al. (2015) investigated the difference between different age-groups in relation to the outcome variable 'BMI'. BMI was classified into normal weight ($18.5 \geq BMI < 25$), overweight ($25 \geq BMI < 30$), and obese ($BMI \geq 30$). The main conclusion that was drawn from this research, was that the effect of neighbourhood characteristics on BMI was most significant and consistent for the older age groups (65+). For the other age groups, the contextual factors did not contribute significantly to the variation in obesity and overweight. In relation to a change in body composition (lean mass and fat), rises the possibility of having a higher BMI with the increase of age. Furthermore, they found that, In the total sample, better quality and availability of daily shopping facilities, reachability of facilities for daily use, and neighbourhood aesthetics were associated with lower prevalence of both overweight and obesity. (Putrik et al., 2015)

In addition, an important factor that has been a frequent topic of research, is the social economic status and the social capital of the people. Social capital has been defined as the features of social organization, including social trust, civic participation and norms of reciprocity that facilitate cooperation for mutual benefit (Kawachi, 1999). Some of these mechanisms may lower the risk of obesity through social control, promotion of access to local services and amenities, and psychosocial processes which provide affective support and mutual respect. According to Kawachi (1999), more social capital would lead to more health benefits and therefore it could be assumed that more social capital would lead to a lower risk of obesity. This is also mentioned by Wilkinson (1996) who explains that the income of an area has a negative relationship with health outcomes as obesity.

Often, studies conducted towards the topic of overweight and obesity focussed on one region and the influences within that region. Furthermore, those influences are mostly not multi-sited and are mainly related to a certain domain of research (Social studies, economic studies, environmental studies

etcetera) even though quite a significant amount of studies mention that obesity is a complex phenomenon that involves a lot of influences. For example, Aronne et al. (2009) mention that the topic of obesity is complicated since the aetiology of it is complex and includes multiple factors as genetic, physiologic, environmental, psychological, social, economic, and even political factors that interact in varying degrees to promote the development of obesity.

2.2.2 Literature regarding regional differences obesity: Europe

Several studies investigated which factors contributed to the differences in prevalence of obesity on the population level within Europe. Vidra (2019) mentioned in her research concerning the obesity epidemic in Europe that there are large differences in obesity prevalence between countries and that these differences can at least partly been explained by individual and contextual factors (Vidra, 2019). Especially factors as socio-economic status and nutritional characteristics seem to be important (Berghofer et al., 2008). Across Europe there are substantial socioeconomic differences that might affect the risk of getting obesity. generally, people with lower socioeconomic status tend to be at higher risk of becoming obese than people with a higher SES which could, according to Vidra, possibly be due to the limited access to health services that these people have, insufficient income to buy healthy foods and limited access to engage in physical activity. However, Vidra mentions that, at the population level, wealthier countries may report having obesity levels similar to those of poorer countries (Vidra, 2019). The reason for this might be in the different cultural values relating to nutritional habits, differences in food availability and alcohol consumption levels (Blundell et al., 2017). Furthermore, in the central, eastern and southern regions within Europe, the obesity prevalence rates are higher than in the western and northern regions. Which could be explained by these differences in socio-economic conditions and lifestyle and nutritional characteristics of these countries. The discussion regarding urbanisation and globalisation of certain lifestyle factors might have a negative impact on the traditional Mediterranean diet (Blundell et al., 2017). In countries that have relatively high differences between rural and urban areas regarding population density and environmental characteristics, the prevalence of obesity is generally higher in rural parts than in urban parts of the country. However, in a small, densely populated country as the Netherlands, urbanization does not seem to have a major impact on the prevalence of obesity (Seidell, 1995). Ethnic affiliation might also play a role in the wide variations in BMI across European populations independent from socio-economic status. Multiple European countries have undergone population changes related to the immigration from eastern Europe as well as from non-European countries (Berghofer et al., 2008). Furthermore, it is mentioned that obesity is a complex issue since it is not only affected by age and period but also by birth cohort, which refers to the specific characteristics of people born in the same period (Reither, Hauser & Yang, 2009). These cohort effects vary substantially by race/gender and educational attainment.

2.2.3 Characteristics of eastern Groningen regarding food choices

Research towards the regional differences in the province of Groningen has been conducted using qualitative methods. In the eastern part of the Province of Groningen, the nutritional status of large parts of the population is poor (Visser, 2016). Furthermore, Castelijns and Kalverboer (2009) argued that high overweight and obesity rates are caused by poor nutritional status, which is in return caused by the relatively low socio-economic status and conditions in the region. This low socio-economic status is generally characterized by low incomes and low educational levels of the population in the area. Additionally, the ethnographic study towards intergenerational perspectives on food practices, overweight and obesity in eastern Groningen conducted by Sanne Visser (2016) shows that different habits and cultural norms and values of the people living in eastern Groningen influence their diet and the risk of getting obesity. Using the capability approach proposed by Sen, the food choices of individual household's members are highlighted related to their views on freedom, opportunities and capabilities to achieve these valuables in the food choice process (Visser, 2016). The participants, living in eastern Groningen mentioned that their financial situation, health situation and family

situation affect these capabilities and opportunities in terms of food choice. Furthermore, there are intergenerational perceptions on food choices and obesity outcomes. Also, the opinions of the population regarding lifestyle interventions as implemented, for example, by governmental organizations is influenced intergenerationally. There is no unidirectional though on healthy food and eating which asks for a multidimensionality in health research and interventions. This is especially needed when these interventions have to take place at local levels as in the eastern part of the province of Groningen since food practices are influenced by local customs and beliefs (Visser, 2016).

2.3 Conceptual model

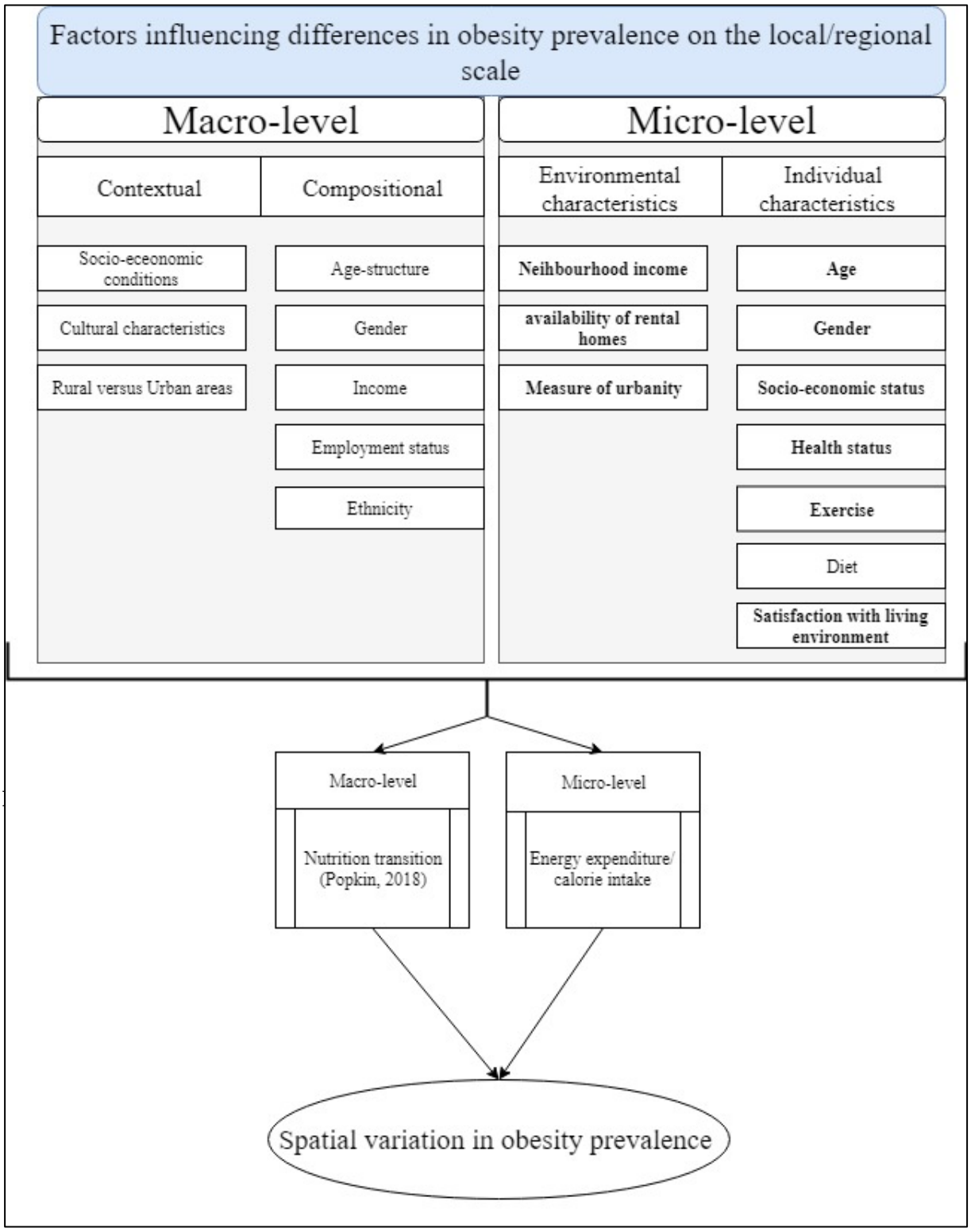
In figure 2.2, the conceptual model is displayed. This model shows the different factors on the macro and micro level that influence the prevalence of obesity. Micro refers to small-scale, individual or small group interactions, while macro refers to large scale processes. On the macro level, as mentioned by Dahlgren and Whitehead (1991) And Vidra (2019), contextual factors seem to be largely influential when it comes to regional differences in prevalence of obesity. Lower socio-economic conditions of a country could increase the risk of becoming obese which could be related to the limited access to health services and insufficient income to buy healthy food (Vidra, 2019, Shaw et. al, 2002). Furthermore, cultural aspects on the macro level are related to differences in nutritional habits and lifestyle characteristics which also influences differences in obesity prevalence on the macro level. The third contextual factor, mentioned by Blundell et al. (2017), refers to differences between rural and urban areas. Rural areas generally show higher numbers of obesity prevalence than urban areas, but this mainly counts for countries that have high differences between rural and urban areas in terms of population density. Compositional characteristics of the population that could influence spatial differences on the macro level are the age-structure, sex, ethnicity, employment status, and income (Collins et al. 2017).

On the micro level, the environmental characteristics that are taken into account are the measure of urbanity of an area, the percentage of rental homes and the neighbourhood income. These variables are used as indicators since previous research pointed out that they might influence differences in obesity prevalence between neighbourhoods (Harrington & Elliot, 2009). The individual characteristics that could influence spatial differences in prevalence of obesity are related to demographic characteristics, socio-economic factors and factors related to nutritional habits and exercise.

On the macro level, the differences between compositional and contextual aspects of an area can influence in which state of the nutritional transition (Popkin, 2018) a country or other large-scale region is which largely influences the spatial differences in prevalence of obesity on the macro level. On the micro level, differences in obesity occurrence are influenced by environmental and individual characteristics that subsequently affect the energy expenditure and calorie intake of individuals.

This research focusses on individual data and the municipal level data related to this individual data and therefore, as can be seen in the model, only the micro-level characteristics are marked bold.

Figure 3.2: Conceptual model



Note: variables used in this research are marked bold

2.4 Hypotheses/expectations

The main hypotheses are based on the theories mentioned in the literature section and relate to the research questions. The main hypotheses are:

Research question 1:

- It is expected that the occurrence of obesity is highest in the municipalities situated in the eastern part of the province.

Research question 2:

- It is expected that individual characteristics related to socio-economic status, health, gender and age are the most important explanatory factors of the population and contribute to the geographical differences in prevalence of obesity

Research question 3:

- It is expected that the environmental characteristics related to the socio-economic conditions and measure of urbanity contribute significantly to the explanation of geographical differences in prevalence of obesity.

3. Data and methods

3.1 Research design

This research explores the individual and aggregated environmental characteristics that influence the prevalence of obesity in the province of Groningen. Both individual level survey data and aggregated data on municipal level are used to analyse which factors are most important in relation to the probability of getting obesity and could explain the geographical differences in prevalence of obesity on a local scale. The quantitative character of the data makes quantitative, statistical analyses most suitable for this research and adds to existing qualitative research within this region. Using logistic analyses, calculations are made regarding the different individual variables and its effect on the probability of getting obesity. In that way, the most influential individual characteristics are explored. Subsequently, to find out what the influence is of the environmental, aggregated data on municipal level, multi-level analyses are performed and analysed.

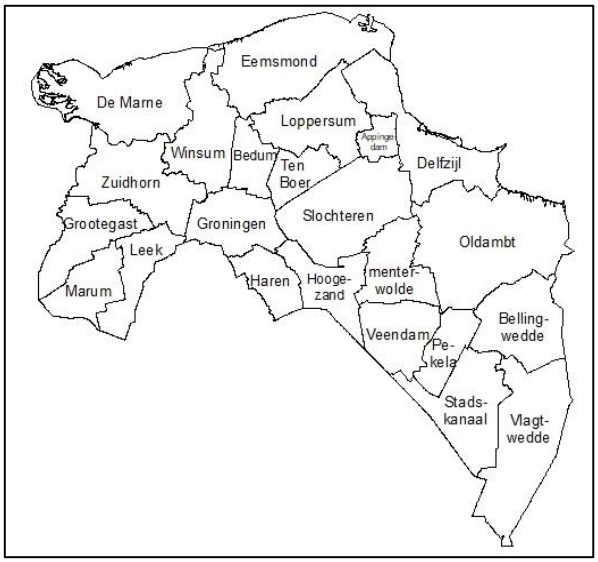
3.2 Setting

The study area for this research was the Province of Groningen, situated in the northern part of the Netherlands (figure 3.1 and 3.2). This area is characterized by large differences of the population in terms of development and demographic characteristics (Sociaal Planbureau Groningen, 2019). The municipality of Groningen where the main city of the Province is situated, is growing in terms of population and urbanization and students make up a large share of these people. This leads to the fact that the municipality has a relatively young population which is reflected in the data that was used in this research. The surrounding municipalities are partly taking advantage of this trend however, they frequently suffer from an ageing population since people leave towards the city (Sociaal Planbureau Groningen, 2019). The municipalities that are situated further away from the main city, are often areas in decline. These regions are characterized by a decrease in population numbers between 2008 and 2015 and subsequently a decrease in the numbers of employment opportunities, provoking a downwards spiral for these regions (Kooiman & Simons, 2015). The eastern part of Groningen is considered one of these regions. Since the main dataset that was used for this research is derived from the health survey conducted in 2016, the administrative borders of the municipalities in 2016 were taken into account as the borders of the municipal areas that are considered in this research. This results in a number of areas of 23 municipalities with individuals aged 19 up to 102. Although the municipality of Groningen differs from the other municipalities within the province since the share of students within this area is high, the municipality is not excluded from the analysis. When removing the population from the sample, it would lead to sample selection and therefore could bias the results.

Figure 3.1: Area of research within the Netherlands

Source: Esri NL

Figure 3.2: Municipalities within the Province of Groningen



Source: Map made with ArcMap

3.3 Data

The study was based upon data from the most recent Health Monitor conducted by Statistics Netherlands, RIVM and the GGD in 2016. This is a large health survey conducted every four years and contains information regarding topics related to experienced health, social issues, lifestyle characteristics, socio-economic status, neighbourhood satisfaction and other issues that might related to, for instance, health care (Rijksinstituut voor Volksgezondheid en Milieu, 2019). GGD Groningen provided the specific dataset for the use of this study with the variables that would be needed to conduct this research. Information that would be too confidential was excluded. The total number of individuals from the province of Groningen that filled out this survey was n=16.591 of the 36.284 individuals that were asked to fill out the survey which resulted in a response rate of 45%. From this survey, the data for the analyses regarding individual characteristics that might influence the prevalence of obesity, was obtained. The data for the environmental analyses was gathered from CBS Statline, which is an open-source database from Statistics Netherlands. This environmental, aggregated data was collected with the municipal areas of the Province of Groningen in 2015 as connecting factor to be able to relate this data to the data from the individual dataset. This resulted in one large dataset with both individual characteristics of 16.591 respondents and environmental, municipal data of these 23 municipalities the respondents lived in in 2016.

3.4 Operationalisation of variables

3.4.1 Dependent variable: Obesity

The outcome measure, for both the analyses of the individual data and environmental data, was the variable of interest: Body Mass Index (BMI). BMI is a commonly used indication for measuring weight related. A high BMI is often related to consequences regarding health status and increases the risk of getting non-communicable diseases (Popkin, 2017). BMI was computed from the Health Monitor through the variables concerning self-reported weight (kg) and height (cm). It was classified into underweight (BMI<18.5) low normal weight (BMI 18.5 < 20) high normal weight (BMI 20 < 25) overweight (BMI 25 < 30) and obesity (BMI ≥ 30). Since this study focusses specifically on the topic of obesity, the outcome measure is a dummy variable related to having a BMI equal to or higher than 30 or a BMI lower than 30. The categories are defined as:

- Normal weight and overweight (18.5–29.9 kg/m2)
- Obese (30≥ kg/m2)

The categories are coded in this research as:

- Normal weight (0) and obese (1)

The cases with missing values for the outcome variable 'obesity' were removed from the dataset. The percentage of these dropped values per municipal area are displayed in table 3.1. In total, 920 cases were removed of the 16.591 cases that were initially in the dataset.

Table 3.1: missing values for the variable obesity per municipality

Municipality	**Missing**	**%**
Appingedam	46	6.94%
Bedum	30	5.10%
Bellingwedde	20	3.22%
Ten Boer	23	4.67%
Delfzijl	55	7.35%
Groningen	72	4.43%
Grootegast	35	6.10%
Haren	34	4.22%
Hoogezand-Sappemeer	42	5.97%
Leek	39	5.09%
Loppersum	27	4.48%
Marum	18	3.40%
Stadskanaal	44	5.72%
Slochteren	42	6.16%
Veendam	45	6.16%
Vlagtwedde	52	6.58%
Winsum	40	5.53%
Zuidhorn	48	5.80%
Pekela	43	7.30%
Eemsmond	43	5.73%
Marne	37	5.63%
Oldambt	57	7.62%
Menterwolde	28	4.65%
Total	**920**	**5.55%**

3.4.2 Independent variables

The independent variables are categorized upon either their compositional or contextual character. Composition locates the understanding of inequality between areas at the individual level whereas contextual factors refers to the setting in which these individuals live (Shaw, Dorling and Mitchell, 2002). The compositional variables are derived from the Health Monitor (2016) since the monitor contains ultimately data on the individual level and this data can, consequently, be organized on the municipal level. The contextual variables are derived from the CBS Statline database and are selected upon the criterium that the data is from the same period as the data from the Health Monitor and that it

is related to the same municipalities. Those variables related to environmental characteristics of the municipalities in the province of Groningen are connected to the individual data of the Health Survey based upon the respondent's residential municipality.

3.4.3 Individual variables

The explanatory individual variables were derived from the Health Monitor (2016) and refer to a respondent's reported answer regarding a specific survey question. Based on the research questions and the previous research towards the topic of obesity, the questions that are taken into account refer to demographic characteristics of respondents as age, marital status and gender as well as characteristics concerning socio-economic status, social capital and reported neighbourhood deterioration. The last characteristic refers to how a person perceives his or her neighbourhood environment. For individual socio-economic status, the level of education, difficulty making ends meet and employment status were used as indications. Information on an individual's income was not available as data from the Health Monitor and therefore difficulty making ends meet, as a categorical variable with two answer categories was used. In table two, the measurement and categories created per variable are presented. There were no missing values in the independent variables since all missing values per variable were already categorized as the answer category 'unknown'. To minimize bias and keep enough variables in the dataset to perform a regression with enough statistical power, the unknown variables were treated as separate categories of a variable and therefore could be interpreted as such.

Table 3.2: Measurement and coding of individual variables

Variable name	Measured as/coded as*	Note:
Age	Categorical variable based on age-groups of 15 years and 75+ 1. 19-34 years 2. 35-49 years 3. 50-64 years 4. 65-74 years 5. 75+	This category was also available as continuous variable. But, because of the specific characteristics of each age-group, the categorical variable was used in the analyses.
Gender	Categorical variable: 0. Male 1. Female	
Marital status	Categorical variable: 1. Married/cohabiting 2. Living together 3. Unmarried/never married 4. Divorced/LAT 5. widowed 9. Unknown	
Level of education (SES)	Categorical variable: 1. Lower education (no education/primary school) 2. middle education (lbo, mavo) 3. middle education (mbo, havo, vwo) 4. Higher education (hbo, wo) 9. unknown	
Difficulty making ends meet (SES)	Categorical variable 1. No difficulty 2. Difficulty 9. Unknown	Indication of purchasing power of an individual

Work status (SES)	Categorical variable: 0. Employed 1. Unemployed, bijstand arbeidsongeschikt 2. Housekeeper 3. Retired/Student 9. Unknown	Employed indicates that a person has a paid job for more than an hour per week. Unemployed refers to a person who is searching for a job, is unable to work or receives a social assistance benefit. The third category refers to people who choose not to have a payed job because of housekeeping duties.
Loneliness	Categorical variable based upon 'De Jong Gierveld schaal' (4 categories) 0. Not lonely (score 0-2) 1. Moderate loneliness (score 3-8) 2. Severe loneliness (score 9-10) 3. Very severe loneliness (score 11) 9. Unknown	Social capital was measured by using the variable 'Loneliness'. Loneliness is measured by the GGD on the 'De Jong Gierveld' scale which assigns scores to respondents regarding their answers concerning social interactions and feeling of loneliness
Perceived neighbourhood deterioration	Categorical variable based upon the question: did the neighbourhood improve? 0. Improved 1. Stayed the same 2. Declined 9. Unknown	The question focusses on the topic of the perceived environment of an individual. The individual could answer if they though that their neighbourhood improved, stayed the same or declined.
Neighbourhood nuisance	Categorical variable with 5 categories using the question: What kinds of nuisance do you experience in your neighbourhood? (option to choose 3 answers per individual) 0. No nuisance 1. Physical nuisance (sound, smell, garbage, dogpoop) 2. Green spaces (not enough green, slecht onderhoud) 3. Traffic nuisance 4. Other 9. Unknown	The question regarding neighbourhood nuisance, where respondents could check three boxes to answer the question: 'what kinds of nuisance do you experience in your neighbourhood?', was used as an indicator for neighbourhood environment. Due to the large amount of choice categories regarding this survey question, in this research the answers were merged upon their similar character, resulting in 5 categories; no nuisance, physical

		nuisance, green-spaces, traffic nuisance and other.
Chronic Illness	Categorical variable with 3 categories based upon the question: does the respondent have a chronic illness? 0. Yes 1. No 2. Unknown	
Exercise	Categorical variable. Sports at least once a week 0. No 1. Yes 2. Unknown	

*The lowest value is used as the reference category of the variable (if not, it is made explicit in the results)

3.4.4. Environmental variables

Three main explanatory environmental variables per municipality for the year 2015 are used in this research and were derived from CBS Statline; measure of urbanicity, median municipal income and percentage of rental homes. It was considered to include more environmental variables, however including three municipal characteristics referring to different indicators of neighbourhood would be fine given the scope of this thesis. For an indication of the physical environmental characteristics, the measure of urbanicity was used. In the data from the Central Bureau for Statistics, urbanity of a municipality was classified into five groups based upon the number of addresses per square kilometre (table 3.3). This data was assigned to the cases in the dataset created with the individual data from the Health Monitor with the municipalities as connecting variable. Secondly, the Median municipal income was added as an indicator of neighbourhood SES since it is referring to the aggregate income of the municipality (CBS Statline, 2015a). The variable was measured in euros and is treated continuous. The percentage of rental homes, in relation to the percentage of owner-occupied homes, was another indicator for neighbourhood SES. The values of the variable were calculated by dividing the number of rental homes per municipality by the total number of housing available within this municipality.

Table 3.3: Measurement of environmental variables

Median municipal income	For this contextual variable, municipal level data was used. This data is obtained through the database of the Central bureau for statistics in the Netherlands (CBS Statline, 2015a). 3 groups are created since the variance was too small to make the variable a continuous one. The following categories were created: 1. Low (<20.000) 2. Medium (20.000<25000) 3. High (25.000>)
Percentage of rental homes	This contextual variable was measured using the data on owner occupied homes and rental homes in neighbourhoods (CBS Statline, 2015b).
Measure of urbanicity	As an indication of the physical environmental characteristics, the measure of urbanity was used (CBS Statline, 2015a) In the data from the

Central Bureau for Statistics, there are five categories concerning urbanity:

0. Very high urbanity (> 2500 addresses per km2)
1. High urbanity (1500 – 2500 addresses per km2)
2. Medium urbanity (1000-1500 addresses per km2)
3. Low urbanity (500-1000 addresses per km2)
4. Very low urbanity (<500 addresses per km2)

3.5 Ethical considerations

Data from the health monitor should be treated with care and caution since it contains a substantial number of personal information of respondents on the local level. Since data was gathered by three institutions that have substantial knowledge and experience in the field of conduction surveys, it is assumed that caution and confidentiality during the gathering of data was provided and the privacy of the respondents was prioritized. This was also confirmed by information from the privacy policy of the GGD (GGD Groningen, 2018). Furthermore, generalization of subgroups should be treated carefully since it could generate harm towards that specific population caused by prejudice.

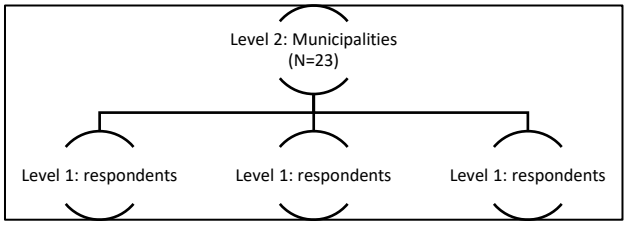
3.6 Method of analysis

To analyse what geographical patterns and differences regarding the prevalence of obesity could be identified in the province of Groningen and to answer the first research question, descriptive statistics of the variable 'obesity' with respect to the 23 municipalities were provided. For the visualisation of the data and to provide an overview of geographical patterns in occurrence of obesity within the province, maps were generated with ArcGIS. The average percentage of people with obesity within the whole region and the range regarding the 23 municipalities were calculated to describe the overall situation within the province and the variation between municipalities.

To answer the second research question which focusses on the role of individual factors in relation to the prevalence of obesity, crosstabs and maps were made to analyse the geographical differences of these characteristics in relation to the percentage of people with obesity. Obesity was categorized based upon age groups and gender to see what the distribution of obesity is regarding main demographic characteristics. Mean age, male/female ratio, percentage of people with a low educational level (measured as the aggregation of the two lowest categories of educational level) and self-reported neighbourhood deterioration were chosen as data-input for the maps made with ArcGIS. With these maps, spatial differences in, respectively, individual demographic characteristic, SES and individuals reported neighbourhood satisfaction could be shown. These patterns were analysed in relation to the occurrence of obesity in the province of Groningen to explore if there are similarities or notable differences regarding geographical distributions. To analyse the predictive character of the compositional variables related to the outcome variable 'obesity', logistic regressions were performed. With regard to previous research, literature concerning the topic of obesity and outcomes of the logistic regressions, all the models were performed separately for males and females. Furthermore, it was tested if the outcomes of multiple explanatory variables were significantly different looking at 95% confidence intervals for males and females separately. The first logistic analyses were executed using the variables relating to compositional characteristics separately in relation to the outcome variable 'obesity'. The outcome of the univariate analysis was shown in a table presenting the odds ratios and significance levels for all the compositional variables. Secondly, a multivariate logistic analysis was performed including the variables together, providing a better understanding of the different sizes and signs of the effects per variable when including other variables in the model.

The third research question is answered through analysing the geographical arrangement of the contextual, aggregated data on municipal level. This was done through the provision of a crosstab of all the contextual factors in relation to the municipalities and by creating maps of the three contextual variables. Although the student population in the municipality of Groningen influenced the values of the variables within this area, they were not removed from the data-sample since this would also cause sample-selection bias in the results of the further analyses. Multi-level logistic analyses were performed to investigate if the contextual variables significantly contributed to the risk of getting obesity and if so, what characteristics of the municipalities were most important. The additional purpose of the multilevel analysis is to account for variance in the outcome variable measured at the lowest, individual, level by analysing information from the municipal level of analysis relating to the aggregated contextual factors that are situated on this level. The statistical reason for this, is the fact that respondents in hierarchical data share a context or frame of reference, in this case the municipality. There is a cause of dependency among observations. Because of this nested data (individuals within municipalities) a standard logistic regression analysis could cause bias the results since there might be a violation of the assumption that there is independency between observations. Multilevel analysis could disentangle these effects within a cluster. The hierarchical structure of the data within the sample is displayed in figure 6. The level-1 variables are situated on the respondent's level and the level-2 variable in which the individual level is nested, are the municipalities within the province of Groningen (N=23). To test if the variance between municipalities is significantly different, the Wald-test was performed in regard to the empty model with an average number of respondents within the municipalities of N=670.

Figure 3.3: Hierarchical data structure



The coefficients, in odds ratios, obtained from the multilevel analysis are presented in a table with both the compositional and contextual variables for males and females separately. The outcomes are related to previous analyses and the additional effect of the contextual variables are interpreted in order to answer the third research question of the study regarding the contribution of the contextual effects on the prevalence of obesity. Concluded, the analyses are elaborated upon all together to provide a general understanding of the different aspects influencing the prevalence of obesity within the province of Groningen.

4. Results

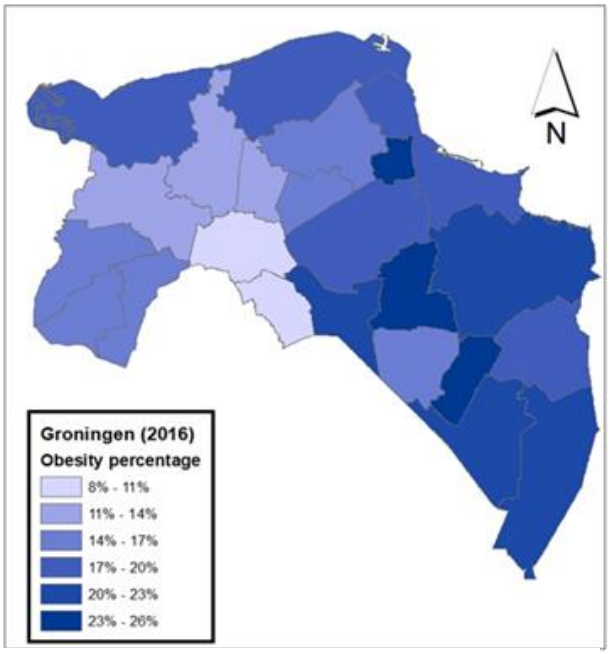
In this chapter the results of the descriptive and logistic analyses will be presented in relation to the different research questions. To provide an understanding of the different compositional factors that are influential concerning the prevalence of obesity, after the discussion of the current pattern of obesity occurrence within the province of Groningen, the individual variables are discussed. Furthermore, the outcomes of the multi-level analyses are presented to elaborate upon the additional contribution of the contextual factors. Maps are provided to show geographical patterns within the province of Groningen regarding variables on the individual and environmental level from both the sample data and municipal data. First, the compositional factors will be the main subjects of analysis and to explore to what extent the contextual factors are of influence, these are subsequently added to the analysis by performing multilevel analyses.

4.1 Analyses

4.1.1 Obesity occurrence in Province of Groningen

The study population are the residents living in the different municipalities within the province of Groningen. In total, 15,423 residents were included in the study. Of these people, 2,644 individuals had reported a BMI higher than or equal to 30 and therefore were considered to have obesity. The remaining residents had a BMI lower than 30. The average percentage of people with obesity per municipality was 17.6% with a range between municipalities of 16.5%. The number of respondents per municipality in the province of Groningen that did report a BMI lower than 30 and the respondents that did report a BMI equal to or higher than 30 are shown in table 4.1. To make the geographical differences within the province visible, the percentage of people with obesity per municipality are displayed in figure 4.1. Notable is that for most of the municipalities located in the eastern part of the province (except for Veendam) the prevalence is higher than in the western part. Also, the municipalities situated near the 'Waddenzee', situated north of the region, report a percentage of people with obesity that is higher than the average of 17.6%. The municipality of Groningen and its surrounding municipalities show a relatively low percentage of obesity. Especially Haren, which is located south-east of Groningen, should be mentioned with its low percentage of obesity since the demographic characteristics are quite different from the population in the municipality of Groningen. These differences could be due to multiple factors elaborated upon in the discussion section of this thesis.

Figure 4.1: Obesity percentages per municipality



Source data: CBS, GGD, RIVM (2016)

Table 4.1 Observations and percentages of obesity per municipality

Municipality N=23	Obese: yes	%	Obese: no	%	Total
Appingedam	143	(23.4%)	469	(76.6%)	612
Bedum	74	(13.4%)	480	(86.6%)	554
Bellingwedde	108	(18.1%)	488	(81.9%)	596
Ten Boer	78	(16.8%)	386	(83.2%)	464
Delfzijl	127	(18.6%)	554	(81.4%)	681
Groningen	155	(10.5%)	1,322	(89.5%)	1,477
Grootegast	82	(15.4%)	450	(84.6%)	532
Haren	72	(9.4%)	692	(90.6%)	764
Hoogezand-Sappemeer	133	(20.6%)	513	(79.4%)	646
Leek	122	(17.0%)	597	(83.0%)	719
Loppersum	94	(16.4%)	479	(83.6%)	573
Marum	77	(15.1%)	432	(84.9%)	509
Stadskanaal	147	(20.6%)	566	(79.4%)	713
Slochteren	125	(19.7%)	508	(80.3%)	633
Veendam	112	(16.7%)	559	(83.3%)	671
Vlagtwedde	148	(20.3%)	582	(79.7%)	730
Winsum	81	(11.9%)	599	(88.1%)	680
Zuidhorn	105	(13.6%)	665	(86.4%)	770
Pekela	139	(25.9%)	398	(74.1%)	537
Eemsmond	126	(18.0%)	575	(82.0%)	701
De Marne	108	(17.6%)	506	(82.4%)	614
Oldambt	157	(23.0%)	525	(77.0%)	682
Menterwolde	131	(23.2%)	434	(76.8%)	565
Total	2,644	(17.1%)	12,779	(82.9%)	15,423

Source data: CBS, GGD, RIVM (2016)

4.1.2 Individual variables: Geographical differences

The frequencies and percentages of respondents with obesity, related to the individual variables, are presented in table 4.2. The number of missing values concerning the individual variables was low since for all the variables a separate category was created containing the 'unknown' values. Only the category 'perceived neighbourhood deterioration' has missing values (n=56). As observed in table 4.2, among females, the percentage of people with obesity is higher compared to males. Another important individual demographic characteristic is age. The percentage of obesity does increase with age. However, when categorizing age upon gender, the outcomes differs between males and females (Appendix 4). Only the youngest age-group, 19-34 years, has a lower number of obese people in relation to the other age-groups for both males and females. Concerning the presence of a chronic illness in relation to having obesity, there seems to be a large difference between having or not having a chronic illness since a large share of people that have obesity (57%) also report that they have a chronic illness compared to the 39% of people that do not have obesity who report chronic illness. Furthermore, within the sample, most of the people with obesity do not exercise. Regarding characteristics that refer to socio-economic status, most of the respondents that have obesity have enjoyed middle education and do not have difficulty making ends meet.

Table 4.2. Description of individual sample data

	Obesity n=2,644	
	n	% (of total obesity)
Gender		
Male	1,105	(41.79%)
Female	1,539	(58.21%)
Age		
19 - 34 years	187	(7.1%)
35 - 49 years	386	(14.6%)
50 - 64 years	787	(29.8%)
65 - 74 years	435	(16.5%)
75+	849	(32.1%)
Marital status		
Married/Cohabiting	1,667	(63.1%)
Living together	186	(7%)
Unmarried/Never married	220	(8.3%)
Divorced/LAT	170	(6.4%)
Widowed	372	(14.1%)
Unknown	29	(1.1%)
Chronic illness		
Yes	1,497	(56.6%)
No	1,100	(41.6%)
Unknown	47	(1.8%)
Exercise (≥ once a week)		
no	1,759	(66.5%)
yes	674	(25.5%)
Unknown	211	(8%)
Loneliness (De Jong Gierveld scale)		
Not lonely (score 0-2)	1,293	(48.9%)
Moderate loneliness (score 3-8)	1,031	(39%)
Severe loneliness (score 9-10)	174	(6.6%)
Very severe loneliness (score 11)	72	(2.7%)
Unknown	74	(2.8%)
Perceived neighbourhood deterioration		
Improved	171	(6.5%)
Stayed the same	1,938	(73.5%)
Declined	485	(18.4%)
Unknown	44	(1.6%)
Missing: n=56		
Neighbourhood nuisance		
No nuisance	790	(29.9%)
Physical nuisance	475	(18%)
Lack of green spaces	397	(15%)
Traffic nuisance	130	(4.9%)
Other	683	(25.8%)
Unknown	169	(6.4%)
Level of Education (SES)		

Low (no education, primary school)	299	(11.3%)
Middle (lbo, mavo)	1,064	(40.2%)
Middle (mbo, havo, vwo)	787	(29.8%)
High (hbo, wo)	400	(15.1%)
Unknown	94	(3.6%)
Work status (SES)		
Employed	807	(30.5%)
Unemployed	280	(10.6%)
Housekeeper	463	(17.5%)
Retired/Student	937	(35.4%)
Unknown	157	(5.9%)
Difficulty making ends meet (SES)		
No difficulty	1,986	(75.1%)
Difficulty	577	(21.8%)
Unknown	81	(3.1%)

Maps that visualize the data per municipality regarding the mean age, individual-reported neighbourhood deterioration, number of females per 100 males and percentage of people with a lower education are shown in figure 4.2 up to 4.5. Comparing these geographical differences of compositional variables within the province to the regional differences in obesity prevalence, it is notable that some variables show more similarities than others. Figure 4.2 presents the mean age of the sample population within a municipality. The municipality of Groningen shows the lowest mean age (48-50) and municipalities in the north and south-eastern part of the province show the highest mean-age. However, the difference between east and west is not that apparent since some of the municipalities surrounding the municipality of Groningen, that did have a lower percentage of people with obesity, do also partly show a similar mean age as the municipalities in the eastern part, where the prevalence of obesity is higher.

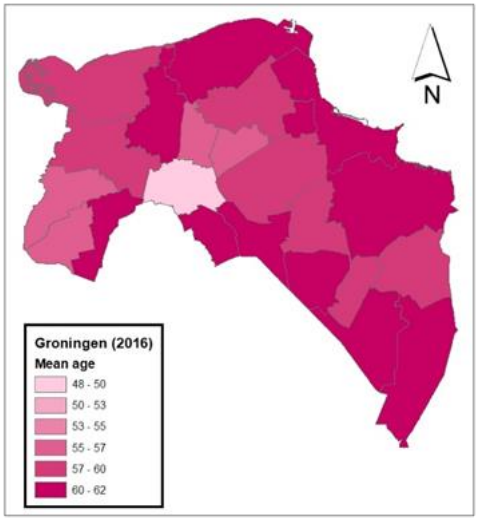
As one of the indicators of an individual's socio-economic status, the percentage of people with a lower education is visualized in figure 4.3. In the municipalities situated in the eastern part of the province, the percentage of people with a lower education is predominantly above 39% of the population. In the municipalities surrounding the municipality of Groningen this number is relatively lower. In the municipality of Groningen and Haren (situated south-east of the Groningen) the percentage of lower educated people is below 25%. Related to the prevalence of obesity, there is a similarity when analysing the pattern of people with a lower education. The percentage of lower educated people in the eastern part of the province is higher than in the municipality of Groningen and its surroundings. Also similar is the pattern regarding the municipalities near the Waddenzee that, likewise, show a higher percentage of people with a lower education.

Figure 4.4 shows the number of females per 100 males as an indicator of the gender ratio. In every municipality the number of females, from the sample population, is higher than the number of men except for the municipality of Veendam. When comparing the municipality of Veendam on this map with the map regarding the prevalence of obesity, it is notable that the prevalence of obesity within this municipality is also slightly lower than the prevalence in the surrounding municipalities. Furthermore, comparing the western part with the eastern part of Groningen, there does not seem to be a clear pattern in line with the prevalence of obesity.

On the map regarding an individual's reported neighbourhood deterioration (figure 4.5), the percentages of people that reported that they feel like their neighbourhood has gotten worse, are shown. Related to the pattern of obesity within the province, it shows a quite similar spatial pattern. Municipalities in the eastern part of Groningen have a higher share of people that think that their neighbourhood declined than the municipalities in the western part (except for De Marne). The areas

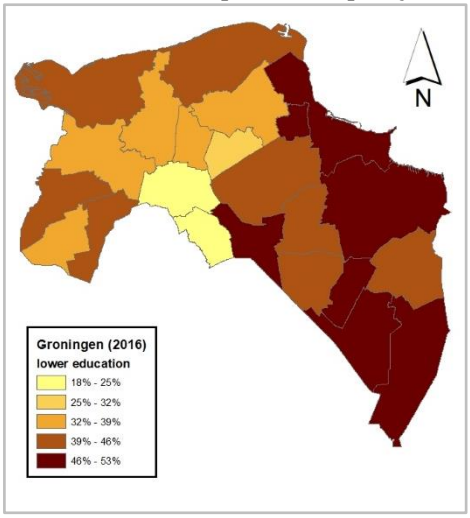
surrounding the municipality of Groningen show a lower percent of respondents who reported that their neighbourhood deteriorated. Furthermore, it is notable that the municipalities near the Waddenzee, which also showed a relatively high prevalence of obesity, have a relatively high percentage of people who reported that they think that their neighbourhood declined in terms of environmental characteristics.

Figure 4.2: mean age per municipality.



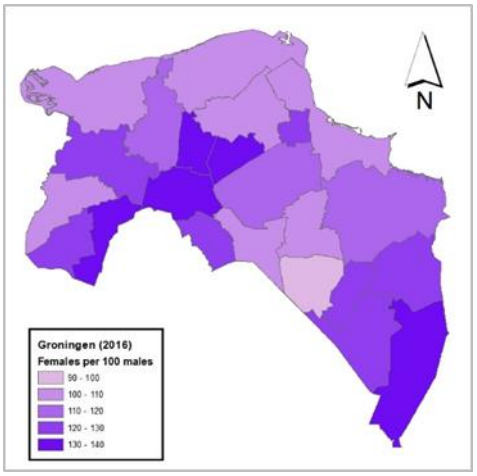
Source data: CBS, GGD, RIVM

Figure 4.3: Percentage of people with a lower education per municipality.



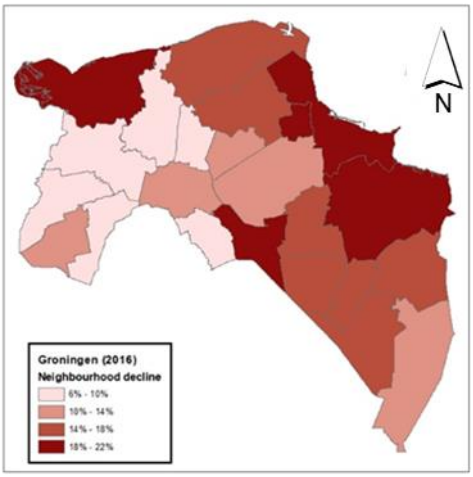
Source data: CBS, GGD, RIVM (2016)

Figure 4.4: Females per 100 males per municipality.



Source data: CBS, GGD, RIVM

Figure 4.5: Neighbourhood deterioration per municipality.



Source data: CBS, GGD, RIVM

4.1.3 Individual characteristics as predictors of obesity

The outcomes of logistic regressions with individual variables as explanatory variables, are visualized in table 4.4 for males and table 4.5 for females. The univariate analyses of the categorical variable 'age' shows significant results for both males and females. However, for females the odds of being obese, compared to the youngest age-group, are higher when the person is in an older age group whereas for men, this pattern is not prevalent. regarding the multivariate analysis, the coefficients for the variable are still significant for males but for females, the significant effect dissolves when including other variables.

For marital status, the odds of having obesity when being female and having never married or

being unmarried are 0.71 points the odds of having obesity when being a female and married. Therefore, someone who is married is more likely to be obese. For males, only the coefficient of being widowed compared to being married is significant and the odds of being obese increase under that circumstance with 1.42 points. The other categories of the variable are for both males and females insignificant.

For both males and females, the variable regarding having a chronic illness is strongly significant ($p<0.001$). The odds of being obese when having no chronic illness is for both sexes 0.58 times the odds of being obese when having a chronic illness. When analysing the predictive margins regarding gender and chronic illness, for women, the risk of getting obese is higher when having a chronic illness compared to men who have a chronic illness (Appendix 6). The same outcome pattern is visible regarding the variable 'exercise'. The odds of being obese for both males and females decrease significantly when someone sports once or more than one time a week compared to someone who does not exercise at all. And for females this effect is significantly larger compared to males (Appendix 6).

For both males and females, loneliness shows only significant outcomes in the univariate analysis. There, the odds of being obese increase when being moderately lonely or severe lonely compared to being not lonely. In the multivariate analyses the odds of being obese also increase when someone experiences a certain intensity of loneliness compared to not experiencing loneliness at all, nonetheless, this effect is not significant.

The two variables concerning the environment in which a person lives, neighbourhood deterioration and neighbourhood nuisance, show for males insignificant results except for the category 'declined' of neighbourhood deterioration in the univariate analysis. The odds of being obese increase, for males, with 1.63 points when someone reported that their neighbourhood declined compared to a male that reported that their neighbourhood improved. However, in the multivariate analysis, the results are not significant. For females, the two variables show more significant outcomes. In the multivariate analysis, the perceived decline of a neighbourhood increases the odds of being obese with 1.42 points compared to a neighbourhood that improved. The categories 'lack of greens spaces', 'traffic nuisance' and 'other nuisance', all show significant results for females and all increase the odds of being obese compared to someone who does not experience any nuisance in their neighbourhood.

The three variables that relate to an individual's socio-economic status, show significant results for both males and females. However, whereas in the univariate the variable 'work status' is for both males and females significant, in the multivariate analysis the outcomes are not significant anymore except for being female and unemployed in the univariate analysis. The odds of being obese when having a high educational level decrease significantly for both males and females (0.38 for males and 0.38 for females) compared to someone that has a low education level. The size of the decrease increases per educational level category (appendix 5). For both males and females, having difficulty to make ends meet increases the odds of having obesity (1.72 for males, 1.61 for females). Overall, it seems that demographic characteristics of a person and the effect of the neighbourhood environment seem to have different effects on the odds of being obese for females and males. Furthermore, the effects of variables concerning socio-economic status and variables related to health and exercising show quite similar patterns between males and females and in general a higher SES goes together with a decrease in the odds of being obese compared to someone with a lower SES and having a 'better' health status and exercising more also decrease the odds of being obese compared to someone with health issues and not exercising.

Table 4.3. Outcomes logistic regression compositional variables and obesity: Males

	Males			
	Univariate		**Multivariate**	
Compositional variables	OR	P>|z|	OR	P>|z|
Age category				
(ref= 19-34)				
35 - 49 years	0.93	0.000***	2.12	0.000***
50 - 64 years	1.09	0.000***	2.03	0.000***
65 - 74 years	0.98	0.000***	1.96	0.002**
75+	0.95	0.000***	1.60	0.025*
Marital status				
(ref= Married)				
Living together	0.70	0.007**	0.86	0.274
Unmarried/Never married	0.84	0.102	0.96	0.721
Divorced/LAT	0.88	0.380	0.75	0.067
Widowed	1.48	0.002**	1.42	0.012*
Unknown	1.67	0.086	1.21	0.547
Chronic illness				
(ref= Yes)				
No	0.51	0.000***	0.58	0.000***
Unknown	0.93	0.794	0.85	0.531
Exercise				
(ref= Sports less dan 1 day a week)				
Sports at least 1 day a week	0.45	0.000***	0.60	0.000***
Unknown	0.98	0.895	1.03	0.832
Loneliness				
(ref= Not lonely)				
Moderate loneliness (score 3-8)	1.25	0.001**	1.03	0.651
Severe loneliness (score 9-10)	1.56	0.003**	1.13	0.422
Very severe loneliness (score 11)	1.06	0.808	0.67	0.091
Unknown	1.06	0.793	0.67	0.119
Neighbourhood deterioration				
(ref= Improved)				
Stayed the same	1.18	0.177	1.13	0.348
Declined	1.63	0.001**	1.23	0.165
Unknown	1.26	0.482	0.86	0.677
Nuisance				
(ref= No nuisance)				
Physical nuisance	1.00	0.968	0.98	0.859
Lack of green spaces	1.21	0.074	1.12	0.295
Traffic nuisance	0.97	0.825	1.01	0.943
Other	0.97	0.722	0.91	0.297
Unknown	1.21	0.199	1.17	0.363

Level of education				
(ref= Low, primary school/no education)				
Middle (lbo, mavo)	0.70	0.001**	0.73	0.009**
Middle (mbo, havo, vwo)	0.49	0.000***	0.59	0.000***
High (hbo, wo)	0.28	0.000***	0.38	0.000***
Unknown	0.67	0.067	0.83	0.563
Work status				
(ref= Employed)				
Unemployed	1.80	0.000***	1.01	0.961
Housekeeper	1.35	0.169	0.90	0.642
Retired/Student	1.03	0.659	0.80	0.100
Unknown	1.46	0.015*	1.04	0.870
Difficulty making ends meet				
(ref= No difficulty)				
Difficulty	2.10	0.000***	1.72	0.000***
Unknown	1.38	0.127	0.95	0.885

*p<0.05 **p<0.01 ***p<0.001

Table 4.4. Outcomes logistic regression compositional variables and obesity: females

	Females			
	Univariate		**Multivariate**	
	OR	P>|z|	OR	P>|z|
Age category				
(ref= 19-34)				
35 - 49 years	1.48	0.001**	1.25	0.086
50 - 64 years	1.85	0.000***	1.24	0.085
65 - 74 years	1.84	0.000***	1.18	0.270
75+	2.09	0.000***	1.19	0.222
Marital status				
(ref= Married)				
Living together	0.65	0.000***	0.83	0.108
Unmarried/Never married	0.62	0.000***	0.71	0.007**
Divorced/LAT	1.06	0.575	0.84	0.151
Widowed	1.32	0.000***	1.04	0.663
Unknown	0.84	0.546	0.69	0.215
Chronic illness				
(ref= Yes)				
No	0.48	0.000***	0.58	0.000***
Unknown	0.91	0.682	0.80	0.330
Exercise				
(ref= Sports less dan 1 day a week)				
Sports at least 1 day a week	0.55	0.000***	0.72	0.000***
Unknown	1.07	0.551	1.11	0.386

Loneliness				
(ref= Not lonely)				
Moderate loneliness (score 3-8)	1.39	0.000***	1.13	0.063
Severe loneliness (score 9-10)	1.79	0.000***	1.23	0.092
Very severe loneliness (score 11)	1.45	0.026*	0.83	0.285
Unknown	1.23	0.206	0.74	0.112
Neighbourhood deterioration				
(ref= Improved)				
Stayed the same	1.39	0.005**	1.19	0.152
Declined	2.09	0.000***	1.42	0.011*
Unknown	2.24	0.001**	1.32	0.288
Nuisance				
(ref= No nuisance)				
Physical nuisance	1.06	0.516	1.05	0.540
Lack of green spaces	1.42	0.000***	1.25	0.016*
Traffic nuisance	1.25	0.119	1.36	0.040*
Other	1.19	0.022*	1.21	0.015*
No values	1.49	0.001**	1.30	0.054
Unknown				
Level of education				
(ref= Low, primary school/no education)				
Middle (lbo, mavo)	0.69	0.000***	0.71	0.002**
Middle (mbo, havo, vwo)	0.50	0.000***	0.60	0.000***
High (hbo, wo)	0.28	0.000***	0.38	0.000***
Unknown	0.94	0.716	1.43	0.144
Work status				
(ref= Employed)				
Unemployed	2.36	0.000***	1.31	0.024*
Housekeeper	1.62	0.000***	0.95	0.605
Retired/Student	1.35	0.000***	0.99	0.913
Unknown	1.68	0.000***	0.76	0.137
Difficulty making ends meet				
(ref= No difficulty)				
Difficulty	1.86	0.000***	1.61	0.000***
Unknown	1.53	0.008**	0.96	0.870

*p<0.05 **p<0.01 ***p<0.001

4.1.4 Environmental variables: Geographical differences

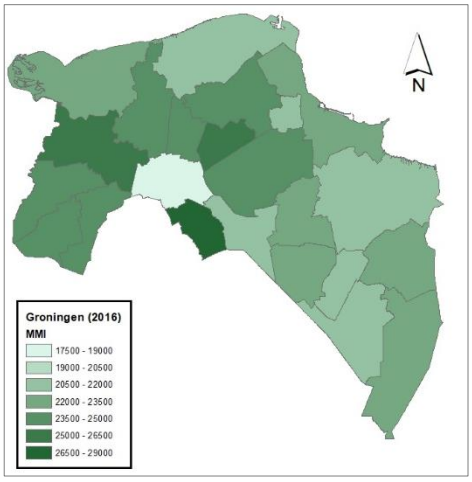
Descriptive statistics of all the compositional variables are shown in table 4.5 and subsequently visualized in figure 4.6, 4.7 and 4.8. Regarding every contextual variable, the municipality of Groningen shows different values than the other municipalities and therefore could be considered an area with specific, divergent characteristics regarding the environmental variables. Measure of

urbanicity, percentage of rental homes are higher compared to the other municipalities within the province and the median municipal income is lower. The municipality of Appingedam, situated in the north-eastern part of the province, also reports different values than its surrounding municipalities regarding the contextual variables. The median municipal income is low but the percentage of rental homes and measure of urbanicity seem relatively high. However, the prevalence of obesity within this municipality is comparable to the prevalence of its surrounding areas. Furthermore, when visually comparing the different areas within the municipality regarding the contextual data, it does seem that the pattern is not ultimately a difference between the eastern and western part of the province but more of the area surrounding the municipality of Groningen and the rest of the province, a pattern that was also visible when analysing multiple variables concerning the individual data. The municipality of Haren shows, for example, a high median municipal income, as well as the municipality of Zuidhorn, both situated near the municipality of Groningen.

Table 4.5: Description of environmental data

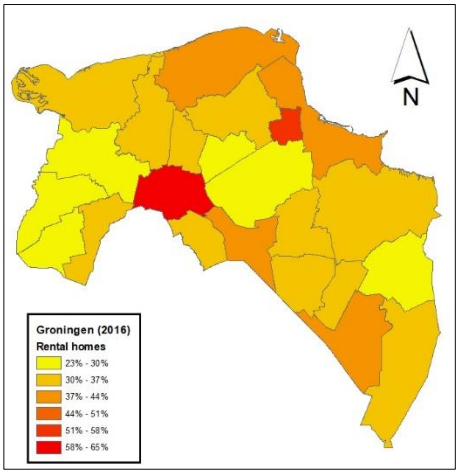
	Measure of urbanicity 1= Very high (> 2500 addresses per km2) 2= High (1500 – 2500 addresses per km2) 3= Medium (1000-1500 addresses per km2) 4= Low (500-1000 addresses per km2) 5= Very low (<500 addresses per km2)	**Mean municipal income** ×1000 euros	**Percentage rental homes (of total housing in municipality)** Including student population
Appingedam	3	21,3	52%
Bedum	4	24,7	32%
Bellingwedde	5	22,7	27%
Ten Boer	5	25,5	23%
Delfzijl	4	22,7	39%
Eemsmond	5	21,9	40%
Groningen	1	18,1	61%
Grootegast	5	23,8	26%
Haren	4	28,6	31%
Hoogezand-Sappemeer	3	21,4	44%
Leek	4	23,9	35%
Loppersum	5	23,6	35%
De Marne	5	22,4	32%
Marum	5	24,3	28%
Menterwolde	5	23,1	36%
Oldambt	4	21,6	37%
Pekela	4	21,2	36%
Slochteren	5	25,0	27%
Stadskanaal	4	21,4	39%
Veendam	4	22,2	34%
Vlagtwedde	5	22,2	32%
Winsum	5	24,4	31%
Zuidhorn	5	25,7	26%

Figure 4.6: Median Municipal Income per municipality.



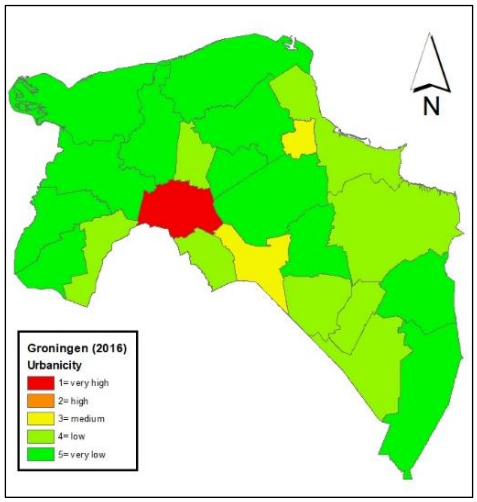
Source data: CBS Statline: Kercijfers wijken en buurten (2015)

Figure 4.7: Percentage of rental homes per municipality



Source data: CBS Statline: Voorraad woningen (2015)

Figure 4.8: Measure of urbanity per municipality.



Source data: CBS: Kerncijfers wijken en Buurten (2015)

4.1.5 Environmental characteristics: contribution as predictors of obesity

To study the influence of the three environmental variables in relation to obesity, multilevel analyses for both males and females were performed to account for the municipal areas in which the individuals live. The outcomes show that the measure of urbanicity per municipality has a significant effect in the univariate analysis for both males and females. Compared to high urbanicity, someone who lives in a municipality with a medium measure of urbanicity has higher odds (2.08 males 2.68 females) of having obesity. In the multivariate analysis this effect decreases and is not significant anymore. In the Multivariate analysis, for females the variable MMI (categorical) shows a significant effect. Someone who lives in an area where the median municipal income is between 20.000 and 25.000 euros, has odds of getting obese that is 2.38 points higher than someone who lives in a municipality where the median municipal income is below 20.000. The percentage of rental homes in a municipality is for both males and females insignificant with a coefficient close to one, confirming the weak relationship. The between municipalities variance is 0.02 for males and 0.015 for females. Which both seem relatively low. The weak and mainly insignificant results concerning the environmental characteristics

could be due to sample characteristics and the size of the study-area, elaborated upon in the discussion and data limitations section.

Table 4.6: Outcomes of the analysis including contextual data: Males

Multilevel analyses **Individual and environmental variables**	**Males**			
	Univariate		**Multivariate**	
	OR	P<|Z|	OR	P<|Z|
Environmental variables				
MMIcat				
(*Ref=<20000)*				
20000-25000	1.587	0.087	2.157	0.053
>25000	1.041	0.893	2.015	0.141
Urbanicity				
(Ref=Very high)				
Medium	2.083	0.029*	0.913	0.699
Low	1.573	0.118	1.026	0.803
Very low	1.326	0.321	1.000	
%Rental homes	1.010	0.197	1.024	0.051
Individual variables				
Age category				
(Ref=19-35)				
35 - 49 years			2.138	0.000***
50 - 64 years			2.037	0.000***
65 - 74 years			1.937	0.002**
75+			1.582	0.030*
Marital status				
(Ref=Married)				
Living together			0.863	0.304
Unmarried/Never married			0.964	0.771
Divorced/LAT			0.750	0.068
Widowed			1.402	0.015*
Unknown			1.188	0.580
Chronic illness				
(Ref=Yes)				
No			0.585	0.000***
Unknown			0.842	0.523
Exercise				
(Ref=less than one day a week)				
Practices sports at least one day a week			0.611	0.000***
Unknown			1.021	0.880

Loneliness (De jong Gierveld scale)		
(Ref=not lonely (score<3)		
Moderate loneliness (score 3-8)	1.027	0.717
Severe loneliness (score 9-10)	1.125	0.456
Very severe loneliness (score 11)	0.661	0.083
Unknown	0.673	0.128
Neighbourhood deterioration		
(Ref=Improved)		
Stayed the same	1.122	0.375
Declined	1.197	0.234
Unknown	0.825	0.598
Nuisance		
(Ref=No Nuisance)		
Physical nuisance	0.984	0.876
Lack of green spaces	1.102	0.387
Traffic nuisance	1.028	0.862
Other	0.877	0.180
Unknown	1.177	0.355
level of education		
(Ref=Low education)		
Middle (lbo, mavo)	0.736	0.011*
Middle (mbo, havo, vwo)	0.593	0.000***
High (hbo, wo)	0.402	0.000***
Unknown	0.850	0.610
Difficulty making ends meet		
(Ref=No difficulty)		
Difficulty	1.708	0.000***
Unknown	0.938	0.846
Work status		
(Ref=Employed)		
Unemployed	0.993	0.954
Housekeeper	0.916	0.706
Retired/Student	0.796	0.096
Unknown	1.038	0.867
_cons	0.050	0.000
Municipality		
var(_cons)	0.020145	0.0148996

*p<0.05 **p<0.01 ***p<0.001

Table 4.7: Outcomes of the analysis including contextual data: Females

Multilevel analyses **Individual and environmental variables**	**Females**			
	Univariate		**Multivariate**	
	OR	P<|Z|	OR	P<|Z|
Environmental variables				
MMIcat				
(Ref=<20000)				
20000-25000	2.259	0.001**	2.380	0.029*
>25000	1.831	0.031*	2.329	0.074
Urbanicity				
(Ref=Very high)				
Medium	2.688647	0.001**	0.932	0.768
Low	2.067825	0.007**	0.847	0.103
Very low	2.169295	0.003**	1.000	
% rental homes	0.996355	0.639	1.010	0.392
Individual variables				
Agecat				
(Ref=19-35)				
35 - 49 years			1.222	0.119
50 - 64 years			1.232	0.097
65 - 74 years			1.157	0.333
75+			1.187	0.239
Marital status				
(Ref=Married)				
Living together			0.849	0.168
Unmarried/Never married			0.769	0.044*
Divorced/LAT			0.861	0.214
Widowed			1.041	0.658
Unknown			0.687	0.220
Chronic illness				
(Ref=Yes)				
No			0.578	0.000***
Unknown			0.789	0.297
Exercise				
(Ref=less than once a week)				
Practices sports at least one day a week			0.732	0.000***
Unknown			1.097	0.437
Loneliness (De jong Gierveld scale)				
(Ref=Not lonely (score<3)				

Moderate loneliness (score 3-8)	1.118	0.085
Severe loneliness (score 9-10)	1.236	0.091
Very severe loneliness (score 11)	0.825	0.278
Unknown	0.733	0.100
Neighbourhood deterioration		
(Ref=Improved)		
Stayed the same	1.182	0.172
Declined	1.386	0.019*
Unknown	1.330	0.281
Nuisance		
(Ref=No nuisance)		
Physical nuisance	1.075	0.406
Lack of green spaces	1.257	0.016*
Traffic nuisance	1.439	0.015*
Other	1.128	0.162
Unknown	1.330	0.039*
level of education		
(Ref=low education)		
Middle (lbo, mavo)	0.723	0.003**
Middle (mbo, havo, vwo)	0.621	0.000***
High (hbo, wo)	0.412	0.000***
Unknown	1.481	0.113
Difficulty making ends meet		
(Ref=No difficulty)		
Difficulty	1.615	0.000***
Unknown	0.961	0.872
Work status		
(Ref=Employed)		
Unemployed	1.298	0.030*
Housekeeper	0.957	0.642
Retired/Student	1.005	0.966
Unknown	0.773	0.160
_cons	0.100	0.003
Municipality		
var(_cons)	0.0207	0.0146646

*p<0.05 **p<0.01 ***p<0.001

5. Conclusion

The objective of this research was to explore and analyse the main underlying compositional and contextual factors that influence the occurrence and prevalence of obesity. In this study, the focus will be on data on the individual and environmental factors that could explain the relatively high differences in prevalence of obesity within the province of Groningen.

5.1 Summary of the results

The outcomes of the data visualization on the provincial level show that the average obesity percentage per municipality is 17.6 percent with Haren showing the lowest value (9%) and Pekela the highest value of 26% (Pekela) resulting in a range between municipalities of 16.5(%). Furthermore, there is a higher prevalence of obesity in the eastern part of the Province of Groningen and in the areas near to the Waddenzee compared to the municipality of Groningen and its surrounding municipalities. The compositional factor variables show similar patterns related to the prevalence of obesity, but the intensity of the similarity differs. Mainly the percentage of people with a lower educational level and the reported neighbourhood deterioration show the same division between the municipalities in eastern Groningen and the municipalities surrounding the municipality of Groningen. Regarding the visual analysis of the data relating to the environmental characteristics, municipal income, percentage of rental homes and measure of urbanicity, this relation to the geographical differences in occurrence of obesity is less evident. Only the median municipal income slightly relates to these differences.

Outcomes of the logistic analyses show that age, variables relating to health and SES are the most influential regarding the prediction of being obese for both males and females in relation to the regional differences within the province of Groningen. The environmental characteristics show less significant results and are therefore considered less important regarding the predictability of being obese, based upon this sample, and when explaining regional differences in prevalence of obesity. Furthermore, there were different effects between males and females of the compositional variables on the odds of being obese. One of the outcomes is that, for women, the significant effect of age changes remarkably when including other variables whereas for men, the effect remains significant and the effects of health and exercise are stronger for females than for males.

5.2 Discussion and explanation of results

5.2.1 Division east- and west-Groningen

In the literature and previous findings regarding obesity prevalence patterns in the Netherlands, the health-status of the population of the eastern part of Groningen is often considered an issue and seems to lack the other areas of the country. In the context of this research, the division between the eastern and the western part of the province was made since this division is often considered when addressing health issues within this specific region. Castelijns and Kalverboer (2009) mentioned in the programme for lifestyle interventions that for East-Groningen it seems that the cause of this ‘lacking behind’ roots in the limited motivation of the people living in that area and the lack of skills to realise a healthy lifestyle in relation to the socio-economic status of the inhabitants. However, based upon this research, it becomes evident that it might not be specifically a clear division between the eastern and western part of the province relating to a lack of skills and motivation, but that the issue is more complex and has multiple causes regarding different individual and environmental characteristics that are intertwined with and influencing each other. Even though the percentage of obese people living in the municipalities situated in the eastern part is, inevitably, higher than the percentage of people with obesity in most of the municipalities in the western area, it limits the interpretation to talk about one or two reasons causing this. Moreover, these regional differences are related to multiple interacting characteristics of people which seem associated with the place of residence. Spatial analyses show that there is a difference between people living near an urbanized area and people living in areas that are a longer distance away from this these areas. In addition, the municipalities near the municipality of Groningen, which can be considered the municipality with the highest measure of urbanicity, youngest population and area with a relatively high share of people that are highly educated, show a lower

percentage of people with obesity than the areas that are situated near the Waddenzee (in the northern part of the province) and the areas east from the municipality with the city of Groningen. However, this low percentage of people with obesity within this area could not only be due to one characteristics as the low mean-age of the population since, for example, Haren reported a high mean age but the percentage of people with obesity is the lowest of all the municipalities within the province.

According to Castelijns and Kalverboer (2009), the main factors contributing to the relative bad health-status of people living in the eastern part of the Province of Groningen, are the lack of motivation to realise a healthy lifestyle, the lag regarding socio-economic development in relation to the other areas within the province and the 'relative isolation' of the region (Castelijns & Kalverboer, 2009, p.1).

Outcomes of this research towards obesity that relates to lifestyle characteristics, show that, in line with the remarks of Castelijns and Kalverboer and the expectations based upon previous studies as the qualitative study of Sanne Visser, the socio-economic status of people is an important factor that explains the relatively high occurrence of people with obesity in the eastern part of the province. However, SES is based upon three different individual variables; level of education, work status and difficulty making ends meet. Whereas level of education and difficulty making ends meet are significant predictors of obesity, work status is not. Although there are differences between males and females, elaborated upon in the next section. Two individual characteristics that are strong predictors of obesity are if an individual has a chronic illness and if someone exercises one time or more than once a week. From this it seems that the risk of having obesity is related to other lifestyle factors and health issues that make it possible for someone to realise a healthy lifestyle as Castelijns and Kalverboer also mentioned. Related to the study of Vidra, we can say that on the local level, the influences on geographical differences relate to the influences on the European level, especially regarding factors relating to socio-economic status.

The percentage of people that reported that their neighbourhood has gotten worse, shows a relationship with the occurrence of obesity within the province. The areas where this number is high, the percentage of people with obesity is also higher, compared to the areas where people think that their neighbourhood stayed the same or has improved. However, it should be kept in mind that this is a self-reported feeling of neighbourhood satisfaction which might be related with a general feeling of satisfaction.

The analyses of the three environmental factors show that in the multivariate analysis only one category of the median municipal income for females is a significant predictor and the effect of all the other environmental variables are not. Which is not in line with the expectations based upon previous studies related to contextual factors. Therefore, we might assume that, when including both individual and environmental characteristics in the analysis, the individual characteristics are still the main predictors of obesity. However, it should be taken into account that there was not much variation between municipalities regarding this categorical variable. The municipality of Groningen was the only municipality with a high measure of urbanity, and this was the municipality with the lowest percentage of people with obesity. Based on the outcomes of this research, we could not confirm the theory of Giddens (2004) that the context is an important factor when explaining the phenomenon of obesity. However, these outcomes might have been different when the area of analysis was larger and there would have been more variation regarding observations on the contextual level.

5.2.2 Complexity: differences males and females

Additional to the outcomes of the analyses in relation to the expectations of Castelijns and Kalverboer, the different outcomes for males and females should be mentioned. When discussing the influence of characteristics of both the population as well as the context, previous studies towards the topic of obesity have shown that there are significant differences between males and females regarding the size of effects and the significance levels of variables. This accentuates the complex character of the obesity epidemic as mentioned by Aronne et al. (2009)

In previous studies and literature, gender is mentioned as an important predictor of obesity.

One of the findings was that women are more likely to become obese than men (Robert and Reither, 2004). Therefore, it was expected that the areas with a larger share of females show a higher percentage of people with obesity. However, this was not strongly supported by analysing the geographical differences regarding the female ratio in relation to obesity which implied that it is not the number of females within a region that increases the prevalence of obesity within that area, but it could be dependent on the specific characteristics of those women. This assumption was supported by the statistical analyses that showed that women have a higher probability of getting obesity compared to men and the outcome that the explanatory variables used in this research, have different effects for males and females. For example, the effect of the satisfaction with the neighbourhood someone lives in, has proven to be different for men than for women which could be due to different factors as elaborated upon by Bell et al. (2014).

Furthermore, the outcomes show that, for females, the significant effect of age decreases when including other variables in the model whereas for men the effect of age remains significant in the multivariate analysis. However, comparing the different age-groups in the univariate analyses and also when analysing descriptives (table 4 appendix 4), it can be noted that for females, the odds of having obesity increase when the age-group is higher compared to the youngest age-group whereas for males, the middle age-group only has an increase in odds of being obese compared to the youngest age-group. From this, we could say that it is possible that there are some cultural or social factors related to specific age-cohorts (Reither, Hauser & Yang, 2009) influencing the prevalence of obesity among age-groups related to gender. These differences in health related to gender that are associated with socially constructed roles and social positions occupied by men and women, should be distinguished from sex differences that are related to biological differences (Curtis, 2014). Regarding another main demographic characteristic, marital status, there are also different effects for males and females. The only significant category for males is being widowed compared to being married. The odds of being obese decrease when being widowed. For females, the odds of being obese decrease significantly when having never married or being unmarried compared to being married what could relate to the age of the individual in relation to cultural norms and values of different age-cohorts.

The effect of socio-economic status is not that different for males and females. For both genders, the level of education is an important predictor of obesity as well as the difficulty to make ends meet. The odds of being obese do increase with 1.61 (females) and 1.72 (males) points when having difficulty compared to not having difficulty making ends meet. Based on these outcomes, we could assume that, as expected, SES is a strong predictor of having obesity for both males and females. Furthermore, other strong predictors are variables related to health and exercise. Health issues increase the odds of having obesity with relatively large numbers for both males and females and exercising decreases the odds. However, for both variables, the effect is significantly larger for women than for man, implicating that women are more susceptible for health-related issues than men or that women report a worse health status than men in general. Although the contextual factors seem less influential, the influence of the environment, especially regarding the outcomes of the female-analyses, are still visible when looking at self-reported and experienced neighbourhood perception. As Giddens (1984) mentioned, we could not disconnect the individual from the context in which he or she lives in however, this could be done in different ways and different forms of analyses could show different results. The size of the effect of geographical differences, as also mentioned by Giddens, could differ based upon the geographical scale of the study. Since the scale of this research is quite small, outcomes might differ on the national scale.

The multi-level analyses show that there are also differences between males and females and univariate and multivariate analyses. As previously mentioned, the only environmental indicator that shows significant results is the measure of urbanicity. For females, in the univariate all the categories are significant compared to high urbanicity. The odds of having obesity do increase when living in a less urbanized area. However, in the multivariate analysis, this effect highly decreases, and the odds are less than one compared to living in an area with a high measure of urbanicity. Therefore, the characteristics of the municipality seem less important than the individual characteristics especially

when including both in the analyses. Because of the previous mentioned differences between males and females, it is favourable to make a distinction between males and females when interpreting and analysing the relationship between individual and contextual characteristics and obesity

5.2.3 Individual versus environmental factors on the local level

Outcomes of this research show that on a local scale with relatively small differences between municipalities regarding environmental characteristics, the individual factors of the population are stronger predictors of obesity than the environmental characteristics. These individual factors are therefore most reliable when talking about regional differences within the province of Groningen. However, when not including the individual characteristics in the analysis, the measure of urbanity and the median municipal income are significant for females which, again, shows the different effects of variables between males and females. On the municipal level, the three 'channels' through which the contextual characteristics influence the health differences of a population as mentioned by Karvonen and Rimpelä (1996), cannot be confirmed. This could be due to the small differences between cultures within the study region that otherwise could have caused the subcultural effect. This cultural effect was also mentioned by Vidra (2019) since on the European level, the differences in prevalence of obesity are for a large part influenced by the cultural context of the area related to nutritional habits. These effects were not visible in the outcomes of this thesis. However, when performing qualitative research on a small-scale region, as done by Visser, the outcomes could possibly differ in relation to this quantitative approach.

5.3 Evaluation of data and methods

Despite using high quality data from both an individual sample and register-data sources, there are some characteristics of the sample and methodological issues that could induce some bias in the outcomes of this research.

An important data issue regarding the sample is that the individual data consists of self-reported data what could lead to response bias. Response bias is a widely discussed phenomenon in behavioural and healthcare research where self-reported data are used. This form of bias occurs when individuals offer self-assessed measures of some phenomenon. These estimates could be caused by misunderstanding of what a proper measurement is or what is socially desirable to answer, related to the social desirability bias (Rosenman, Tennenkoon & Hill, 2011). In relation to BMI this might cause bias since people tend to report a lower weight and higher length than what it in reality is. Especially in important population subgroups. Research showed that errors in self-reported weight were greater in overweight females than in males and that the higher the weight, the larger the error (Rowland, 1990). Therefore, it could be that, in reality, there are fewer or assumable more people with obesity than the number that is prevalent in the sample.

Another issue is related to the sample population. The municipality of Groningen has a relatively high share of students in comparison with the other municipalities in the sample. Therefore, the inclusion of this area might influence the outcomes of the analyses since this population has specific characteristics that are related to the reason why they live in the municipality of Groningen, to study, mainly higher education. However, not including this population could also induce bias since then we would consciously exclude a part of the sample. This would then be called sample-selection bias.

Thirdly, the concept of endogeneity should be mentioned as an issue related to study the topic of obesity and making inferences regarding this lifestyle-related issue. When saying that something causes another thing, the cause has to precede effects. However, in most social-world contexts, these factors work together and the time-division regarding 'what comes first' is not that clear (Pearce & Witten, 2010). Bhopal (2002) refers to this causality as a web of series and interlinked concentric circles. viewing the web from different angles, could reveal alternative perspectives on causality instead of one preceding the other. Related to this research, this should also be noted when interpreting the results and making predictions regarding the risk of getting obesity. There are multiple variables

that influence each other and the risk of getting obesity. However, obesity could in return also influence the lifestyle and other characteristics of an individual. It is therefore not always possible to say what comes first, which is often called 'endogeneity'.

The last concept in relation to data-issues regarding this research is the issue of generalizability. Since this research focusses on a small geographical scale whit a specific demographic, cultural an economic profile, the outcomes might not be generalizable to other contexts that differ from this population.

5.4 Overall conclusion

The outcomes of this research show that both compositional and contextual effects somehow explain the prevalence and regional differences of obesity but most of it is explained by the compositional factors related to an individual's age, health and socio-economic status. Furthermore, the variation between municipalities was low regarding the environmental variables implicating that, on a local level, the environmental characteristics do not add significantly to the spatial variation and the individual characteristics of the population are the most important influencers regarding small scale differences in obesity occurrence. The expectation of Castelijns and Kalverboer (2009) that the causes of the high prevalence of obesity within the Province of Groningen are situated in the context of ageing, lack of needs to realise a healthy lifestyle and relatively low socio-economic status are partly confirmed since SES and health have proven to be strong predictors of obesity but these are not the only factors that that contribute to the geographical differences. Additionally, a remarkable outcome of the current research is that there are significant differences between males and females regarding the effect of different individual variables which could stem from specific characteristics of both genders and the proven effect and trends of different cohort effects (Reither, Hauser & Yang, 2004). Women seem to have more strong factors influencing the risk of getting obesity that are related to their environment than men and for females, age seems to be interacting with multiple other variables since the effect of it changes when other variables are included. This multi-faceted and complex nature lifestyle-related issues, and specifically the complex intrinsic nature of obesity should be taken into account when doing research towards and talking about causes of obesity prevalence and the risk relating to specific subgroups characterized by different factors.

5.5 Policy recommendations and further research

In relation to the outcomes of this research, individual targeted policies focussed on people with lower SES to provide them with information regarding obesity and the influence of exercising and food, would be useful to help people to not become obese. Furthermore, gender specific health interventions focussed on the most important factors for males and females should be taken into account since there are different factors influencing the risk of getting obesity regarding gender. To accomplish this, acknowledging the complex intrinsic nature of lifestyle related issues as obesity is important. The issue of obesity should not be generalized since there is not one factor causing the epidemic and there are different cohort and gender effects. The recognition and observation of these different factors should be at the base of every policy-making process related to health issues. For further research, studies on a larger geographical scale could be conducted to be able to investigate the role of the contextual factors in a more elaborated manner due to more variation. Research towards specific sub populations (e.g. students, women, men, elderly etc) could also be recommended since there are multiple different factors specific for populations which still remain unexposed.

References

Anderson, N. (2004). Encyclopaedia of Health & Behaviour. American Psychological Association Thousand Oaks, Calif: Sage Publications.

Anthamatten, P., & Hazen, H. (2011). The Geographies of Health. New York: Routledge.

Apostolopoulou, M., Christos, S., Konstantinos, M., Simon, C., Theodoros, D., & Apostolos, H. (2012). Age, Weight and Obesity. Maturitas 71(2), 115-119.

Aronne, L., Nelinson, D., & Lillo, J. (2009). Obesity as a disease state: a new paradigm for diagnosis and treatment. Clinical cornerstone, 9(4), 9-25.

Baum, C., & Ruhm, C. (2007). Age, Socioeconomic Status and Obesity Growth. Journal of Health Economics, Elsevier, vol. 28(3), 635-648.

Bell, J., Hamer, M., & Shankar, A. (2014). Gender Specific Associations of Objective and Perceived Neighbourhood Characteristics with Body Mass Index and Waist Circumference Among Older Adults in the English Longitudinal Study of Ageing. American Journal of Public Health 104(7), 1279-1286.

Bell, J., Hamer, M., & Shankar, A. (2014). Gender-Specific Associations of Objective and Perceived Neighborhood Characteristics with Body Mass Index and Waist Circumference Among Older Adults in the English Longitudinal Study of Ageing. AMERICAN JOURNAL OF PUBLIC HEALTH 104(7), 1279-1286.

Berghöfer, A., Pischon, T., Reinhold, T., Apovian, C., Sharma, A., & Willich, S. (2008). Obesity prevalence from a European perspective: a systematic review. Journal of Public Health, 1-10.

Bhopal, R. (2002). Cause and effect: the epidemological approach. In R. Bhopal, Concepts of Epidemiology: an integrated introduction to the ideas, theories, principles and methods of epidemiology (pp. 131-154). Oxford: Oxford University Press.

Black, J., & Macinko, J. (2008). Neighborhoods and Obesity. Nutrition Reviews 66(1), 2-20.

Blundell, J., Baker, J., Boyland, E., Blaak, E., Charzewska, J., Henauw, S., Fruhbeck, G., Gonzales-Gross, M., Hebebrand, J., Holm, L., Kriaucioniene, V., Lissner, L., Oppert, J.M., Schindler, K., Silva, A.L., Woodward, E. (2017). Variations in the Prevalence of Obesity Among European Countries, and a Consideration of Possible Causes. Obesity Facts 10(1), 25-37.

Boyle, P., Curtis, S., Graham, E., & Moore, E. (2004). The geography of health inequalities in the developed world: views from Britain and North America. England: Ashgate Publishing Company.

Castelijns, E., & Kalverboer, K. (2009). Masterplan Zorg voor de Toekomst, Noord- en Oost-Groningen. Groningen: Zorg Innovatie Forum.

CBS Statline. (2015a). Kerncijfers wijken en buurten 2015. Retrieved from: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83220NED/table?fromstatweb

CBS Statline. (2015b). Voorraad woningen; eigendom, type verhuurder, bewoning, regio. Retrieved from: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/82900NED/table?ts=1563527759937

CBS, GGD, & RIVM. (2016). Gezondheidsmonitor 2016 Volwassenen en Ouderen.

Collins, J., Ward, B. M., Snow, P., Kippen, S., & Judd, F. (2017). Compositional, Contextual, and Collective Community Factors in Mental Health and Well-Being in Australian Rural Communities. Qualitative health research, 27(5), 677–687.

Curtis, S. (2004). Health and Inequality. London: SAGE publications.

Dahlgren, G., & Whitehead, M. (1991). Policies and Strategies to Promote Social Equity in Health. Stockholm, Sweden: Institute for Futures Studies.

ESRI NL. (n.d.). Rotterdam.

Eurostat. (2016). European health interview survey - almost 1 adult in 6 in the EU is considered obese - share of obesity increases with age and decreases with education level. Retrieved on June 6th, 2019 from: http://ec.europa.eu/eurostat/documents/2995521/7700898/3-20102016-BP-EN.pdf/c26b037b-d5f3-4c05-89c1-00bf0b98d646.

García-Muñoz, T., Neuman, S., & Neuman, T. (2018). Behavioral Health Risk Factors: The Interaction of Personal and Country effects. International Society of Behavioral Medicine 25(2), 183–197.

GGD Groningen. (2016). Gezondheidsprofiel volwassenen 2016. Groningen: GGD Groningen.

GGD Groningen. (2018). Privacyreglement GGD Groningen . Groningen: GGD.

Giddens, A. (1984). The constitution of society: outline of the theory of structuration. Berkeley and Los Angeles: University of California Press.

Harrington, D., & Elliott, S. (2009). Weighing the importance of neighbourhood: A multilevel exploration of the determinants of overweight and obesity. Social Science & Medicine 68, 593–600.

Hosseinpoor, A., Williams, J., Amin, A., Carvalho, I., Beard, J., Boerma, T., Shea, B. (2012). Social Determinants of Self-Reported Health in Women and Men: Understanding the Role of Gender in Population Health. Plos One, 1-9.

Jen, M. H., Jones, K., & Johnston, R. (2009). Compositional and contextual approaches to the study of health behaviour and outcomes: Using multi-level modelling to evaluate Wilkinson's income inequality hypothesis. Health & Place 15, 198– 203.

Karvonen, S., & Rimpelä, A. (1996). SOCIO-REGIONAL CONTEXT AS A DETERMINANT OF ADOLESCENTS' HEALTH BEHAVIOUR IN FINLAND. Social Science & Medicine v43 n10, 1467-1474.

Kawachi, I. (1999). Social capital and community effects on population and individual health. Annals of the New York Academy of Sciences, 120-30.

Kooiman, N., & Simons, P. (2015). Sociaaleconomische trends: Banen van werknemers in krimpregios. Den Haag: CBS.

Macyntire, S., & Ellaway, A. (2003). Neighborhoods and Health: An Overview. New York: Oxford University Press.

Matheson, F., Moineddin, R., & Glazier, R. (2008). The weight of a place: A multilevel analysis of gender, neighbourhood material deprivation and Body Mass Index among Canadian Adults. Social Science and Medicine 66, 675-690.

McCartney, G., Collins, C., & Mackenzie, M. (2013). What (or who) causes health inequalities: Theories, evidence and implications? Health Policy 113 (3), 221-227.

Mehmetoglu, M., & Jakobsen, G. (2017). Applied Statistics Using STATA. California: Sage Publishing.

Nelson, M., Gorden-Larsen, P., Song, Y., & Popkin, B. (2006). Built and Social environments, Associations with Adolescent overweight and Activity. American Journal of Preventive Medicine, 109-117.

Nilsson, N., & Nilsson, E. (2009). Overweight and cognition. Scandinavian Journal of Psychology, 50, 660-667.

Pearce, J., & Witten, K. (2010). Geographies of obesity: environmental understandings of the obesity epidemic. Burlington: Routledge.

Popkin, B. (2017). Relationship between shifts in food system dynamics and acceleration of the global nutrition transition. Nutrition Reviews v75 n2, 73-82.

Popkin, B. (2018). Tackling the Obesity epidemic. North Carolina: University of North Carolina.

Putrik, P., Amelsvoort, L., Vries, N., Mujakovic, S., Kunst, A., Oers, H., . . . Kant, I. (2015). Neighborhood Environment Is Associated with Overweight and Obesity, Particularly in Older Residents: Results from Cross-Sectional Study in Dutch Municipality. Journal of Urban Health: Bulletin of the New York Academy of Medicine 92(6), 1038-1051.

Reither, E. N., Hauser, R. M., & Yang, Y. (2009). Do birth cohorts matter? age-period-cohort analyses of the obesity epidemic in the United States. Social Science & Medicine 69(10), 1439-1448.

Rijksinstituut voor Volksgezondheid en Milieu (2019). Standaardvraagstelling Volwassen en Ouderen Retrieved on July 7th, 2019. From https://www.monitorgezondheid.nl/vragenlijsten/vragenlijsten-volwassenen-en-ouderen

Robert, S.A., Reither, E.N. A multilevel analysis of race, community disadvantage, and body mass index among adults in the US. Social Science and Medicine 59(12), 2421-34.

Rosenkrantz, R., & Dzewaltowski, D. (2008). model of the home food environment pertaining to childhood obesity. Nutrition reviews v66, n3, 123-140.

Rosenman, R., Tennekoon, V., & Hill, L. (2011). Measuring bias in self-reported data. Journal of Behaviour and health research, 320–332.

Rowland, M. (1990). Self-reported weight and height. American Journal of Clinical Nutrition 52(6), 1125-1133.

Seidell, J. (1995). Obesity in Europe. Obesity Research v3 n2, 89-93.

Shaw, M., Dorling, D., & Mitchell, R. (2002). Health, Place and Society. Essex: Pearson Education Limited.

Sociaal Planbureau Groningen. Bevolking. Retrieved on July 10th, 2019 from: https://sociaalplanbureaugroningen.nl/bevolking/

Stattford, M., Cummins, S., Ellaway, A., Sacker, A., Wiggins, R., & Macintyre, S. (2007). Pathways to Obesity: Identifying local, modifiable determinants of physical activity and diet. Social Science & medicine 65, 1882-1897.

Swinburn, B., Egger, G., & Raza, F. (1999). Dissecting Obesogenic Environments: The Development and application of a framework for identifying and prioritizing environmental interventions for obesity. Preventive Medicine 29, 563–570.

Vidra, N. (2019). The obesity epidemic in Europe. Groningen: University of Groningen.

Visser, S. (2016). Gewoon et'n: An ethnographic study of intergenerational perspectives on food practices, overweight, and obesity in Eastern Groningen, the Netherlands. Groningen: Rijksuniversiteit Groningen.

Volksgezondheidszorg, (2017). Cijfers en feiten overgewicht. Retrieved on 01-07-2019 from: volksgezondheidszorg.info: https://www.volksgezondheidenzorg.info/onderwerp/overgewicht/cijfers-context/trends#node-trend-overgewicht-volwassenen

World Health Organization. (2017, 08). 10 facts on obesity. Retrieved on May 20th, 2019 from: https://www.who.int/features/factfiles/obesity/en/

Wilkinson, R. (1996). Unhealthy societies, The afflictions of inequality. London: Routledge.

Appendices

Appendix 1: Observations per category individual data.

	n	%
Gender		
Male	7,024	(45.5%)
Female	8,399	(54.5%)
Age		
19 - 34 years	1,900	(12.3%)
35 - 49 years	2,404	(15.6%)
50 - 64 years	4,187	(27.2%)
65 - 74 years	2,424	(15.7%)
75+	4,508	(29.2%)
Marital status		
Married/Cohabiting	9,551	(61.9%)
Living together	1,473	(9.6%)
Unmarried/Never married	1,675	(10.9%)
Divorced/LAT	967	(6.3%)
Widowed	1,609	(10.4%)
Unknown	148	(1.0%)
Chronic illness		
Yes	6,535	(42.4%)
No	8,670	(56.2%)
Unknown	218	(1.4%)
Exercise (≥ once a week)		
no	8,632	(56.0%)
yes	5,780	(37.5%)
Unknown	1,011	(6.6%)
Loneliness (De Jong Gierveld scale)		
Not lonely (score 0-2)	8,492	(55.1%)
Moderate loneliness (score 3-8)	5,379	(34.9%)
Severe loneliness (score 9-10)	744	(4.8%)
Very severe loneliness (score 11)	382	(2.5%)
Unknown	426	(2.8%)
Perceived neighbourhood deterioration		
Improved	1,288	(8.4%)
Stayed the same	11,700	(76.1%)
Declined	2,177	(14.2%)
Unknown	202	(1.3%)
Neighbourhood nuisance		
No nuisance	4,954	(32.1%)
Physical nuisance	2,896	(18.8%)
Lack of green spaces	1,977	(12.8%)
Traffic nuisance	755	(4.9%)
Other	4,020	(26.1%)

Unknown	821	(5.3%)
Level of Education		
Low (no education, primary school)	1,071	(6.9%)
Middle (lbo, mavo)	5,001	(32.4%)
Middle (mbo, havo, vwo)	4,880	(31.6%)
High (hbo, wo)	4,084	(26.5%)
Unknown	387	(2.5%)
Work status		
Employed	5,628	(36.5%)
Unemployed	1,087	(7.1%)
Housekeeper	2,213	(14.4%)
Retired/Student	5,747	(37.3%)
Unknown	748	(4.9%)
Difficulty making ends meet		
No difficulty	12,857	(83.4%)
Difficulty	2,186	(14.2%)
Unknown	380	(2.5%)

Appendix 2: Description of contextual variables

	Measure of urbanicity 1= Very high (> 2500 addresses per km2) 2= High (1500 – 2500 addresses per km2) 3= Medium (1000-1500 addresses per km2) 4= Low (500-1000 addresses per km2) 5= Very low (<500 addresses per km2)	**Mean municipal income** ×1000 euros	**Percentage rental homes (of total housing in municipality)** Including student population
Appingedam	3	21,3	52%
Bedum	4	24,7	32%
Bellingwedde	5	22,7	27%
Ten Boer	5	25,5	23%
Delfzijl	4	22,7	39%
Eemsmond	5	21,9	40%
Groningen	1	18,1	61%
Grootegast	5	23,8	26%
Haren	4	28,6	31%
Hoogezand-Sappemeer	3	21,4	44%
Leek	4	23,9	35%
Loppersum	5	23,6	35%
De Marne	5	22,4	32%
Marum	5	24,3	28%
Menterwolde	5	23,1	36%
Oldambt	4	21,6	37%
Pekela	4	21,2	36%
Slochteren	5	25,0	27%
Stadskanaal	4	21,4	39%
Veendam	4	22,2	34%
Vlagtwedde	5	22,2	32%
Winsum	5	24,4	31%
Zuidhorn	5	25,7	26%

Appendix 3: STATA output MMI categorical

```
. sum MMI, detail

                  Median Municipal Income
-------------------------------------------------------------
      Percentiles      Smallest
 1%         18100          18100
 5%         18100          18100
10%         21200          18100       Obs                15,423
25%         21400          18100       Sum of Wgt.        15,423

50%         22700                      Mean             22857.03
                        Largest        Std. Dev.        2354.381
75%         24400          28600
90%         25500          28600       Variance          5543112
95%         25700          28600       Skewness         .0785867
99%         28600          28600       Kurtosis         3.59618

.
```

Appendix 4: Obesity per age category, males and females

Females: Age in 5 categories

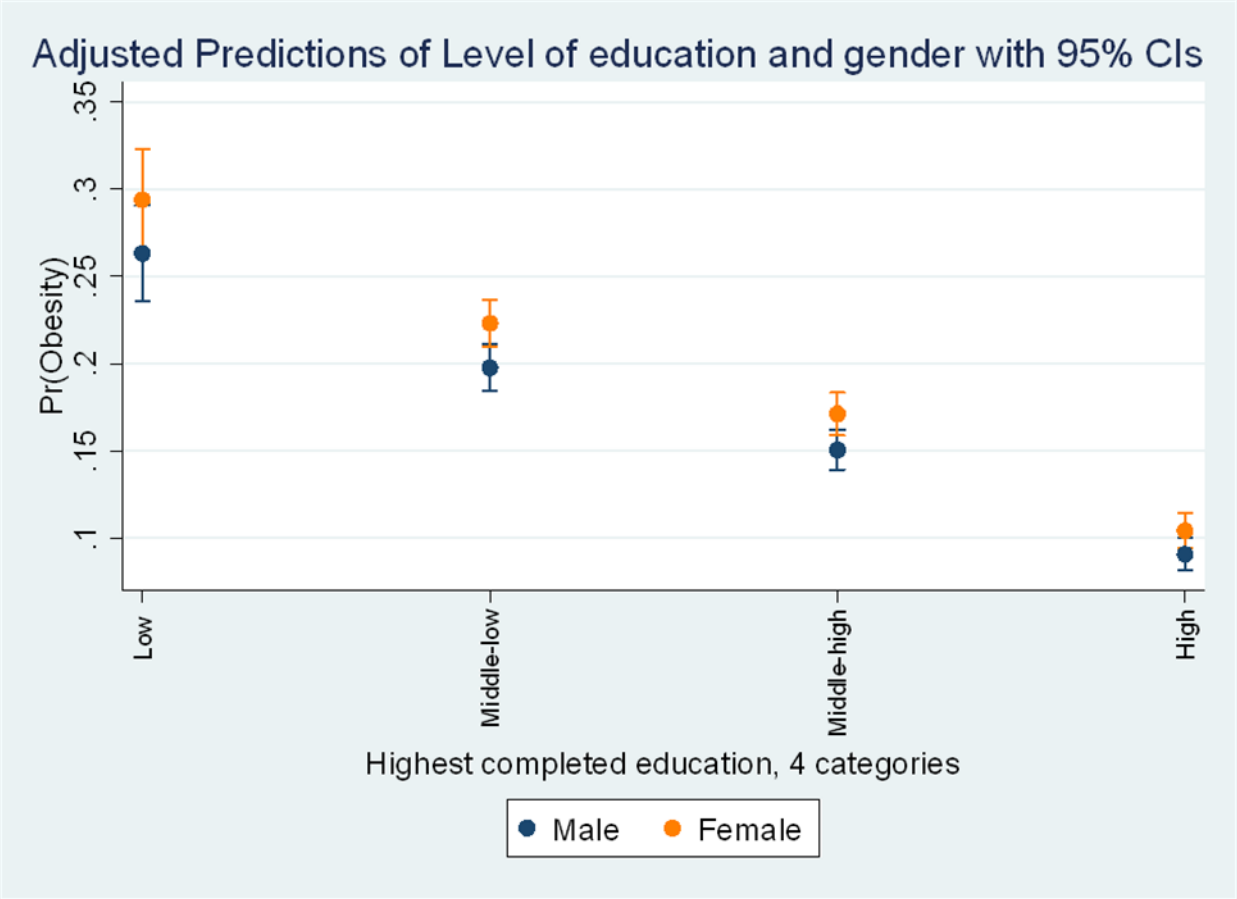
Obese	19-34	35-49	50-64	65-74	75+	total
no	1065	1188	1807	969	1831	6860
yes	139	230	437	233	500	1539
total	1204	1418	2244	1202	2331	8399

Males: Age in 5 categories

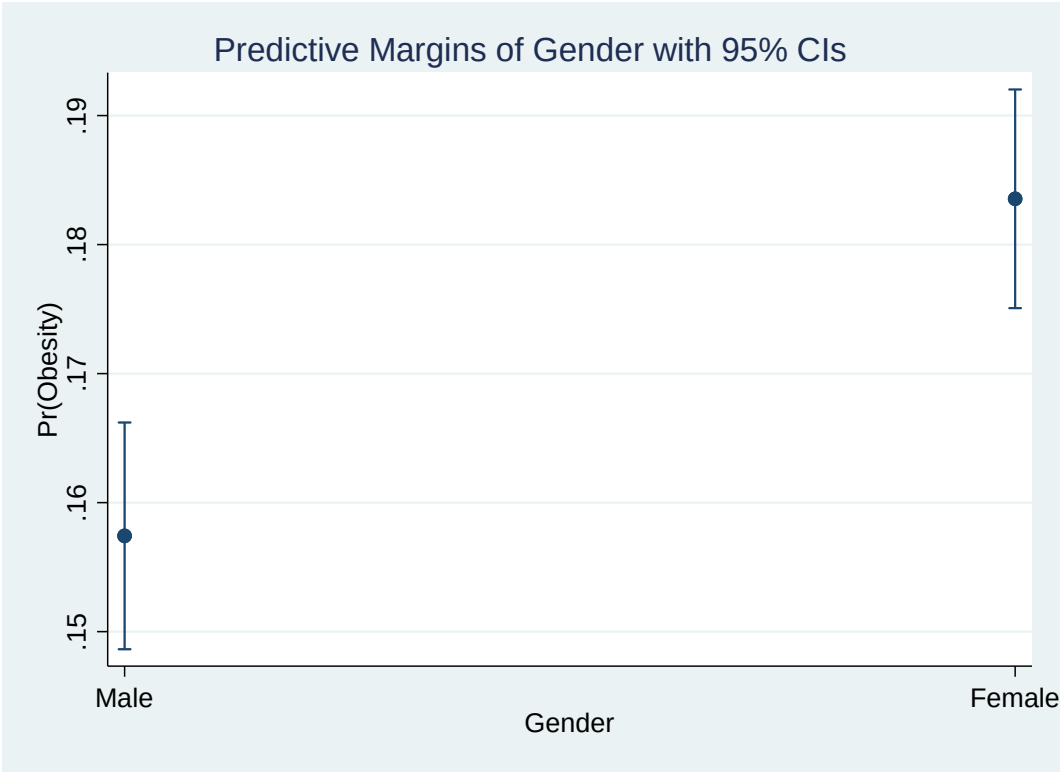
Obese	19-34	35-49	50-64	65-74	75+	total
no	648	830	1593	1020	1828	5919
yes	48	156	350	202	349	1105
total	696	986	1943	1222	2177	7024

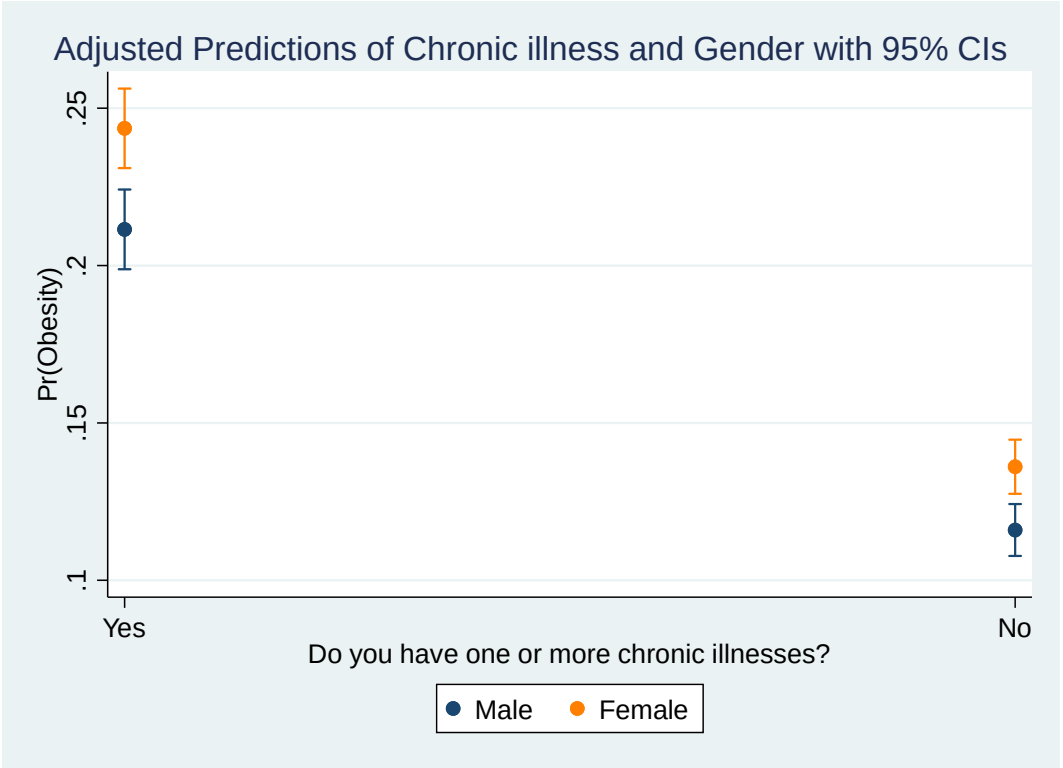
Appendix 5: Predictive margins Level of education males/females

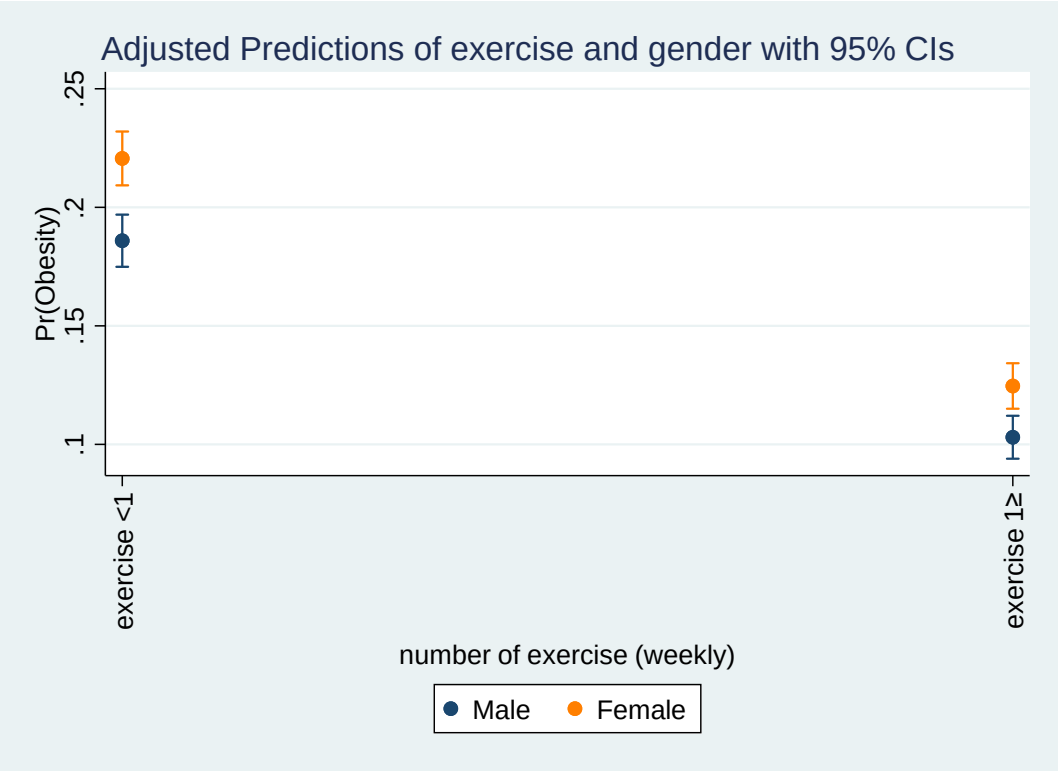
	Margin	Std. Err.	P>z	[95% Conf. Interval]	
Level of education					
Low	0.260089	0.018551	0.000	0.2237298	0.296449
Middle1	0.202076	0.007591	0.000	0.1871991	0.216953
Middle2	0.178101	0.007967	0.000	0.1624855	0.193717
High	0.12119	0.007794	0.000	0.1059139	0.136465



Appendix 6: Predictive margins Gender, Chronic Illness, Exercise (with 95% CIS)






Adjusted Predictions of exercise and gender with 95% CIs
Pr(Obesity)
.1
.15
.2
.25
exercise <1
exercise 1≥
number of exercise (weekly)
Male
Female