Physical activity levels in times of the COVID-pandemic

The impact of personality traits, socio-demographic and environmental factors in Venlo, the Netherlands

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Preface

This thesis called “Physical activity levels in times of the COVID-pandemic” marks the end of my master at Eindhoven University of Technology. This makes me proud and sad at the same time, as it means a closure of a major chapter of my life. However, I am curious what the upcoming opportunities and steps in my life will be. I was engaged in this thesis from November 2021 to July 2022. The basis of this research is a questionnaire conducted amongst inhabitants of the municipality of Venlo.

I would like to thank my supervisors Pauline van den Berg and Astrid Kemperman for providing guidance and feedback during my graduation project. In addition, I would like to thank Pieter van Gorp and Raoul Nuijten for their overall feedback and insights to improve my thesis. Whenever I was stuck in the process, there was always someone to help me out.

Secondly, I would like to thank the municipality of Venlo, especially Minou Weijs-Perrée, for her feedback and help in publishing the questionnaire. I am more than thankful for this opportunity. Subsequently, I would like to thank all the respondents; without their cooperation I would not have been able to conduct the analyses.

Lastly, I would like to grasp this opportunity to thank everyone who has been part of my student life in Eindhoven for the great time I had over the past years. Special thanks go to my boyfriend Wouter and my parents for always being there for me during my graduation project and studies. In the moments of lost interest, you kept me motivated.

I hope you enjoy reading this report.

Esmée Boereboom
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Summary

A major ongoing problem for public health are the low levels of physical activity (Hofman et al., 2021). Meeting the physical activity standards became even harder since March 2020, due to the COVID-pandemic. The Dutch government had put restrictions on group sizes in- and outdoors, the use of sport facilities, and advised citizens to stay home. Current studies show a decrease in physical activity during the pandemic and an increase in sedentary behaviour due to the lockdown measures (de Boer et al., 2021; Stockwell et al., 2021). This study extends existing knowledge and aims to provide insights into several factors that may affect physical activity levels in times of the COVID-pandemic. Hence, the main question of this research therefore, is: *"How do individual determinants, including personality traits, and the social, physical and natural environmental factors affect physical activity levels in times of the COVID-pandemic?"*

The Social-Ecological model formed the basis of this research. An extensive literature review was carried out to explore which individual determinants, social, physical and natural environmental factors affect physical activity. Furthermore, possible interventions to promote physical activity were explored. From the literature review it was concluded that different variables play a role in physical activity. Considering the individual determinants, according to the literature age, gender, education, income, employment, ethnicity, household composition, self-perceived health, gym membership, lifestyle and personality traits have a relationship with physical activity. Within the social environment, social support, social cohesion and culture affect physical activity. However, culture is not included in this study as social environmental variable. The literature review showed that from the physical environment, dwelling type, outdoor space, density, infrastructure (walkability), parks and sports facilities, neighbourhood aesthetics, neighbourhood safety and walkability affect physical activity levels. In addition, the natural environment also plays a role in the amount of physical activity according to the literature review. It is shown that seasonal variations, weather conditions and topography can determine the amount of physical activity. However, these variables are outside the scope of this study, as to measure these variables multiple measurements over time are needed. Lastly, interventions proposed by literature that may help increasing physical activity levels are in the digital environment (rewards in app, activity sharing in app), social environment (age-appropriate activities, individually adapted sport programs), physical environment (accessible sports/leisure facilities in public space, car-free city centre, improved/maintained infrastructure for walking/cycling), or policy environment (campaigns, workshops). Current literature about the preferences of citizens in implementing these interventions is very limited. Therefore, a stated choice experiment was conducted in this study, that allows measuring preferences for new still to be implemented alternatives or services.

Based on the literature review an online questionnaire was set-up to gather data of the inhabitants of Venlo. The questionnaire included questions about individual characteristics, social environment, perception of the physical environment, COVID and physical activity. A total of 358 respondents completed the questionnaire, of which 325 responses could be used for the analysis. The sample included 37% females and 63% males. Most respondents are aged 41-64 years (49.2%) or over 65 years (40.9%). Furthermore, 56.9% of the respondents had a high education level. This data has been analysed using a bivariate analysis and a multiple linear regression model in SPSS version 27. In addition, the questionnaire included a stated-choice experiment to analyse the preference for possible interventions to increase physical activity. Respondents had to choose four times between two packages of interventions, with the ability to choose 'none of these'. The packages were created based on an experimental design. Two variants of the choice sets were made and assigned randomly to the respondents. The proposed

interventions in the packages were personal support and guidance from an exercise broker/sports coach (yes/no), sports activity sharing via an app (possible/not possible), age-appropriate activities in neighbourhood (yes/no), availability free public fitness equipment in public space (improved/same as you current situation), availability free public sports facilities (improved/same as you current situation), access to gym (same price as now/with a discount), and earn rewards through app per activity (not possible/possible). The data of the stated-choice experiment was analysed by using a Multinomial Logit (MNL) model and a Latent Class (LC) model in NLogit version 6.0. The MNL is used to examine which intervention was most preferred by the respondents. The LC model was used to make a distinction between two classes of respondents with similar preferences. By using a bivariate analysis, the relationship between individual characteristics, social environment, perception of the physical environment, COVID, physical activity and class membership was examined.

The multiple linear regression model that was estimated on the dependent variable physical activity and the independent variables gender, ethnicity, self-perceived health, smoking, vegetable intake, sporty friends/family, social support, infrastructure (getting from place to place), and other ways of exercising during the COVID-pandemic showed that five variables have a significant relationship with physical activity. Being attracted to other ethnic groups showed to have a negative relationship with physical activity. Smoking also resulted in a negative relationship with physical activity. Having found other ways of exercising due to the COVID-pandemic, having a higher self-perceived health and being more satisfied with the infrastructure to get from place to place showed to all have a positive relationship with physical activity. All in all, from the multiple linear regression model could be concluded that the most important variables affecting physical activity are self-perceived health and having found other ways of exercising due to the COVID-pandemic.

Considering the stated-choice experiment, this study showed that in general respondents find personal support and guidance from and exercise broker/sports coach and the improved availability of free public fitness equipment in public space the most important intervention. Two classes of respondents could be identified through the LC model, namely ‘no preference class’ and ‘preference class’. The respondents in ‘no preference class’ were more likely to choose no package of interventions. They were characterized by higher levels of social support and more satisfaction with the walkability, maintenance of the cycling paths, the parks and sports facilities in the neighbourhood, and a higher score for safety compared with the ‘preference class’. Furthermore, the ‘no preference class’ included more households without children compared to the ‘preference class’. Subsequently, the ‘preference class’ included more households with children or one-person households. The ‘preference class’ respondents are more likely to choose one of the proposed packages of interventions. For them, the most important interventions are personal support and guidance from an exercise broker or sports coach and the improved availability of free public fitness equipment. The least important intervention for them is the improved availability of public sports facilities, such as walking and cycling paths. Sports activity sharing via an app appears to be not important to the residents.

It must be noted that this study had some limitations by which the results might be influenced, for example the sample was not representative for the municipality of Venlo because of the overrepresentation of older and higher educated people. Furthermore, the sampling bias might have caused for the fact that a large proportion of the respondents met the physical activity guidelines. Overall, this study showed that only a few variables have a relationship with physical activity. Respondents with a higher self-perceived health, connected with the Dutch ethnicity, do not smoke, or found other ways of

exercising due the COVID-pandemic have higher levels of physical activity. Furthermore, respondents who are more satisfied with the infrastructure to get from place to place also appear to have higher levels of physical activity. It can be concluded that respondents of the 'preference class' prefer to have personal support and guidance from an exercise broker/sports coach and improved availability of public fitness equipment. Respondents of both classes prefer to have access to a gym with discount to make physical activity more accessible. Hence, policy makers and the municipality of Venlo are advised to implement these interventions into the built environment. Furthermore, since smoking and health do affect physical activity levels, they are also advised to discourage smoking and promote physical activity for people with a lower self-perceived health. The latter might be done by implementing the proposed interventions to make physical activity accessible for more people. Furthermore, when another wave of the COVID-pandemic arrives, it is also advised to support people in finding alternative ways of exercising since it was found that people who have found other ways of exercising due to the COVID-pandemic have higher levels of physical activity.

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1. Introduction

1.1. Background to the problem

The awareness that physical activity serves as a way to promote health dates back to early civilizations. In early Greek times, the importance of physical well-being and an active lifestyle was already highlighted by Hippocrates and Plato. At that time, physical activity was already part of education (MacAuley, 1994). Over the years, more knowledge was gained about this subject. Currently, it is known that being physically active brings many benefits to the health of a human being, in general advantages for both physical and mental health. Research shows that physical activity may lead to the prevention of multiple chronic diseases, such as heart disease, cancer and diabetes (Durstine et al., 2013). Regarding mental health benefits, physical activity may prevent depression and anxiety (Matias et al., 2022; Schuch et al., 2018, 2019). Participation in team sports may be even better for mental health (Matias et al., 2022).

The World Health Organization (WHO) has set up guidelines for the amount of physical activity that is recommended per age category. The aerobic guideline for adults aged 18–64 years is set to have at least 150–300 minutes of moderate-intensity physical activity or 75–150 minutes of vigorous-intensity physical activity per week (World Health Organization, 2020). Table 1 shows the division within the intensity levels. Furthermore, it is recommended to exercise muscle-strengthening activities at least two times a week (World Health Organization, 2020).

Table 1: Physical activity intensity division (CDC, 2020)

Moderate intensity (MVPA)	Vigorous intensity (VPA)
Walking >4.8 km/h	Jogging or running
Water aerobics	Swimming
Cycling <16 km/h	Cycling >16 km/h
Tennis doubles	Tennis singles
Ballroom dancing	Aerobic dancing
General gardening	Heavy gardening
	Hiking uphill

A major ongoing problem for public health are the low levels of physical activity among the world's population (Hofman et al., 2021). The most recent global numbers are from 2016, in which 28% of the adults did not meet the required physical activity levels (World Health Organization, 2020). Increasing physical activity of the global population would prevent four to five million early deaths due to lower risk of diseases (World Health Organization, 2020). The majority of the population of the Netherlands does not comply with the physical activity guidelines. Figure 1 shows the amount of people per year that meet the physical activity guidelines of the WHO. In 2019, 48.4% of the Dutch population met the WHO guidelines (RIVM, 2021). So, the majority of the Dutch population did not get sufficient physical activity.

Figure 1: Percentage of Dutch population meeting physical activity guidelines of WHO (RIVM, 2020)

Since March 2020 the WHO declared a global pandemic due to the COVID-19 outbreak (Cucinotta & Vanelli, 2020). Hence, the Dutch government has implemented several measures to reduce the spread of the virus. Key rules are social distancing, which refers to keeping 1.5 meters distance from people outside your household, and restrictions on group sizes and gatherings. Hereby, there are also restrictions put on sports facilitators (Rijksoverheid, 2021). Overall, these restrictions limited the possibilities in being physically active and made it even harder for people to live a healthy lifestyle (van der Werf et al., 2021). People were obliged to exercise on their own, without access to suitable equipment. In addition, the curfew caused that some people ran out of time for physical activity. Hence, a shift in lifestyle may occur in which a decrease in physical activity occurs due to governmental restrictions.

According to RIVM (2020), in 2020 during the pandemic, 51.9% of the Dutch population met the WHO guidelines. However, the number of 2020 might be biased as due to the COVID measures people could not be visited at home for an interview, instead they only could participate via a survey. In addition, the inquiry period 'in a normal week in the past months' has been used and this might have resulted in an overestimation of physical activity (Duijvestijn et al., 2021). According to the study by Hofman et al. (2021), 59% of the participants of the study in 2020 did not meet the physical activity guidelines of the WHO. The study from de Boer et al. (2021) shows that 40% of the respondents lowered their amount of physical activity in the first months. From June onwards, it stabilized to an average decrease of 23%. The majority of current studies conclude that there is a decrease in physical activity during the pandemic and an increase in sedentary behaviour due to the lockdown measures (Stockwell et al., 2021). Therefore, it is expected that a decrease can be seen during the COVID-pandemic.

The pandemic shed a new light on the plea for physical activity as, according to scientific research, being physically active reduces the risk of hospitalization, ending up on the intensive care or even death after a COVID-19 infection (Sallis et al., 2021). Therefore, there recently has been an increased interest in the topic of physical activity. Current research shows several options to increase physical activity, such as provide free access to fitness centres, use of gamification and apps, providing individual age-appropriate programs and clear campaigns (Centers for Disease Control and Prevention, 2011; Mazeas et al., 2022).

1.2. Research objective and questions

Lifestyle changes and physical activity during the pandemic has been studied in several countries. Parts of lifestyle are the habits of people, such as alcohol use, smoking, exercise, hours of sleep, eating behaviour and stress (van der Werf et al., 2021). Physical activity can be seen as part of lifestyle (van der Werf et al., 2021). Physical activity is defined as any movement produced by muscles of a human being including movements during leisure time, for transport, and work (World Health Organization, 2020).

During the pandemic each country could determine their measures to contain the virus themselves. Hence, results of specific case studies on physical activity levels during the COVID-pandemic should be carefully looked after as differences in measures could lead to more restrictions. Considering Dutch research, the research by Hofman et al. (2021) shows insights in factors determining physical activity in Rotterdam during the pandemic among different sub-groups of the population. They conclude that older age, lower education level, poorer health or disabilities and depression are factors determining lower physical activity during the pandemic. Considering lifestyle, they conclude that smoking, alcohol intake and eating less healthy result in lower physical activity levels during the pandemic. The research of de Boer et al. (2021) focuses on socioeconomic differences in education and income. They conclude the same and add that people living alone or with young children have a higher chance of decreased physical activity levels. De Boer et al. (2021) also highlights the importance of focusing on low socio-economic status groups in research concerning physical activity. Concluding, socio-demographic characteristics such as age, gender, education, income, employment, ethnicity and health affect physical activity (de Boer et al., 2021; Hofman et al., 2021).

Little is known about how environmental factors affect the amount of physical activity during the pandemic. The outcome of research before the pandemic shows that several physical environmental characteristics positively affect physical activity, such as access to green spaces and facilities, density, pedestrian friendly environment, traffic and crime safety and aesthetically pleasant neighbourhood (Cerin et al., 2017; Kärmeniemi et al., 2018; van Cauwenberg et al., 2018). Furthermore, little is known about the preferences of citizens regarding interventions to increase physical activity levels.

This study extends the existing knowledge by specifically focusing on the city of Venlo. In 2021, 46% of the inhabitants of Venlo do not conduct weekly exercise, whereas the average in the Netherlands was 54.2% (Gemeente Venlo & I&O Research, 2021; RIVM, 2021). This study aims to provide insights into the environmental and sociodemographic factors that affect the physical activity levels in times of the COVID-pandemic in Venlo. A questionnaire will be conducted among inhabitants of Venlo in 2022. This dataset will be analysed with statistical regression models. A part of the questionnaire consists of a stated choice experiment to measure the preferences of respondents for new still to be implemented interventions or services, such as age-appropriate activities or app usage. The stated choice data will be analysed with a multinomial logit model and a latent class model. The insights can be used by policymakers and municipalities to design a built environment that stimulates physical activity and hereby improves physical and mental wellbeing amongst their inhabitants. The following research questions have been formulated:

Main question: How do individual determinants, including personality traits, and the social, physical and natural environmental factors affect physical activity levels in times of the COVID-pandemic?

1. How do individual determinants impact physical activity?
2. How do physical environmental factors impact physical activity levels?

3. How do social environmental factors affect physical activity?
4. How does the natural environment affect physical activity?
5. How do the proposed interventions or services, such as using apps, age-appropriate activities, and public sports facilities stimulate active behaviour?

1.3. Relevance

1.3.1. Scientific relevance

This study contributes to the existing literature by providing a better understanding of the environmental and socio-demographic factors impacting physical activity during the COVID-pandemic. It provides an approach for the city of Venlo in the Netherlands, as the questionnaire is conducted amongst inhabitants of Venlo. The social-ecological model provides a framework for understanding barriers and stimulators for physical activity behaviour (Bornstein & Davis, 2014). The social-ecological model will form the basic framework of this research. It shows that physical activity is affected by individual (socio-demographics and personality traits), social, physical and natural environment (Bornstein & Davis, 2014). Previous studies before the pandemic mainly dove into one of the following subjects: the socio-demographic, environmental, or psychological factors to explain physical activity. This study attempts to study all these and includes objective and subjective measures. Hereby, the aim is to provide insights and possible interventions to promote physical activity among all classes of society. Furthermore, it may help the government to provide suitable (COVID-)measures in which physical activity still is possible and accessible.

The results of this study might also be used in other cities and countries, as, although different cities have different context, there are also similarities between cities. European and American cities have a lower density, are less compact and have higher level of open spaces compared to Asian or Latin American cities. West and Northern European cities have more in common with American cities than other European cities (Huang et al., 2007). It must be noted that Dutch cities often have well integrated cycling infrastructure, which makes them different from other countries. However, also in for example Denmark and Germany a high number of cyclist are seen (Vogel Kielgast et al., 2017). Venlo is a medium sized Dutch city (CBS, 2021b, 2021a). Hence, the results might be generalizable to other medium-sized (Dutch) cities due to similarities in the environment, such as level of urbanity (suburbs with low-rise buildings, city centre with medium sized buildings) and the presence of walking and cycling paths (CBS, 2021b). However, it is advised to take the socio-economic context, distances and availability to facilities, and country or city context into account before generalizing the results of this research to different countries or cities.

1.3.2. Societal relevance

Policymakers and municipalities might not be fully aware of the contribution of the built environment and public health policies in promoting physical activity. Therefore, this research aims to provide a better understanding of the environmental and individual factors that affect physical activity and the possible interventions by which physical activity can be promoted. The insights can be used by municipalities, policymakers and health-care providers to improve physical activity for all classes and to design a built environment in which physical activity is promoted to increase public health.

1.4. Outline of report

The remainder of this report is structured as follows. Chapter 2 discusses the existing literature. The literature review will be used to set up a conceptual model. Based on the conceptual model a questionnaire will be developed in chapter 3. Chapter 4 describes the methodology used to analyse the

data. The data retrieved through the questionnaire will be described in chapter 5 and the results will be elaborated in chapter 6 (Stated choice experiment) and chapter 7 (Bivariate and regression analysis). Chapter 8 provides a discussion between the results of this study and the literature review. Hence, the report will be closed with the policy implications and conclusion in chapter 9.

2. Literature review

This chapter provides the definition of physical activity. It will give insights in the current research of how COVID affects physical activity. Furthermore, it will elaborate on the personality traits, socio-economic and environmental factors affecting physical activity. Lastly, it will sketch some possible interventions in ongoing research to promote physical activity. The findings are used to conclude with a preliminary conceptual model.

2.1. Physical activity

Physical activity can be seen as part of lifestyle (van der Werf et al., 2021). Physical activity is defined as any movement produced by muscles of a human being including movements during leisure time, for transport, and parts of a person's work (World Health Organization, 2020).

Before the COVID-pandemic hit, 48.4% of the Dutch population met the physical activity guidelines of the WHO (RIVM, 2021). The COVID-pandemic decreased the amount of physical activity undertaken worldwide. However, differences between regions and countries can be recognized, caused by regional variation in infection rates, enforcement and measures (Tison et al., 2020). Wilke et al. (2021) studied physical activity levels in Australia, Austria, Argentina, Brazil, Chile, France, Germany, Italy, Netherlands, South Africa, Singapore, Switzerland, Spain and USA. They conclude that 66.8% (of N=13503) of the participants have a decrease in physical activity levels. Again, variation was seen between countries, see Figure 2. In the Netherlands a decrease in physical activity has taken place during the pandemic. This is in line with the Dutch studies discussed explained in the introduction. Overall, respondents with a higher level of physical activity before the pandemic were seen to have the largest decrease (Stockwell et al., 2021; Wilke et al., 2021). This might be explained by the fact that the lockdown measures urged people to work from home, consequently physical activity due to commuting time decreased. Furthermore, sport and leisure facilities were closed which all leads to increased sedentary behaviour instead of physical activity (Stockwell et al., 2021).

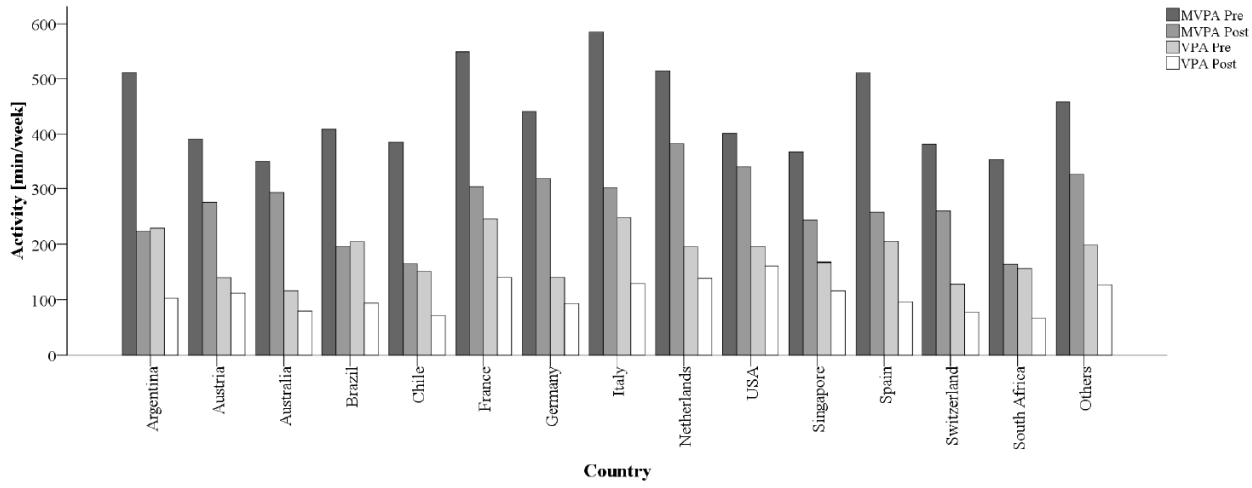


Figure 2: Variation between countries (Wilke et al., 2014)

Maintaining regular physical activity provides many benefits for both physical as well as mental health (World Health Organization, 2020). Therefore, there is an ongoing need to stimulate and improve the physical activity levels. According to World Health Organization (2020), policies may help to increase physical activity by, for example, accessible and safe forms of non-motorized transport, encouraging of

active commuting and physical activity during the work day, physical education in primary and secondary schools, community-based and school-sport programmes to create chances for all ages, and accessible sport and recreation facilities.

This is also portrayed by the social-ecological model, see Figure 3 (left). Social-ecological models provide a framework for understanding barriers and stimulators for physical activity behaviour, so these models can help to identify opportunities to promote physical activity. These models consider the entire context, ranging from social to physical environments (Bornstein & Davis, 2014; Lee et al., 2017). This framework will also be used in this research as a base. As seen in Figure 3 (right), the social-ecological model is adapted for physical activity and active living. The spheres of the social-ecological model that affect physical activity are individual determinants, social environment, and built and natural environment (Bornstein & Davis, 2014; Lee et al., 2017). The non-adapted social-ecological model also includes policy environment, therefore this sphere will also be included in this research. Hence, the factors affecting physical activity used in this research are individual determinants, personality traits, social environment, physical environment, natural environment and the policy environment.

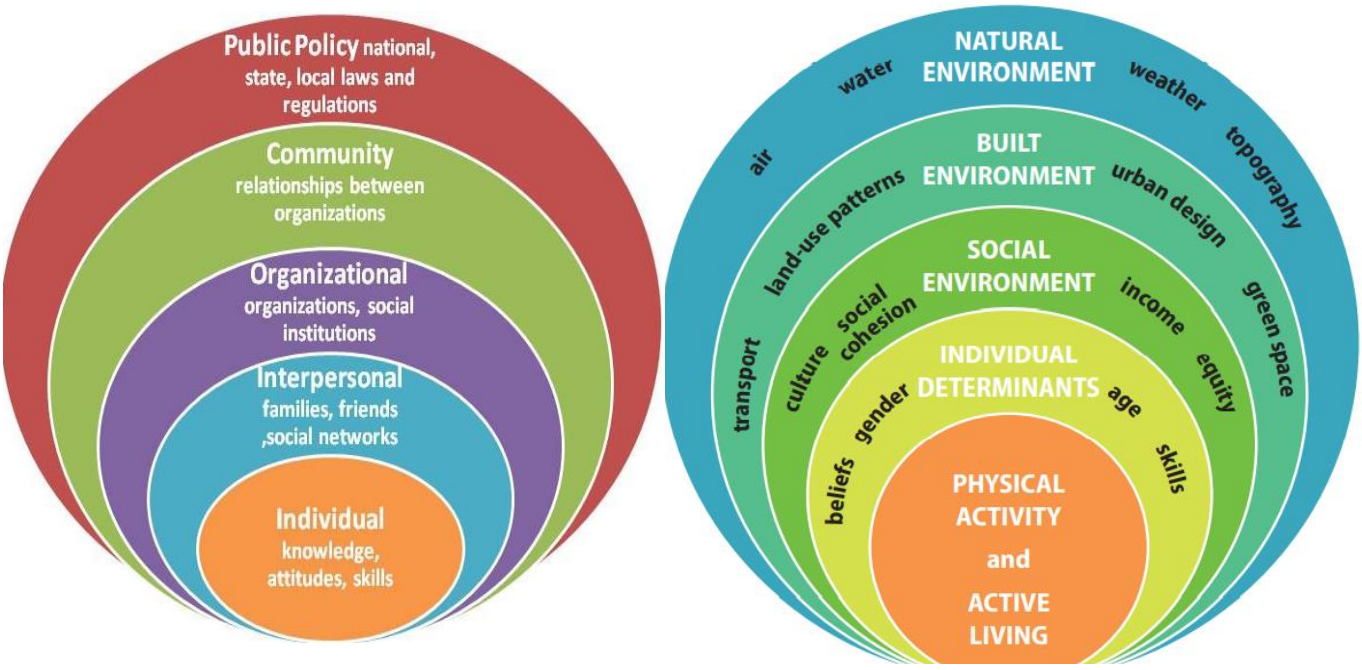


Figure 3: Social-Ecological model (left) and adopted Social-Ecological model for physical activity (left) (Bornstein & Davis, 2014; Lee et al., 2017)

2.2. Individual determinants

This paragraph describes the relationship between individual determinants and physical activity. The individual determinants are split into socio-demographic characteristics and personality traits.

2.2.1. Socio-demographic characteristics

The relationship between socio-demographic characteristics and physical activity appears in several previous studies. Socio-demographic characteristics such as age, gender, education, income, employment, ethnicity and marital status affect physical activity (Pharr et al., 2020). In addition, health and gym membership play a role in the amount of physical activity undertaken (Kamphuis et al., 2007; Schroeder et al., 2017). This section discusses the most important findings in current literature.

Age

Physical activity declines when people get older (Pharr et al., 2020). During the COVID-pandemic, age is also found to be related to physical activity. The younger respondents were more physically active, whereas the elderly reported the lowest level of physical activity (Hofman et al., 2021; Puciato, 2019). On the other hand, van der Werf et al. (2021) concludes that younger people lived unhealthier during the pandemic. However, the latter concerns the complete lifestyle hereby for example eating habits are also included. This may bias the results. Complementing these two conclusions, the youngest and oldest respondents have the largest decrease of physical activity (Wilke et al., 2021).

Gender

Gender is one of the socio-demographic factors which may affect physical activity levels. Before the pandemic, research indicates that women are less likely to participate in physical activity compared to men (Pharr et al., 2020). This also supported by the study of Hofman et al. (2021) during the pandemic. They found that women more frequently have lower physical activity levels. However, Wilke et al. (2021) found no differences between men and women.

Education, income and employment

Education, income and employment are three indicators of socio-economic status (SES) (Brattbakk & Wessel, 2013). As seen later in this report, there are difference in physical activity between different SES groups. In this paragraph, education, income and employment and their impact on physical activity will be separately discussed.

Lower physical activity is found in groups who have a lower education both during and before the pandemic (Hofman et al., 2021; Pharr et al., 2020; Puciato, 2019). However, according to Pharr et al. (2020), before the pandemic there is only a weak association between education level and physical activity.

People with a lower income participated in less physical activity before the pandemic, however again this is a weak association (Pharr et al., 2020). A study during the pandemic found that income is not significant (de Boer et al., 2021). When comparing people with part-time and full-time jobs during the pandemic, it can be seen that part-time jobs result in lower physical activity compared to full-time jobs when intention for exercising is low (Teran-Escobar et al., 2021). Before the pandemic, manual workers had the highest level of physical activity (Puciato, 2019), this might be caused by the high level of physical work. Both during and before the pandemic, it appears that unemployed participants often have lower physical activity levels (Hofman et al., 2021; Puciato, 2019). This might be explained by having a larger distance to sporting facilities and less walking or cycling to and at work. Neighbourhoods with an average low income have less free sports facilities in the neighbourhood, which may reduce the opportunities and accessibility for people with lower income to sport regularly (Estabrooks et al., 2003), resulting in lower physical activity for this class of society. So, low SES groups are less likely to participate in physical activity.

Ethnicity

According to existing research, ethnicity is another socio-demographic variable that affects the frequency and level of physical activity. A study in the United states shows that there is a weak association between ethnicity and physical activity levels (Pharr et al., 2020). Research conducted in the Netherlands before the pandemic shows differences between Dutch participants and ethnic minorities. Dutch participants had higher frequency of vigorous activities. Dutch men report higher cycling time, whereas African-Surinamese people report higher walking times (de Munter et al., 2010).

Sallis et al. (2021) studied whether patients with higher inactivity had higher risk for severe COVID-19 outcomes during the pandemic. They show that white patients most frequently meet the physical activity guidelines of the WHO compared to other ethnic groups, see Table 2.

Table 2: Ethnicity meeting physical activity guidelines (Sallis et al., 2010)

Ethnicity	Meeting physical activity guidelines WHO
Asian	7.3%
Black	4.6%
Hispanic	5.5%
Native American	4.5%
Pacific Islander	5.8%
White	9.4%
Other	11.8%

It must be noted that the major ethnicity groups in the Netherlands differ from the United States. In Venlo, 70% is native Dutch, 17% have a western migration background and 12% have a non-western migration background (CBS, 2021b). People with migration background often have lower education levels and income (de Mooij et al., 2020), therefore it is expected that there are also differences in physical activity between ethnic groups in the Netherlands.

Household composition

During the pandemic, research showed that living alone or with young children have a higher chance of lower physical activity levels (de Boer et al., 2021). When looking at findings regarding household size before the pandemic, there are differences seen in the amount of people adhering to the physical activity guidelines American College of Sports Medicine[1]. As seen in Table 3, meeting the physical activity for a 2-person household is lowest (Puciato, 2019). People living alone have the highest physical activity level. So, the household composition does matter in the amount of physical activity taken.

Table 3: Men versus women adhering to the physical activity guidelines before the pandemic (Puciato, 2019)

Household size	Men	Women
1	54.2%	50.9%
2	29.8%	39.5%
3	47.5%	45.8%
4	47.7%	40.0%
≥5	40.1%	46.0%

Self-perceived health

Self-perceived health is a very subjective topic, however it is often used in questionnaires to generally measure the health of participants. Sallis et al. (2021) studied physical activity and its association with a higher risk of severe covid-19 infection amongst patients during the pandemic. It appears that regularly inactive patients had a higher chance of hospitalization. This might indicate that people with a higher self-perceived health are more active. This is partly supported by van der Werf et al. (2021), as they conclude that people who experience stress because of health concerns lived unhealthier during the pandemic. On

[1] They recommend moderate intensity activities 5 times a week for 30 minutes a day. That equals at least 150 minutes per week, which is the same as the guidelines of the WHO (ACMS, 2018; World Health Organization, 2020).

the other hand, people who were anxious for getting infected with COVID resulted to live healthier during the pandemic (van der Werf et al., 2021). In addition, Hofman et al. (2021) states that a poorer health results in lower physical activity. Before the pandemic, lower SES groups more often reported their health as a barrier for physical activity (Kamphuis et al., 2007).

Gym membership

There is a limited amount of literature available about whether or not gym membership affects the amount of physical activity. From findings before the pandemic appears that physical activity increases when having a gym membership. Concerning the total amount of physical activity, 87% of the members and only 30% of non-members meet the WHO guidelines for aerobic activities. When looking at both WHO guidelines, it is seen that 75% of the members and 18% of the non-members meets them (Schroeder et al., 2017). In the Netherlands, 54% of the people who met the WHO guidelines for physical activity in 2019 have a gym or sport membership (CBS, 2020c).

Especially during the pandemic research regarding gym membership is limited. It is known that gym members in general had a hard time to continue their sports activities due to the closure of gym centres and no sport partners (Kaur et al., 2020). However, compared to non-members it is not known what the differences are. In Venlo, 31% of the inhabitants is a member of a sport association and 29% is member of a fitness centre (Klein-Kranenburg & Veld, 2020).

Lifestyle

Lifestyle is defined as "someone's way of living" (Cambridge Dictionary, n.d.). There are several factors of a lifestyle which a person can modify. These include alcohol consumption, smoking, daily fruit and vegetable consumption, body-mass-index and physical activity (Ng et al., 2020). The study of González-Monroy et al. (2021) showed a systematic review of multiple studies. They conclude that there is a change in fruit and vegetable intake as a result of the COVID pandemic. Furthermore, the alcohol consumption increased and a clear change in eating and drinking habits during the COVID pandemic is seen (González-Monroy et al., 2021). In addition, Hofman et al. (2021) states that smoking and eating less healthy results in lower physical activity.

2.2.2. Personality traits

Personality traits influence the behaviour of people and therefore may refer to the individual determinants of the social-ecological model. The research of Wilson & Dishman (2015) studied personality and physical activity in articles published before November 1st 2013. They conclude that there is a significant relationship between physical activity and the personality traits extraversion, neuroticism, conscientiousness, openness and agreeableness. Kekäläinen et al. (2020) also studied personality traits and physical activity before the pandemic. He concludes that extraversion and conscientiousness positively affects self-reported physical activity levels. Neuroticism and agreeableness are not associated with physical activity. Openness only showed a weak positive association to self-reported physical activity (Kekäläinen et al., 2020).

The research by van Geest (2020) aimed to find which personality traits hinder or enable physical activity levels before and during the pandemic among inhabitants of Eindhoven. In his research, he used the Mini International Personality Item Pool (IPIP)[2] to assign respondent to one of the five personality traits

[2] Mini-IPIP is a short form of the IPIP. There are 20 questions involved in the Mini-IPIP, whereas in the latter 50 questions are included (Donnellan et al., 2006; Goldberg, 1999).

openness, conscientiousness, extraversion, agreeableness, and neuroticism based on Wilson & Dishman (2015). He found that people with the main personality neuroticism were the only one who showed an increase in physical activity when comparing before and during the pandemic, however the number of people in that group were only 15, so results may be doubtful as they also contradict previous research of Wilson & Dishman (2015).Van Geest (2020) also found that there is a correlation between extraversion and physical activity, which is in line with previous research. People belonging to the group of extraversion have the highest physical activity level compared to the other groups. The correlation of extraversion and physical activity remained also during the pandemic. The group conscientiousness only appears to correlate with physical activity before the pandemic, not during. For the groups who score higher on agreeableness and openness, van Geest (2020) did find that their activity decreased during the pandemic, however he could not find a correlation for the explanation of this during his research.

2.3. Social environment

Social environment is another sphere of the social-ecological model explaining physical activity. Culture, social support and social cohesion are amongst others part of it. In some cultures, women are hindered in performing physical activity. This is especially the case in developing countries such as Israel, India and the United Arab Emirates due to cultural societal beliefs and lack of appropriate facilities (Abbasi, 2014).

Social cohesion is the concept of mutual trust and solidarity among residents (Sampson et al., 1997). The study of Kim et al. (2020) shows that elderly who experience neighbourhood social cohesion are more likely to participate in physical activity. In addition to social cohesion, social support may help in changing physical activity behaviour (Mendonca et al., 2014).

The Theory of Planned Behaviour shows the relationship between attitude and behaviour. This framework has been used to explain physical activity motivation and behaviour. The three elements are attitude, subjective norms and perceived behavioural control. The subjective norm is the perceived social pressure that affects the decision to perform, amongst others, physical activity (del Carmen Neipp et al., 2013). Perceived behavioural control is the perception of the ability of a person that he or she can perform the behaviour within her/his control. The more perceived behavioural control, the more likely the person is to carry out the activity (del Carmen Neipp et al., 2013). The study of del Carmen Neipp et al. (2013) shows that more perceived behavioural control results in greater intention for physical activity. The subjective norm was a weak predictor for the intention to perform physical activity (del Carmen Neipp et al., 2013).

The physical activity behaviour of other people in the social environment are related to personal physical activity, depending on the level of support received by that person. Especially, behaviour of friends and partner affects own physical activity behaviour (Darlow & Xu, 2011). Social support is defined by Lin et al. (1979) as “support accessible to an individual through social ties to other individuals, groups, and the larger community” (Lin et al., 1979). Social support is beneficial for both low and high SES groups (Kamphuis et al., 2007). Social support positively affects the amount and frequency of physical activity. When receiving more social support, it is more likely that people engage in sufficient amount of physical activity (Mendonca et al., 2014). Social support is found to be more important for women than for men (Sherwood & Jeffery, 2000; Ståhl et al., 2001). From the research of Morrissey et al. (2015) appeared that the support from friends and family results in higher levels of physical activity. The role of support of friends is especially important for adults, since adults participate in physical activity to be active with friends. For youth, the support of family is especially important.

When looking at findings during the pandemic, it can be seen that receiving social support also significantly correlated with physical activity (Bopp et al., 2021; Lesser & Nienhuis, 2020). Social support may be even more important for inactive individuals, as it appears that they are more likely to exercise physical activity with others compared to active participants. This may be important to take into account to change behaviour (Lesser & Nienhuis, 2020). Furthermore, elderly who receive more social support are more likely to execute leisure time physical activity, such as walking. Especially support from family and friends are important (Lindsay Smith et al., 2017).

2.4. Physical environment

Most research on the topic physical environment is executed before the pandemic. According to the Knowledge Centre for Sport & Physical Activity Netherlands, a physical activity friendly environment is "an environment that facilitates, stimulates and challenges people to be physically active, to play, to exercise or to do sports" (Hoyng & Scholte, 2021). The outcome of research before the pandemic shows that several physical environmental characteristics positively affect physical activity, especially amongst older adults and children, these are: access to green spaces and facilities, density, pedestrian friendly environment, traffic and crime safety and aesthetically pleasant neighbourhood (Cerin et al., 2017; Kärmeniemi et al., 2018; van Cauwenberg et al., 2018).

Interventions in the physical environment may stimulate and help in engaging in physical activity, as better urban planning may lead to enhancing outside activities and the use of active modes of transport(Vogel Kielgast et al., 2017). Hoyng & Scholte (2021) developed the Physical Activity Friendly Environment Model in which there are three important elements: hardware, software and orgware. The hardware refers to physical infrastructure, so the presence of sports accommodation, parks, public recreational facilities and infrastructure. Software refers to stimulation of activity. This can be done through activities, social support, stimulation via interventions, campaigns and the usage of apps. The orgware is about the vision, maintenance, monitoring and management of the hardware and software by the municipality and other parties involved (Hoyng & Scholte, 2021). This section discusses the most important findings concerning urban density, infrastructure, parks and sport facilities and safety.

2.4.1. Dwelling type and density

A higher population and housing density results in more physical activity, especially walking and cycling rates increase due to shorter distances to facilities. Subsequently, in rural areas the distance to facilities are larger (Kärmeniemi et al., 2018; Svensson et al., 2017). Higher population density often indicates a specific type of dwelling, namely apartments (Svensson et al., 2017). The Swedish study of Svensson et al. (2017) shows that people living in an apartment spend less time on housework but more time on inactive sedentary behaviour, such as watching tv. This can be explained by the size of the dwelling and availability of garden (Teran-Escobar et al., 2021). Larger dwellings imply more maintenance and cleaning work. This in turn shows that moderate intensity is more sensitive to differences in type of dwelling (Teran-Escobar et al., 2021). So, the impact of high density on physical activity is mixed.

Research on this topic during the pandemic is very limited. A hypothesis during the pandemic could be that a higher urban density might not positively affect physical activity during lockdown since people in rural low density areas can more easily visit nature and parks. Hereby, they might more easily adhere the physical activity guidelines. The hypotheses concerning dwelling type would be that during the pandemic, people living in an apartment had a harder time to adhere to the WHO guidelines for physical activity.

2.4.2. Infrastructure and walkability

In general, maintenance and connectivity of infrastructure is of huge importance for the use of it (Kwarteng et al., 2014; Li et al., 2008). People living in neighbourhoods with well-connected streets show to have higher frequency of meeting the physical activity guidelines of WHO (Li et al., 2008). Both higher objective and perceived walkability of a neighbourhood contribute to higher physical activity levels (Arvidsson et al., 2012). The condition of the sidewalk is positively related to physical activity, meaning better sidewalk conditions result in higher amounts of physical activity (Kwarteng et al., 2014). Street conditions however were not found to have a significant relation to physical activity (Kwarteng et al., 2014). New routes and paths for walking and cycling increases the physical activity levels, this is especially the case for low SES groups. The frequency of use of walking and cycling paths/routes increases the closer the distance to them are (Kärmeniemi et al., 2018; Panter et al., 2016; Wilson et al., 2004). No literature was found that researched this topic during the pandemic.

2.4.3. Parks and sport facilities

Improving accessibility to facilities, parks and infrastructure positively affects the physical activity levels (Kärmeniemi et al., 2018). Increasing the attractiveness of parks may be done through amenities such as seating and play or sports equipment (Nasar, 2015). The Dutch study of Kamphuis et al. (2007) studied some perceived environmental determinants of physical activity between low and high SES groups. They executed focus group interviews and discussions. The results are shown in Table 4.

Table 4: Access to green and facilities related to physical activity (Kamphuis et al., 2007)

	Low SES	High SES
Accessibility of facilities	-	++
Enjoyable nature in surrounding	+	+

Considering the access to sport facilities, Kamphuis et al. (2007) shows that the accessibility of facilities is a large stimulator for high SES groups. However, for low SES groups the inaccessibility of facilities is a barrier for physical activity. This is caused by the relatively high costs for equipment and membership for the low SES groups. Access to home sport facilities, such as a home trainer, were seen as stimulator for physical activity (Kamphuis et al., 2007). These findings might indicate that there is a need to improve affordability and accessibility of facilities for the low SES groups. Furthermore, it shows the importance of accessible sport facilities in parks or the city itself. Lastly, both low and high SES groups enjoy natural scenery during physical activity (Kamphuis et al., 2007). This might show the importance of access to natural sights in a neighbourhood, and the access to green and parks.

During the pandemic and the subsequent lockdown a negative impact on physical activity is seen due to the limited access to public sport facilities (WHO, 2021). Therefore, households dependent on public facilities are estimated to show a larger decrease in physical activity. However, parks were visited more, as those were one of the only options to exercise physical activity. Living closer to a park had a positive effect on the use of it and physical activity (Geng et al., 2021).

2.4.4. Aesthetics and safety

Aesthetics may attract people towards a place, hereby affecting physical activity. No literature was found that studied this topic during the pandemic. Therefore, only the results from before the pandemic are discussed. People living in an aesthetically pleasant neighbourhood may be more inclined to walk or

exercise (Nasar, 2015). Neighbourhood aesthetics are often perceived the same by different socio-economic groups (Nasar, 2015).

Table 5: Neighbourhood aesthetics related to physical activity (Kamphuis et al., 2007)

	Low SES	High SES
Neighbourhood aesthetics	- -	+

According to Kamphuis et al. (2007), high SES groups report that neighbourhood aesthetics positively affects their physical activity, since they often report their neighbourhood as well-designed, green, and inviting for outdoor physical activity. Low SES-groups on the other hand report neighbourhood aesthetics as a barrier for physical activity, see Table 5 (Kamphuis et al., 2007). This barrier is caused by the fact that low SES groups more often report their neighbourhood as unpleasant (Wilson et al., 2004).

Neighbourhood unsafety is seen as a small barrier for physical activity in high SES groups. In low SES groups, the barrier is bigger as they more frequently feel less safe in their neighbourhood, especially at night (Kamphuis et al., 2007). Low SES groups also report their environment as less accessible and less safe for physical activity (Wilson et al., 2004). So, both neighbourhood aesthetics and safety are related to physical activity.

Traffic safety relates to the presence of sidewalks, walking and cycling paths, intersections, traffic speed and traffic volume (Nasar, 2015). Traffic safety increases the probability of being active for all groups (Jongeneel-Grimen et al., 2013). Jongeneel-Grimen et al. (2013) measured the effect of changes in traffic safety over time. They conclude that improving the traffic safety may lead to increased levels of physical activity within the neighbourhoods.

There is no sufficient evidence concerning the effect of crime related safety on physical activity (Foster & Giles-Corti, 2008). Crime safety is related with order, cleanliness, lighting and views (Nasar, 2015). Results from the study of Foster & Giles-Corti (2008) suggest that physical activity of women and elderly may be affected more by crime. For all three topics of safety discussed above no literature was found considering the effect of safety during the pandemic.

2.5. Natural environment

Another sphere of the social-ecological model is the natural environment. The main elements of this sphere are the weather conditions and topography. Garriga et al. (2021) executed a systematic review of 26 publications between January 2015 and September 2020 in 18 different countries. The results show that most publications found significant seasonal variations in physical activity. For example, in subtropical desert climate with high summer temperatures and humidity, the physical activity levels decrease in summer. Only three studies show non-significant differences, which were in countries with low winter temperatures (Canada, Norway, Denmark and Sweden). The results of these three studies are against the expectations. Possible explanations are that they included a modest sample size, had a low response rate during winter or the temperature differences between summer and winter were not as clear as expected (Garriga et al., 2021).

It can be concluded that the physical activity levels are higher in summer and spring compared to the other seasons, whereas sedentary behaviour increases in winter. Seasonal variations affect people with higher levels of physical activity more, as they increase their physical activity levels in summer and spring (Garriga et al., 2021). This shows that season affects physical activity levels. In addition, it shows that there

are differences between countries due to different climates. Weather conditions also affect physical activity levels. Physical activity among adults decreases on days with rain or snow. The low rates of physical activity during winter may also be caused by lower levels of daylight during winter season (Bélanger et al., 2009).

In addition to different seasonal variations and weather conditions, differences in topography may also results in difference in physical activity behaviour. Szabo et al. (2014) conclude that the natural environment influences the type and levels of physical activity. People living in lowlands engage more in walking and cycling activities, whereas people living in highlands engage more in hiking and skiing for example. This might be explained by the fact that it is more difficult to engage in cycling activities in areas with mountains, whereas in areas with mountains and low temperature skiing is an easy activity (Szabo et al., 2014).

2.6. Policy level and digital environment

Previous versions of the socio-ecological model also include a fifth layer called the policy level. This layer is all about the governing bodies who are in charge of setting and enforcing policies, regulations and law. This sub-section discusses the governmental and municipal structure in the Netherlands. In addition, it shows potential interventions to promote physical activity.

2.6.1. Governmental and municipal structure

In the Netherlands four public tiers can be distinguished, namely: the central government, the provinces, municipalities and water authorities. There are twelve provinces in the Netherlands. The central government distributes money to the provinces to manage the nature, infrastructure and to provide services. Within those provinces there are multiple municipalities who also receive money. Within the municipality the task and responsibilities are divided over multiple disciplines, ranging from social and spatial to organizational sectors. The municipality executes the national law and implements its own policy, such as building dwellings and cycling infrastructure. Interventions in the built environment must apply to the national and municipal policy, however the municipality has the freedom to give body to, amongst others, their environmental vision, health and spatial policies (Gemeente Eindhoven, n.d.; Ministry of the Interior and Kingdom Relations, n.d.).

The municipality is closest to the people and is responsible for urban planning, traffic, transport, public schools and social administration (Ministry of the Interior and Kingdom Relations, n.d.). As this research is being executed in the municipality of Venlo, it is important to look at their policy. The municipality of Venlo believes it is important to know the opinion of their residents when preparing and implementing policies. Hence, the municipality of Venlo spreads surveys several times per year via their 'Gemeentepanel'. Hereby, a big audience can be reached as the panel consist of 1759 members (on the 11th of May 2022). Examples of the topics of the surveys via the DigiPanel are satisfaction about the living environment, COVID related issues and policy related (Gemeente Venlo, n.d.).

Health and physical activity are currently not major drivers in policies and interventions (Vogel Kielgast et al., 2017). The surveys via Gemeentepanel Venlo or other sources to reach big audiences may help in indicating the shortcomings and ways of improvements for different neighbourhoods. The different disciplines within a municipality must cooperate to create an integral solution (Hoorn et al., 2022).

2.6.2. Strategies to increase physical activity

In general, the government and municipality have a very important task to create awareness for the importance of physical activity. Increasing physical activity can be done through planning and design of the physical environment from policies to individual interventions (Estabrooks et al., 2003; Vogel Kielgast et al., 2017). The government and municipality are at the heart of changing behaviour and implementing interventions to promote physical activity. They must promote physical activity through public policies, programs and strategies. Insights from current literature already show some potential interventions to promote physical activity. Not all interventions might be suitable in each neighbourhood, as different neighbourhoods may need a different approach due to difference in socio-economic context and facilities (physical environment). In addition, different persons might be motived by other motivational factors (Bencsik et al., 2016).

Intervention 1: Campaigns

Interventions and the possibilities for physical activity may not be clear to the public. Therefore, the governmental bodies may publish campaigns through multiple media channels. These campaigns may stimulate and motivate people to engage in physical activity. According to Hoyng & Scholte (2021) it is very important to have clear campaigns, wayfinding and websites to inform inhabitants about the options for physical activity within a city. The campaigns may be adapted to the different target groups and sustained for a longer period. For example, a greater focus may be put on those in need, such as neighbourhoods with lower socio-economic status and elderly (Centers for Disease Control and Prevention, 2011). Hence, for example a campaign can be set up in which the government and municipalities invest in sports providers to set up activities for these groups. This is a few years ago already done (European Commission & WHO, 2014). Nowadays, this is often promoted through an exercise broker or sport coach assigned by the municipalities (Van Stam & Van Lindert, 2018). An example of wayfinding is decision prompts telling people to use the stairs instead of escalators and elevators in the physical environment. The decision prompts can be informative as well, for example, information about health or calories burned can be presented on the prompts (Centers for Disease Control and Prevention, 2011).

Intervention 2: Accessible physical environment

Access to public places is needed for physical activity. The availability of low-cost or free facilities to exercise physical activity is especially important for low SES groups (Kamphuis et al., 2007). Higgerson et al. (2018) investigated the impact of free access to facilities on different socio-economic groups. They conclude that providing free access to leisure facilities increases the amount of physical activity for low SES groups, which decreases the inequality between high and low SES groups. Therefore, this might be one of the potential interventions to increase the physical activity levels, especially for the low SES groups or other groups in need. Important to note is that people need to be aware that those places exist, therefore community members need to be involved (Centers for Disease Control and Prevention, 2011).

Intervention 3: Infrastructure walking and cycling

Policies in transportation may help in stimulating active transport. The municipality should continue to create a safe environment by improving and maintaining their infrastructure for walking and cycling, since that encourages to make journeys by foot or bike (Vogel Kielgast et al., 2017). A lack of safe routes to walk is a barrier for physical activity. For example, a safe route for children to school increases physical activity levels. Creating a safe, well-maintained and high-quality environment therefore is an important intervention. The availability of nearby public transit stops also increases physical activity as people have the opportunity to walk or cycle to these stops (Vogel Kielgast et al., 2017).

Intervention 4: Car-free city centre

Some respondents of Van Geest (2020) suggested that the car should get a less prominent place in traffic or should be even banned from Eindhoven in order to stimulate people to walk and cycle. A car-free city centre might be an intervention.

Intervention 5: Creating a digital environment

The use of digital interventions nowadays is a promising development. Gamification is an important topic and "makes use of game design elements in nongame context" (Mazeas et al., 2022). Hereby, it develops a way to stimulate physical activity of participants by making it more enjoyable and playful. Gamification makes use of motivational affordances, such as points, rewards, leaderboards, levels and teams. This influences psychological and physical outcomes resulting in behavioural change (Mazeas et al., 2022). Mazeas et al. (2022) conducted a systematic literature review on the effect of gamification on physical activity and concludes that gamification increases the number of steps taken per day and that it has a positive overall effect on physical activity. However, after the end of the gamification program the effect decreased with time. Hence, there is a small 'long-term' effect (within 12 to 24 weeks after the program), but not persistent (Mazeas et al., 2022). The study of Lemola et al. (2021) shows that an in-app rewarding system positively influences physical activity. Rewarding systems can be tangible (e.g. monetary) or digital (e.g. virtual badge) based. It is shown that tangible rewards increase the frequency in physical activity (Mitchell et al., 2013). The study of Barte & Wendel-Vos (2017) showed that the short-term effects of unconditional incentive, such as free membership or clothing, do not affect physical activity. This contradicts the findings of Mitchell et al. (2013). Conditional incentives are related to physical activity (rewards for reaching goals set in minutes, distance). Conditional incentive rewards show to have some positive effects for physical activity. All in all, there is limited research on the long term effect of monetary incentive (Barte & Wendel-Vos, 2017; Mitchell et al., 2013).

Intervention 6: Social environment - Age-appropriate interventions

Social interventions need to focus on developing social networks to increase social support. Social support helps to increase physical activity levels (Centers for Disease Control and Prevention, 2011). Respondents of Van Geest (2020) indicated that the municipality must stimulate organizations to send out invitations for age-appropriate activities. As stressed out in the literature, social support is important for elderly. An option for age-appropriate activities would be to organize walking, cycling or fitness groups via, for example, community centres or neighbourhood associations. These group activities may also increase the use of public sport facilities. Creating a buddy system or setting appointments with others to complete a set amount of minutes of physical activity might be another intervention (Centers for Disease Control and Prevention, 2011).

A Dutch example for age-appropriate activities for (older) adults is the app called 'Ommetje' which is developed for and with (older) adults. Here they can record and share their walking routes with similar minded people to stimulate physical activity (den Haan et al., 2018).

Research during the pandemic showed that sharing physical activity experience on social networks stimulates a positive social image and enhances social connections during the pandemic (Zuo et al., 2021). In addition, virtual training programs saw a large increase in use during the pandemic. These programs helped people to exercise physical activity and to stay socially connected to people (Newbold et al., 2021). Training programs can be developed with the help of sport providers within the city.

Intervention 7: Individually adapted programs

Some people respond well to standard programs and campaigns, but many people benefit from a personalized program since personality traits, motivation and choices differ. Therefore, an individually adapted program might be necessary from some groups (Centers for Disease Control and Prevention, 2011). An idea would be to create this in line with the promising digital interventions in times of the COVID pandemic. A digital platform can be created in which participants can address their needs, motivation and preferences of physical activity. Hereby, tailored advise and support can be given to increase physical activity.

Intervention 8: Workshops

To increase awareness of the possibilities to conduct physical activity, information needs to be spread to the inhabitants and communities. This can partly be done by the campaigns, but another way might be by organizing informative workshops. Workshops can be organized to create the awareness and to explain the urge for people to be physically active. Furthermore, it can provide several ways of exercising to inspire other people (Centers for Disease Control and Prevention, 2011).

Overall, physical activity needs to be integrated in peoples' lives. Physical activity must be accessible for all groups. This may be done through the help of the proposed interventions above. The policy environment must create room for these interventions by creating new policies and campaigns. It is important that the community and sport providers are involved in the process of implementing the interventions as well. The questionnaire constructed in next chapter will involve a stated choice experiment. Packages of interventions will be outlined that might motivate respondents to exercise more based on the aforementioned interventions.

2.7. Conclusion

This chapter showed that individual determinants, social, physical, natural, policy and digital environment affect the extent to which people exercise physical activity. The preliminary conceptual model is determined based on the literature review described above. Figure 4 shows the preliminary conceptual model including the relevant factors. The natural environment will not be included in the remainder of the report due to data limits. Furthermore, the variable culture of social environment will also not be included in the remainder of the report. The box 'interventions' is based on chapter 2.6.2. All the other variables of the conceptual model will be taken into account in this study.

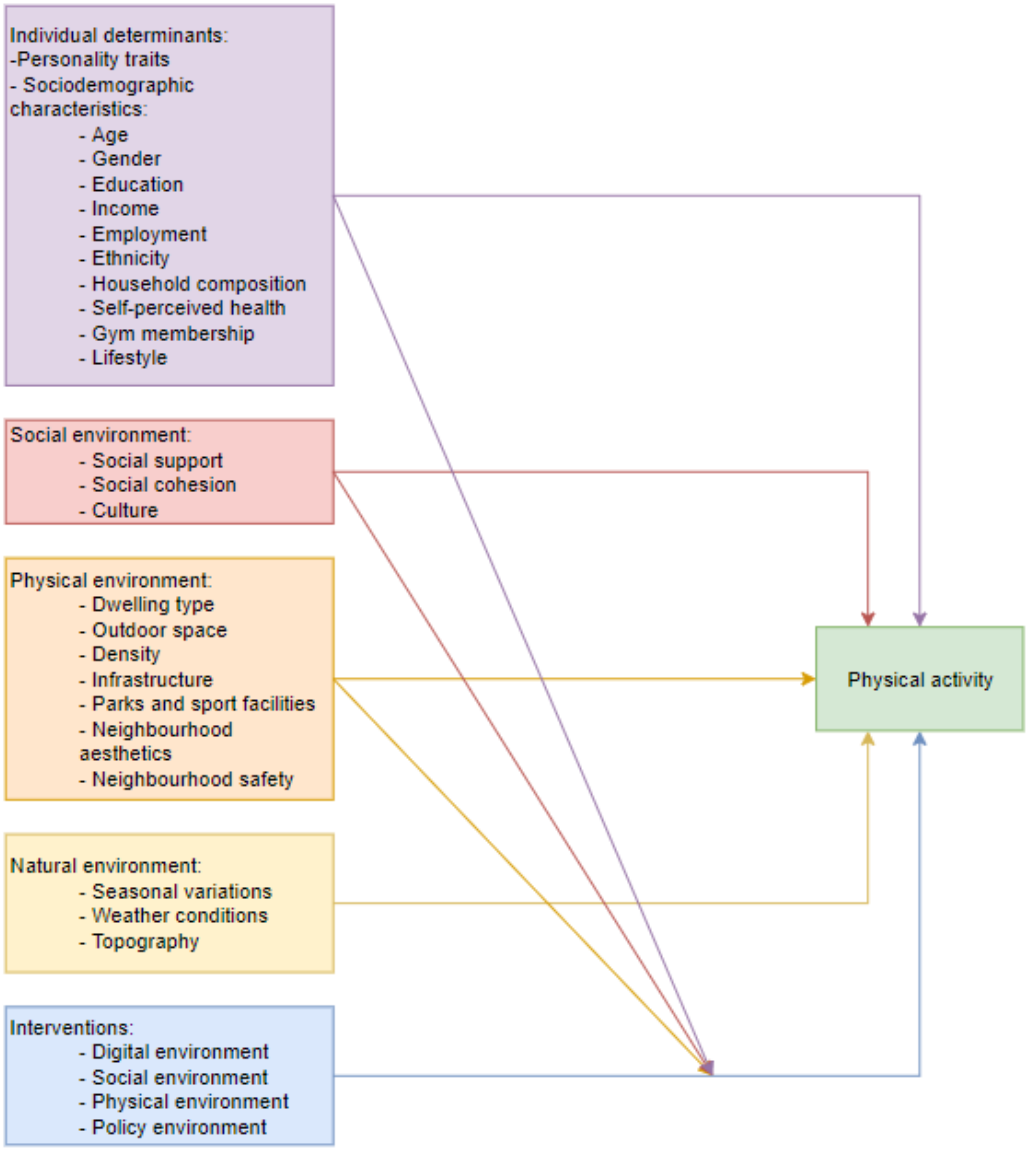


Figure 4: Preliminary Conceptual model

3. Research design and data collection

The previous chapter described the literature review and concluded with a conceptual model. This chapter will show the research design and the data collection. Based on the conceptual model questions are formed which will be included in the questionnaire. Furthermore, additional datasets that will be used are explained.

3.1. Research design

For this study a questionnaire is designed to gather data on individual determinants, including personality traits, social environment, physical environment, interventions and physical activity. This data is needed in order to study relationships between these variables and physical activity.

This section shows how the variables in the conceptual model are translated into measurable variables for the questionnaire. The final questionnaire is added in appendix A. The data gathered through the questionnaire will be complemented with existing datasets from CBS. Data on safety, physical environment, facilities and density are added based on existing datasets.

3.1.1. Individual determinants

Socio-demographic

The socio-demographic characteristics are the first variables asked to participants, question 1 to 17 relate to this topic. Participants are asked to fill in their age based on categories. Categories are used because it secures the privacy of the respondents. In addition, the gender is asked in which participants can answer male/female/gender neutral or rather not say.

Respondents are asked to fill in their education level, income, employment status and ethnicity. For education level seven categories are used in which respondents note their highest achieved level of education. This question can be answered with ‘primary school’, ‘secondary school’, ‘Senior secondary vocational education’, ‘applied university’, ‘university bachelor’, ‘university master’ or ‘rather not say’. The joint net monthly income of the household is asked and divided into seven categories. Employment status indicates the employment status (including work hours). The categories are divided into ‘full time’, ‘part-time (21-35 hours)’, ‘part-time (1-20hours)’, ‘student’, ‘retired’, ‘no paid work’, or ‘Other, namely:’. Ethnicity is asked by the question ‘to which ethnic group do you feel most connected?’. The answers are based on the largest ethnic groups in the Netherlands. There is an option for people to write down another group if their group is not presented in the answer-options.

In addition, the dwelling type, years in neighbourhood, household composition and postal code are asked to the participants. The dwelling types are divided into ‘detached dwelling’, ‘semi-detached dwelling’, ‘row house’, ‘apartment’ or ‘other’. The household composition is divided in ‘one-person household’, ‘couple without children’, ‘couple with children’, ‘single parent family’ or ‘other’. The postal code is an open question and is included to roughly determine the location and neighbourhood of the respondent based on PC6. Hereby, additional data can be linked by the 6-digit postal code. Furthermore, respondents are asked whether or not they are member of a fitness centre and/or sport association.

Considering health, respondents are asked how they would assess their health. They can answer the question on a five-point scale, ranging from very bad (0) to very good (4). Lastly, the lifestyle of respondents is asked by four questions with the answer options ‘yes’ or ‘no’. The questions ‘do you smoke?’, ‘Do you drink 3 or more glasses of alcohol per day?’, ‘Do you eat vegetables daily?’ and ‘Do you eat fruit daily?’ are asked.

Personality traits

The personality traits of participants are measured by using the International Personality Item Pool (IPIP) (Goldberg, 1999). However, this is a very extensive form. Therefore, the mini-IPIP will be used to prevent the questionnaire of being too extensive. That is a shortened form of the IPIP as 50 items are reduced to 20 items. It is an acceptable form to measure the five-factor model of personality: Extraversion (E), Agreeableness (A), Conscientiousness (C), Neuroticism (N) and Imagination (I) (Donnellan et al., 2006). In Table 6, the questions of the mini-IPIP are visible. As seen, each participant gets four questions on each personality trait. Hereby, a mean score can be calculated to determine the main personality trait per participant. Respondents can answer the questions on a five-point scale, ranging from strongly disagree (0) to strongly agree (4).

Table 6: Items Mini-IPIP for personality traits (Donnellan et al., 2006)

Item	Factor	MINI-IPIP Scale
1	E	I am the life of the party
2	A	I sympathize with others' feelings
3	C	I get chores done right away
4	N	I have frequent mood swings
5	I	I have a vivid imagination
6	E	I do not talk a lot
7	A	I am not interested in other people's problems
8	C	I often forget to put things back in their proper place
9	N	I am relaxed most of the time
10	I	I am not interested in abstract ideas
11	E	I talk to a lot of different people at parties
12	A	I feel others' emotions
13	C	I like order
14	N	I get upset easily
15	I	I have difficulty understanding abstract ideas
16	E	I keep in the background
17	A	I am not really interested in others
18	C	I make a mess of things
19	N	I seldom feel blue
20	I	I do not have a good imagination

3.1.2. Social environment

According to the literature review, social support, social cohesion and culture may affect physical activity behaviour both before and during the pandemic (Lesser & Nienhuis, 2020; Mendonca et al., 2014). First, two statement are given which participants can answer on a five-point scale, ranging from strongly disagree (0) to strongly agree (4). These statements are 'I would rate my friends/family as sporty' and 'I would rate my neighbours as sporty'.

The primary attributes of social cohesion are trust, solidarity, connectedness and sense of belonging (Miller et al., 2020). Miller et al. (2020) investigated how 24 different studies measured social cohesion. It appears that 16 different scales were used, however the most common scale used is the one of Sampson et al. (1997). Sampson et al. (1997) developed a scale with five statements as shown in Table 7. These

statements will be used to measure social cohesion. The five items are measured on a five-point scale, ranging from strongly disagree (0) to strongly agree (4).

Table 7: Items social cohesion scale based on Sampson et al. 1997

Item	Social cohesion items
1	People around here are willing to help their neighbours
2	This is a close-knit neighbourhood
3	People in my neighbourhood can be trusted
4	People in my neighbourhood generally do not get along with each other
5	People in my neighbourhood do not share the same values

Social support is measured by twelve statements developed by Zimet et al. (1988). They developed a scale called 'Multidimensional Scale of Perceived Social Support'. Four items are related to the adequacy of social support from family (items 3, 4, 8 and 11), four items are related to social support from friends (items 6, 7, 9 and 12), and four items related to social support of significant others (items 1, 2, 5, 10). To increase response variability and minimize ceiling effect Zimet et al. (1988) measure the items on a seven-point scale, ranging from very strongly disagree (0) to very strongly agree (6). The items are shown in Table 8.

Table 8: Items Social support scale based on Zimet et al. (1988)

Item	Social support items
1	There is a special person who is around when I am in need
2	There is a special person with whom I can share my joys and sorrows
3	My family really tries to help me
4	I get the emotional help and support I need from my family
5	I have a special person who is a rea source of comfort to me
6	My friends really try to help me
7	I can count on my friends when things go wrong
8	I can talk about my problems with my family
9	I have friends with whom I can share my joys and sorrows
10	There is a special person in my life who cares about my feelings
11	My family is willing to help me make decisions
12	I can talk about my problems with my friends

3.1.3. Physical environment

According to the literature review, dwelling type, perceived walkability, density, (maintenance of) infrastructure, availability of parks and sport facilities, neighbourhood aesthetics and neighbourhood safety are of importance for physical activity considering the physical and social environment. Additional data on physical environment will be collected via 'Leefbarometer' on PC4 level, here a score on physical environment is given per postal code (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020).

Density

The density is not asked in the questionnaire, however an additional dataset will be linked to the data of the questionnaire based on postal code. The data on density can be collected from CBS on PC5 level (CBS, 2020a). The most recent available year is 2020.

Infrastructure and walkability

The Neighbourhood Environment Walkability Scale is a questionnaire developed to measure the perceived walkability in the neighbourhood. This questionnaire includes 39 statements, which are divided over several categories (Cerin et al., 2006). Since the amount of statements is very extensive, it is chosen to include a limited amount of questions. Table 9 shows the items that are included to measure perceived walkability. Participants can answer the physical environment questions based on a five-point scale, ranging from strongly disagree (0) to strongly agree (4).

Table 9: Items perceived walkability based on Cerin et al. (2006)

Item	Perceived walkability items
1	I can do most of my shopping in local stores
2	It is easy to walk to a transit stop (bus, train) from my home
3	Stores (daily goods) are within walking distance from my home
4	The sidewalks in my neighbourhood are well maintained
5	It is safe to walk in or near my neighbourhood
6	There are many interesting things to look at while walking in my neighbourhood
7	The speed of traffic in the neighbourhood I live is usually slow
8	My neighbourhood is well lit at night
9	I see and speak to other people when I am walking in my neighbourhood
10	There are attractive buildings/homes in my neighbourhood
11	The streets in the neighbourhood are understandable and recognizable

Some questions related to the maintenance and connectivity of infrastructure are already included in the question concerning perceived walkability (see item 2, 10 of Table 9). Apart from the questions of perceived walkability, two questions will be included to measure maintenance and connectivity of infrastructure, namely 'The cycling lanes in my neighbourhood are well maintained' and 'There are many alternative routes for getting from place to place in my neighbourhood'. These are both of the scale by Cerin et al. (2006). The first question is included for the maintenance of cycling lanes in the neighbourhood and the second is included to have data about the connectivity of streets in the neighbourhood.

Parks and sport facilities

The questionnaire contains five questions about the satisfaction and use of public parks and facilities. These are shown in Table 10. All questions can be answered based on a five-point scale, ranging from strongly disagree (0) to strongly agree (4). Additional data on facilities will be collected via 'Leefbarometer' on PC4 level, here a score on facilities is given per postal code (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020).

Table 10: Items parks and sport facilities

Item	Perception of parks and sport facilities
1	I am satisfied with the sport friendliness of my neighbourhood
2	I am satisfied with the accessibility of green areas (parks) in my neighbourhood
3	I am satisfied with the access to leisure facilities in my neighbourhood
4	There are sufficient public sport facilities in my city (Examples are: outdoor fitness equipment, walking and cycling paths etc)
5	I use the public sport facilities in my city (Examples are: outdoor fitness equipment, walking and cycling paths etc)

Neighbourhood safety

The Neighbourhood Environment Walkability Scale can also be used to measure aesthetics and safety within a neighbourhood. The aesthetics are measured by six items, the traffic safety by ten items and the crime safety by five items. To prevent the questionnaire of being too extensive, a limited number of questions are included. Considering neighbourhood aesthetics, the questions with the highest standardized loading are already included as part of perceived walkability.

Considering safety, the first question that will be asked is whether or not participants are satisfied with the general safety in their neighbourhood, based on a five-point scale ranging from strongly disagree (0) to strongly agree (4). Furthermore, for traffic safety one item of Cerin et al. (2006) will be used, namely the statement "There is so much traffic along the streets in my neighbourhood that it makes it difficult or unpleasant to walk in my neighbourhood". This item is measured on a five-point scale, ranging from strongly disagree (0) to strongly agree (4).

Lastly, one item of Cerin et al. (2006) will be used to measure the perceived crime safety. This item is "The crime rate in my neighbourhood makes it unsafe to go on walks at night". This item is measured on a five-point scale, ranging from strongly disagree (0) to strongly agree (4). Additional data on crime safety can be collected via 'Leefbarometer' on PC4 level (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020). This data can be linked to the outcome of the questionnaire based on postal codes.

3.1.4. Physical activity

Various guidelines have been developed to measure physical activity. As previously mentioned, physical activity is defined as any movement produced by muscles of a human being including movements during leisure time, for transport, and parts of a person's work (World Health Organization, 2020). For this study it might be interesting to have the possibility of comparing the results of this questionnaire to the results of 'Centraal Bureau Statistiek' (CBS). CBS uses the short questionnaire to assess health enhancing physical activity (SQUASH) to measure physical activity (CBS, 2018). The SQUASH survey also makes a distinction between activities during work, transport and leisure time (Wendel-Vos & Schuit, 2004). Therefore, this is deemed as a suitable way for this questionnaire. Table 11 shows the questions included in the questionnaire.

Table 11: Items physical activity based on SQUASH (Wendel-Vos & Schuit, 2004)

Physical activity items	**Days per week**	**Average time (in minutes) per day**	**Effort**	**Hours per week**
Commuting				
Walking from/to work or school	x	x	x	
Cycling from/to work or school	x	x	x	
Activity at work				
Light and moderately strenuous work (sitting/standing work, with occasional walking, such as desk work or walking work with light loads				x
Heavy strenuous work (ongoing work or work that requires regular lifting of heavy objects				x
Household activity				

Light and moderately strenuous housework (standing work, such as cooking, washing dishes, ironing, and walking work such as vacuuming and shopping)	x	x		
Vigorous housework (scrubbing the floor, knocking out the carpet, walking with heavy groceries)	x	x		
Leisure time activity				
Walking	x	x	x	
Cycling	x	x	x	
Gardening	x	x	x	
Doing odd jobs/do-it-yourself	x	x	x	
Sport activity				
Sports	x	x	x	

3.1.5 COVID-pandemic

As the COVID-pandemic might have been an obstacle for people to be physical active, it is interesting to see how the attitude of respondents towards the COVID-pandemic affects their physical activity behaviour. Therefore, the questions as presented in Table 12 are incorporated in the questionnaire. Furthermore, from the literature review it appeared that people might have found other ways of exercising during the measures taken against the COVID-pandemic. Therefore, it is interesting to know whether or not people have found other ways of exercising and how this might affect their physical activity behaviour.

Table 12: Items COVID

Item	COVID
1	I am afraid that I contract the coronavirus
2	Currently, I feel comfortable in public spaces (such as shops)
3	I visit other people at home
4	If the coronavirus had not been an obstacle at all, I would have exercised more
5	I have found other ways of exercising due to corona. If yes, please explain

3.1.6. Possible interventions – Stated choice experiment

The potential interventions provided in chapter 2.6 are incorporated in the questionnaire through a Stated Choice Experiment (SCE). Before the SCE, the respondents get three questions as shown in Table 13.

Table 13: Items app usage

Item	Question
1	Do you use an app for exercising? (Examples are Strava, Komoot, Fitbit, Ommetje)
2	Would you exercise more if there would be an app that gives rewards for exercising? (Examples of rewards are money, coupons, sports membership)
3	Do you have other ideas in which the municipality could help to get people to exercise more?

The items for the SCE are reduced to a maximum of seven to reduce the complexity. This is done based on the potential interventions found in the literature and in consultation with the municipality about which interventions are important for them. Table 14 indicates the items which will be presented to respondents in the packages. Considering the number of attributes, each item has two attribute levels to reduce the complexity and the number of questions needed in the questionnaire.

Table 14: Items SCE

Environment	Elements stated choice experiment	Attribute 0	Attribute 1
Individual	Personal support and guidance from an exercise broker/sports coach for appropriate sports and exercise offer	Yes	No
Social – Digital environment	Sports activity sharing via an app	Possible	Not possible
Social environment	Age-appropriate activities and workshops in my neighbourhood (Examples are walking and running groups)	Yes	No
Physical environment	Availability of free public fitness equipment in public spaces	Improved	Same as now
Physical environment	Availability of public sports facilities (Examples are running and walking paths, cycling paths etc)	Same as now	Improved
Physical environment	Access to gym	Same price as now	With discount
Digital environment	Earn rewards through an app per activity	Not possible	Possible

An orthogonal experimental design was used to create eight packages. The experimental design of the stated choice experiment is shown in Table 15. Each respondent will evaluate four choice sets, each including two packages and a 'none of these'-option. Respondents are asked to indicate which packages would motivate them the most compared to their current situation. If none of the packages is better than their current situation, then the respondents can thick the box 'none of these'. There will be two variants of the choice sets presented to the respondents, hence each respondent will get one of the two variants at random. The designs of the two variants are shown in Table 16.

Table 15: Experimental design

Package	Personal support	Sports sharing through app	Age-appropriate activities	Public fitness equipment	Public sports facilities	Access to gym	Rewards through app
1	Yes	Possible	Yes	Improved	Same as current situation	Same price as now	Not possible
2	Yes	Possible	Yes	Same as current situation	Improved	With a discount	Possible
3	Yes	Not possible	No	Improved	Same as current situation	With a discount	Possible
4	Yes	Not possible	No	Same as current situation	Improve	Same price as now	Not possible
5	No	Possible	No	Improved	Improved	Same price as now	Possible

6	No	Possible	No	Same as current situation	Same as current situation	With a discount	Not possible
7	No	Not possible	Yes	Improved	Improved	With a discount	Not possible
8	No	Not possible	Yes	Same as current situation	Same as current situation	Same price as now	Possible

Table 16: Two variants of the SCE

Question	Variant 1 (Packages)	Variant 2 (Packages)
1	7 versus 5	8 versus 2
2	3 versus 6	1 versus 5
3	8 versus 1	6 versus 7
4	4 versus 2	3 versus 4

3.2. Minimum sample size

There are several guidelines for the minimal sample size which is needed to accurately analyse the data. A commonly used rule-of-thumb for the minimum sample size for stated choice experiment is developed by Orme (2010):

$$\frac{NTA}{C} \geq 500$$

N= Number of respondents
T= Number of tasks
A= Number of alternatives per task (not including the none alternative)
C= Number of analysis cells (Highest number of attributes)

In this stated choice experiment, each respondent gets four choice sets (tasks) with two alternatives per choice set. The maximum number of levels in an attribute is two. Hereby, the minimum sample size according to Orme (2010) is 125 respondents. However, over the years it is argued that 500 representations per main-effect is a minimum, 1000 representations would be better. Therefore, it would be better to have 250 respondents. Furthermore, as the individuals may have different motivation, the interventions might be perceived differently by different classes of individuals. Therefore, a latent class analysis will be performed later on. This also requires a higher response rate, since the minimum sample size will be twice as high when two classes are made, so also a total of 250 respondent are minimally needed in that case (Orme, 2010).

3.3. Data collection

Figure 5: Location Venlo (OpenStreetMap, n.d.)

The municipality of Eindhoven, 's Hertogenbosch, Helmond and Venlo were approached to take part in the data collection of this research. The municipality of Venlo was the only municipality who was willing to publish the questionnaire. Therefore, the work field of this study contains the municipality of Venlo. The municipality of Venlo is located in the South-East of the Netherlands, near the border with Germany, as can be seen in Figure 5. It is a medium sized Dutch city with approximately 102,500 inhabitants (CBS, 2021b, 2021a)

The municipality of Venlo published the questionnaire via their 'gemeentepanel' (Gemeente Venlo, n.d.). As a member of the panel, one will receive an invitation for questionnaire multiple times per year. Subscription to the panel is voluntary. In total, 1759 people received the email with an invitation to take part in the questionnaire for this research. The questionnaire was held online through LimeSurvey and open to response from 11th of May until 25th of May 2022. Additionally, the data collected through the questionnaire can be linked to datasets from CBS and the municipality of Venlo based on postal codes as described in section 3.1.

3.4. Informed written consent

The data retrieved through the questionnaire may contain privacy sensitive information. Therefore, informed written consent was needed. The respondents were informed about the purpose of the study via an information sheet (see appendix B). The respondents were able to give explicit consent for the collection of personal data, special category personal data, the storage of the research data for future research, and the storage of anonymized data in the repository of TU Eindhoven for future research. The collected data is pseudonymized, hereby the personal data will not be traceable to individual responses. This report will only contain aggregated data, hereby it can no longer lead to the identification of individuals. The Ethical Review Board has assessed and approved this research on the 9th of May 2022.

3.5. Resume

This chapter showed the research design and data collection method. First, the design of the questionnaire has been explained. Secondly, the minimum sample size for the stated choice experiment is shown, which is 250 respondents. Afterwards, the data collection is explained. Hence, the questionnaire was distributed among members of the panel of the municipality of Venlo. Informed written consent was needed from the participants, hence an information sheet was designed in which the collection of data is explained. The respondents could give explicit consent for the collection and storage of the data.

4. Methodology

The previous chapter has shown the research design and data collection. This chapter will provide the methodology steps. Furthermore, it will give a theoretical base of the concepts and methods used.

4.1. Outline of steps

As described above, a cross-sectional approach is used to collect data at one point in time through an online questionnaire distributed among panel members of the municipality of Venlo. First, descriptive statistics will be elaborated through the statistical package SPSS version 27. After the descriptive statistics, the data of the stated choice experiment will be analysed through the statistical package NLogit 6. Data needs to be prepared before analysing, since effect coding is needed for this part of the analysis. In NLogit, two choice models will be estimated. First, the Multinomial Logit (MNL) model. An MNL model is used to examine the general preferences of respondents for certain interventions in order to increase physical activity levels. Secondly, a Latent Class (LC) model is estimated to identify classes with similar preferences for interventions. The outcome of the LC model, the probability that a respondent falls into class one or two, can be used in SPSS. The respondents are assigned to the class with the highest probability. Afterwards, a bivariate analysis is executed to examine the relationship between individual determinants, social environment, physical environment or physical activity and class membership.

Besides the analyses of the SCE, a bivariate analysis will be executed in SPSS version 27 to analyse the relationships between all independent variables and physical activity. Hereby, for example the relationship between household composition and physical activity can be estimated. The significant variables resulting from this bivariate analysis will be used as input in the last step, the regression analysis. For regression analysis, dummy coding is necessary for the categorical variables. A multiple linear regression model will be used. Figure 6 shows an overview of the steps.

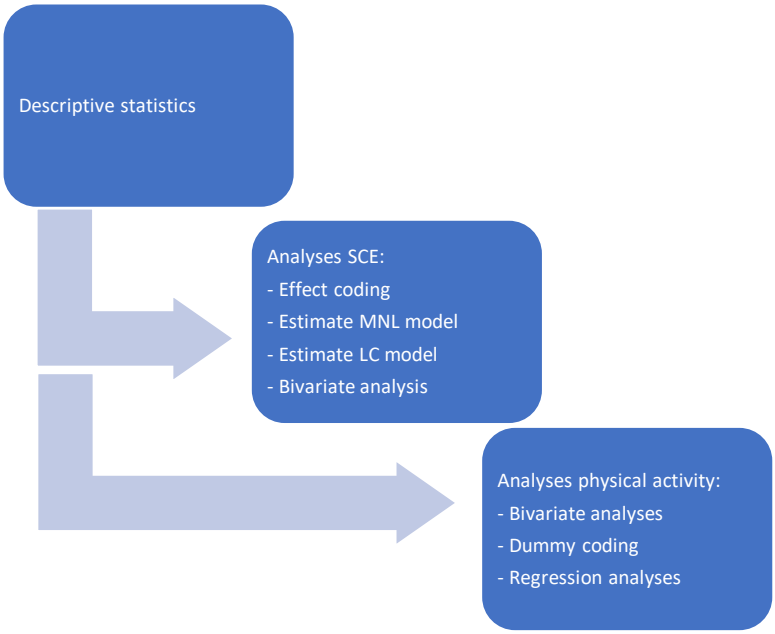


Figure 6: Outline of steps

4.2. Descriptive statistics

The descriptive statistics will be elaborated for each variable in order to provide insights into the characteristics of the sample, such as the frequencies and the representativeness of the sample. If a scale is used to measure a variable, it is checked whether merging is allowed based on Cronbach's Alpha value. Cronbach's Alpha can be used to check the internal consistency of a scale, such as the perceived walkability scale or social support scale. The Cronbach's Alpha will show how related a set of items are as a group to what is intended to be measured. The value of Cronbach's Alpha normally ranges between 0 and 1. The closer to 1, the more reliable the scale is. An acceptable threshold for combining the items to a sum score is a Cronbach's Alpha of 0.7 or higher. When the value is 0.7 or higher it means that respondents have the same pattern for these items and thus a sum score for these items can be calculated (Gliem & Gliem, 2003). However, there is some disagreement about that threshold, as Ursachi et al. (2015) states that 0.6 is sometimes also used as a threshold for combining based on the Cronbach's Alpha. All in all, Table 17 will be used for the interpretation of the Cronbach's Alpha.

Table 17: Cronbach's Alpha interpretation (Gliem & Gliem, 2003)

Cronbach's Alpha value	Conclusion
0.9 – 1	Excellent
0.8 – 0.9	Good
0.7 – 0.8	Acceptable
0.6 – 0.7	Questionable
0.5 – 0.6	Poor
< 0.5	Unacceptable

The chi-square test is used for nominal or ordinal items to check the representativeness of a sample. For continuous variables the T-test can be used. When p-value < 0.05, the H_0 can be rejected. The hypothesis for these test are formulated as follows:

H_0= The distribution of the sample is equal to the distribution of the municipality of Venlo
H_1= The distribution of the sample is not equal to the distribution of the municipality of Venlo

4.3. Stated choice experiment

Choice behaviour can either be measured by a revealed or stated preference method. In revealed choice study, a choice is made in a real situation. In a stated choice experiment choices are made in hypothetical situations. Hence, stated choice experiments are popular for measuring choice preferences of people (Hensher et al., 2015). A stated choice experiment is chosen in this study to hypothetically test still to be implemented interventions or services.

The book by Hensher et al. (2015b) describes two different multinomial models: the Multinomial Probit (MNP) model and the Multinomial Logit (MNL) model. The most commonly used model is the logit model since the MNP is way more complex to estimate. In logit models, the unobserved effects are distributed by multivariate generalized Extreme Value (GEV) distribution. This distribution is skewed instead of normal. Hence, other coefficients in the utility function are seen due to the difference in distribution between probit and logit models. In stated choice experiments, only the observed effects can be measured. A logit model assumes that the variances of the unobserved effects are the same for all alternatives. There are also multiple types of logit models, namely MNL model, nested logit and mixed logit model. The MNL model is the easiest logit model since all covariances are assumed zero. So, the MNL

model assumes unobserved components with covariances to be zero and constant variance (Hensher et al., 2015b, 2015a). Latent class models are often used as addition to the MNL model as they define underlying patterns of preferences by assigning respondents to classes (Hensher et al., 2015a). Hence, a MNL model and latent class model will be used to analyse the SCE. These will be explained in the following paragraphs.

4.3.1. Multinomial logit model

First, a MNL model will be estimated. The purpose of a MNL model is to reveal preferences for the different interventions to increase physical activity levels and to rank the relative importance of each intervention within the choice of the respondents. With an MNL model, knowing the utilities of the attributes and alternatives it is possible to calculate the probability for choosing an alternative. The MNL model uses the following formula to estimate the choice probability that a person chooses alternative *i* in a choice set *h* (Hensher et al., 2015b, 2015a):

$$P_i = \frac{\exp(V_i)}{\sum_{l \in H} \exp(V_{i'})}$$

Pi = Probability that alternative i is chosen
Vi = Structural utility of alternative i
H = Choice set

In which $V_i = \sum_n \beta_n \cdot X_{in}$
B_{nc}= Weight of the attribute n
X_{in}= Value of alternative i on attribute n

The probabilities of all alternatives sum up to one. It can be interpreted as follows; if one alternative is more likely to be chosen, then the probability for the other alternatives decreases (Hensher et al., 2015b, 2015a).

The goodness-of-fit of the MNL model is estimated by McFadden's R-squared. The higher this value, the better the probabilities represent the observed probabilities. The R-squared should have a value between 0.2 and 0.4 to have a good fit. NLogit does not predict the R-squared of the MNL model correct, as it calculates the Log-likelihood (constant only) instead of Log-likelihood of the null model (0). Hence, the R-squared and adjusted R-squared need to be calculated by hand. This can be done through the following formula (Hensher et al., 2015b, 2015d; Hittner, 2020):

$$\rho^2 = 1 - \frac{LL(\beta)}{LL(0)}$$

$$\rho^2_{adjusted} = 1 - \frac{(1-\rho^2)(N-1)}{N - IV - 1}$$

In which:
ρ^2= R-sqaured
N= Sample size
IV= Number of independent variables

As seen, the rho-square is based on the log-likelihood function of the model and the null model. It measures how well the model with the estimated parameters performs compared to the null-model in which all parameters are zero.

4.3.2. Latent Class Models

Secondly, a LC model will be estimated. The purpose of the LC model in this study is to reveal if there are different classes of respondents with different preferences. Hence, the relationship between individual determinants, social environment, physical environment and the class membership can be studied. Hereby, the analyses of the LC model might reveal which interventions suit which classes and how these classes relate to differences in individual determinants, social or physical environment.

The LC model uses the following formula to estimate the choice probability (Hensher et al., 2015a):

$$\Pr[\mathrm{h}|\mathrm{i}] = \frac{\exp\left(\mathrm{V_{iqh}}\right)}{\sum_{\mathrm{l}\in\mathrm{H}}\exp\left(\mathrm{V_{iqh'}}\right)}$$

Where:
Pi = Probability that alternative i is chosen by person q in choice set h
Vi = Structural utility of alternative i for person q in choice set h
H = Choice set

In which $V_i = \sum_n \beta_n c \cdot X_{in}$
B_{nc}= Weight of the attribute n for class c
X_{in}= Value of alternative i on attribute n

The number of classes can be altered until a maximum of five classes, the model with the best 'fit' will be elaborated. The best model is the model can be found when compared the AIC values and R-squared of both the MNL and LC model. Considering the LC model, it must be noted that in order to have meaningful classes, the coefficients must be estimated. If they are not estimated, then that specific amount of classes cannot be used. The LC model generates the probability of a respondent to belong to one of the classes, these are called class membership probabilities (Hensher et al., 2015). Based on these probabilities, the respondents can be assigned to one of the classes. Afterwards, a bivariate analysis is executed to examine the relationship between individual determinants, social environment, physical environment or physical activity and class membership.

4.4. Bivariate Analysis

Besides the analyses of the SCE, a bivariate analysis will be executed in SPSS to analyse the relationships between all independent variables and the dependent variable physical activity. The dependent variable is calculated in various ways for the bivariate analyses, as the first calculation of physical activity resulted in very few significant relationships. Therefore, multiple calculations of the physical activity are done in order to elaborate the dependent variable with most significant independent variables. Different tests are used for the bivariate analysis depending on the measurement scale of the variable. Variables that were organized according to a 5-point Likert scale are interpreted on an interval scale in the bivariate and regression analysis. There are three relevant test when the dependent variable is measured on a continuous scale. The tests that can be used when the dependent variable is measured on a continuous scale are Pearson correlation, independent samples t-test and one-way ANOVA. All tests require normal distribution, that can be tested with a visual inspection (Kent State University Libraries, 2022). When the dependent variable is treated as categorical value, then crosstabs can be used and the chi-square test.

Pearson correlation

The Pearson Correlation is used when the dependent and independent variable are both measured on a continuous scale (interval or ratio) (Kent State University Libraries, 2022). The hypothesis are:

H_0= There is no significant relationship between X and Y
H_1= There is a significant relationship between X and Y

When $p<0.05$ then the null hypothesis can be rejected.

The correlation coefficient between the two variables can have a value between -1 and +1, where -1 indicates a perfect negative relationship and +1 indicates a perfect positive relationship. This can be interpreted as follows: A negative relationship occurs when one variable increases as the other variables decreases. A positive relationship means that the increase of one variable causes the other variable to increase as well. The value 0 means that there is no linear relationship (Kent State University Libraries, 2022).

Independent samples t-test

The independent samples t-test is used when the dependent variable is continuous (interval or ratio) and the independent variable is categorical (nominal or ordinal) with exactly two categories. This test is used to compare two means in two groups. The independent samples t-test requires normality and homogeneity of variances (Kent State University Libraries, 2022). The first step is interpreting Levene's test, which can be used for the following hypothesis:

H_0= The variances of X and Y are equal (Equal variances assumed)
H_1= The variances of X and Y are not equal (Equal variances not assumed)

When $p<0.05$ then the null hypothesis can be rejected. The second step is to look at the outcome of the t-test for equality of means. If $p<0.05$, then the difference in means is significant and the null hypothesis should be rejected (Kent State University Libraries, 2022).

One-Way ANOVA

One-way ANOVA is used when the dependent variable is continuous (interval or ratio) and the independent variables is categorical (nominal or ordinal) with more than two categories. This test is used to test statistical differences among the means of two or more groups (Kent State University Libraries, 2022). The following hypothesis are tested:

H_0= All group means are equal
H_1= At least one of the group means is different

When $p<0.05$ then the null hypothesis can be rejected. A post hoc test is then performed to show the differences between the tested groups. A prerequisite for this ANOVA is that there should be homogeneity of variances. If this is violated ($p<0.05$), then Welch ANOVA should be interpreted instead of ANOVA itself (Kent State University Libraries, 2022).

Chi-square test

The chi-square test is used when the dependent and independent variable are categorical (ordinal or nominal) (Kent State University Libraries, 2022). This test assesses the relationship between these two variables. Chi-square can be calculated by using the following formula, this is also used by SPSS:

$$X^2 = \sum_{i=1}^{R} \sum_{j=1}^{C} \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$$

Where:
o_{ij}= observed count in row i and column j
e_{ij}= expected count in row i and column j

The hypothesis which are tested in the chi-square test can be formulated as follows:

H_0= X is independent of Y
H_1= X is not independent of Y

When p<0.05 then the null hypothesis can be rejected (Kent State University Libraries, 2022).

4.5. Regression analysis

After the bivariate analysis, a regression analysis will be executed. The input for the regression analysis are the significant independent variables from the bivariate analyses and the dependent variable physical activity. For the regression analysis it is necessary to dummy code the independent variables that are measured on a nominal (≥3 categories) or ordinal scale, also known as categorical variables. The amount of dummy's that is needed per variable is the total amount of categories of the variable minus one. There are multiple types of regression which can be executed in SPSS. Multiple linear regression is used in regression analysis as the dependent variable is measured on a continuous scale.

4.5.1. Multiple linear regression

The multiple linear regression is used to determine the relative contribution of each independent variable to the total variance in physical activity levels. Multiple linear regression has six assumptions, namely (Lund Research Ltd, 2018):

1. Independence of observations
2. Linearity
3. Homoscedasticity
4. No multicollinearity
5. No outliers
6. Normal distribution

These assumptions are checked prior to the interpretation of the model. The model performance and interpretation of the models is checked by the following items. Model summary gives an overview of the R-squared and adjusted R-squared. By comparing the adjusted R-squared of different models, it can be seen whether or not the model explains the variance better. The adjusted R-squared is preferred for interpretation, since it takes into account the number of independent variables. Secondly, the output of ANOVA shows the fit of the model. The significance of ANOVA must be lower than 0.05. If that is the case, then the regression model is a good fit of the data. Lastly, the coefficients are the output of the regression model. The unstandardized coefficients show how much the dependent variable varies with an independent variable when all other variables are held constant (Lund Research Ltd, 2018). These are interpreted when p<0.1.

4.6. Data reliability and validity

Reliability

The reliability is the extent to which results can be reproduced under similar conditions. It can be checked by repeating the study at a later point in time under similar conditions (Taherdoost, 2016).

Internal validity

Internal validity is that the causal relationships that are tested are reliable and not influenced by other factors (Patino & Ferreira, 2018). So, the instrument or item should measure what it claims to measure. In order to secure internal validity, items of this questionnaire are based on existing research from several sources which have tested and described the items.

It must be noticed that it is possible that respondents misinterpret a questions or one of the answers. The risk is minimized by using questions based on existing research and by pre-testing the survey before sending it to the public. The pre-testing is done by peer-students, supervisors and the contact person of the municipality. The feedback from the pre-test is used to adjust questions and/or answers. However, unfortunately, from the comments which respondents left when finishing the survey, it appeared that a few respondents found the stated choice experiment unclear.

External validity

External validity is the extent to which results from a study can be applied to other situation, cities or groups (Patino & Ferreira, 2018). The respondents are invited via the panel of municipality Venlo. This is a voluntary panel with members only from the municipality of Venlo. Ideally this panel is representative for the inhabitants of the municipality of Venlo. This can be checked by how well the respondents match the distribution of population within the municipality of Venlo by looking at the distribution of the data of CBS or the municipality of Venlo.

Venlo is a medium sized Dutch city (CBS, 2021b, 2021a). Hence, the results might be generalizable to other medium-sized Dutch cities due to similarities in the environment, such as level of urbanity (suburbs with low-rise buildings, city centre with medium sized buildings) and the presence of walking and cycling paths (CBS, 2021b). However, it is advised to take the socio-economic context, distances and availability to facilities, and country into account before generalizing the results of this research to different countries or cities.

4.7. Resume

This chapter provided a theoretical background into the methods that will be used. The stated choice experiment will be analysed through a multinomial logit model (MNL) and a latent class (LC) model. The MNL model is used to reveal preferences for different interventions and the LC model is used to reveal different classes of respondents with different preferences for interventions. A bivariate analysis will be executed afterwards to examine the relationship between individual determinants, social environment, physical environment or physical activity and class membership.

In addition, to examine the relationships between all independent variables and the dependent variable physical activity, a bivariate analysis and regression analysis will be executed. The dependent variable physical activity is measured on a continuous scale, hence multiple linear regression is used. Multiple linear regression has six assumptions which need to be checked prior to running the model.

5. Data description

The previous chapter provided information about the methodology that has been used to collect and process data. This chapter provides insights into the characteristics of the questionnaire data, which can be used to test expected relationships between individual determinants, social environment, physical environment, natural environment, interventions and physical activity.

5.1. Sample description

The sample of the study should ideally be divided among different neighbourhoods of the municipality of Venlo and be mixed in socio-demographic characteristics because of validity of this study. The questionnaire is spread amongst the panel of the municipality of Venlo. At the moment of publishing the survey, on 11th of May 2022, 1759 people were a member of the panel (Gemeente Venlo, n.d.). However, as it is a voluntary panel a perfect distribution among the neighbourhoods and socio-demographic characteristics could not be achieved.

In total 608 respondents started the questionnaire, of which 358 respondents completed the questionnaire. A part of the respondents who did not finish the questionnaire already stopped before giving consent (55.2%). In addition, 6.8% terminated the questionnaire since they did not give consent.

A part of the responses from respondents who completed the questionnaire cannot be used for analysis due to various reason, see Figure 7. Therefore, in total 325 responses can be used for the analysis. Hence, the minimal sample size of 250 respondents is met. In total, 1759 panel members received an invitation, therefore there is a response rate of 20.4% of which 18.5% can be used for further analysis. The following paragraphs will describe the distribution of the sample.

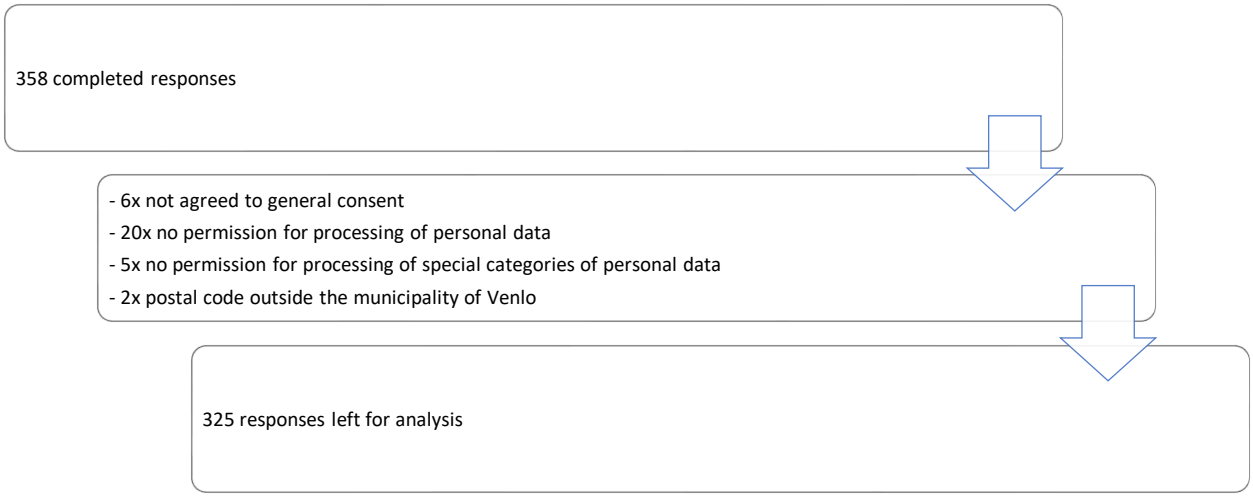


Figure 7: Responses

5.2. Descriptive statistics

This section shows the distribution of the variables from the questionnaire and compares the distribution to the average of the municipality of Venlo. Some answer categories from the questionnaire are recoded to be able to compare the data to the data of the municipality of Venlo. Furthermore, recoding is necessary in some cases as small percentage or low frequencies in answer options can influence the result in the analysis in a negative way.

5.2.1. Individual determinants

First, a descriptive analysis will be performed for the individual determinants. The variables consider age, gender, education, income, employment, ethnicity, household composition, self-perceived health, gym membership, years in the neighbourhood, postal code, lifestyle and personality. The data of the sample is, where possible, compared to data from CBS or the municipality of Venlo to check the representativeness of the sample. Furthermore, if a scale is used to measure a variable, it is checked whether this is allowed based on Cronbach's Alpha value. Table 18 gives an overview of the frequencies of the individual determinants.

Table 18: Frequencies of individual determinants

		Sample (N)	**Sample (%)**	**Venlo (%)**
	Age			(CBS, 2021b)
0	18-40 years	32	9.9	46.7
1	41-64 years	160	49.2	33.5
2	>65	133	40.9	22.3
	Gender			(CBS, 2021b)
0	Female	120	36.9	50.1
1	Male	204	62.8	49.9
2	Gender neutral	1	0.3	Coded as missing
	Education			(CBS, 2021b)
0	Low	53	16.3	34
1	Moderate	87	26.8	42
2	High	185	56.9	24
	Income			
0	Less than 1000 euros per month & 1000-2000 euros per month (low)	22	6.8	
1	2001-3000 euros per month (Moderate)	83	25.5	
2	3001-4000 euros per month (High)	80	24.6	
3	4001-5000 euros per month	66	20.3	
4	More than 5000 euros per month	53	16.3	
5	I do not know / I would rather not say	21	6.5	
	Employment			
0	Fulltime (36 hours or more)	88	27.1	Employed: 65.9
1	Parttime (21-35 hours)	50	15.4	
2	Parttime (1-20 hours)	17	5.2	
3	Retired	150	46.2	Unemployed; 34.1
4	No paid work	20	6.2	
	Ethnicity			
0	Dutch	314	96.6	
1	Other	11	3.4	
	Household composition			(CBS, 2021b)
0	One-person household	43	13.2	38.9
1	Couple without children	189	58.1	30.3
2	Couple with children & single-parent family	93	28.6	30.7
	Years in the neighbourhood			

0	0-4 years	46	14.2	
1	5-19 years	115	35.4	
2	20-29 years	62	19.1	
3	>30 years	102	31.4	
	Self-perceived health			
0	Very Bad	3	0.9	
1	Bad	26	8.0	
2	Average	117	36.0	
3	Good	160	49.2	
4	Very good	19	5.8	
	Gym membership			(Gemeente Venlo & I&O Research, 2021)
0	Both	18	5.5	-
1	Sport association	76	23.4	32
2	Fitness centre	49	15.1	29
3	None	182	56.0	45

Age

In the questionnaire, age has been split into 16 categories, in which each category represents range of 5 years, except for the categories 0-18 years and 86 years or older. The categories are merged to a scale that is comparable to the CBS data, which is used to compare the distribution of the sample to the total distribution in the municipality of Venlo (CBS, 2021b). According to CBS, 46.7 percent of the inhabitants of Venlo is aged 18-40 years old. 33.5 percent is aged 40-64 years old and only 22.3 percent is aged older than 65 years. As seen in Table 18, the sample of this research has a different distribution. The largest group, namely 49.2 percent, of the sample is 40-64 years. The second largest group, 40.9 percent, is 65 years and older, and only 9.9 percent is aged 18-40 years. Therefore, this sample has an overrepresentation of people aged 40 years and older compared to the actual numbers in the municipality of Venlo and an underrepresentation of people aged 18-40 years.

When executing the Chi-square test, a p-value of 0.000 was found. Therefore, it can be concluded that the distribution of age in the sample differs significantly from the distribution of age in the municipality of Venlo.

Gender

In the questionnaire, gender was split into three categories. Table 18 shows the frequencies per category, as seen 36.9 percent of the respondents were female, 62.8 percent were male and 0.3% was gender neutral. The data of the respondent who indicated 'gender neutral' is not used in further analysis on gender, since this data is not comparable to the CBS data and the frequency is too small. The CBS data from 2021 is also presented in Table 18. As seen, the division female/male is almost 50/50 (CBS, 2021b). The sample from the questionnaire underrepresents females and overrepresents male.

The Chi-square test shows a p-value of 0.009. Hereby, it can be concluded that the distribution of gender in the sample differs significantly from the distribution of gender in the municipality of Venlo.

Education

In the questionnaire, education level was split into seven categories. To check the representativeness of the sample, the sample is compared to CBS data. CBS uses three categories, namely: low, moderate and

high. A low education level includes primary school, vmbo, mbo level 1, and lower grades of havo/vwo, moderate education level includes havo/vwo, and mbo level 2 to 4, and high education level considers hbo (applied sciences) and university degrees (CBS, n.d.).

As this categorization is not in line with the division in the questionnaire, other categories must be used for the questionnaire data. High level of education included university of applied sciences, university (bachelor) and university (master, including postdoctoral degree and PhD). Moderate education level includes senior secondary vocational education. Lastly, low education level includes primary school and secondary school. No respondent answered 'rather not say', therefore this category is left out. It must be noted that the comparison between data used by CBS and in this report is not ideal.

From the Chi-square follows a p-value of 0.000. Therefore, the sample differs significantly from the distribution of the education in the municipality of Venlo. Higher educated people are more inclined to fill in this questionnaire.

Income

Table 18 shows the result of the descriptive analysis. The question on income included seven answer options in the questionnaire. However, the categories 'less than 1000 euros per month' and '1000-2000 euros per month' are merged as these included low frequencies. As seen, there are many respondents with an income above 3000 euros per month. As the average net monthly income in the Netherlands is around 2500 euros per month (Karthaus, 2021). Therefore, there is an overrepresentation of households with a high income.

Employment

In Venlo, the net employment rate among the population aged 15-75 years was 65.9 percent in 2020 (CBS, 2020b). This is the most recent available number. When looking at the frequencies from the sample in Table 18, it can be seen that two respondents (0.6%) have a part-time (1-20 hours) job and are also retired. These respondents will be approached as parttime (1-20 hours). Furthermore, it can be seen that 46.2 percent of the respondents is retired, 4.3 percent has no paid work and 1.8 percent filled in other. So, the net employment participation from the sample is 47.7 percent. This is lower than the net employment rate in the municipality of Venlo. This might again be caused by the overrepresentation of people over 65 years old. This overrepresentation is also confirmed by the Chi-square test, as that returned a p-value of 0.0005.

Six respondents answered 'other', and they could indicate the reason or type of work they do. Five people are unfit for work and one respondent filled in social assistance benefit. Therefore, these are merged with the category 'no paid work'.

Ethnicity

The questionnaire contained ten categories of ethnicity, of which only six categories were used in answers of respondents. As seen in Table 18, 96.9 percent of the respondents feel most connected with the Dutch ethnic group. All the other categories are merged to one category called 'other', since small percentages or low frequencies in answer options can influence the result in the analysis in a negative way. The new category 'other' exists out of two Antillean, two Belgian, three German, one Turkish and three respondents who answered 'other'. The latter could indicate the groups with whom they feel most connected. One person felt most connected with 'Limburg', the two other persons did not feel connected to one single ethnical group. These respondents were also recoded as 'other'.

The representativeness of this sample could not be checked by CBS or data of the municipality of Venlo as this is incorporated in their questionnaires anymore. However, it can be concluded that the Dutch are overrepresented.

Household composition

The questionnaire included five categories of household composition. To check the representativeness of the sample, the sample is compared to CBS data (CBS, 2021b). CBS used three categories, namely: one-person household, couple with children, and couple with children & single-parent family. Therefore, the categories couple with children and single-parent family are merged into one category named 'couple with children & single-parent family'. 1.2 percent of the respondents answered 'other' household composition. It is unknown what their composition is. Therefore, this category is merged with the largest group, namely couple without children.

As seen in Table 18, the category 'couple with children' is overrepresented. This is also confirmed by the Chi-square test, as this returned a p-value of 0.000. Therefore, the distribution of household composition in the sample differs significantly from the distribution in the municipality of Venlo.

Years in the neighbourhood

When executing the descriptive statistics for years in the neighbourhood, it could be noticed that there were two, obviously false, outliers of 5912 and 5951 years. These two respondents filled in their postal code numbers. For the analyses, these two numbers will be removed and replaced by the mean value 22.24 years. The minimum value is 0 years, the maximum value is 81 years. Figure 8 shows the histogram of the variable. This variable is recoded into four categories for further analysis, as seen in Table 19.

Table 19: Years in the neighbourhood

	Item	Percentage	Frequencies
0	0-4 years	14.2	46
1	5-19 years	35.4	115
2	20-29 years	19.1	62
3	>30 years	31.4	102

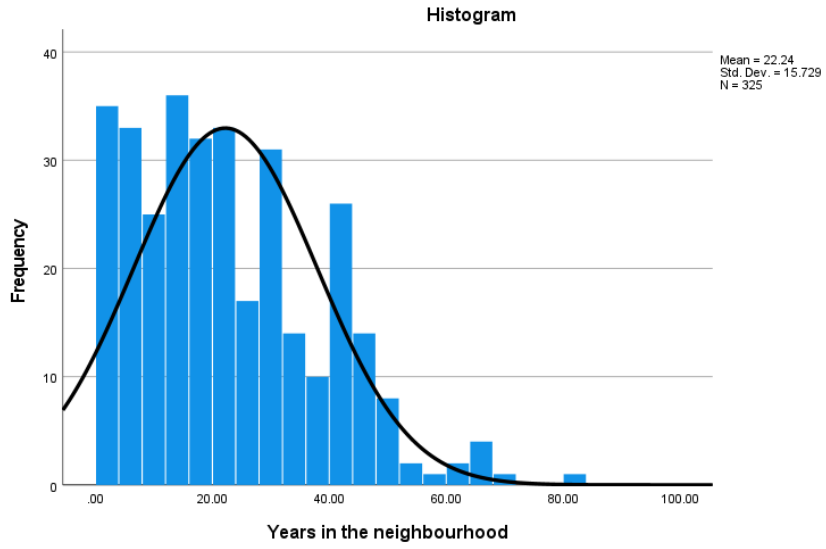
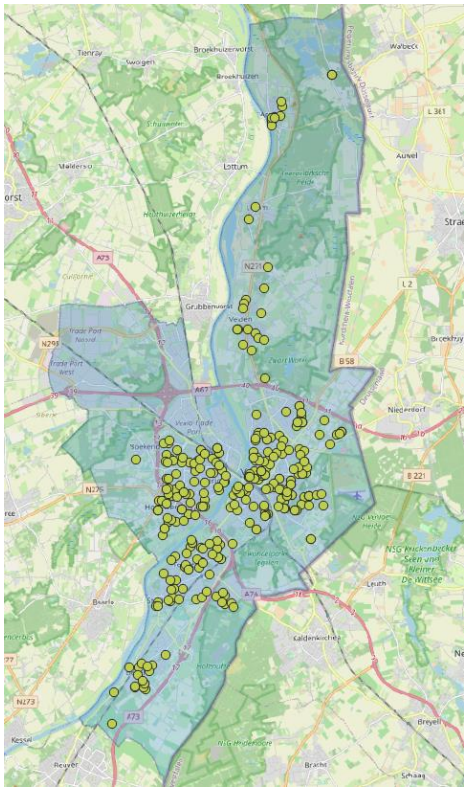


Figure 8: Histogram of years in the neighbourhood before recoding

Postal code



The postal codes are mapped through QGIS. The 'MMQGIS' plugin can geocode the postal codes from the questionnaire into latitude and longitude locations on a map. Unfortunately, that plugin was not able to find all postal codes. Therefore, a google spreadsheet plugin was used, which could automatically match latitudes and longitudes to postal codes (Talarian (Awesome Table BV.), 2022). The output of this excel is subsequently used as input in QGIS.

Figure 9 shows the distribution of respondents in the municipality of Venlo. As seen, the distribution is spread over different parts of the municipality. The industrial parts of Venlo do not cover responses, which aligns with the expectations. It can be seen that the response is mainly centred to the city Venlo itself.

Figure 9: Response locations (OpenStreetMap, n.d.)

Self-perceived health

A five-point scale was used in the questionnaire to measure self-perceived health, ranging from very bad to very good. As seen in Table 18, only 0.9% of the respondent indicated to have a very bad health, however since this variable will be treated as interval it is not needed to merge this category with another. The majority of the respondents have a good (49.2%) or average (36%) health.

Gym membership

Gym membership is also included as individual determinant. As seen in Table 18, 56 percent of the respondents is not a member of a fitness centre or sport association. The other 44 percent is member of a sport association, fitness centre or both. A chi-square test is used to compare the sample to the data of the municipality of Venlo. Data of the municipality of Venlo was only available for item 1 (member of sport association), 2 (member of fitness centre), 3 (no member). Therefore, the chi-square test is calculated on those items. The result is a p-value of 0.01. Hence, the distribution within the sample is not the same as the distribution within the municipality.

Lifestyle

Lifestyle was measured based on the questions of the municipality of Venlo. Table 20 shows that most respondents do not smoke or drink. Furthermore, the majority of the respondents eats vegetables daily, whereas two third of the respondents eats fruit daily.

(Gemeente Venlo & I&O Research, 2021)This data can be compared to the data of the municipality of Venlo. From Table 20 can be concluded that in this study there are less respondents who smoke, eat

vegetables and eat fruit daily compared to the data of the municipality. Furthermore, there are slightly more people who drink 3 or more glasses of alcohol per day. The latter might be caused by the higher average age of respondents to this research. The municipality of Venlo shows that people of 55 years and older more regularly drink 3 or more glasses of alcohol per day, therefore a higher percentage in the data of this research can be seen (Gemeente Venlo & I&O Research, 2021).

Before executing the Cronbach's Alpha, the items of smoking and drinking must be reversed since a 'no' on this answer is assumed as positive lifestyle. A Cronbach's Alpha value of 0.316 is the results, which is very weak. Therefore, these four items do not result in a reliable scale for lifestyle. Therefore, no sum score will be calculated for lifestyle. The items will, however, be included in the remaining analysis separately.

When executing the Chi-square test, a p-value of 0.338 was found. Therefore, it can be concluded that the distribution of household composition in the sample is equal to the distribution in the municipality of Venlo.

Table 20: Frequencies of lifestyle items

	No (%)	**Yes (%)**	***No (%) - Venlo***	***Yes (%) - Venlo***
Lifestyle			(Gemeente Venlo & I&O Research, 2021)	
Do you smoke? (Reversed)	92.6	7.4	*86*	*14*
Do you drink 3 or more glasses of alcohol per day? (Reversed)	92.9	7.1	*94*	*6*
Do you eat vegetables daily?	8.3	91.7	*7*	*93*
Do you eat fruit daily?	31.3	68.9	*23*	*77*

Personality

The personality traits of participants are measured by using the MINI-IPIP. Respondents got 20 items, based on which they are classified to one of the personality groups: Extraversion, Agreeableness, Conscientiousness, Neuroticism and Imagination (Donnellan et al., 2006).

Before executing Cronbach's Alpha, some reverse coding was needed. As seen in Table 21, item 6 – 10 and 15 – 20 need to be reverse coded. The Cronbach's Alpha for extraversion, agreeableness and neuroticism were above the 0.7 acceptable threshold. Therefore, a sum score for these personality groups can be calculated. The Cronbach's alpha per personality group can be seen in Table 22. For the groups conscientiousness and imagination, the Cronbach's Alpha were 0.631 and 0.676 respectively. This indicates a questionable interpretation according to Gliem & Gliem (2003). However, as this scale for personality is used widely, a sum score will also be calculated for these two personality groups. Respondents will be assigned to one group, the group for which they have the highest score.

Table 21: Items Mini-IPIP for personality traits (Donnellan et al., 2006)

			Fully disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Fully agree (%)	Cronbach's Alpha if item Deleted
Item	Factor	MINI-IPIP Scale						
1	E	I am the life of the party	2.8	12.3	48.6	32.3	4.0	0.718
2	A	I sympathize with others' feelings	-	1.8	10.2	69.2	18.8	0.698
3	C	I get chores done right away	1.8	18.5	36.3	34.8	8.6	0.594
4	N	I have frequent mood swings	21.8	41.8	23.7	10.5	2.2	0.691
5	I	I have a vivid imagination	2.5	12.3	39.7	36.9	8.6	0.660
6	E	I do not talk a lot (reversed)	8.6	37.8	36.6	15.4	1.5	0.689
7	A	I am not interested in other people's problems (Reversed)	20.6	57.8	12.6	8.3	0.6	0.710
8	C	I often forget to put things back in their proper place (Reversed)	27.4	44.6	16.9	9.5	1.5	0.549
9	N	I am relaxed most of the time (Reversed)	1.5	9.8	25.2	55.1	8.3	0.708
10	I	I am not interested in abstract ideas (Reversed)	7.1	25.2	46.8	18.5	2.5	0.578
11	E	I talk to a lot of different people at parties	2.5	13.2	29.8	44.3	10.2	0.701
12	A	I feel others' emotions	0.3	4.3	20.0	61.8	13.5	0.731
13	C	I like order	0.6	5.8	20.0	56.3	17.2	0.538
14	N	I get upset easily	17.8	55.1	18.5	7.4	1.2	0.704
15	I	I have difficulty understanding abstract ideas (Reversed)	13.2	40.9	35.1	9.8	0.9	0.612
16	E	I keep in the background (Reversed)	4.6	36.6	40.0	16.3	2.5	0.665
17	A	I am not really interested in others (Reversed)	26.8	59.1	9.8	3.7	0.6	0.669

18	C	I make a mess of things (Reversed)	40.3	47.1	8.0	3.4	1.2	0.547
19	N	I seldom feel blue (Reversed)	4.9	19.7	20.3	41.8	13.2	0.721
20	I	I do not have a good imagination (Reversed)	19.7	54.8	20.6	4.6	0.3	0.572

Table 22: Cronbach's alpha personality

Extraversion						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
2	16	9.3015	7.094	2.66345	4	0.752
Agreeableness						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
4	16	11.8615	4.990	2.23384	4	0.766
Conscientiousness						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
4	16	11.2215	5.908	2.43055	4	0.631
Neuroticism						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
0	16	5.5077	8.436	2.90446	4	0.768
Imagination						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
4	16	9.9754	5.987	2.44684	4	0.676

The respondents are assigned to the personality group of which they obtained the highest score. 53 respondents had an equal score for two groups, this was found between the personality groups agreeableness and conscientiousness, agreeableness and imagination, and in some cases between agreeableness and extraversion. Half of these respondents were assigned to agreeableness, the other half was assigned to conscientiousness, imagination or extraversion. Figure 10 shows the size per personality group. As seen the group Agreeableness is largest, followed by Conscientiousness.

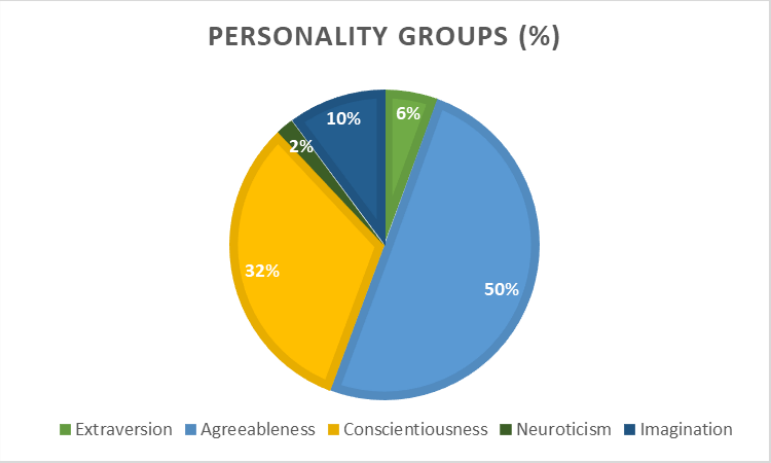


Figure 10: Overview of sizes per personality groups

5.2.2. Social environment

The social environment includes the variables social support and social cohesion. These were measured by using the scales of Zimet et al. (1988) and Sampson et al. (1997) respectively. The following section shows the descriptive statistics of these variables. Besides, two statements were presented to the respondents, namely 'I would rate my friends/family as sporty' and 'I would rate my neighbours as sporty'. The frequencies of these two statements can be seen in Table 23. Most respondents have a neutral opinion about these statements. 30.8% of the respondents rate their friends and family as sporty, whereas only 17.2% of the respondents rate their neighbours as sporty.

Table 23: Frequencies friends/family and neighbours sporty

	Fully disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Fully agree (%)
I would rate my friends/family as sporty	2.2	14.8	49.8	30.8	2.5
I would rate my neighbours as sporty	3.1	20.3	59.4	17.2	-

Social support

Social support is measured by the scale of Zimet et al. (1988). Table 24 shows the frequencies of each item used in the questionnaire. As can be concluded from this table, most people agree with the statements of social support, meaning they most of the time have a person who helps or with whom they can share their feelings. The Cronbach alpha score is 0.911, see Table 25, and does not increase when an item is deleted from the scale. This score can be interpreted as excellent for combining the variables into an average sum score for social support. Figure 11 shows the histogram of the sum score for social support. The sum score varies from 4 to 48 with a mean of 33.18. A score of 4 means that the respondent has a low social support, while 48 indicates a respondent show has a high level of social support in his environment.

Table 24: Social support frequencies and Cronbach's Alpha if deleted

		Fully disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Fully agree (%)	Cronbach's Alpha if item Deleted
	Social support						
Significant other	There is a special person who is around when I am in need	2.5	10.2	20.0	45.5	21.8	0.910
Significant other	There is a special person with whom I can share my joys and sorrows	2.2	6.2	15.7	48.3	27.7	0.907
Family	My family really tries to help me	4.0	4.6	24.6	48.3	18.5	0.901
Family	I get the emotional help and support I	4.6	7.4	25.5	46.5	16.0	0.901

	need from my family						
Significant other	I have a special person who is a real source of comfort to me	2.5	8.6	25.2	36.6	27.1	0.907
Friends	My friends really try to help me	0.9	3.4	32.0	49.5	14.2	0.902
Friends	I can count on my friends when things go wrong	1.5	4.6	20.0	54.5	19.4	0.904
Family	I can talk about my problems with my family	4.0	8.3	20.9	48.3	18.5	0.901
Friends	I have friends with whom I can share my joys and sorrow	1.8	6.5	21.2	49.5	20.9	0.903
Significant other	There is a special person in my life who cares about my feelings	1.8	6.2	13.8	46.2	32.0	0.907
Family	My family is willing to help me make decisions	4.0	9.8	29.2	42.5	14.5	0.903
Friends	I can talk about my problems with my friends	1.5	6.2	23.4	52.3	16.6	0.902

Table 25: Cronbach's Alpha Social Support

Social Support						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
4	48	33.18	63.602	7.975	12	0.911

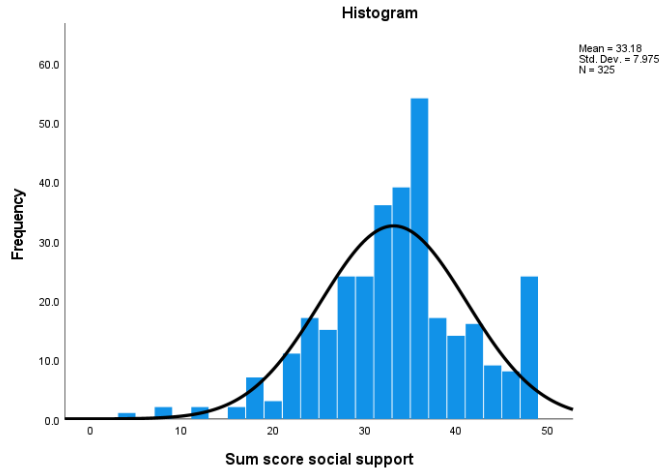


Figure 11: Histogram sum score social support

Zimet et al. (1988) also makes a distinction between significant others, family and friends. The Cronbach's Alpha is therefore also checked for these separate categories. As seen in Table 26, all Cronbach's Alpha values are higher than 0.7 and therefore the sum per category can be made. Again, a score of 0 means a low social support from that group, while 16 means an excellent social support. Figure 12 shows the histograms of the sum scores of these categories.

Table 26: Cronbach's Alpha for significant others, family and friends

Social Support: Significant others						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
0	16	11.45	11.261	3.356	4	0.887
Social Support: Family						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
0	16	10.57	13.073	3.616	4	0.94
Social Support: Friends						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
0	16	11.16	9.398	3.066	4	0.929

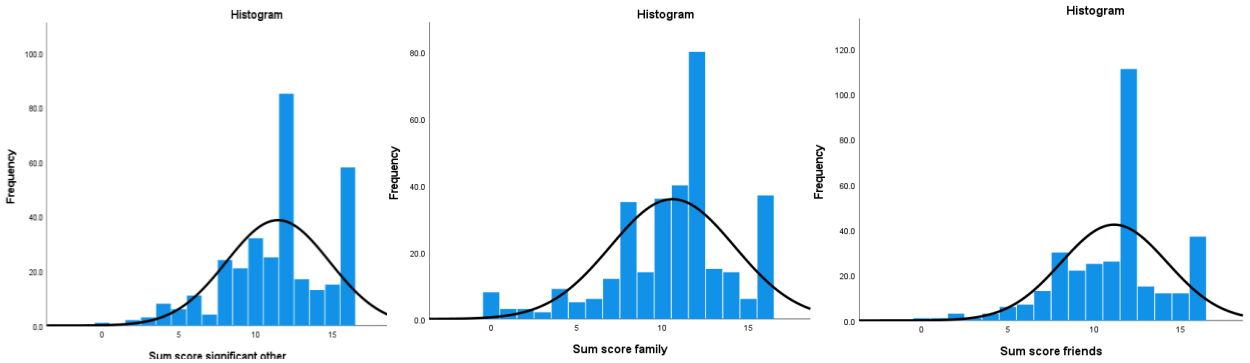


Figure 12: Histogram sum score significant others (left), family (middle), friends (right)

Social cohesion

Social cohesion is measured by the scale of Sampson et al. (1997). Table 27 shows the frequencies of each item used in the questionnaire. Two items are reverse-score items, namely 'People in my neighbourhood generally do not get along with each other' and 'people in my neighbourhood do not share the same values. These items are reversed in order to be able to compute a total score on social cohesion. After reversing, the Cronbach's Alpha is calculated to check the internal consistency of the social cohesion score. The Cronbach's Alpha score is 0.817, see Table 28, and does not increase when an item is deleted from the scale. This can score interpreted as good for combining the variables into an average sum score for social cohesion. Figure 13 shows the histogram of the sum score for social cohesion. A score of 0 means a low level of social cohesion in the neighbourhood, while a score of 20 means excellent social cohesion in the neighbourhood.

Table 27: Social cohesion frequencies and Cronbach's Alpha if item deleted

	Fully disagree (%)	**Disagree (%)**	**Neutral (%)**	**Agree (%)**	**Fully agree (%)**	**Cronbach's Alpha if item Deleted**
Social cohesion						

People around here are willing to help their neighbours	0.6	4.6	19.1	62.5	13.2	0.782
This is a close-knit neighbourhood	2.2	15.4	47.4	29.5	5.5	0.763
People in my neighbourhood can be trusted	1.8	3.1	25.8	60.3	8.9	0.761
People in my neighbourhood generally do not get along with each other (reversed)	19.1	60.3	14.8	4.9	0.9	0.800
People in my neighbourhood do not share the same values (reversed)	9.8	45.8	27.1	14.8	2.5	0.798

Table 28: Cronbach's Alpha Social Cohesion

Social Cohesion						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
0	20	13.1292	9.557	3.09149	5	0.817

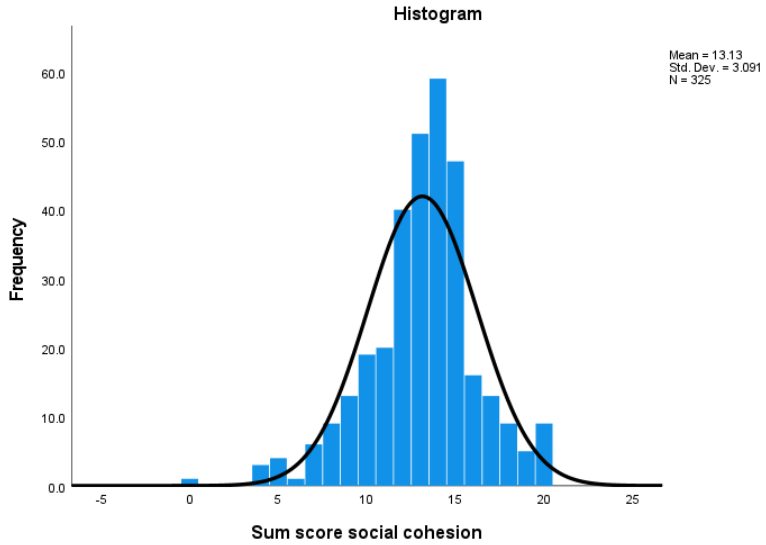


Figure 13: Histogram sum score social cohesion

5.2.3. Physical environment

Dwelling type & outdoor space

The questionnaire contained one question about dwelling type. This question included five answer categories. It was not needed to merge these categories. If respondents answered the category 'other', then they could indicate in what type of dwelling they live. The answers were: included semi-detached dwelling (5x), corner houses (6X), chalet (3x), flat (1x), loft (1x), maisonette (1x), senior dwelling (2x), mansion (1x), monumental dwelling (1x), life-resistant dwelling (1x) and town house (1x). As a flat

obviously can be categorized as apartment, this response is recoded to apartment. Therefore, the following frequencies, as in Table 29, are obtained. The mean is 1.84 with a standard deviation of 1.174.

The questionnaire also contained one question about the outdoor space of a dwelling, here five answer categories were included. As the frequency of a balcony less than 5 m2 was low, this category is merged with a balcony more than 5m2. The name of this category is set to balcony. The frequencies can be seen in Table 29. The mean of this variable is 1.41 with a standard deviation of 0.717.

Table 29: Dwelling type and outdoor space frequencies

	Dwelling type	**Percentage**	**Frequencies**
0	Apartment	14.2	47
1	Rowhouse	27.4	89
2	Semi-detached dwelling	25.5	83
3	Detached dwelling	25.2	82
4	Other	7.4	24
	Outdoor space	**Percentage**	**Frequencies**
0	Balcony	12.0	39
1	Garden less than <50 m2	36.3	118
2	Garden 51 m2 or more	50.2	163
3	No outside space	1.5	5

Density data

The data on density is retrieved from an external dataset from CBS (2020a). It is matched with the results of the questionnaire based on PC5. Table 30 shows the division within the sample. Most respondents live in an environment with 500-1000 addresses per km^2, which is called little urban, followed by 1500-2500 addresses per km^2, called strongly urban.

Table 30: Density frequencies (CBS, 2020a)

	Density	**Sample (%)**
0	<500 addresses per km^2 (not urban)	15.1
1	500-1000 addresses per km^2 (little urban)	36.0
2	1000-1500 addresses per km^2 (moderately urban)	12.6
3	1500-2500 addresses per km^2 (strongly urban)	24.0
4	>2500 addresses per km^2 (very strongly urban)	12.3

Perceived walkability

Perceived walkability is measured by using the scale from Cerin et al. (2006). In this study, several items are used to compose a walkability score. Table 31 shows the frequencies of each item used in the questionnaire.

To check the internal consistency of the perceived walkability scale, Cronbach's Alpha is used. When including all 11 items in the sum score, the Cronbach's Alpha is 0.739. When looking at the Cronbach's Alpha if item is deleted, it is seen in Table 31 that the Cronbach's Alpha increases to 0.740 when deleting the item 'I see and speak to other people when I am walking in my neighbourhood'. However, since this is a very small increase, the item will still be included in the sum score. A score of 8 means a low level of perceived walkability in the neighbourhood, while a score of 44 means a high level of perceived walkability

in the neighbourhood. The Cronbach's alpha can be seen in Table 32 and the histogram of the sum score in Figure 14.

Table 31: Perceived walkability frequencies and Cronbach's Alpha if item deleted

	Fully disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Fully agree (%)	Cronbach's Alpha if item Deleted
Perceived walkability						
I can do most of my shopping in local stores	1.8	8.3	3.7	48.3	37.8	0.727
It is easy to walk to a transit stop (bus, train) from my home	3.4	4.3	8.0	55.7	28.6	0.720
Stores (daily goods) are within walking distance from my home	4.9	12.6	12.0	43.4	27.1	0.722
The sidewalks in my neighbourhood are well maintained	7.1	19.4	23.1	40.9	9.5	0.706
It is safe to walk in or near my neighbourhood	1.2	7.1	16.6	55.7	19.4	0.716
There are many interesting things to look at while walking in my neighbourhood	2.8	14.8	32.3	40.0	10.2	0.721
The speed of traffic in the neighbourhood I live is usually slow	14.5	28.0	20.0	31.4	6.2	0.732
My neighbourhood is well lit at night	2.5	4.9	17.5	64.9	10.2	0.711
I see and speak to other people when I am walking in my neighbourhood	2.2	6.8	20.3	58.2	12.6	0.740
There are attractive buildings/homes in my neighbourhood	8.9	26.8	36.0	23.1	5.2	0.721
The streets in the neighbourhood are understandable and recognizable	0.6	4.3	19.1	61.5	14.5	0.706

Table 32: Cronbach's Alpha Perceived Walkability

Perceived walkability						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
8	44	28.49	31.189	5.585	11	0.739

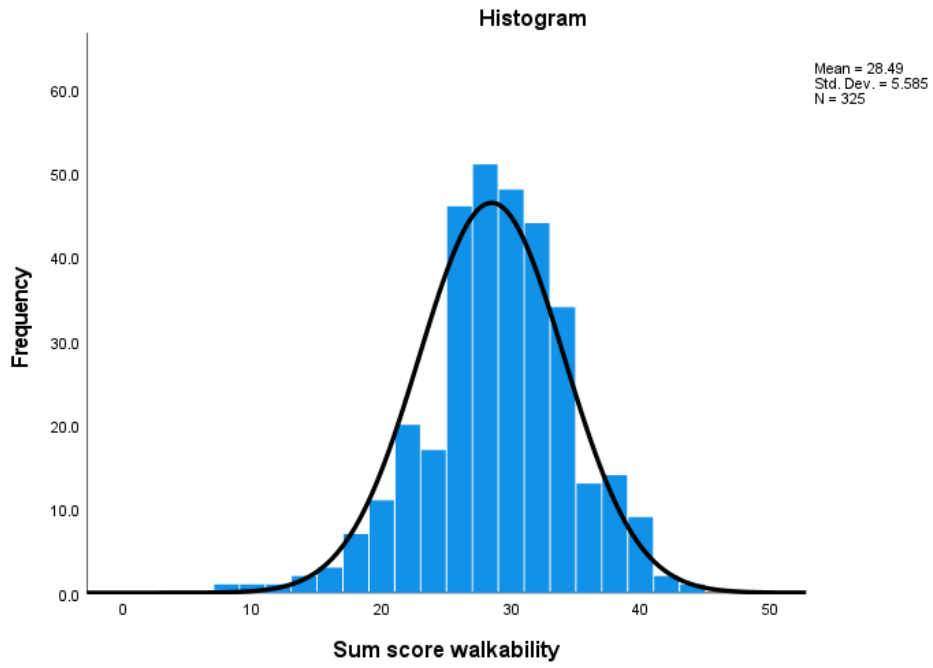


Figure 14: Sum score perceived walkability

Infrastructure

Infrastructure was also included in the questionnaire based on items of the study of Cerin et al. (2006). The frequencies can be seen in Table 33. The items cannot be merged to a sum score, as the Cronbach's Alpha is 0.591. Therefore, these two variables will be included in the analysis separately.

Table 33: Infrastructure

	Fully disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Fully agree (%)
Infrastructure					
The cycling lanes in my neighbourhood are well maintained (Q69.1)	4.6	15.1	24.9	49.2	6.2
There are many alternative routes for getting from place to place in my neighbourhood (Q69.2)	1.8	5.5	19.1	60.6	12.9

Parks and sport facilities

The questionnaire contained five questions about the satisfaction and use of public parks and facilities based on a five-point scale, ranging from strongly disagree (0) to strongly agree (4). Table 34 shows the frequencies of each item used in the questionnaire. The questions were not derived from an existing scale to measure the satisfaction with parks and sports facilities. However, when including all 6 items in the sum score, the Cronbach's Alpha is 0.739 (see Table 35). When looking at the Cronbach's Alpha if item is deleted, it is seen in Table 34 that the Cronbach's Alpha increases to 0.743 when deleting the item 'I use the public sport facilities in my city'. However, again since this is very minimal increase, the item will be incorporated in the sum score. Figure 15 shows the histogram of the sum score for satisfaction with parks and sports facilities. A score of 0 means a low level of satisfaction with the parks and sport facilities in the

neighbourhood, while a score of 20 means high satisfaction with the parks and sport facilities in the neighbourhood.

Table 34: Satisfaction parks and sport facilities and Cronbach's Alpha if item deleted

	Fully disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Fully agree (%)	Cronbach's Alpha if item Deleted
Satisfaction parks and sport facilities						
I am satisfied with the sport friendliness my neighbourhood	4.0	11.1	44.6	36.0	4.3	0.696
I am satisfied with the accessibility of green areas (parks) in my neighbourhood	1.5	4.0	16.0	58.5	20.0	0.703
I am satisfied with the access to leisure facilities in my neighbourhood	2.8	8.9	37.8	43.1	7.4	0.673
There are sufficient public sport facilities in my city (Examples are: outdoor fitness equipment, walking and cycling paths etc)	5.8	10.8	28.6	48.6	6.2	0.652
I use the public sport facilities in my city (Examples are: outdoor fitness equipment, walking and cycling paths etc)	10.8	17.8	16.6	46.5	8.3	0.743

Table 35: Cronbach's Alpha Perceived Walkability

Perceived facilities						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
0	20	12.22	10.798	3.286	5	0.739

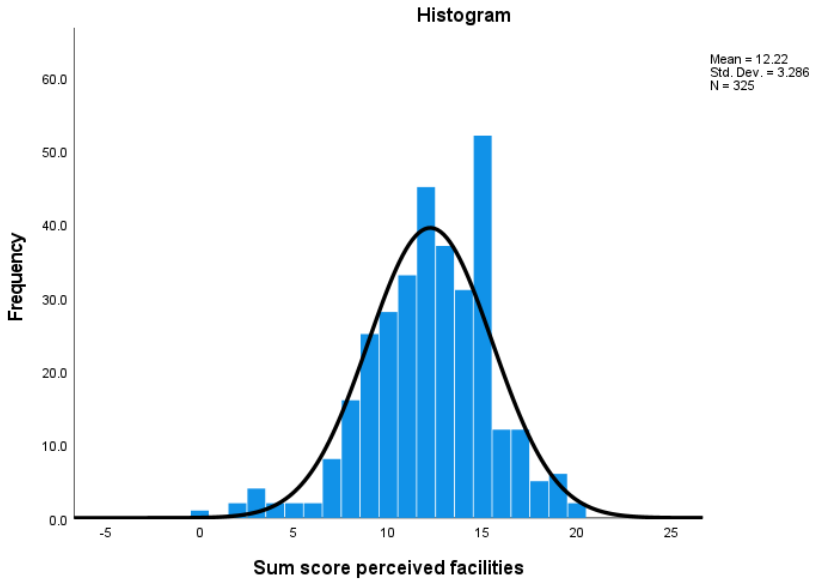


Figure 15: Histogram sum score perceived facilities

Neighbourhood safety

Again, to check the internal consistency of the neighbourhood safety scale, Cronbach's Alpha is used. When including all items in the sum score, the Cronbach's Alpha is 0.792. As seen in Table 36, the Cronbach's alpha does not increase when deleting an item. Therefore, the sum score will be based on all four items. The Cronbach's Alpha and the histogram of the sum score can be seen in Table 37 and Figure 16 respectively. A score of 0 means a low level of neighbourhood safety, while a score of 20 means excellent level of neighbourhood safety.

Table 36: Frequencies neighbourhood safety

	Fully disagree (%)	**Disagree (%)**	**Neutral (%)**	**Agree (%)**	**Fully agree (%)**	**Cronbach's Alpha if deleted**
Safety						
I am satisfied with the general safety (crime, traffic safety, etc.) in my neighbourhood	4.0	15.1	23.7	49.2	8.0	0.721
The crime rate in my neighbourhood makes it unsafe to go on walks at night (Reversed)	20.0	47.4	21.5	9.8	1.2	0.788
I am satisfied with the amount of traffic in my neighbourhood	8.9	20.9	25.8	40.3	4.0	0.738
There is so much traffic along the streets in my neighbourhood that it makes it difficult or unpleasant to walk in my neighbourhood (Reversed)	17.8	49.2	18.8	10.5	3.7	0.709

Table 37: Cronbach's Alpha neighbourhood safety

Neighbourhood safety						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
0	20	9.9385	9.718	3.11744	5	0.792

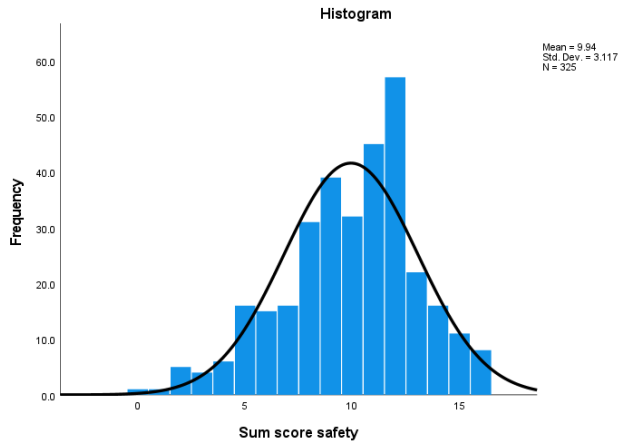


Figure 16: Histogram sum score neighbourhood safety

Leefbarometer

As already mentioned, additional datasets are combined with the data from the questionnaire since objective data might differ from subjective data. Hence, for the physical environment data a score for safety, physical environment and the facilities could be obtained from Leefbarometer level (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020). The Leefbarometer score is given relative to the national average. The Leefbarometer score is added based on postal codes. The results can be seen in Table 38 and Figure 17. The score for safety is on average lower than the national average, so the municipality of Venlo is on average less safe compared to the national average.

Table 38: Leefbarometer score means (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020)

Variable	Mean	St. dev.
Leefbarometer safety	-0.03974	0.08833
Leefbarometer physical environment	0.02437	0.02756
Leefbarometer facilities	0.006149	0.04746

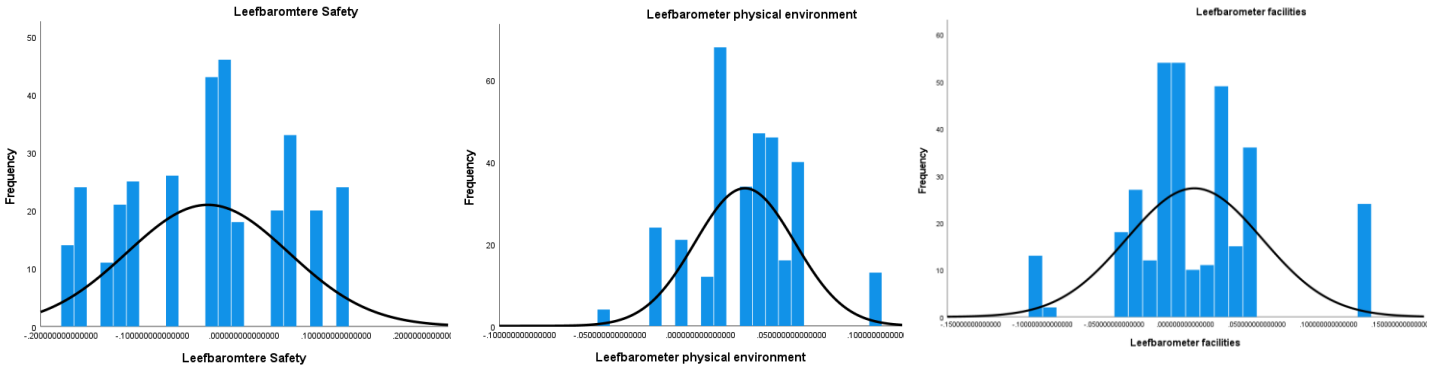


Figure 17: Histograms of the Leefbarometer scores per item

5.2.4. Physical activity

Physical activity is measured by using the SQUASH survey (Wendel-Vos & Schuit, 2004). This survey uses the Dutch Standard for Healthy Exercise (Norm Gezond Bewegen). This standard indicates that a person should at least be physically active five days per week for a minimum of 30 minutes (Wendel-Vos & Schuit, 2004). This standard is used by the CBS and the municipality of Venlo itself. First, this variable is described. Afterwards, the total amount of minutes per respondent is calculated and it is checked whether they comply with the WHO standards. According to the WHO, adults should do at least 150-300 minutes moderate-intensity physical activity, or at least 75-150 minutes of vigorous-intensity physical activity. In addition, muscle-strengthening activities must be executed on two or more days (World Health Organization, 2020).

SQUASH – NGB-norm

The instructions for the processing of the SQUASH survey were used to recode and transform the data to the dependent variable needed (Wendel-Vos & Schuit, 2004). First, new variables are computed. Afterwards, the minutes per day are multiplied by the number of days a respondent executes the activity. Hereby, the total minutes per week per activity is generated. When the number of sport days per week is missing, but the minutes and intensity per sport is filled in, then the SQUASH instructions assumes that the respondent executes this activity one day. Therefore, for these cases the days per week is set to one when missing. Furthermore, it was seen that one respondent filled in '888' as answer for all the physical activity questions, therefore the value of this respondent is set to 0. Furthermore, if the minutes per activity type exceeded 960, then the value was also set to 0 as this amount of activity per day is not reliable (Wendel-Vos & Schuit, 2004). The value 0 is used to replace these values, because this is the way the SQUASH survey processes its data (Wendel-Vos & Schuit, 2004). Table 39 shows the cases per activity which were set to 0.

Table 39: Recoded cases

Variable	Action
Light physical activity at work	2x to 0
Heavy physical activity at work	1x to 0
Light household work	6x to 0
Heavy household work	2x to 0
Leisure time – walking	1x to 0, another respondent answer 530 minutes, but he obviously meant 5 days and 30 minutes. So, this is corrected
Leisure time – cycling	10 days is set to 1 day
Leisure time – doing odd jobs	2x

Physical activity at work or school was asked in hours per day, however the other questions in which respondents needed to indicate their time spent per day was in minutes. Therefore, some of the respondents filled in this question in minutes, resulting in some unreliable values for physical activity at work or school. The obvious unreliable values were set to 0, since this is the way the SQUASH survey processes its data (Wendel-Vos & Schuit, 2004).

A disadvantage of the SQUASH is that the activities walking and cycling can be filled in in multiple questions, namely: leisure time physical activity and sports. This was also seen in the results of the

questionnaire. Therefore, when a respondents filled in walking or cycling as a sport, the minutes for walking or cycling in leisure time were not included in total minutes of physical activity to prevent double count.

After these adjustments, Metabolic Equivalent (MET) values were assigned to the sports activities. This is a unit of measurement which indicates how much energy an activity costs relative to the amount of energy required in resting. The MET-values in Table 40 are retrieved from the SQUASH document, however not all sports were included in this document (Wendel-Vos & Schuit, 2004). Therefore, the missing MET-values were retrieved from the internet. 'Pilates' is assigned with a MET value of 3.7 and for 'triathlon' the average of swimming, running and cycling (racing) is taken (BurnedCalories, n.d.; Wendel-Vos & Schuit, 2004).

The respondents had to indicate how intense the activities were. Based on the MET-values and the self-reported intensity, an intensity score could be calculated based on Table 41. This intensity-score is used to calculate whether or not the respondent complies with the Dutch Standard for Healthy Exercise.

Table 40: Intensity based on MET (Wendel-Vos & Schuit, 2004)

	Light	Average	Heavy
<18 years	<5 MET	5-8 MET	≥8 MET
18-55 years	<4 MET	4-6,5 MET	≥6,5 MET
55 years or older	<3 MET	3-5 MET	≥5 MET

Table 41: Intensity scoring (Wendel-Vos & Schuit, 2004)

	Intensity based on self-report		
Intensity based on MET	Light	Average	Heavy
Light	1	2	3
Average	4	5	6
Heavy	7	8	9

The calculation of compliance with the Dutch Standard for Healthy Exercise is done as follows: activities are included in the calculation when the intensity score is 3 or higher and the minimum number of minutes that the activity is performed per day is at least 30. Light household activity and light physical activity at work have a lower value than the threshold and are therefore not included as activity in the calculation (Wendel-Vos & Schuit, 2004).

As seen in Table 42, the result is that 283 respondents comply with the Dutch Standard for Healthy Exercise, which is 87%. This is an unexpected high number, as only 13% does not comply. The most recent number from the municipality of Venlo is that only 54% complies with the standard (Gemeente Venlo & I&O Research, 2021).

Table 42: Results Dutch Standard for Healthy Exercise (NGB-norm)

Item	Percentage	Frequencies
0 days	2.8	9
1 days	0.9	3
2 days	2.8	9
3 days	2.5	8
4 days	4.0	13
5 days	3.4	11

6 days	4.9	16
7 days	78.8	256

When looking at the results of question 92 in Table 43, it is seen that 71% of the respondents is physical active at 5 or more days per week for at least 30 minutes. This is already a lower number, however this excludes the minutes of heavy physical activity at work or heavy household work, which according to the SQUASH and the Dutch Standard for Healthy Exercise should be included.

Table 43: Results Q92

Item	Percentage	Frequencies
0 days	1.8	6
1 days	2.8	9
2 days	5.8	19
3 days	9.2	30
4 days	8.9	29
5 days	14.8	48
6 days	10.8	35
7 days	45.8	149

WHO-norm

Besides the processing of the SQUASH, the total minutes of physical activity is calculated to check compliance with the WHO-norm (World Health Organization, 2020). According to the WHO, adults should do at least 150-300 minutes moderate-intensity physical activity, or at least 75-150 minutes of vigorous-intensity physical activity (World Health Organization, 2020). Here, again light household activity and light physical activity at work are not included. The total minutes of physical activity is calculated by summing the minutes that were indicated as 'average' or 'heavy' intense by the respondents. Again, when a respondents filled in walking or cycling as a sport, the minutes for walking or cycling in leisure time were not included in the total minutes of physical activity to prevent double count. Table 44 show the result and Figure 18 the histogram. As seen, 85.2% of the respondents are active for more than 150 minutes per week.

Table 44: Results total minutes WHO standard

	Item	Percentage (%)	Frequency (#)
0	0-75 minutes	10.2	33
1	76-149 minutes	4.6	15
2	150-299 minutes	13.5	44
3	300-599 minutes	24.0	78
4	600-1200 minutes	27.7	90
5	>1200 minutes	20.0	65

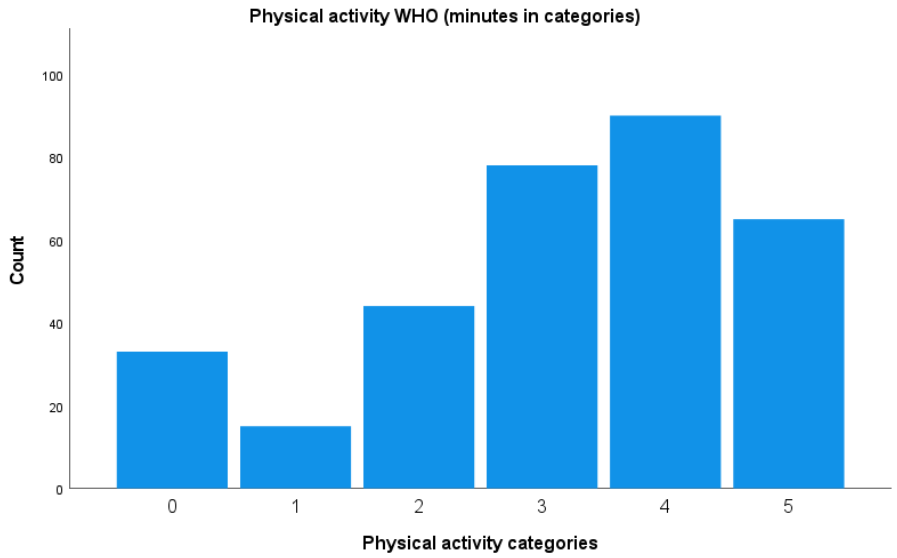


Figure 18: Histogram physical activity WHO standard

Other physical activity questions (excluding the SQUASH)

Question 93 shows if respondents spend the same amount of time on physical activity as before the COVID pandemic. As seen in Table 45, the majority (59.4%) of the respondents spends the same time on these activities.

Table 45: Frequencies time spent compared to before COVID

	0	1	2	3	4
	A lot less (%)	**Less (%)**	**The same (%)**	**More (%)**	**A lot more (%)**
Q93					
Do you spend same amount of time walking, cycling, doing odd jobs, gardening, sports or other strenuous activities as before the COVID pandemic?	3.7	12.3	59.4	22.2	2.5

Question 94 'Do you ever use an app when exercising?' was included to check whether respondents already use apps during exercising. The majority of the respondents (55.7%) never uses an app, whereas 12.9% always uses an app, see Table 46.

Table 46: Frequencies app usage

	0	1	2	3	4
	Never (%)	**Rarely (%)**	**Sometimes (%)**	**Often (%)**	**Always (%)**
Q94					
Do you ever use an app when exercising?	55.7	7.1	13.8	10.5	12.9

Question 95 'Would you exercise more if there was an app that gives rewards for exercise?' shows that 68.6% of the respondents are not going to exercise more if there is an app that gives rewards for exercising, see Table 47.

Table 47: Frequencies reward app

	0	1	2
	No	**Yes**	**I do not know**
Q95			
Would you exercise more if there was an app that gives rewards for exercise?	68.6	10.2	21.2

5.2.5. Potential interventions

The stated choice experiment included two different variants, which were randomly assigned to the respondents by the string 'if(! is_empty(PIN), PIN, rand(1, 2))'. As seen in Table 48, 163 respondents got variant 1 and 162 got variant 2. Looking at Table 48, it can be noticed that around a hundred respondents choose the option 'None of these' in each question.

Table 48: Frequencies stated-choice experiment

Package A (#)	**Package B (#)**	**None of these (#)**
Stated choice variant 1 (#163 total)		
43	17	103
48	13	102
17	39	107
16	54	93
Stated choice variant 2 (#162 total)		
17	43	102
30	28	104
15	40	107
47	19	96

5.2.6. COVID

This paragraph discusses the questions about COVID. In the questionnaire four question were incorporated about the attitude towards COVID, as seen in Table 49. As seen in Table 50, according to the Cronbach's Alpha a sum score can be calculated excluding the last item as the value then increases from 0.454 to 0.693. The item 'If the coronavirus had not been an obstacle at all, I would have exercised more' will be included as a separate variable in the remaining analysis. Figure 19 shows the sum score of the first three items of Table 49 which will also be used in the remaining analysis.

Table 49: Frequencies COVID items

	Fully disagree (%)	**Disagree (%)**	**Neutral (%)**	**Agree (%)**	**Fully agree (%)**	**Cronbach's Alpha if item deleted**
COVID						
I am afraid that I contract the coronavirus (reversed)	21.5	38.2	21.8	14.2	4.3	0.341
Currently, I feel comfortable in public spaces (such as shops)	2.2	7.4	12.9	51.7	25.8	0.194
I visit other people at home	1.2	7.7	7.7	53.2	30.2	0.214

If the coronavirus had not been an obstacle at all, I would have exercised more (Q34.4)	14.5	33.8	17.5	24.0	10.2	0.693

Table 50: Cronbach's Alpha COVID

COVID						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
1	12	8.5354	5.373	2.31797	4	0.693

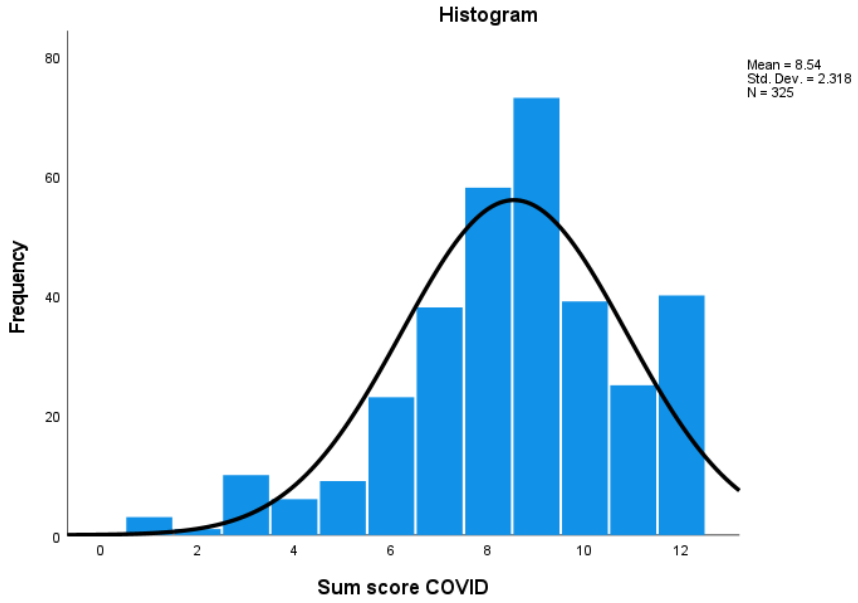


Figure 19: Histogram sum score COVID

Another question included in the questionnaire was whether or not people had found other ways of exercising due to the COVID-pandemic. 59.7 percent of the respondents did not find other ways, while 40.3 percent did. The respondents who did find other ways of exercising could indicate what type of activities they did. The result of the new ways of exercising is summarized in Figure 20.

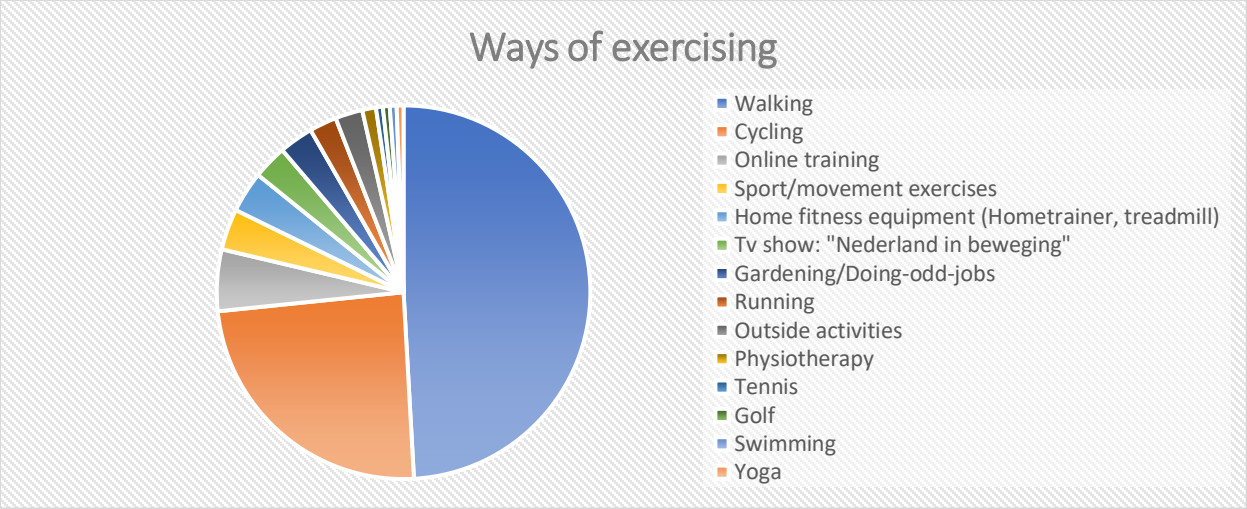
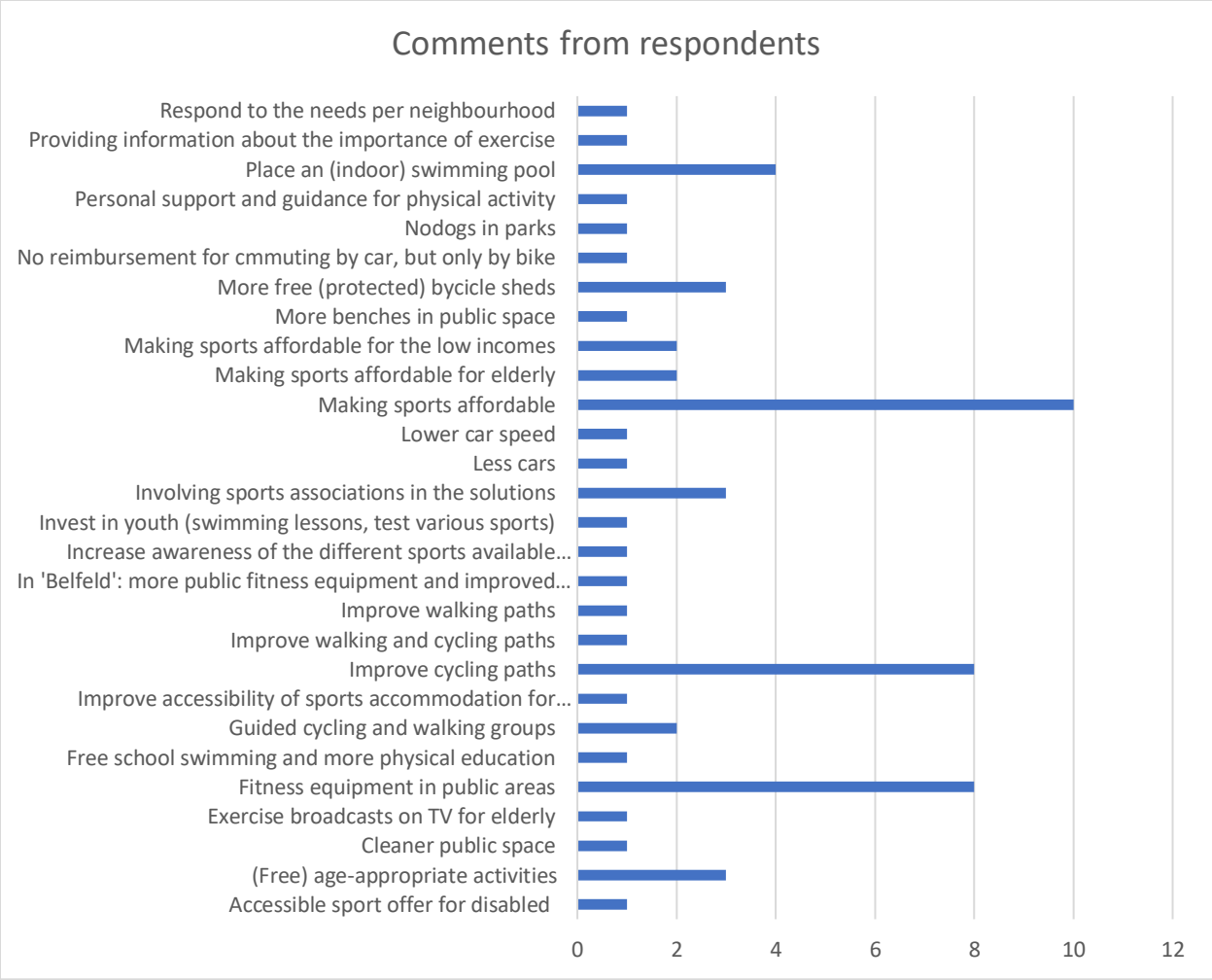


Figure 20: New ways of exercising during the COVID-pandemic

Furthermore, the respondents were able to leave a comment when they had other ideas in which the municipality could help to improve physical activity levels. Table 51 summarizes the comments. As seen, most respondents indicated that the municipality should make sports affordable, improve cycling paths, and implement more fitness equipment in public areas. Furthermore, an (indoor) swimming pool, (free) age-appropriate activities and more (free) bicycle sheds are often mentioned. Lastly, some respondents indicated that the municipality should involve the sports associations in implementing the interventions, as otherwise the gap between the municipality and the sport associations increases even more.

Table 51: Overview of comments with ideas of the respondents



5.3. Conclusion

This chapter showed the results of the descriptive statistics. It can be concluded that the sample is not representative for the population of Venlo. It was seen that there is an overrepresentation of males, adults aged 65 years or older, highly educated people, one-person households and couples without children, and unemployed people. Furthermore, the descriptive statistics showed that 50% of the respondents belongs to the personality trait 'agreeableness', whereas only 2% is neurotic.

Physical activity was calculated in multiple ways. Most of the respondent met the physical activity guidelines. The WHO calculation showed that 85.2% of the respondents are active for more than 150 minutes per week, and thus comply with the WHO standards. The Dutch Standard for Healthy Exercise showed that 87% of the respondents complied with their standard. According to question 92 of the questionnaire, 71% of the respondents is physical active for 5 or more days per week for at least 30 minutes. All variables described here will be used in the next chapters to gain insights into which variables affect the physical activity levels.

6. Results - Stated Choice Experiment

In the previous chapter, the descriptive analysis of the variables resulting from the questionnaire was carried out. This chapter will show the results of the stated choice experiment. First, the data preparation is explained. A multinomial logit model and latent class model are estimated and their results are discussed. Lastly, respondents will be assigned to classes. Herewith, the relationships between latent class membership and individual, social and physical characteristics are examined in a bivariate analyses.

6.1. Data preparation

Before being able to analyse the data of the stated choice experiment in NLogit, the data needs to be prepared and recoded. Coding allows for the measurement of non-linear effects in the different levels of the attributes, which is necessary for accurate data analysis. There are two options for the recoding of the attribute levels, namely dummy coding or effect coding. The advantage of effect coding, in comparison to dummy coding, is that the utilities are compared to the grand mean whereas in dummy coding they are compared to the base level of an attribute. The disadvantage for dummy coding is that it assumes to have perfectly confounded the base attribute level with the grand mean. Hereby, the effect of each attribute level is less clear (Hensher et al., 2015c). Therefore, here effect coding is used. Table 52 shows the effects coding used.

Table 52: Effect coding SCE

Abbreviation	Attribute	Level	Label	Effects coding	Derived part-worth utility
Support	Personal support and guidance from an exercise broker/sports coach for appropriate sports and exercise offer	Level 0	Yes	1	B_1*1
		Level 1	No	-1	B_1*-1
Track	Sports activity sharing via an app	Level 0	Possible	1	B_2*1
		Level 1	Not possible	-1	B_2*-1
Age	Age-appropriate activities and workshops in my neighbourhood (Examples are walking and running groups)	Level 0	Yes	1	B_3*1
		Level 1	No	-1	B_3*-1
PublicFitness	Availability of free public fitness equipment in public spaces	Level 0	Improved	1	B_4*1
		Level 1	Same as your current situation	-1	B_4*-1
PublicSport	Availability of public sports facilities (Examples are running and walking paths, cycling paths etc)	Level 0	Same as your current situation	1	B_5*1

		Level 1	Improved	-1	B_5*-1
Gym	Access to gym	Level 0	Same price as now	1	B_6*1
		Level 1	With a discount	-1	B_6*-1
Rewards	Earn rewards through an app per activity	Level	Not possible	1	B_7*1
		Level 1	Possible	-1	B_7*-1

The data extracted from LimeSurvey is not in the correct structure for NLogit, as it is not yet effect coded. Therefore, a Python code is used to transform the output of the stated choice experiment from LimeSurvey to effect coding. This code can be seen in Appendix C.

The effect coding is shown in Table 53. For each respondent 12 rows are created, which indicates the profiles from which the respondent could choose. The column 'variant' indicates the variant of the stated choice model that the respondent got. The column 'choice set' indicates the question number, the column 'profile' indicates the profile number. The column 'chosen' indicates the answer which the respondent gave, if coded 1 the respondent choose this answer, otherwise it is 0. The respondents were able to answer 'none of these', this is coded by using a constant. If a respondents choose the answer 'none of these', the constant is set to 1. The remaining columns indicate the attribute levels in the profiles. The values of the attribute are 0 for the constant.

Table 53: Data structure based on effect coding

Response ID	Variant	Choice set	Profile	Chosen	Constant	Support	Track	…	Rewards
23	1	1	7	0	0	-1	-1		1
23	1	1	5	1	0	-1	1		-1
23	1	1	0	0	1	0	0		0
23	1	2	3	1	0	1	-1		-1
…									
639	2	8	0	0	1	0	0		0

6.2. Multinomial Logit (MNL) model

An overview of the output of the MNL model can be seen in Table 54. The complete output can be seen in Appendix D. The significance levels from Table 54 indicate whether the attribute had a significant influence on the choice behaviour of the respondents. The output only indicates the coefficients for attribute level 0 of coded variables, hence the values for attribute level 1 can be calculated by multiplying the value by -1. The coefficients can be interpreted in comparison to one another. The attribute can be considered significant when the significance is smaller than 0.1. When the attribute is insignificant, then the estimated utility might also be based on, for example, coincidence.

The significance levels from Table 54 show that the majority of the attributes is significant, except for sports activity sharing. Therefore, it can be concluded that there is no evidence that sports activity sharing has an influence on the choice of participants for an intervention package. The remaining attributes do

influence the choice of the participants in the intervention packages. The constant indicates whether a respondent prefers choosing an alternative over the 'none of these' option. A negative constant indicates that the respondents are more likely to choose one of the packages of interventions rather than the 'none of these' option. Whereas a positive constant indicates that the respondents are more likely to choose the 'none of these' option instead of one of the packages of interventions. From the MNL model can be seen that the participants are more likely to choose the 'none of these' option rather than one of the packages of interventions.

Table 54: Summary of output MNL models

Attributes	Level	β	Sig.
Constant (No choice)	-	1.31	***
Personal support and guidance from an exercise broker/sports coach for appropriate sports and exercise offer	Yes	0.24	***
	No	-0.24	-
Sports activity sharing via an app	Possible	-0.022	n.s.
	Not possible	0.022	-
Age-appropriate activities and workshops in my neighbourhood (Examples are walking and running groups)	Yes	0.18	***
	No	-0.18	-
Availability of free public fitness equipment in public spaces	Improved	0.24	***
	Same as your current situation	-0.24	-
Availability of public sports facilities (Examples are running and walking paths, cycling paths etc)	Same as your current situation	-0.10	*
	Improved	0.10	-
Access to gym	Same price as now	-0.23	***
	With a discount	0.23	-
Earn rewards through an app per activity	Not possible	-0.12	**
	Possible	0.12	-

* Significant at the 0.01 level
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)
n.s. Not significant

The most preferred attribute level is the one with the highest positive part-worth utility (β). A negative part-worth utility indicates that the respondent dislikes that attribute. Hence, from Table 54 can be concluded that respondents prefer personal support, age-appropriate activities, improved free public fitness equipment, improved public sports facilities, access to the gym with a discount, and the possibility rewards through an app per activity. As already mentioned, sports activity sharing via an app was not significant. Figure 21 shows a visualization of the part-worth utilities.

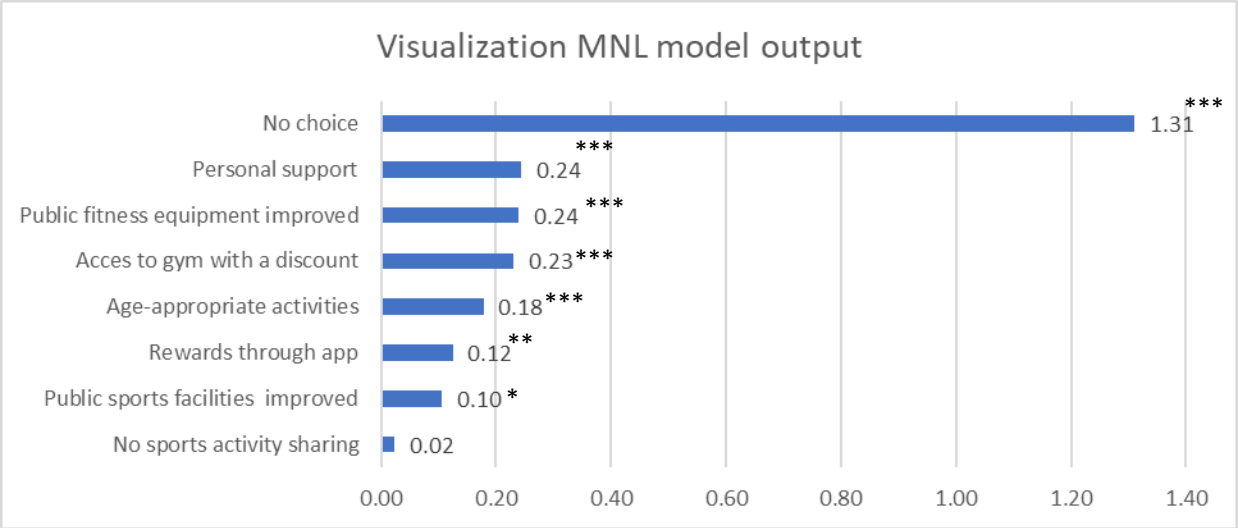


Figure 21: Visualization of the part-worth utilities and significance levels of the MNL model

Based on the highest and lowest part-worth utility of the attributes, the relative importance per attribute can be calculated. First, the range between the two values of each attribute will be calculated. Secondly, the relative importance is calculated. This can be seen in Table 55. The higher the range, the stronger the influence on the choice behaviour. Hence, from Table 55 can be concluded that, excluding the choice/no choice attribute, personal support from an exercise broker and the availability of free public fitness equipment in public spaces are the most important factors affecting the choice for a package of interventions. The possibility for sports activity sharing via an app has no effect on the choice, since this variable is insignificant. The item availability of public sport facilities has the lowest effect on choice.

Table 55: Relative importance of attributes MNL model

Attribute	Range	Relative importance
Personal support and guidance from an exercise broker/sports coach for appropriate sports and exercise offer	0.48	21.2%
Availability of free public fitness equipment in public spaces	0.48	21.2%
Access to gym	0.46	20.3%
Age-appropriate activities and workshops in my neighbourhood (Examples are walking and running groups)	0.36	15.9%
Earn rewards through an app per activity	0.24	10.6%
Availability of public sports facilities (Examples are running and walking paths, cycling paths etc)	0.20	8.8%
Sports activity sharing via an app	0.044	1.9%

As seen from the model fit statistics in Table 56, the McFadden Rho-square (ρ^2) of the MNL model is $1 - (\frac{-1146.96940}{-1428.19598})$= 0.1969. This indicates a low model fit, as the ρ^2 should be between 0.2 and 0.4 for an excellent model fit. So, therefore the MNL model explains the choice behaviour in a limited way; it does not take heterogeneity in the preferences into account. Therefore, it is also interesting to look at the Latent Class (LC) models, as these models take into account different types of respondents by creating classes with similar preferences for interventions.

Table 56: MNL model fit

Model fit statistics	
LL (B)	-1146.96
LL (0)	-1428.19598
ρ^2	0.1969
ρ^2 adjusted	0.1792

All in all, from the MNL model follows that all items affect the choice of the participants, except for the sports activity sharing. The most important interventions according to the choice behaviour of the respondents are personal support and improved availability of free public fitness equipment, followed by access to gym with a discount and age-appropriate activities. Earning rewards through an app and the improved availability of public sport facilities (such as walking and cycling paths) also affect the choice of people, but way less than the previous mentioned interventions.

6.3. Latent Class (LC) model

After running the MNL models, the LC models are estimated. The LC model can be estimated to a maximum of five classes. An overview of the model statistics can be seen in Table 57. The complete LC output can be seen in Appendix E. To conclude which LC model is the best, the AIC and ρ^2 are used and compared to the MNL model. As seen, the LC models with four and five classes could not be estimated due to the following error 'Error 1027: Models – estimated variance matrix of estimates is singular. The models with two and three classes could both run and showed to have a lower AIC and a higher ρ^2 value compared to the MNL model. When looking at the AIC and ρ^2 values, the LC model with three classes is preferred, however the model with three classes showed to have insignificant confidence intervals for the first class. Therefore, the LC model with two classes explains the choice behaviour better and will be further elaborated.

Table 57: Overview AIC and ρ^2 values of the LC models

LC Model	AIC	ρ2	ρ2 adjusted
1 class (MNL model)	2309.9	0.1969	0.1792
2 class	1753.5	0.3980	0.3940
3 class	1735.5	0.4106	0.4047
4 class*	-	-	-
5 class*	-	-	-

**Could not be estimated due to the error – estimated variance matric of estimates is singular*

A summary of the output of the LC model with two classes can be seen in Table 58. Again, both the constants are significant. However, the differences between the classes are clearly visible. The constant in class one is positive, therefore respondents in class one are more likely to choose the 'none of these-option rather than one of the package with interventions. Whereas the second class has a negative constant, meaning that they are more likely to choose one of the packages with interventions rather than the 'none of these' option. Class one will be referred to as the 'no preference class', class two will be referred to as 'preference class'.

Looking at the class probabilities, it can be seen that 60.8% of the respondents belongs to the 'no preference class' and 39.2% belongs to the 'preference class'. This equals 196 and 129 respondents respectively. So, the majority of the respondents are less inclined to choose for packages of interventions,

which means that they are less motivated by the interventions, are not willing to adopt the interventions or do not need interventions in order to exercise more.

Table 58: Summary LC model with two classes

Attributes	Level	No preference class		Preference class	
		β	Sig.	β	Sig.
No choice (constant)	-	3.54	***	-1.01	***
Personal support and guidance from an exercise broker/sports coach for appropriate sports and exercise offer	Yes	0.036	n.s.	0.36	***
	No	-0.036	-	-0.36	-
Sports activity sharing via an app	Possible	-0.24	n.s.	-0.036	n.s.
	Not possible	0.24	-	0.036	-
Age-appropriate activities and workshops in my neighbourhood (Examples are walking and running groups)	Yes	0.0037	n.s.	0.20	**
	No	-0.0037		-0.20	
Availability of free public fitness equipment in public spaces	Improved	-0.17	n.s.	0.22	***
	Same as your current situation	0.17	-	-0.22	-
Availability of public sports facilities (Examples are running and walking paths, cycling paths etc)	Same as your current situation	0.016	n.s.	-0.18	**
	Improved	-0.016	-	0.18	-
Access to gym	Same price as now	-0.39	*	-0.22	**
	With a discount	0.39	-	0.22	-
Earn rewards through an app per activity	Not possible	0.57	n.s.	-0.21	***
	Possible	-0.57		0.21	-
Class probabilities		0.608	***	0.392	***

* Significant at the 0.01 level
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)
n.s. Not significant

As seen in Table 58, the 'no preference class' has a significant positive coefficient for the no-choice option. Hence, in the 'no preference class' are the respondents who are less inclined to adopt one of the interventions as they are more likely to choose 'none of these'. The fact that this group is more likely to choose for 'none of these' option might also explain the fact that most attributes in this class are not significant.

The 'preference class' has a significant negative coefficient for the no-choice option. Hence, respondents in this class are more likely to choose one of the packages of interventions rather than the 'none of these' option. This class is thus motivated by the interventions to participate in more physical activity. Respondents in class two prefer personal support over no personal support, age-appropriate activities over no age-appropriate activities, improved public fitness equipment and public sports facilities over their current situation, access to gym with a discount, and the possibility to earn rewards per activity over no rewards. Figure 22 shows a visualization of the LC model output.

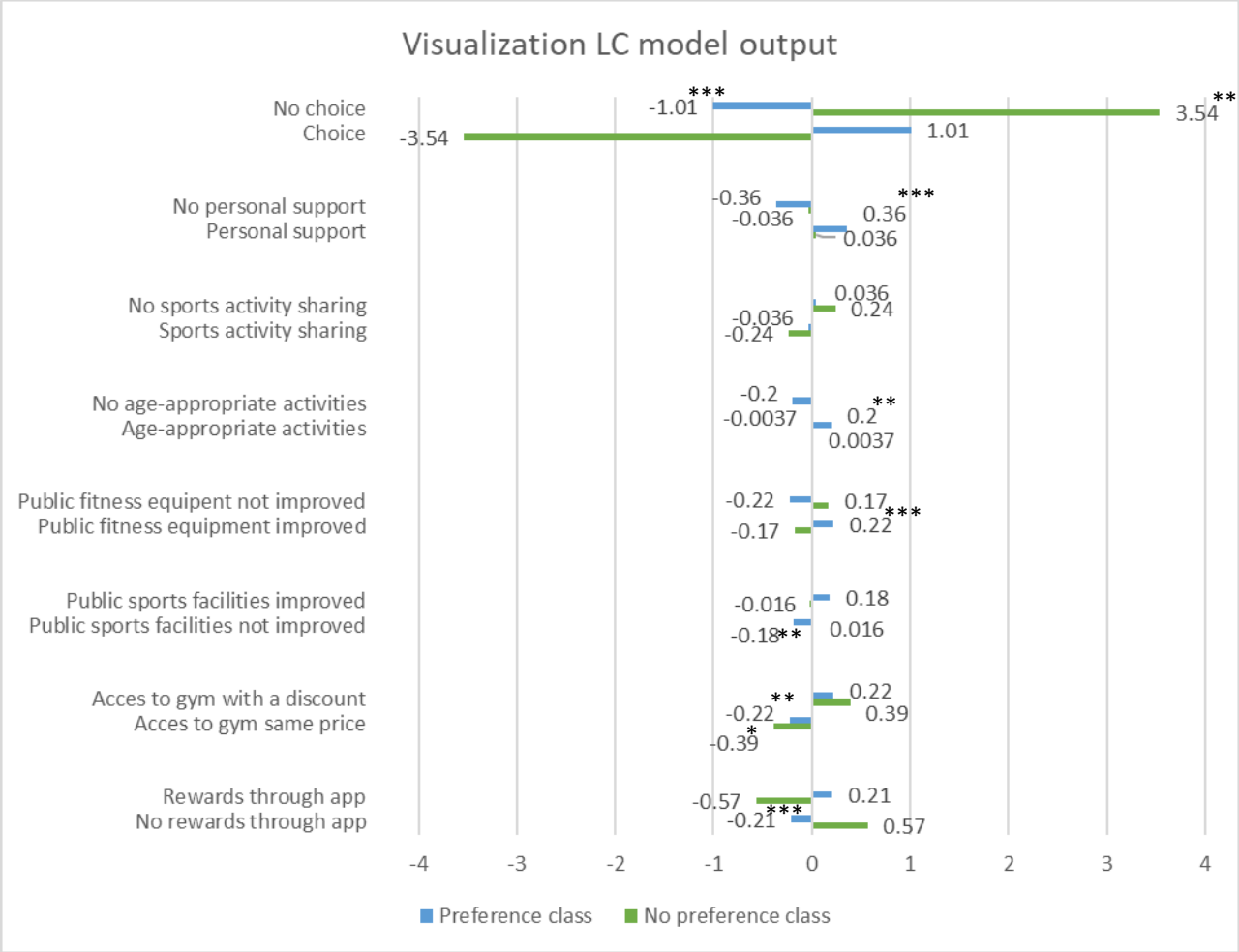


Figure 22: Visualization of the part-worth utilities and significance levels of the LC model

Based on the highest and lowest part-worth utility of the attributes, the relative importance can be calculated for the two classes of the LC model. These can be seen in Table 59.

Table 59: Relative importance of attributes LC model

Class 1 'No preference class'	Range	Relative Importance	Class 2 'Preference class'	Range	Relative Importance
Personal support and guidance from an exercise broker/sports coach for appropriate sports and exercise offer	0.072	2.5%	Personal support and guidance from an exercise broker/sports coach for appropriate sports and exercise offer	0.72	25.2%
Sports activity sharing via an app	0.48	16.8%	Sports activity sharing via an app	0.072	2.5%
Age-appropriate activities and workshops in my neighbourhood (Examples are walking and running groups)	0.0074	0.3%	Age-appropriate activities and workshops in my neighbourhood (Examples are walking and running groups)	0.40	14.0%

Availability of free public fitness equipment in public spaces	0.34	11.9%	Availability of free public fitness equipment in public spaces	0.44	15.4%
Availability of public sports facilities (Examples are running and walking paths, cycling paths etc)	0.032	1.1%	Availability of public sports facilities (Examples are running and walking paths, cycling paths etc)	0.36	12.6%
Access to gym	0.78	27.4%	Access to gym	0.44	15.4%
Earn rewards through an app per activity	1.14	40.0%	Earn rewards through an app per activity	0.42	14.7%

It can be concluded that for the no preference class, the most important attribute is access to gym as this is the only significant variable. The attributes age-appropriate activities, availability of public sports facilities and personal support have no effect on the preference of this class. For the preference class, the most important attribute is personal support from an exercise broker/sports coach. Secondly, improved availability of free public fitness equipment in public space and access to the gym with a discount are equally important. Followed by earning rewarding through an app per activity and the improved availability of public sports facilities (such as walking and cycling paths). The least important variable is the non-significant variable sports activity sharing via an app. Afterwards, the least important significant variable is the availability of public sports facilities.

6.4. Bivariate analyses

The probability for each respondent to belong in the no preference class or preference class is given by the LC output. The respondents are assigned to the class with the highest probability. Hereafter, the relationships between the latent class membership and individual, social and physical environmental factors are examined by using cross-tabulations with chi-square tests and independent t-tests. Chi-square is used between two categorical variables, the independent samples t-test is used when there is one dichotomous and one continuous variable.

Relationship class membership and individual determinants

The relationship between class membership and individual determinants are examined through a bivariate analyses. The significant results can be seen in Table 60. The complete results can be seen in Appendix F. As seen, there are only two significant relationships. These are household composition and personality. However, it must be noted that they are only significant at the 0.1 significance level. The no preference class includes more couples without children compared to the preference class. The preference class includes more couples with children and single parent families. Considering personality, it is seen that the personality groups agreeableness, imagination and neuroticism are more often found in the preference class compared to the no preference class.

Table 60: Relationship between class membership and individual determinants

	Sample (%)	**No preference class (%)**	**Preference class (%)**	**X^2 or t.**	**Sig.**
Household composition				**X^2**	
One-person household	13.2	12.8	14.0	**4.819***	0.090
Couple without children	58.1	62.8	51.1		

Couple with children & single-parent family	28.6	24.5	34.9		
Personality				**X^2**	
Agreeableness	50.2	48.5	52.7	**8.767***	0.070
Conscientiousness	32.3	34.7	28.7		
Extraversion	5.5	7.1	3.1		
Imagination	10.2	9.2	11.6		
Neuroticism	1.8	0.5	3.9		

* Significant at the 0.1 level (2-tailed)

Relationship class membership and social environment

Considering the relationship between class membership and social environment, it can be observed that social support, social support of significant others, social support of family and social support of friends have significant relationships with class membership. The results are presented in Table 61. Respondents belonging to the no preference class have higher levels of social support compared to respondents of the preference class. This is the case for all sources of social support. So, respondents with more social support more often choose for the 'none of these' option.

Table 61: Relationship between class membership and social environment

	Sample (mean)	No preference class (mean)	Preference class (mean)	t.	Sig.
Sporty friends/family	2.17	2.15	2.19	-0.371	0.711
Sporty neighbours	1.91	1.91	1.90	0.176	0.860
Social support	33.18	34.21	31.60	**2.914****	0.004
Social support significant others	11.45	11.82	10.89	**2.450***	0.015
Social support family	10.57	10.95	9.98	**2.305***	0.022
Social support friends	11.16	11.44	10.73	**2.005***	0.046
Social cohesion	13.13	13.32	12.84	0.542	0.167

* Significant at the 0.05 level (2-tailed)
** Significant at the 0.01 level (2-tailed)

Relationship class membership and physical environment

From Table 62 can be concluded that there is significant relationship between class membership and the satisfaction with parks and sports facilities. Respondents in the no preference class have a higher mean of satisfaction with parks and sports facilities compared to respondents of the preference class. Hence, respondents of the no preference class are in general more satisfied with the parks and sport facilities in Venlo. So, respondents with a higher satisfaction with the parks and sports facilities more often choose for the 'none of these' option. The remaining variables of the physical environment do not show a significant relationship with class membership at a significance level of 0.05. There are three variables which are significant at the 0.1 significance level, these are walkability, infrastructure (maintenance cycling paths) and the Leefbarometer score for safety. Respondents who indicated to have higher levels of walkability, are more satisfied with the maintenance of the cycling paths, or have a higher score on the Leefbarometer for safety are more often found in the no preference class.

Table 62: Relationship between class membership and physical environment

	Sample (mean)	No preference class (mean)	Preference class (mean)	t.	Sig.
Walkability	28.49	28.95	27.78	**1.869***	0.063
Parks and sport facilities	12.22	12.52	11.78	**1.975****	0.049
Safety	9.9385	10.00	9.84	0.438	0.662
Infrastructure 69.1	2.37	2.45	2.26	**1.765***	0.079
Infrastructure 69.2	2.77	2.77	2.78	-0.052	0.959
Leefbarometer safety	-0.040	-0.033	-0.050	**1.719***	0.087
Leefbarometer physical activity	0.024	0.025	0.024	0.386	0.700
Leefbarometer facilities	0.0061	0.0035	0.010	0.687	0.214
Density	**Sample (%)**	**Class 1 (%)**	**Class 2 (%)**	**X^2**	**Sig.**
<500 addresses per km^2	15.1	14.3	16.3	6.039	0.196
500-1000 addresses per km^2	36.0	36.2	35.7		
1000-1500 addresses per km^2	12.6	10.7	15.5		
1500-2500 addresses per km^2	24.0	28.1	17.8		
>2500 addresses per km^2	12.3	10.7	14.7		

* Significant at the 0.1 level (2-tailed)

** Significant at the 0.05 level (2-tailed)

Relationship class membership, COVID and app usage

Table 63 shows that there are no significant relationships between class membership and COVID or app usage.

Table 63: Relationship class membership, COVID and app usage

	Sample (%)	No preference class (%)	Preference class (%)	X^2	Sig.
Q38: COVID other ways of exercising					
No	59.7	57.7	62.8	0.853	0.356
Yes	40.3	42.3	37.2		
Q93: Physical activity compared before COVID					
A lot less	3.7	4.1	3.1	1.069	0.899
Less	12.3	12.2	12.4		
The same	59.4	58.2	61.2		
More	22.2	22.4	21.7		
A lot more	2.5	3.1	1.6		
Q94: Usage of app					
Never	55.7	51.5	62.0	3.859	0.425
Rarely	7.1	8.2	5.4		
Sometimes	13.8	15.3	11.6		
Often	10.5	10.7	10.1		
Always	12.9	14.3	10.9		
Q95: Reward app					

No	68.6	68.9	68.2	0.315	0.854
Yes	10.2	10.7	9.3		
I do not know	21.2	20.4	22.4		

Relationship class membership and physical activity

Table 64 shows that there is no significant relationship between class membership and the dependent variable physical activity.

Table 64: Relationship class membership and dependent variable

Dependent variable	Measurement level	Sample (mean)	No preference class (mean)	Preference class (mean)	t.	Sig.
Dutch standard for healthy exercise (Days)	Continuous	1.66	1.65	1.67	-0.270	0.787
					X^2	
Dutch standard for healthy exercise (Days)	Categorical	1.66	1.65	1.67	2.902	0.234
Dutch standard for healthy exercise (Days)	Nominal (dichotomous)	0.87	0.86	0.89	0.815	0.367
Physical activity minutes (WHO)	Categorical	3.14	3.13	3.16	2.403	0.791
					t.	
Physical activity minutes (WHO)	Continuous	812.208	758.372	894.004	-2.334	0.183
Total sports minutes only	Continuous	176.515	160.082	201.484	-1.407	0.160
Q92 Physical activity days	Continuous	5.37	5.28	5.51	-1.059	0.290

6.5. Conclusion

This chapter showed the results of the MNL model, LC model and the bivariate analysis of class membership. Overall, it has shown that 60.8% of the respondents belongs to class one and 39.2% belongs to class two. Class one can be interpreted as a group of respondents that are more likely to choose the 'none of these' option instead of one of the packages of interventions, called 'no preference class'. In the no preference class are respondents who are less inclined to adopt one of the interventions as they are more likely to choose 'none of these'. The fact that this group is more likely to choose for 'none of these' option might also explain the fact that most attributes in this class are not significant.

Respondents in class two are more likely to choose one of the packages of interventions rather than the 'none of these' option. This class is thus motivated by the interventions to participate in more physical activity. Therefore, they are referred to as 'preference class'. Respondents in the preference class prefer personal support over no personal support, age-appropriate activities over no age-appropriate activities, improved public fitness equipment and public sports facilities over their current situation, access to gym with a discount, and the possibility to earn rewards per activity over no rewards. For class two, the most

important attribute determining their choice for a package is personal support from an exercise broker/sports coach. The least important significant attribute is the availability of public sports facilities, see Figure 23. As seen in Figure 23, for the 'no preference class' the only significant variable is access to the gym with a discount.

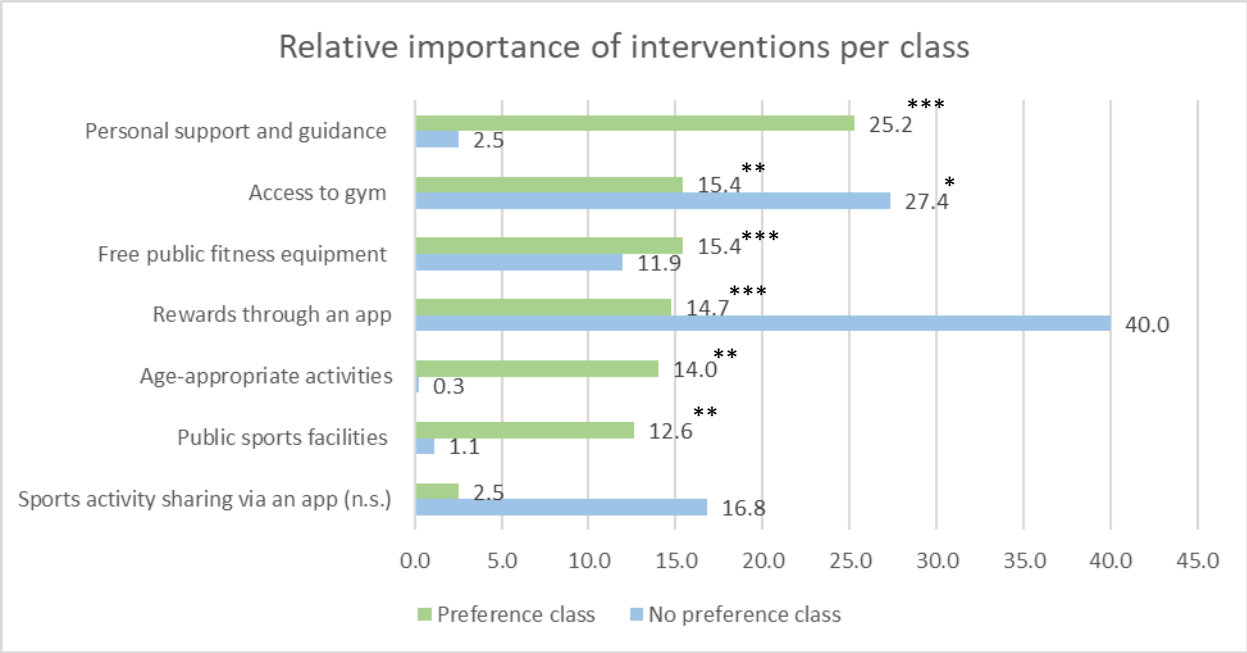


Figure 23: Relative importance of interventions per class

The differences between these two classes were examined through a bivariate analysis. Figure 24 illustrates the significant relationships with class membership. Respondents in the no preference class are more satisfied with the parks and sport facilities in the city of Venlo and have a higher level of social support compared to respondents in class two. Furthermore, respondents who indicated to have higher levels of walkability, are more satisfied with the maintenance of the cycling paths, or have a higher score on the Leefbarometer for safety are more often found in the no preference class. This may explain the fact that this class are more inclined to choose 'none of these' instead of one of the packages. The 'no preference class' includes more conscientious and extravert persons, whereas the 'preference class' includes more neurotic, agreeable and imaginative persons. Lastly, it was seen that the 'no preference class' includes more households without children compared to the 'preference class'. Subsequently, the 'preference class' included more households with children or one-person households.

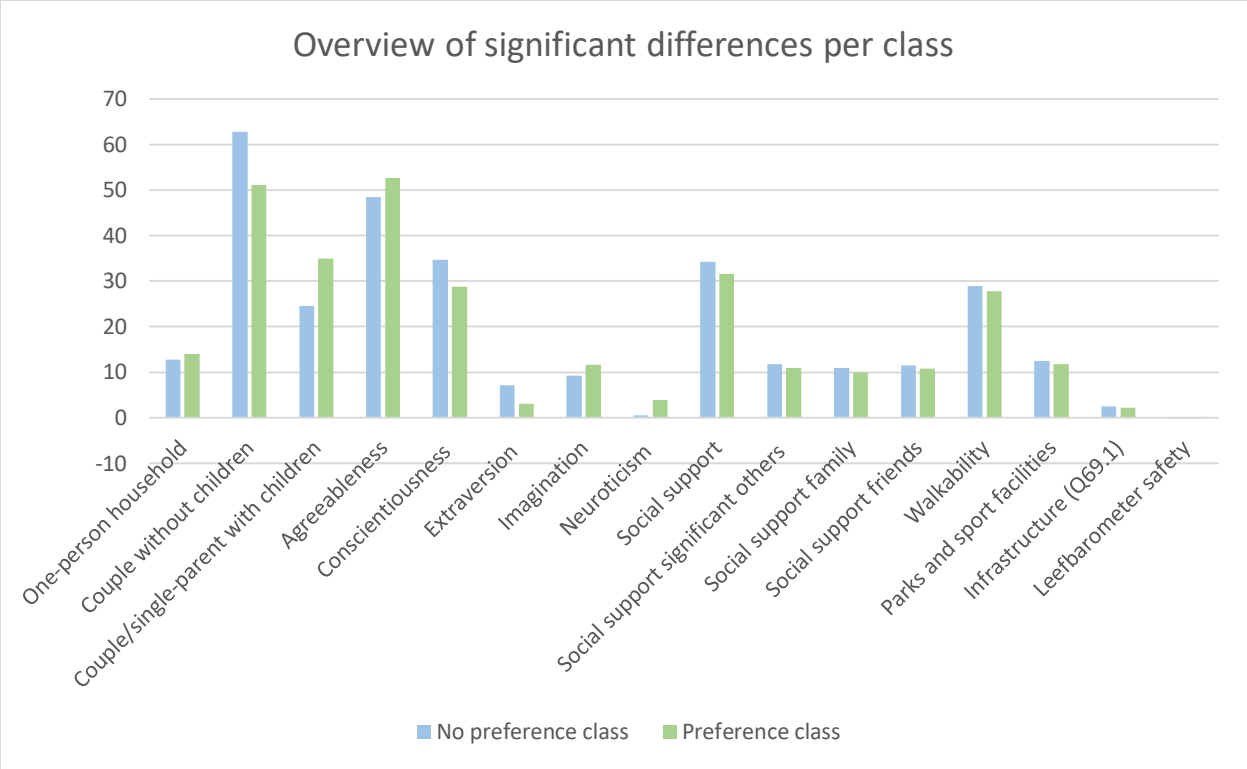


Figure 24: Significant relationships class membership

7. Results – Bivariate and regression analyses

In the previous chapter the results of the SCE are described. In this chapter, the bivariate analysis will be carried out between the independent and dependent variable (physical activity) to explore significant relationships. The SCE is not included in this chapter. First, the type of tests will be explained. Afterwards, the bivariate analysis will be executed. The significant variables from the bivariate analysis will be used as input for the regression analysis.

7.1. Bivariate analysis

The measurement scales of the variables and the subsequent tests that will be used are shown in Table 65. As explained in Chapter 4, when dealing with a continuous dependent variable, ANOVA, independent samples -t-test and Pearson's Correlation will be used in the bivariate analysis. When the dependent variable is categorical, then ANOVA and chi-square test will be used.

When calculating the dependent variable and executing the bivariate analyses it appeared that there were many insignificant variables. Therefore, the dependent variable was calculated in different ways. Hence, the bivariate analysis with most significant variables will be used for the regression analysis. How the dependent variable is calculated is as follows:

1. Physical activity defined as total minutes of sports per week. These minutes only include the minutes for sport, so the answers to question 88 of the questionnaire.
2. According to the processing file of the SQUASH survey, physical activity is calculated based on the activities per week that were at least 30 minutes and had a MET-value of three or more. The result is the number of days, ranging from 0 – 7, that a person is physically active. The activities included here are all activities, so physical activity at work/home, cycling/walking to/from school/work, leisure time walking/cycling/gardening/doing-odd-jobs, and sports activities. The days per week are here interpreted as continuous measurement scale. When a respondents filled in walking or cycling as a sport, the minutes for walking or cycling in leisure time were not included in the total minutes of physical activity to prevent double count. This calculation is according to the Dutch Standard for Healthy Exercise.
3. The same calculation is used as in point two, however, here the days per week are recoded into categories. Hence, the variable is interpreted as categorical variable.
4. The same calculated as explained in two, however, the days per week are here interpreted as nominal (dichotomous) variable. In which the categories are merged to 0 – 4 days and 5 – 7 days.
5. Physical activity as total minutes of physical activity. The total minutes of physical activity is calculated by summing the minutes that were indicated as 'average' or 'heavy' intense by the respondents. Again, when a respondents filled in walking or cycling as a sport, the minutes for walking or cycling in leisure time were not included in the total minutes of physical activity to prevent double count. This variable was interpreted as continuous variable. This calculation is according to the World Health Organization.
6. Physical activity as calculated in three, however, now the variable is recoded into six categories and interpreted as categorical variable.
7. Lastly, a question was incorporated in the questionnaire which stated "In an average week, on how many days do you spend at least half an hour walking, cycling, doing odd jobs, gardening, sports or other strenuous activities?". The answers, ranging from 0 – 7, to this question is used as

dependent variable. This amount of days differs from two, three and four as it does not include the days in which the respondents are physical active at work or in their household.

The outcomes of the bivariate analyses with the seven different dependent variables will be discussed in the next sections in subsequent order. The dependent variable which results in the most significant independent variables will be used for the regression analyses.

Table 65: Measurement scales of the variables

Variable	Interpretation measurement scale	Bi-variate analysis continuous variables	Bi-variate analysis categorical variables
Dependent variable			
Dutch standard for healthy exercise (Days)	Continuous		
Dutch standard for healthy exercise (Days)	Categorical		
Dutch standard for healthy exercise (Days)	Nominal (dichotomous)		
Physical activity minutes (WHO)	Continuous		
Physical activity minutes (WHO)	Continuous		
Total sports minutes only	Continuous		
Q92 Physical activity days	Continuous		
Independent variables from questionnaire			
Age	Ordinal	ANOVA	Chi-square test
Gender	Nominal (dichotomous)	Independent samples t-test	Chi-square test
Education level	Ordinal	ANOVA	Chi-square test
Income	Ordinal	ANOVA	Chi-square test
Employment	Nominal	ANOVA	Chi-square test
Ethnicity	Nominal (dichotomous)	Independent samples t-test	Chi-square test
Household composition	Nominal	ANOVA	Chi-square test
Years in neighbourhood	Ordinal	ANOVA	Chi-square test
Self-perceived health	Interval	Pearson's Correlation	ANOVA
Gym membership	Nominal	ANOVA	Chi-square test
Lifestyle	Multiple nominal questions (dichotomous)	Independent samples t-test	Chi-square test
Personality	Interval	Pearson's Correlation	ANOVA
Sporty friends/family	Interval	Pearson's Correlation	ANOVA
Sporty neighbours	Interval	Pearson's Correlation	ANOVA
Social support	Interval	Pearson's Correlation	ANOVA
Social cohesion	Interval	Pearson's Correlation	ANOVA
Dwelling type	Nominal	ANOVA	Chi-square test
Outdoor space	Nominal	ANOVA	Chi-square test
Density	Ordinal	ANOVA	Chi-square test
Perceived walkability	Scale/Interval	Pearson's Correlation	ANOVA
Satisfaction parks/sport facilities	Scale/Interval	Pearson's Correlation	ANOVA
Maintenance infrastructure	Interval	Pearson's Correlation	ANOVA
Neighbourhood safety	Interval	Pearson's Correlation	ANOVA
Usage of app	Ordinal	ANOVA	Chi-square test
Reward app	Nominal	ANOVA	Chi-square test
Stated choice experiment		ANOVA	Chi-square test
COVID sum score	Interval	Pearson's Correlation	ANOVA
'If the coronavirus had not been an obstacle at all, I would have exercised more'	Interval	Pearson's Correlation	ANOVA
'I have found other ways of exercising due to COVID'	Nominal (Dichotomous)	Independent samples t-test	Chi-square test

Independent variables from additional datasets			
Density	Ordinal	ANOVA	Chi-square test
Leefbarometer: Safety	Continuous	Pearson's Correlation	ANOVA
Leefbarometer: Physical environment	Continuous	Pearson's Correlation	ANOVA
Leefbarometer: facilities	Continuous	Pearson's Correlation	ANOVA

7.1.1. Dutch standard for healthy exercise (continuous) and sport minutes only

First, the dependent variable physical activity being days according to the Dutch standard for health exercise is used as dependent variable in the bivariate analysis. Table 66 shows the distribution of the dependent variable.

Table 66: Frequency physical activity (calculation according to Dutch Standard for Healthy Exercise)

Item	Percentage (%)	Frequencies (#)
0 (0-4 days)	12.9	42
1 (5-6 days)	8.0	26
2 (7 days)	79.1	257

The complete results of the bivariate analysis can be seen in Appendix G. Table 67 only shows the significant variables. From Table 67 can be concluded that there is one significant relationship at $p<0.01$, namely the satisfaction with parks and sport facilities and physical activity. The Pearson's correlation shows a positive value, meaning that people who are more satisfied with the parks and sport facilities score higher on physical activity than unsatisfied people. The variables age, gym membership, lifestyle vegetable intake and perceived walkability are all almost significant, at $p<0.1$. It can be concluded that people aged >41 years have higher physical activity levels compared to people aged 18-40 years, members of a gym and/or sport association also have higher levels of physical activity. Furthermore, people who eat vegetables daily have almost one day more of physical activity compared to people who do not. Lastly, people who perceived higher walkability levels also appear to have higher physical activity.

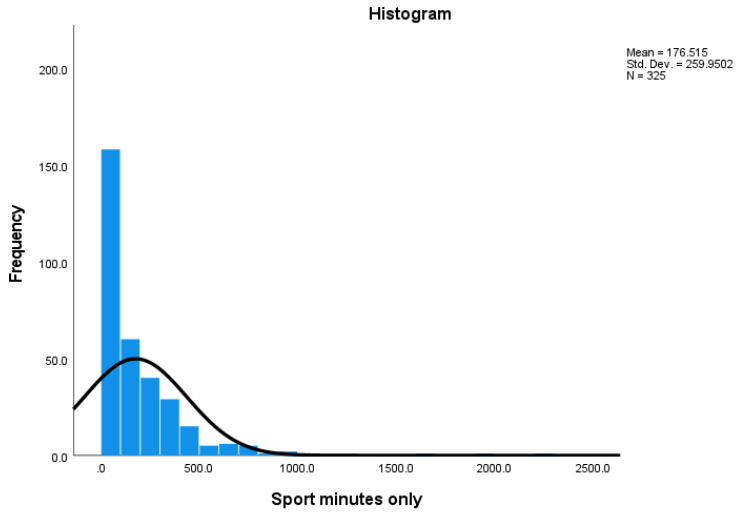


Figure 25: Histogram sport minutes total

Secondly, bivariate analyses are executed with the sports minutes only as dependent variable. Figure 25 shows the histogram of this variable.

The significant relationships are gym membership, outdoor space, usage of app (Q94), lifestyle smoking, lifestyle fruit intake, different ways of exercising due to the COVID-pandemic (Q38), self-perceived health, sporty friends/family and the Leefbarometer score for physical activity. This can all be seen in Table 67.

A post hoc test is executed for gym membership, outdoor space and usage of app (Q94). The post hoc test shows that at a 0.05 significance level there are differences between several categories, the output can be seen in Appendix H (Table 82). Respondents without a membership have lower levels of physical activity compared to all other groups. Respondents with a membership for both a sport association and a fitness centre have higher levels of physical activity compared to all other groups. The post hoc test for outdoor space did not give significant differences. From the means can be concluded that respondents with no outdoor space (mean=408 minutes) have higher levels of physical activity compared to the other groups (mean<202 minutes).

Secondly, a post hoc test is executed for usage of app (Q94). Here, it appeared that, at the 0.05 significance level, there are difference between respondents who always use an app and respondents who never, rarely or sometimes use an app. Respondents who always use an app have higher physical activity levels than other respondents.

Lifestyle, smoking and fruit intake, also have a significant relationship with physical activity levels. As seen, respondents who smoke have a significantly lower level of physical activity (approximately 100 minutes less). For respondents who do not eat fruit daily, the physical activity levels are approximately 60 minutes lower compared to the respondents who eat fruit daily. Considering the significance of different ways of exercising due to the COVID-pandemic (Q38), it can be seen that respondents who found other ways of exercising have a mean of 214 minutes, whereas respondents who did not found other ways of exercising have a mean of 151 minutes. So, respondents who found other ways of exercising have higher levels of physical activity. The Leefbarometer score for physical environment significantly affects the physical activity minutes. In this case, a positive Pearson's correlation is found. Hence, a higher Leefbarometer score for physical environment results in higher levels of physical activity. Lastly, self-perceived health and having sporty friends/family have a positive significant Pearson correlation. Hence, a higher self-perceived health and people who indicated that they have sporty friends/family had higher physical activity levels.

Table 67: Results bivariate analysis 2 and 1: Dutch standard for health exercise (continuous) and physical activity sports minutes only

Variable		**Dutch standard for healthy exercise (continuous)**				**Physical activity sports minutes only (continuous)**			
ANOVA		**Mean**	**St. Dev.**	**F.**	**Sig.**	**Mean**	**St. Dev.**	**F.**	**Sig.**
Age	18-40 years	1.41	0.837	**2.993***	0.052			0.401	0.670
	41-64 years	1.65	0.711						
	>65	1.74	0.626						
Gym membership	Both	1.83	0.514	**2.122***	0.097	407.67	499.00	**12.939*****	0.000
	Sport association	1.76	0.596			253.75	191.44		
	Fitness centre	1.76	0.596			223.77	250.09		
	None	1.58	0.767			108.68	229.68		
Outdoor space	Balcony			0.232	0.874	146.92	303.82	**2.762****	0.042

		Garden less than <50 m2					141.52	170.94		
		Garden 51 m2 or more					201.82	267.19		
		No outside space					408.00	846.83		
Independent samples t-test			**Mean**	**St. Dev.**	**t.**	**Sig.**	**Mean**	**St. Dev.**	**t.**	**Sig.**
Lifestyle	Smoking	No	5.45	1.864	0.877	0.381	184.102	265.10	**2.829*** **	0.008
		Yes	4.38	2.392			82.500	159.05		
	Vegetables	No	4.63	2.306	**-1.698***	0.090			-0.533	0.581
		Yes	5.44	1.876						
	Fruit	No			-0.657	0.512	137.485	174.28	**-2.182** **	0.030
		Yes					194.114	289.05		
'I have found other ways of exercising due to COVID'		No	5.14	2.015	-1.357	0.176	151.031	227.23	**-2.163** **	0.031
		Yes	5.72	1.733			214.256	298.92		
Pearson's Correlation			**Mean**	**St. Dev.**	**r.**	**Sig.**	**Mean**	**St. Dev.**	**r.**	**Sig.**
Self-perceived health					0.048	0.393	2.51	0.764	**0.126** **	0.023
Sporty friends/family					0.053	0.345			**0.171*** **	0.002
Perceived walkability			28.49	5.585	**0.097***	0.080			0.036	0.512
Satisfaction parks/sport facilities			12.22	3.286	**0.167*** **	0.003			0.047	0.396
Leefbarometer: Physical environment					0.024	0.662	0.024	0.028	**0.118** **	0.033

* Significant at the 0.1 level (2-tailed)
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)

7.1.2. Dutch standard for healthy exercise (categorical and dichotomous)

The complete results of the bivariate analysis can be seen in Appendix I. The significant results of this bivariate analysis are shown in Table 69. The same Dutch standard for healthy exercise is used as the previous paragraph, however now it is considered as categorical and dichotomous. Considering the categorical dependent variable, two variables turned out to be significant (see Table 69). Again, the satisfaction with parks and sports facilities. Secondly, the social support of significant others also is significant.

Considering the two significant variables perceived walkability and satisfaction parks and sport facilities it can be seen that there are statistically significant differences between the means of the groups. As can be seen from Table 69, people with higher perceived walkability have higher levels of physical activity. . 0-4 days active concludes a mean score of 26.64 on average, compared to 29.73 for 5-6 days physically active and 28.66 for 7 days physically active. From the variable satisfaction with parks and sport facilities can be concluded that respondent who are more satisfied with the parks and sport facilities have higher levels of physical activity. 0-4 days active concludes a mean score of 10.81 on average, compared to 12.04 for 5-6 days physically active and 12.47 for 7 days physically active.

Secondly, a bivariate analysis is executed for the dichotomous dependent variables. Table 68 shows the frequencies within the two categories of physical activity according to the Dutch standard for healthy exercise.

Table 68: Frequency physical activity dichotomous (calculation according to Dutch Standard for Healthy Exercise)

Item	Percentage (%)	Frequencies (#)
0 (0-4 days)	12.9	42
1 (5-7 days)	87.1	283

Table 69 also shows the results of the bivariate analysis for dichotomous dependent variable. Here, again perceived walkability and satisfaction with parks and sport facilities is significant. The means indicate that both higher perceived walkability and satisfaction with parks and sport facilities are related to higher physical activity levels. The means for perceived walkability are 26.64 when being active for 0-4 days and 28.76 when being active for 5-7 days. The means for satisfaction with parks and sport facilities are 10.81 when being active for 0-4 days and 12.43 when being active for 5-7 days. In addition, having sporty friends and family increases the physical activity levels. The means of sporty friends and family is 2.00 when being active for 0-4 days and 2.19 if the respondents is active for 5-7 days. Hence, the higher the rating for sporty friends and family the higher the physical activity levels. Furthermore, it can be seen that gym membership is significant at p<0.1. Respondents who are member of both sport association and fitness centre have highest levels of physical activity, followed by members of sport association or fitness centre.

Table 69: Results bivariate analysis 3 and 4: Dutch standard for health exercise (categorical and dichotomous)

Variable		**Dutch standard for healthy exercise (categorical)**				**Dutch standard for healthy exercise (dichotomous)**			
Chi-square test		**Mean**	**St. Dev.**	**X^2**	**Sig.**	**Mean**	**St. Dev.**	**X^2**	**Sig.**
Gym membership	Both			6.670	0.352	0.94	0.236	**6.294***	0.098
	Sport association					0.92	0.271		
	Fitness centre					0.92	0.277		
	None					0.83	0.377		
ANOVA / Independent samples t-test		**Mean**	**St. Dev.**	**F.**	**Sig.**	**Mean**	**St. Dev.**	**t.**	**Sig.**
Sporty friends/family				1.653	0.193	2.00	0.663	**-1.693***	0.096
						2.19	0.798		
Perceived walkability	0	26.64	6.044	**3.100****	0.046	26.64	6.044	**-2.308****	0.022
	1	29.73	5.710			28.76	5.472		
	2	28.66	5.449						
Satisfaction parks/sport facilities	0	10.81	3.743	**4.790*****	0.009	10.81	3.743	**-3.028*****	0.003
	1	12.04	3.504			12.43	3.167		
	2	12.47	3.135						

* Significant at the 0.1 level (2-tailed)
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)

7.1.3. Physical activity in minutes (continuous and categorical)

Here, the dependent variable is considered as total minutes of moderate and vigorous physical activity, according to the WHO, as both continuous and categorical. The distribution of the continuous variable

can be seen in Figure 26. The complete results of the bivariate analysis can be seen in Appendix J. The significant results of this bivariate analysis are shown in Table 71.

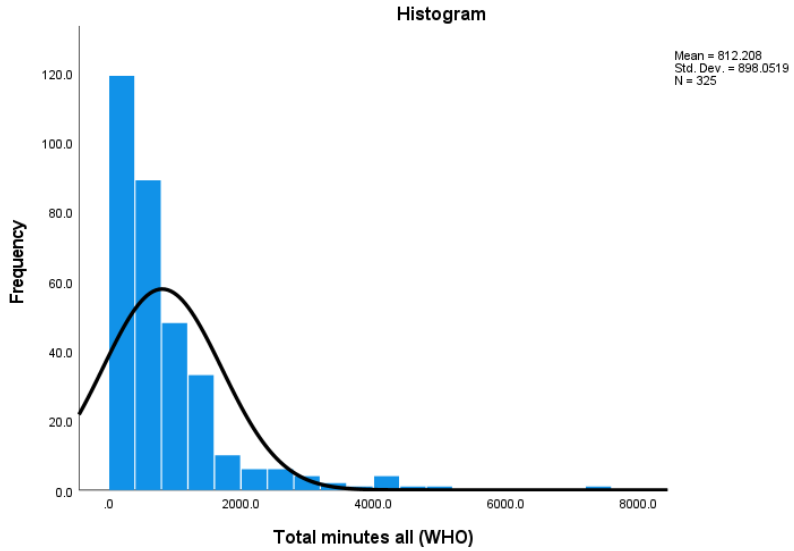


Figure 26: Histogram total minutes physical activity continuous

It can be seen that only the variable age is significant when interpreting the variable as continuous. A post hoc test can be used to observe how age differs between people with different total minutes of physical activity. The Bonferroni did not generate significant differences. The smallest p-value was 0.057, which was found between respondent who are 41-64 years old and 65 years or older. The means show that respondents in the category 41-64 years have a mean of 938 minutes of physical activity per week. The groups 18-40 years old and >65 years old have a lower mean of approximately 690 minutes. Hence, the group 41-64 years old have the highest physical activity level. Furthermore, when looking at the continuous independent variable, it can be seen that years in neighbourhood, density and personality are almost significant at the $p<0.1$. Respondents who live for 30 years or more in their neighbourhood have a higher mean physical activity compared to the other groups. Furthermore, respondents in very strong urban environments (>2500 addresses per km^2) have the highest mean physical activity compared to other groups.

Secondly, the dependent variable is recoded into categories, but still considered as continuous variable. The recoding and frequencies can be seen in Table 70 and Figure 27 respectively. The results of the bivariate analysis can be seen in Table 71.

Table 70: Frequency minutes physical activity in categories (calculation according to WHO)

Item	Percentage	Frequency
0 (0-75 minutes)	10.2	33
1 (76-149 minutes)	4.6	15
2 (150-299 minutes)	13.5	44
3 (300-599 minutes)	24.0	78
4 (600-1200 minutes)	27.7	90
5 (>1200 minutes)	20.0	65

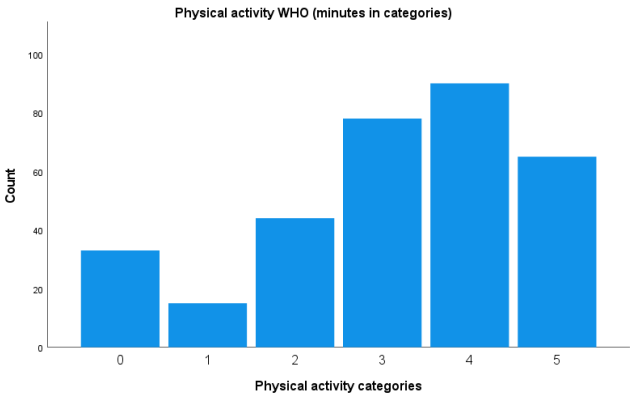


Figure 27: Histogram minutes physical activity in categories

Welch ANOVA is used for the variable household composition and usage of app (Q94) as there was no homogeneity of variance. There are three significant relationships. First, it can be seen that employment is significant. A Bonferroni post hoc test is executed to observe how employment differs between people with different total minutes of physical activity. The post hoc test shows that at a 0.05 significance level there are differences between respondents who work part-time (1-20 hours) and respondents with no paid work. People who work part-time (1-20 hours) have higher levels of physical activity compared to respondents with no paid work.

Secondly, gym membership was found to have a significant p-value. Hence, also a Bonferroni post hoc test was executed. The post hoc test shows that at a 0.05 significance level there are differences between the respondent who are member of sport association and respondents who are no member of a sport association or gym. Members of a sport association have higher levels of physical activity compared to respondents who are no member at all.

The question 'If the coronavirus had not been an obstacle at all, I would have exercised more' is significant. As seen, the Pearson's correlation is positive. The result can be interpreted as follows; respondents who answered yes are more likely to have a higher level of physical activity.

Lastly, it can be seen that age is almost significant with p=0.054. Hence, respondents aged 41-64 years have the highest physical activity compared to the other two groups.

Table 71: Results bivariate analysis 5 and 6: Physical activity in minutes (continuous and categorical)

Variable		**Physical activity in minutes (continuous)**				**Physical activity in minutes (Continuous categories)**			
ANOVA		**Mean**	**St. Dev.**	**F.**	**Sig.**	**Mean**	**St. Dev.**	**F.**	**Sig.**
Age	18-40 years	688.75	772.72	**3.121****	0.045	2.72	1.508	**2.943***	0.054
	41-64 years	937.78	1040.82			3.33	1.435		
	>65	690.85	704.86			3.02	1.588		
Employment	Fulltime (36 hours or more)			1.580	0.179	3.10	1.398	**2.437****	0.047
	Parttime (21-35 hours)					3.38	1.338		
	Parttime (1-20 hours)					3.82	1.334		
	Retired					3.11	1.591		
	No paid work					2.40	1.759		
Household composition	One-person household			0.514	0.598	2.84	1.632	**2.325***	0.073
	Couple without children					3.09	1.600		
	Couple with children & single-parent family					3.40	1.235		
Years in neighbourhood	0-4 years	661.28	625.99	**3.418***	0.067			1.260	0.288
	5-19 years	689.86	627.58						
	20-29 years	778.00	706.96						
	>30 years	1039.01	1259.40						

Gym membership	Both			1.842	0.139	3.50	0.985	**5.585*** **	0.001
	Sport association					3.61	1.357		
	Fitness centre					3.39	1.304		
	None					2.85	1.613		
Density	Not urban	857.75	876.31	**2.065***	0.085			1.717	0.146
	Little urban	752.65	720.69						
	Moderately urban	612.34	755.94						
	Strongly urban	807.53	841.09						
	Very strong urban	1144.61	1434.82						
Pearson's Correlation		**Mean**	**St. Dev.**	**r.**	**Sig.**	**Mean**	**St. Dev.**	**r.**	**Sig.**
Personality		812.21	898.05	**0.100***	0.073			0.029	0.605
'If the coronavirus had not been an obstacle at all, I would have exercised more'				0.065	0.242	1.82	1.238	**0.162*** **	0.003

* Significant at the 0.1 level (2-tailed)
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)

7.1.4. Results Q92 Physical activity days

This section discusses the results of the bivariate analyses when the dependent variable is the result of question 92: "In an average week, on how many days do you spend at least half an hour walking, cycling, doing odd jobs, gardening, sports or other strenuous activities?". Table 72 shows the frequencies within this variable. This variable does not include the days in which the respondents are physical active at work or in their household. The variable is interpreted as continuous variable. Figure 28 shows the histogram of the physical activity days, excluded work and household physical activity.

Table 72: Frequency minutes physical activity Q92

Item	Percentage	Frequencies
0 days	1.8	6
1 days	2.8	9
2 days	5.8	19
3 days	9.2	30
4 days	8.9	29
5 days	14.8	48
6 days	10.8	35
7 days	45.8	149

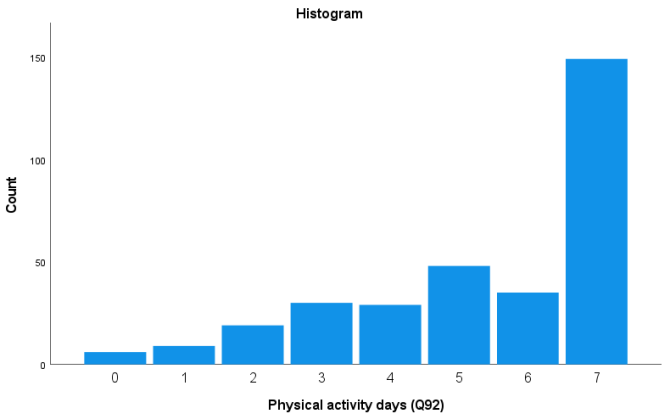


Figure 28: Histogram Q92

Appendix K shows the complete output of this bivariate analysis. Table 73 shows the significant variables of the bivariate analysis. The variables gender, ethnicity, lifestyle smoking, lifestyle vegetable intake, different ways of exercising due to the COVID-pandemic (Q38), self-perceived health, sporty friends/family, social support, social support family and infrastructure: alternatives to get from place to place show to have significant relationships with the dependent variable.

The results of the independent samples t-test show that gender, ethnicity, lifestyle smoking, lifestyle vegetable intake and different ways of exercising due to the COVID-pandemic (Q38) have a significant relationship with the dependent variable physical activity. The results of these variables can be interpreted by looking at the means in Table 73. It can be concluded that females have a higher mean of physical activity compared to males. Considering ethnicity, respondents who feel connected to the Dutch ethnic group have a higher physical activity levels compared to the other ethnic groups. On average, Dutch ethnic groups have one day more on which they are physically active compared to other ethnic groups. The variables from lifestyle which are significant are smoking and the vegetable intake. The means show that respondents who do not smoke are physically active on more days as their mean is 5.45 compared to 4.38 for respondents who smoke. In addition, respondents who eat vegetables daily also appear to have more days on which they are physically active (mean 5.44 compared to 4.63 for respondents who do not eat vegetables daily).

Respondents who found other ways of exercising due to the COVID-pandemic spent more days being physically active per week, since their mean is 5.72 compared to a mean of 5.14 for respondents who did not find other ways of exercising.

Considering the results of the Pearson's Correlation, it can be seen that self-perceived health, sporty friends/family, social support, social support family and the infrastructure: alternatives to get from place to place show to have significant relationships with the dependent variable. A positive correlation indicates that the respondents who scored these variables higher have higher physical activity levels.

Table 73: Results bivariate analysis 7: Q92 physical activity days

Variable						
Independent samples t-test			**Mean**	**St. Dev.**	**t.**	**Sig.**
Gender	Female		5.65	1.986	**2.037****	0.042
	Male		5.20	1.874		
Ethnicity	Dutch		5.41	1.892	**2.098****	0.037
	Other		4.18	2.523		
Lifestyle	Smoking	No	5.45	1.864	**2.154****	0.041
		Yes	4.38	2.392		
	Vegetables	No	4.63	2.306	**-2.105****	0.036
		Yes	5.44	1.876		
'I have found other ways of exercising due to COVID'	No		5.14	2.015	**-2.762*****	0.006
	Yes		5.72	1.733		
Pearson's Correlation			**Mean**	**St. Dev.**	**r.**	**Sig.**
Self-perceived health			2.51	0.764	**0.212*****	0.000
Sporty friends/family			2.17	0.784	**0.137****	0.014
Social support			33.18	7.795	**0.130****	0.019
Social support family			10.57	3.616	**0.132****	0.017
Maintenance of infrastructure	Alternative routes to get from place to place		2.77	0.811	**0.128****	0.021

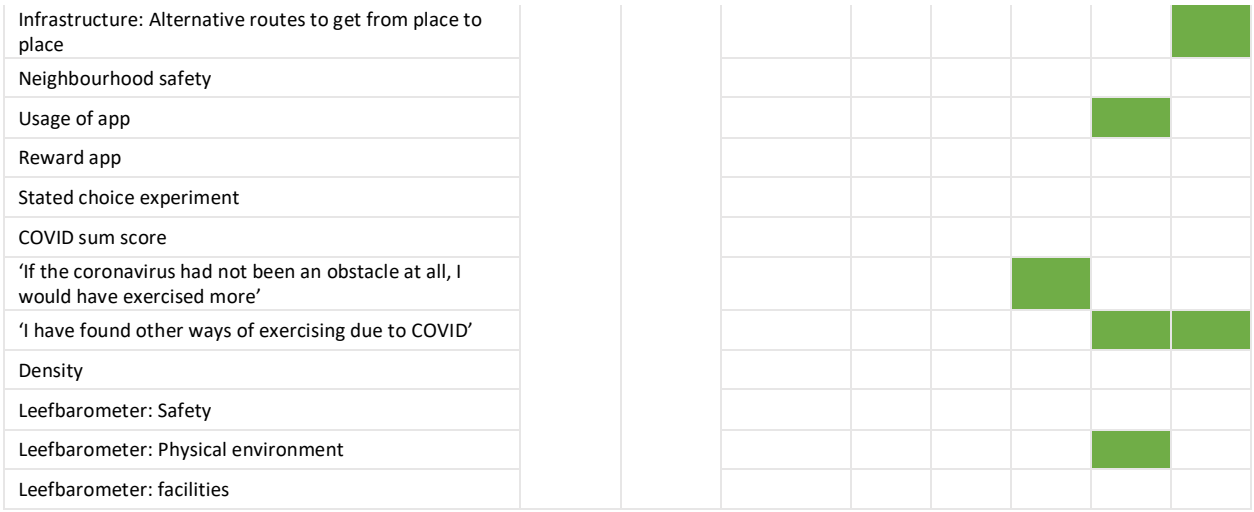
* Significant at the 0.1 level (2-tailed)
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)

7.1.5. Conclusion bivariate analyses

Table 74 gives an overview of the dependent variables and the significant independent variables from the bivariate analysis. It can be concluded that the dependent variable calculated by question 92 (paragraph 7.1.4) results in the most significant independent variables. Therefore, this dependent variable and its significant independent variables will be used in the regression analysis.

Table 74: Overview significant variables (green) per dependent variable

	Dutch standard for healthy exercise (Days) (Continuous)	Dutch standard for healthy exercise (Days) (Categorical)	Dutch standard for healthy Exercise (Days) (Dichotomous)	Physical activity minutes (Continuous)	Physical activity minutes (Categorical)	Total sports minutes only (Continuous)	Q92 Physical activity days (Continuous)
Age	■			■	■		
Gender							■
Education level							
Income							
Employment					■		
Ethnicity							■
Household composition					■		
Years in neighbourhood				■			
Self-perceived health						■	■
Gym membership	■		■		■	■	
Lifestyle: Smoking						■	■
Lifestyle: Drinking							
Lifestyle: Vegetable intake	■						■
Lifestyle: Fruit intake						■	
Personality				■			
Sporty friends/family			■			■	■
Sporty neighbours							
Social support							■
Social support: Family							■
Social support: Friends							
Social support: Significant others							
Social cohesion							
Dwelling type							
Outdoor space						■	
Density					■		
Perceived walkability	■	■	■	■			
Satisfaction parks/sport facilities	■	■	■	■			
Infrastructure: Maintenance cycling paths							



Prior to the regression analysis, multicollinearity must be checked. There is a risk of multicollinearity between the independent variables when the correlation coefficient is 0.8 or higher. This can be checked based on the correlation matrices, see Appendix L. It can be concluded that social support is correlated with social support family, which can be explained by the fact that social support family is part of the social support one receives in general. Therefore, it is decided to not include the variable social support family, but only social support in general since this variable also takes into account the social support of family.

7.2. Regression analyses

From the bivariate analyses can be concluded that the dependent variable with the most significant variables is question 92. This question includes the number of days that a respondent is physical active with walking, cycling, gardening, doing-odd-jobs, sports or other strenuous activities for at least 30 minutes. For the regression analysis it is necessary to dummy code the independent variables that are measured on a nominal (≥3 categories) or ordinal scale, also known as categorical variables. The number of dummy's that is needed per variable is the total amount of categories of the variable minus one. However, there are no independent variables that are measured on a nominal or ordinal scale used in the regression analysis. Therefore, no dummies are needed in this case.

7.2.1 Multiple linear regression

Since the dependent variable is measured on a continuous scale, multiple linear regression is used. Multiple linear regression has several assumptions which need to be checked before interpreting the results. The assumptions and test can be seen in Appendix M. From Table 75 can be seen that the R-value is 0.349 which can be interpreted as moderate level of prediction. The R-squared explains how much of the variance is explained by the independent variables (regression model), which in this case is 12.2%. The adjusted R-squared shows how a set of independent variables can explain the variance, adjusted for the number of independent variables. Hence, the adjusted R-squared is needed to compare models.

Table 75: Model summary

Model	R	R-squared	Adjusted R-squared	Durbin-Watson
1	0.349	0.122	0.097	1.473

The results of ANOVA in Table 76 show whether or not the regression model is a good fit for the data. It can be seen that the significance is 0.000, hence the regression model is a good fit of the data.

Table 76: ANOVA

Model	Sum of squares	Df	Mean square	F	Sig.
Regression	146.011	9	16.223	4.846	0.000
Residual	1051.283	314	3.348		

The model output can be seen in Appendix N. The variables gender, vegetable intake and sporty friends/family are non-significant. Hence, the model will be optimized by eliminating the non-significant variables step-by-step (Backward method), starting with the highest non-significant variable.

Table 77 and 78 show the model summary and ANOVA of the optimized model. As seen, the adjusted R-squared increased from 0.097 to 0.100. Hence, the model explains the variance slightly better. The results of ANOVA again show that the regression model is a good fit of the data since the significance is 0.000.

Table 77: Model summary optimized model

Model	R	R-squared	Adjusted R-squared	Durbin-Watson
2	0.345	0.119	0.100	1.480

Table 78: ANOVA optimized model

Model	Sum of squares	Df	Mean square	F	Sig.
Regression	142.893	7	20.413	6.118	0.000
Residual	1054.400	316	3.165		

The coefficients of the optimized model can be seen in Table 79. The constant can be interpreted as follows: If all independent variables included in the model are zero, then the value of the dependent variable (physical activity days) will be 3.767. The unstandardized coefficients show how much the dependent variable varies with an independent variables when all other variables are held constant. Hence, according to the unstandardized coefficients the physical activity of a respondents in days can be calculated with the following formula:

$$Physical\ activity\ (Days) = 3.767 - 1.296 * other\ ethnicity - 0.842 * smoking + 0.472 * other\ ways\ of\ exercising + 0.480 * self\ perceived\ health + 0.215 * infrastructure$$

The interpretation of this formula and the significant variables will be discussed. Being from other ethnicity than Dutch will decrease the physical activity with 1.296 days. If a respondents smokes, then the physical activity will decrease by 0.842. If respondents found other ways of exercising, then the physical activity increases with 0.472. Similarly. Having a very good health (=3), will increase the physical activity days by 1.44 (=3*0.480). Having a very bad health (=0) will result in no increase or decrease of physical activity. Lastly, if respondents fully agrees (=4) with the fact that there are enough alternatives (infrastructure) to get from place to place then the physical activity increases with 0.86 (=4*0.215). Fully disagree with this statement means no increase or decrease in physical activity (0*0.215=0).

Table 79: Coefficients optimized multiple linear regression model

Variable	Unstandardized beta coefficient	St. error	t.	Sig.
Constant	3.767	0.521	**7.231*** **	0.000
Gender	-0.308	0.212	-1.453	0.147
Ethnicity	-1.296	0.603	**-2.151** **	0.032
Lifestyle: Smoking	-0.842	0.396	**-2.128** **	0.034
Lifestyle: Vegetable intake	0.412	0.375	1.099	0.273
Other ways of exercising due to the COVID-pandemic	0.472	0.212	**2.223** **	0.027
Self-perceived health	0.480	0.141	**3.393*** **	0.001
Infrastructure: Alternatives to from place to place	0.215	0.128	**1.685***	0.093

* Significant at the 0.1 level (2-tailed)
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)

The relative importance of the independent variables can be interpreted by the standardized coefficients (beta). From Table 80 can be concluded that the most important independent variable is self-perceived health, followed by other ways of exercising due to the COVID-pandemic. The least important variables are the non-significant variables gender (male) and vegetable intake.

Table 80: Relative importance of the independent variables

Rank	Independent variables	Standardized beta coefficients	Sig.
1	Self-perceived health	0.183	***
2	Other ways of exercising due to the COVID-pandemic (yes)	0.120	**
3	Ethnicity: other	-0.117	**
4	Lifestyle: Smoking (yes)	-0.115	**
5	Infrastructure: Alternatives to get from place to place	0.091	*
6	Gender: Male	-0.077	n.s.
7	Lifestyle: Vegetable intake (yes)	0.059	n.s.

* Significant at the 0.1 level (2-tailed)
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)
n.s. Not significant

7.3. Who have found other ways of exercising?

The previous paragraph showed that people who found other ways of exercising due to the COVID-pandemic have higher levels of physical activity in the COVID-pandemic. The question arises; which groups found other ways of exercising and what are their characteristics? Therefore, a bivariate analysis is executed with as the dependent variable the question 'I have found other ways of exercising due to COVID'. This variable was measured on a dichotomous scale, with 0 being 'no' and 1 being 'yes'. Therefore, the independent t-test and chi-square are used in the bivariate analysis.

The full results of the bivariate analysis can be seen in Appendix O. Table 81 only shows the significant variables. It can be concluded that people who have found other ways of exercising have a higher education level compared to people who did not find other ways of exercising. Furthermore, this group more often eats fruit and vegetables daily. It is also seen that they have higher levels of social support, higher self-perceived health and, of course, higher levels of physical activity. Lastly, it is seen that this group more often indicated that they would have exercised more if COVID had not been an obstacle at all.

Table 81: Significant variables from the bivariate analysis with dependent variable 'other ways of exercising'

Education	**No other ways of exercising (%)**	**Other ways of exercising (%)**	**X^2**	Sig.
Low	18.0	13.7	**6.932****	0.031
Moderate	31.0	20.6		
High	51.0	65.7		
Lifestyle	**No other ways of exercising (%)**	**Other ways of exercising (%)**	**X^2**	**Sig.**
Vegetables			**7.954***	0.005
No	11.9	3.1		
Yes	66.1	96.9		
Fruit			**8.188***	0.004
No	37.1	22.1		
Yes	62.9	77.9		
	No other ways of exercising (Mean)	**Other ways of exercising (mean)**	**t.**	**Sig.**
Self-perceived health	2.44	2.62	**-2.154****	0.032
Social support	32.35	34.40	**-2.284****	0.023
Social support significant others	11.18	11.85	**-1.763***	0.079
Social support friends	10.84	11.63	**-2.319****	0.021
Physical activity	5.14	5.72	**-2.762***	0.006
'If the coronavirus had not been an obstacle at all, I would have exercised more'	1.61	2.12	**-3.742***	0.000

* Significant at the 0.1 level (2-tailed)
** Significant at the 0.05 level (2-tailed)
*** Significant at the 0.01 level (2-tailed)

7.4. Conclusion

This chapter showed the significant relationships between individual determinants, social environment, physical environment, COVID and physical activity. It was seen that a self-perceived health, other ways of exercising due to COVID, other ethnic groups, smoking and alternatives to get from place to place affect physical activity levels. Furthermore, this chapter showed how people who have found other ways of exercising due to COVID are characterized. They are characterized by having a higher education level, more often eating fruit and vegetables daily, higher self-perceived health, higher social support, higher physical activity and they would have exercised more if the coronavirus had not been an obstacle at all.

8. Discussion

This chapter compares the findings from the statistical analysis with the findings from the literature review. Furthermore it discusses, interprets, and explains the results. Several studies found that physical activity is affected by individual determinants, social environment, physical environment and the policy environment. The results of this study show confirming and contradicting outcomes, which will be discussed in this chapter. First, general implication of this research are discussed which should be highlighted before interpretation of the results. Secondly, the results of the bivariate analysis will be compared with the findings of the literature review. Afterwards, the regression models will be discussed and compared to the literature. Lastly, the output of the MNL and LC models are discussed and compared to the literature.

8.1. Sample

In this research, significant relationships are found between some individual determinants, social environment factors, physical environment factors, policy environment (interventions), and physical activity. These will be discussed in the next paragraph. It has, however, also been shown that the sample differs significantly from the population in Venlo. The sample includes an overrepresentation of males, adults aged 65 years or older, highly educated people, one-person households and couples without children, and unemployed (retired) people. This overrepresentation may be caused by the fact that the questionnaire was spread only via the panel of the municipality of Venlo. This is a voluntary panel which includes people who like to fill in surveys regularly. Furthermore, it was seen that a 71.8% of respondents met the guidelines for physical activity (>5 days active for more than 30 minutes, hence total of 150 minutes or more). This was against the expectations as it was expected that this value was somewhere around 54% in Venlo in 2021 (Gemeente Venlo & I&O Research, 2021). It may therefore be the case that participants who reacted may be more active than respondents who did not respond to the questionnaire, participants could not recall their physical activity levels accurately or the overrepresentation has caused deviation from the expectations. Therefore, the results of the study should be carefully interpreted.

8.2. Factors found to influence physical activity

As dependent variable, the number of days were used on which the respondents perform one of the following activities for at least 30 minutes: walking, cycling, doing odd jobs, gardening, sports or other strenuous activities. This dependent variable is elaborated since it had the highest amount of significant independent variables. However, still, only ten variables were significant according to the bivariate analysis, of which one was excluded for the regression analysis due to multicollinearity, see appendix L. The independent variables that were used as input for the regression analysis are gender, ethnicity, self-perceived health, smoking, vegetable intake, sporty friends/family, social support, infrastructure (alternatives to get from place to place), and other ways of exercising due to COVID.

Multiple linear regression is used for the regression analyses. Not all assumptions for multiple linear regression were met, as the distribution is not completely normal. Hence, the results should be carefully interpreted.

Individual determinants and physical activity

Considering the individual determinants, this study found ethnicity, self-perceived health and smoking have a significant relationship with physical activity levels. This study showed that a positive relationship between self-perceived health and physical activity. Respondents with a better self-perceived health have higher levels of physical activity. This is in line with the expectations from the literature review, as people

with a poorer health have lower levels of physical activity (Hofman et al., 2021). In addition, the study by Hofman et al. (2021) showed that smoking and eating less healthy also result in lower physical activity. This leads to the variables of lifestyle. Smoking appears to have a significant negative relationship with physical activity according to this study. The results of this study show that respondents who smoke have lower levels of physically activity.

Considering ethnicity, respondents who feel connected to the Dutch ethnic group have higher physical activity levels compared to the other ethnic groups. This is in line with the findings of de Munter et al. (2010), who concluded that Dutch participants have a higher frequency of (vigorous) physical activity. On average Dutch ethnic groups have one day more on which they are physically active compared to other ethnic groups.

The literature review also showed that gender, personality traits, age, education, income, employment, household composition, gym membership, lifestyle drinking, vegetable intake and fruit intake have significant relationships with physical activity levels. However, this is not confirmed by the results of this research. The bivariate analysis did show that (lifestyle) vegetable intake had a positive relationship with physical activity. However, this could not be concluded from the regression analysis. Furthermore, the bivariate analysis showed that males have lower physical activity levels compared to females. Again, this could not be concluded from the regression analysis. The literature review showed different conclusion regarding gender. Wilke et al. (2021) found no difference between men and women, whereas Hofman et al. (2021) found that women more often have lower physical activity levels. This difference in result may be explained by the underrepresentation of females and overrepresentation of males in this research.

Social environment and physical activity

The elements of the social environment which, according to the literature review, have significant relationships with physical activity are sporty friends/family, sporty neighbors, social support, social cohesion and culture. Culture was not included in this research as social environmental factor, but rather only as individual determinant. From the results of the regression analysis can be concluded that none of the elements of the social environment have significant relationships with physical activity. This is against the expectations from the literature review (Bopp et al., 2021; Lesser & Nienhuis, 2020; Mendonca et al., 2014; Morrissey et al., 2015).

In the bivariate analysis, sporty friends/family, social support and social support of family did show significant relationships with physical activity. These relationships were, however, not found in the regression analysis. The results of the bivariate analyses show that, for all variables, a positive correlation was seen with physical activity. Hence, respondents who receive more social support in general or social support from family have higher levels of physical activity. This is in line with the expectations from the literature review (Bopp et al., 2021; Lesser & Nienhuis, 2020; Mendonca et al., 2014; Morrissey et al., 2015). It must be mentioned that social support from family and friends was found most important (Lindsay Smith et al., 2017; Morrissey et al., 2015). However, the relationship of social support of friends with physical activity is not supported by this study. Having sporty friends or family did show to be significant in the bivariate analysis, which is in line with the literature review, as the physical activity behaviour of other people in the social environment are related to personal physical activity, depending on the level of support received by that person (Darlow & Xu, 2011).

Physical environment and physical activity

From the literature review, it was concluded that dwelling type, outdoor space, density, infrastructure, parks and sports facilities, neighborhood aesthetics and safety have a significant relationship with physical activity (Kärmeniemi et al., 2018; Svensson et al., 2017; Kwarteng et al., 2014; Kärmeniemi et al., 2018); Li et al., 2008; Nasar, 2015). However, against the odds, this research shows that only one of items of the physical environment are significant in the regression analysis, namely infrastructure alternatives routes to get from place to place. This variable has a positive relationship with physical activity at the 0.1 significance level. The higher the respondents score the alternative routes to get from place to place, the higher their physical activity levels are. This positive relationship with physical activity was expected (Li et al., 2008). Street conditions were not found to have a significant relation to physical activity according to Kwarteng et al. (2014). This is also confirmed by this research, as the maintenance of the cycling paths was insignificant.

COVID and physical activity

Considering COVID related items, it can be concluded that people who have found other ways of exercising due to the COVID-pandemic have higher levels of physical activity. This can be explained by the measures taken by the Dutch government to reduce the spread of the virus during the COVID-pandemic. Examples are social distancing and restrictions on groups sizes and gatherings. Hereby, there were also restrictions put on sport facilitators, such as closure of gyms and sports association, and restriction on group size for physical activity (Rijksoverheid, 2021). Hence, when no other ways of exercising were found, such as walking or cycling outside alone, people were just not able to maintain physically active since most group activities were not allowed.

Conclusion bivariate and regression analyses

The relative importance for the significant independent variables can be concluded based on the regression model. From highest to lowest importance the variables can be ranked as follows: self-perceived health, other ways of exercising due to COVID, other ethnicity, smoking and infrastructure (alternatives to get from place to place). The better people perceive their health, the more physical activity they undertake. People who have found other ways of exercising due to COVID have higher levels of physical activity. People of other ethnic groups have lower levels of physical activity compared to the Dutch ethnic group. People who smoke have lower levels of physical activity. Lastly, people who are more satisfied with the alternatives to get from place to place show higher physical activity levels.

Overall, it is seen that many of the expected relationships following from the literature review are insignificant in this study. This deviation from the expectations may be caused by the sample. People who are not attracted by physical activity may not have responded to this research or people were unable to accurately recall their physical activity. Furthermore, the sample is not representative for the actual distribution within the municipality of Venlo as there is an overrepresentation of older adults, highly education people and males. This may have caused the results to differ.

8.3. Characteristics of people who have found other ways of exercising

The regression analysis showed that one of the most important factors to result in higher physical activity levels is having found other ways of exercising due to COVID. Therefore, a bivariate analysis was executed with ‘other ways of exercising’ as a dependent variable. Hereby, the characteristics of people who have found or who have not found other ways of exercising can be determined. The results showed that people who found other ways of exercising have a higher education level, higher levels of social support, higher

self-perceived health, eat fruit and vegetables more frequently daily, and (as already shown) have higher physical activity levels. These variables did not appear in the regression analysis, which was discussed in chapter 8.2. Hence, there might be an indirect relationship between these variables and physical activity through other ways of exercising. The literature review showed that lower educated people have lower physical activity levels (Hofman et al., 2021; Pharr et al., 2020; Puciato, 2019). This is in line with the finding that people who have found other ways of exercising (and are more physically active) have a high education level.

Furthermore, the results showed that people who have found other ways of exercising more often indicated that they would have exercised more if COVID had not been an obstacle at all. Hence, this group of respondents might be very attracted to and more involved in physical activity. Therefore, this group might have put more effort in maintaining physically active during the COVID-pandemic.

8.4. Evaluation of promising interventions

MNL and LC models are generated to study the choice behaviour of respondents. Respondents were faced with packages of interventions in which they could indicate which package would motivate them to exercise more. From the MNL model follows that all interventions affect the choice of the participants, except for the sports activity sharing. The most important interventions according to the choice behaviour of the respondents are personal support and improved availability of free public fitness equipment, followed by access to gyms with a discount and age-appropriate activities. However, the MNL model explained the choice behavior in a limited way as the McFadden Rho-square was 0.1969. Hence, the LC model is used to elaborate on the findings.

The findings of the LC model showed that two types of participants can be distinguished, namely the 'No preference class' and the 'Preference class'. The most important differences between the two classes is that the 'no preference class' is more inclined to choose for the 'none of these'-option in the SCE. Hence, they prefer no intervention or do not need it to improve their physical activity. They are happy with their current situation. Respondents in the 'preference class' prefer the implementation of the interventions over their current situation. For example, they prefer improved availability of public sports facilities instead of not improved availability, or personal support over no personal support.

The differences between these two classes are examined through a bivariate analysis. As a result, it can be concluded that the differences can be explained by household composition (p=0.090), personality traits (p=0.070), level of social support (p=0.004), the walkability (p=0.063), the satisfaction with parks and sport facilities (p=0.049), the maintenance of the cycling lanes (p=0.079) and the Leefbarometer score for safety (p=0.087). Respondents in the 'no preference class' have a higher level of social support (mean=33.18) compared to respondents from the 'preference class' (mean=34.21). In addition, the respondents in the 'no preference class' are also more satisfied with the parks and sport facilities (mean=12.52 versus 11.78), have a higher score for walkability (mean=28.95 versus 27.78) and are more satisfied with the maintenance of the cycling lanes (mean=2.45 versus 2.26). Furthermore, the 'no preference class' includes more people with the personality traits conscientiousness and extraversion, whereas the 'preference class' includes more people with the personality traits agreeableness, imagination and neuroticism. Lastly, it was seen that the 'no preference class' includes more households without children (62.8%) compared to the 'preference class' (51.1%). Subsequently, the 'preference class' included more households with children (34.9% versus 24.5%) or one-person households (14% versus 12.8%). De Boer et al. (2021) showed that a household with children or living alone have lower physical activity levels during the COVID-

pandemic. These are the classes that are more seen in the 'preference class'. Although no relationship was found between class membership and physical activity, these type of households might be more inclined to seek for opportunities to increase their physical activity levels with the help of the interventions. Puciato (2019) showed that two-person households have the lowest level of physical activity before the COVID-pandemic. It was seen that households without children are more often seen in the 'no preference class'. Hence, the households in the 'no preference class' might be less interested in physical activity and the interventions.

Hence, this explains the fact why the 'no preference' class is more inclined to choose 'none of these' instead of one of the packages with interventions. 60.8% of the respondents belongs to the 'no preference class' and 39.2% belongs to the 'preference class'. It must be said that two respondents commented that the SCE was unclear for them, hence the result must be interpreted carefully.

It is seen that, for the 'no preference class', there is only one significant variable besides the constant, namely the access to the gym. The relative importance of access to the gym is 7.9%, whereas the relative importance of the constant is 71.3%. It appears that the 'no preference class' prefers access to the gym with a discount as opposed to the same price as their current situation. This is the only case in which the 'no preference class' choses an intervention over their current situation.

For respondents in the 'preference class', the most important attribute determining their choice for a package is personal support from an exercise broker/sports coach. The least important significant attribute is the availability of public sports facilities (Examples are running and walking paths, cycling paths etc). Sports activity sharing via an app appeared to be non-significant, which was against the expectations since literature indicated that sharing physical activity experiences stimulates social connections during the COVID-pandemic (Zuo et al., 2021). This may be explained by the fact that 55.7% of the respondents never uses an app, whereas only 10.5% often and 12.9% always. Hence, in the sample there is a relative low percentage of people who use an app which may have affected the result.

Overall, the literature review showed that the availability of low-cost or free facilities for physical activity is important, especially for low SES-groups (Higgerson et al., 2018; Kamphuis et al., 2007). This study did not find the distinction between SES-groups as the variables income, employment and education were not significant. However, it appeared that both improved availability of free public fitness equipment and public sport facilities are preferred by citizens of the 'preference class' and do affect the choice of respondents. Besides the insignificant attribute sports activity sharing, the least important attribute for the choice of the respondents are the public sports facilities (for example walking, cycling paths). However, it must be noted that the improvement of walking and cycling paths was mentioned in the comment box of the questionnaire. Hence, some people do indicate that this must be improved.

The study of Lemola et al. (2021) showed that an in-app rewarding system positively influences physical activity. In this study, the rewards through an app had a relative importance of 8.6% for the 'preference class', hence it does influence the choice of respondents. Besides, 68.6% of the respondents indicated that they would not exercise more if there was an app, this may have caused the lower importance of this factor.

The importance of social intervention is stressed throughout the literature (Centers for Disease Control and Prevention, 2011). In addition, the comments to the research of Van Geest (2020) and this study

showed that age-appropriate activities are preferred. The relative importance of age-appropriate activities was 15.9%. Hence, this finding is in line with the findings of the literature.

Lastly, the most important attributes with a relative importance of 21.2% are personal support and guidance from an exercise broker or sports coach, and improved availability of free public fitness equipment. The importance of this is stressed out in literature, as many people benefit from a personalized program due to difference in personality traits, motivation and choice (Centers for Disease Control and Prevention, 2011). The difference between the two classes were only found in social support and satisfaction with parks and sport facilities. More research into this topic is needed as only one source is found which highlights the importance of the personal support and guidance.

8.5. Limitations and recommendations future research

As already highlighted, one of the main limitations of this study is the representativeness of the sample. The sample includes an overrepresentation of males, adults aged 65 years or older, highly educated people, one-person households, couples without children, and unemployed people. Furthermore, it was seen that a large percentage of respondents met the guidelines for physical activity (>5 days active for more than 30 minutes, hence a total of 150 minutes or more). There may be a sample bias. It may be the case that participants who reacted may be more active than respondents who did not respond to the questionnaire (non-response bias). Therefore, the results of the study should be carefully interpreted. Hence, questionnaires may not be the best method to include minorities and people who are not physically active. The interventions are aimed to include all groups of the society, however now the results are mainly based on higher educated and older citizens who already have a sufficient amount of physical activity. Other types of studies are needed to reach the audience who might be less interested in sports, for example a mix of quantitative (e.g. questionnaires) and qualitative (e.g. interviews, observations) studies. In addition, the questionnaire should not be held solely via the panel of the municipality of Venlo, but for example also by spreading the questionnaire physically in the neighborhoods with ethnic minorities or lower income groups.

Secondly, it might be hard for people to recall their activities in the past. Hereby, the result of the overall physical activity levels might be questionable as people seem to overestimate their physical activity levels. For future research it is therefore recommended to analyze physical activity levels by using multiple measurements over time. Hereby, also the effect of the natural environment (season) can be analyzed. Furthermore, it might be interesting to use direct measurement of physical activity rather than survey data. For example, future research might use wearable devices, such as a sports watch, to measure the physical activity levels.

Thirdly, trade-offs in choosing interventions that might motivate citizens to exercise more are examined through a stated choice experiment (SCE). However, the results might be unrealistic in real life as people may have other barriers to participate in physical activity. Furthermore, two respondents indicated that the SCE was unclear for them and a majority had no preference for the packages. Hence, the results may be less reliable. In addition, the choice of the respondents for the interventions might be different from the actual choice of the respondents in a real-life situation since unobserved effects are not included in SCE. Therefore, for future research it is advised to also follow the revealed preferences method or execute an additional experiment in which it is tested whether implementing the interventions indeed results in an increase in physical activity levels. The latter can be done with a test and control group for example.

Fourthly, interaction effects between the different interventions were not taken into account in the SCE. It might be the case that some interventions strengthen other interventions. This interaction effect is reduced by choosing to include interventions which probably do not enhance each other. Fifthly, the assumption of normal distribution of the multiple linear regression was not met. Hence, the results should be interpreted carefully. Furthermore, there is a relationship between smoking and physical activity. Therefore it is advised to conduct research in whether people who quit smoking will be more physically active.

Lastly, it is advised to take the socio-economic context, distances and availability to facilities, and country into account before generalizing the results of this research to different cities. To gain more insight into preferences for interventions in different type of cities, this experiment should be executed in other cities as well. In addition, this study was executed during the COVID-pandemic. Therefore, the results are applicable to situations during the COVID-pandemic. Hence, to gain insights in variables that affect physical activity and get insights in the possible interventions directions for promoting physical activity after and without COVID, the study should be executed again when the pandemic is over.

8.6. Policy implications

This study showed that physical activity during the COVID-pandemic is affected by some individual determinants, social and physical environment. The results have implications for various stakeholders, such as municipalities, policy makers and health-care providers. The stakeholders should focus on discouraging smoking and promote physical activity for people with a lower self-perceived health. This study showed that smokers and people with lower self-perceived health have lower levels of physical activity. This is a vicious circle which should be stopped, since being physically active brings many benefits to both physical and mental health (Durstine et al., 2013; Matias et al., 2022; Schuch et al., 2018, 2019). Furthermore, the municipality is advised to provide alternative routes to get from place to place. As respondents who are more satisfied with these alternatives have higher levels of physical activity.

The research also presents interventions to increase physical activity levels. It has shown that the ‘no preference class’ receive more social support and are more satisfied with the cycling lanes, walkability, parks and sport facilities within the municipality, hence they are less inclined to choose for an intervention. They are satisfied with their current situation. The ‘preference class’ are more inclined to choose an intervention instead of no intervention at all. Therefore, it is advised that policy makers focus on implementing personal support and guidance from an exercise broker or sports coach within the municipality, especially for the ‘preference class’. These are more often households with children or one-person households and they are citizens with lower levels of social support and citizens who are less satisfied with the walkability, cycling lanes, parks and sports facilities. Furthermore, the policy makers are advised to implement improved availability of public fitness equipment in the public space for this class. In addition, for both the ‘preference’ and ‘no-preference’ class access to the gym is preferred with a discount. Hence, policymakers in cooperation with gym companies should reduce the price for a gym membership.

When another lockdown arrives, the advice would be to stimulate citizens to find other ways of exercising. This can be done through the help of personal support and guidance from an exercise broker or sports coach. They can help to lay out the possibilities for exercising during a new lockdown. In general, it is advised to increase the availability of free public fitness equipment and promote the existence of this equipment. Lastly, smoking must be discouraged by the municipality and policy makers.

9. Conclusion

This study aimed to research the relationship between physical activity and socio-demographic, social environmental factors, physical environmental factors and psychological factors. Previous studies focused on only one of these factors. A regression analysis was used to analyse the significance of these relationships. This study also distinguishes itself from other studies by executing a stated choice experiment in order to obtain insights in choice behaviour of citizens for different interventions to obtain higher levels of physical activity. The questionnaire that was used to obtain the data was carefully designed and distributed via the panel of the municipality of Venlo.

The sub-question "How do the proposed interventions or services, such as using apps, age-appropriate activities, and public sports facilities stimulate active behaviour?" can be answered. Two classes were distinguished, namely 'no preference class' and 'preference class'. The difference between these groups are explained by the household composition, personality traits, level of social support, the walkability, the satisfaction with parks and sport facilities, the maintenance of the cycling lanes and the Leefbarometer score for safety. More households without children were found in the 'no preference class'. Furthermore, people in the 'no preference class' have a higher levels of social support, higher score of walkability, are more satisfied with the maintenance of the cycling lanes, are more satisfied with the parks and sports facilities and have a higher Leefbarometer score for safety. This class more often choses for no extra intervention or service at all. For both the 'preference' and 'no-preference' class access to the gym is preferred with a discount. For the 'preference class' the most important intervention is personal support and guidance from an exercise broker or sports coach, followed by improved availability of free public fitness equipment and access to a gym with discount. The least important intervention is improved public sports facilities (such as walking and cycling paths).

An answer to the main question "How do individual determinants, including personality traits, and the social, physical and natural environmental factors affect physical activity levels in times of the COVID-pandemic? " is as follows. The results of the regression analysis showed that the individual determinants self-perceived health, ethnicity and smoking have a relationship with physical activity levels. From the physical environment, the alternative routes to get from place to place show to have a positive relationship with physical activity. The social environment did not have a relationship with physical activity levels in the regression models, however it does have an effect on class membership. In addition, it has been shown that physical activity levels are higher when other ways of exercising were found during the COVID-pandemic. These people are characterized by having a higher education level, higher social support, higher self-perceived health, eat fruit and vegetables more frequently daily, and they would more likely have exercised more if the COVID-pandemic would not have been an obstacle.

Further research is needed to obtain more insight into physical activity levels during and after the COVID pandemic, as this study showed to have many insignificant variables. However, this study gave new insights by executing a stated choice experiment about the preferences of citizens for different interventions to increase physical activity. These interventions can be implemented by policy makers. Another distinction from other studies is that it shows insights into the characteristics of people who have found other ways of exercising during the COVID-pandemic. As far as this author knows, this is one of the first studies that examines the combination of different types of citizens with different preferences for interventions to increase physical activity levels. The results of this study can be used by policy makers to increase the physical activity levels among their citizens, especially during times of the COVID-pandemic.

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Appendices

Appendix A: First draft questionnaire (Dutch)

Deel 1: Persoonlijke kenmerken

1. Wat is uw leeftijd?
   - 0-18 jaar
   - 18-25 jaar
   - 26-30 jaar
   - 31-35 jaar
   - 36-40 jaar
   - 41-45 jaar
   - 46-50 jaar
   - 51-55 jaar
   - 56-60 jaar
   - 61-65 jaar
   - 66-70 jaar
   - 71-75 jaar
   - 76-80 jaar
   - 81-85 jaar
   - 86 jaar of ouder
   - Zeg ik liever niet
2. Wat is uw geslacht?
   - Man
   - Vrouw
   - Genderneutraal
   - Zeg ik liever niet
3. Wat is uw hoogst behaalde opleiding?
   - Lagere school
   - Middelbare school
   - MBO
   - HBO
   - WO/Universiteit Bachelor
   - WO/Universiteit Master (incl. postdoctoral degree, PhD)
   - Zeg ik liever niet
4. Hoeveel bedraagt het gezamenlijk netto maandinkomen van uw huishouden?
   - Minder dan 1000 euro
   - 1000 -2000 euro
   - 2001-3000 euro
   - 3001-4000 euro
   - 4001-5000euro
   - Meer dan 5000 euro
   - Weet ik niet / Zeg ik liever niet
5. Wat is uw huidige werkstatus? (Meerdere opties mogelijk)
   - Voltijd (36 uur of meer)
   - Deeltijd (21-35 uur)

- Deeltijd (1-20 uur)
- Student
- Gepensioneerd
- Geen betaald werk
- Anders, namelijk:

6. Tot welke etnische groep voelt u zichzelf het meeste verbonden?
   - Nederlands
   - Duits
   - Belgisch
   - Pools
   - Turks
   - Marokkaans
   - Surinaams
   - Antilliaans
   - Anders, namelijk:
   - Zeg ik liever niet
7. Wat voor type woning heeft u?
   - Vrijstaand huis
   - Half vrijstaand huis
   - Rijtjeshuis
   - Appartement
   - Anders, namelijk:
8. Wat is de grootte van de buitenruimte van uw huis?
   - Geen buitenruimte
   - Balkon <5 m^2
   - Balkon 5 m^2 of meer
   - Tuin <25 m^2
   - Tuin 25-50 m^2
   - Tuin 51 m^2 of meer
9. Hoeveel jaar woont u al in uw buurt?
   - OPEN
10. Wat is uw huishoudsamenstelling?
    - Alleenstaand
    - Samenwonend zonder kinderen
    - Samenwonend met thuiswonend(e) kind(-eren)
    - Alleenstaand met thuiswonend(e) kind(-eren)
    - Anders
11. Wat is de postcode van uw woonadres (e.g. 5612 AZ)?
    - OPEN
12. Bent u lid van een sportvereniging of sportschool?
    - Beide
    - Sportvereniging
    - Sportschool
    - Geen van beide
13. Hoe zou u over het algemeen uw gezondheid beoordelen?

- Erg slecht
- Slecht
- Gemiddeld
- Goed
- Erg Goed

Leefstijl (gebaseerd op Stadspeiling gemeente Venlo)

14. Rookt u?
    - Ja
    - Nee
15. Drinkt u 3 glazen of meer alcohol per dag?
    - Ja
    - Nee
16. Eet u dagelijks groente?
    - Ja
    - Nee
17. Eet u dagelijks fruit?
    - Ja
    - Nee

Deel 2: Persoonlijkheid

Antwoorden op onderstaande vragen worden gegeven op basis van 5-point Likert scale: Helemaal oneens - oneens - neutraal – eens – helemaal eens

18. Ik zorg voor leven in de brouwerij
19. Ik leef mee met de gevoelens van anderen
20. Ik doe klusjes meteen
21. Ik heb regelmatig stemmingswisselingen
22. Ik heb een levendige fantasie
23. Ik praat niet veel
24. Ik ben niet geïnteresseerd in de problemen van anderen
25. Ik vergeet vaak dingen op hun goede plek terug te leggen
26. Ik ben meestal ontspannen
27. Ik ben niet geïnteresseerd in abstracte ideeën
28. Ik praat op feestjes met veel verschillende mensen
29. Ik voel andermans emoties aan
30. Ik ben gesteld op orde
31. Ik ben snel overstuur
32. Ik heb moeite om abstracte ideeën te begrijpen
33. Ik houd me op de achtergrond
34. Ik ben niet echt geïnteresseerd in anderen
35. Ik maak een puinhoop van dingen
36. Ik voel me zelden neerslachtig
37. Ik heb weinig fantasie

Deel 3: COVID

Antwoorden op onderstaande vragen worden gegeven op basis van 5-point Likert scale: Helemaal oneens - oneens - neutraal – eens – helemaal eens

38. Ik ben bang voor mijn gezondheid wanneer ik het coronavirus oploop
39. Ik voel mij momenteel op mijn gemak in openbare ruimtes zoals winkels
40. Ik ga bij andere mensen thuis langs
41. Indien het coronavirus helemaal geen obstakel was geweest, dan had ik de afgelopen tijd meer gesport
42. Ik heb door corona andere manieren gevonden om te bewegen. Indien ja, leg uit

Deel 4: Perceptie sociale omgeving

In het tweede deel van de enquête volgen een aantal vragen over uw beleving van de wijk. Elk van de vragen bestaat uit beweringen, die u kunt beoordelen op de mate waarin ze aansluiten bij uw beleving van uw woonwijk.

Sociale omgeving

Antwoorden op onderstaande vragen worden gegeven op basis van 5-point Likert scale: Helemaal oneens - oneens - neutraal – eens – helemaal eens.

43. Ik zou mijn vrienden/familie als sportief beoordelen
44. Ik zou mijn buurtgenoten als sportief beoordelen

Sociale cohesie (gebaseerd op Sampson et al. 1997)

45. Mensen in mijn buurt zijn bereid om hun buren te helpen
46. Dit is een hechte buurt
47. Mensen in mijn buurt zijn te vertrouwen
48. Mensen in mijn buurt kunnen over het algemeen niet met elkaar opschieten
49. Mensen in mijn buurt delen niet dezelfde waarden en normen

Sociale support (gebaseerd op Zimet et al. 1988)

Antwoorden op onderstaande vragen worden gegeven op basis van 7-point Likert scale: Helemaal oneens – oneens – beetje oneens – neutraal – beetje eens – eens – helemaal eens.

50. Er is een speciaal persoon die me helpt wanneer ik het nodig heb
51. Er is een speciaal persoon met wie ik mijn vreugde en mijn verdriet kan delen
52. Mijn familie probeert me echt te helpen
53. Mijn familie geeft me de emotionele steun die ik nodig heb
54. Er is een speciaal persoon in mijn leven die een grote bron van troost is voor mij
55. Mijn vrienden proberen me echt te helpen
56. Ik kan op mijn vrienden rekenen als er dingen misgaan
57. Ik kan met mijn familie over mijn problemen praten
58. Ik heb vrienden met wie ik mijn vreugde en verdriet kan delen
59. Er is een speciaal persoon in mijn leven die geeft om mijn gevoelens
60. Mijn familie staat klaar om me te helpen bij het nemen van beslissingen
61. Ik kan met mijn vrienden over mijn problemen praten

Deel 5: Perceptie fysieke omgeving

Perceived *walkability (gebaseerd op Cerin et al. (2006))*

Antwoorden op onderstaande vragen worden gegeven op basis van 5-point Likert scale: Helemaal oneens - oneens - neutraal – eens – helemaal eens.

62. Het meeste van mijn boodschappen kan ik doen in lokale winkels
63. Openbaar vervoer (bus, trein) is op loopafstand van mijn huis
64. Winkels zijn binnen loopafstand van mijn huis
65. De trottoirs in mijn buurt zijn goed onderhouden
66. Het is veilig om te lopen in en rond mijn buurt
67. Er zijn veel interessante dingen om naar te kijken terwijl ik loop in mijn buurt
68. De snelheid van het verkeer in mijn buurt is normaal gesproken laag
69. Mijn buurt is goed verlicht s 'nachts
70. Ik zie en spreek andere mensen wanneer ik door mijn buurt loop
71. Er zijn aantrekkelijke gebouwen in mijn buurt
72. De straten in mijn buurt zijn duidelijk en herkenbaar

Infrastructuur

Antwoorden op onderstaande vragen worden gegeven op basis van 5-point Likert scale: Helemaal oneens - oneens - neutraal – eens – helemaal eens.

73. De fietspaden in mijn buurt zijn goed onderhouden
74. Er zijn veel manieren om van A naar B te komen in mijn buurt

Veiligheid

75. Ik ben tevreden met de algemene veiligheid (criminele activiteiten, verkeer etc.) in mijn buurt
76. De criminaliteit in mijn buurt maakt het onveilig om snachts naar buiten te gaan
77. Ik ben tevreden met de hoeveelheid verkeer in mijn buurt
78. Er is zoveel verkeer in en rondom mijn buurt waardoor het niet fijn is om er te lopen

Park en sportfaciliteiten

Antwoorden op onderstaande vragen worden gegeven op basis van 5-point Likert scale: Helemaal oneens - oneens - neutraal – eens – helemaal eens.

79. Ik ben tevreden met de sportvriendelijkheid in mijn buurt
80. Ik ben tevreden met de bereikbaarheid van groenvoorzieningen (parken) in mijn buurt
81. Ik ben tevreden met de toegang tot recreatie faciliteiten in mijn buurt
82. Er zijn voldoende openbare sportfaciliteiten in mijn stad (Voorbeelden hiervan zijn: buiten fitnesstoestellen, ren- wandelpaden, e.d.).
83. Ik gebruik de openbare sportfaciliteiten in mijn stad (Voorbeelden hiervan zijn: buiten fitnesstoestellen, ren- wandelpaden, e.d.).

Deel 6: Lichamelijke activiteit

Neem in gedachte een gemiddelde week sinds de corona pandemie. Wilt u aangegeven hoeveel dagen per week u de onderstaande activiteiten verrichtte, hoeveel tijd u daar gemiddeld op zo'n dag mee bezig was en hoe inspannend deze activiteiten waren?

Woon/Werkverkeer (heen en terug) (gebaseerd op SQUASH CBS)

Geef hieronder aan op hoeveel dagen u onderstaande activiteiten uitvoert en hoeveel tijd per dag u besteed hieraan in een gemiddelde week.

	Aantal dagen per week (Open vraag)	Gemiddelde tijd per dag (Open vraag)	Inspanning
Lopen van/naar het werk of school			Keuze uit: Langzaam, gemiddeld of snel
Fietsen van/naar het werk of school			Keuze uit: Langzaam, gemiddeld of snel
Niet van toepassing			Keuze uit: Langzaam, gemiddeld of snel

Lichamelijke activiteit op werk of school (gebaseerd op SQUASH CBS)

Geef hieronder aan hoeveel uur u onderstaande activiteiten uitvoert in een gemiddelde week.

	Aantal uren per week (Open vraag)
Licht en matig inspannend werk (zittend/staand werk, met af en toe lopen, zoals bureauwerk of lopend werk met lichte lasten)	
Zwaar inspannend werk (lopend werk of werk waarbij regelmatig zware dingen moeten worden opgetild)	
Niet van toepassing	

Huishoudelijke activiteit (gebaseerd op SQUASH CBS)

Geef hieronder aan op hoeveel dagen u onderstaande activiteiten uitvoert en hoeveel tijd per dag u besteed hieraan in een gemiddelde week.

	Aantal dagen per week (Open vraag)	Gemiddelde tijd per dag (Open vraag)
Licht en matig inspannend huishoudelijk werk (staand werk, zoals koken, afwassen, strijken, kind eten geven/in bad doen en lopend werk zoals stofzuigen en boodschappen doen)		
Zwaar inspannend huishoudelijk werk (vloer schrobben, tapijt uitkloppen, met zware boodschappen lopen)		
Niet van toepassing		

Vrije tijd (gebaseerd op SQUASH CBS)

Geef hieronder aan op hoeveel dagen u onderstaande activiteiten uitvoert en hoeveel tijd per dag u besteed hieraan in een gemiddelde week.

	Aantal dagen per week (Open vraag)	Gemiddelde tijd per dag (Open vraag)	Inspanning
Wandelen			Keuze uit: Langzaam, gemiddeld of snel
Fietsen			Keuze uit: Langzaam, gemiddeld of snel
Tuinieren			Keuze uit: Langzaam, gemiddeld of snel
Klussen/doe-het-zelven			Keuze uit: Langzaam, gemiddeld of snel

Sport (gebaseerd op SQUASH CBS)

Hieronder kunt u aangeven welke sporten u onderneemt in een gemiddelde week. U kunt maximaal 4 sporten opgeven.

(Open vraag)	Aantal dagen per week (Open vraag)	Gemiddelde tijd per dag (Open vraag)	Inspanning
Sport 1:			Keuze uit: Langzaam, gemiddeld of snel
Sport 2:			Keuze uit: Langzaam, gemiddeld of snel
Sport 3:			Keuze uit: Langzaam, gemiddeld of snel
Sport 4:			Keuze uit: Langzaam, gemiddeld of snel

84. Op welke locaties onderneemt u uw sport activiteiten zoals hierboven genoemd? U kunt meerdere opties aankruisen.
    - Thuis
    - Sportaccommodatie binnen
    - Sportaccommodatie buiten
    - Openbare weg of plein
    - Openbare fitnesstoestellen
    - Park of bos
    - Andere plek

Totaal (gebaseerd op SQUASH CBS)

85. In een gemiddelde week, op hoeveel dagen bent u, alles bij elkaar opgeteld, tenminste een half uur bezig met fietsen, klussen, tuinieren, sporten of andere inspannende activiteiten?
    - 1 dag
    - 2 dagen
    - 3 dagen
    - 4 dagen
    - 5 dagen

- 6 dagen
- 7 dagen
- Niet van toepassing

86. Besteed u dezelfde hoeveelheid tijd aan fietsen, klussen, tuinieren, sporten of andere inspannende activiteiten als voor de corona pandemie?
    - Veel minder
    - Minder
    - Hetzelfde
    - Meer
    - Veel meer

Overig

87. Gebruikt u wel eens een app bij het bewegen? (zoals Strava, Komoot, Fitbit, Ommetje)
    - Altijd
    - Vaak
    - Soms
    - Zelden
    - Nooit
88. Zou u meer gaan bewegen als er een app is die beloningen (geld, waardebon, sport lidmaatschap, virtuele punten) geeft voor bewegen?
    - Ja, waarom OPEN
    - Nee, waarom OPEN
    - Weet ik niet

Deel 7: Oplossingen

In de volgende vragen worden pakketten geschetst met oplossingen die u mogelijk motiveren om meer te gaan bewegen. Geef per vraag aan welk pakket aan oplossingen u het meest zou motiveren om meer te gaan bewegen, indien u geen van beide beter vindt dan uw huidige situatie noteer dan 'geen van beide'.

1.	*Individueel*	Persoonlijke ondersteuning en begeleiding van een beweegmakelaar/buurtsportcoach voor passend sport- en beweegaanbod	Wel	Geen
2.	*Sociaal – Digitaal*	Sportactiviteit volgen van anderen via een app	Wel mogelijk	Niet mogelijk
3.	*Sociaal – Buurt*	Leeftijdsgebonden activiteiten en workshops in uw buurt (Zoals, ren en wandelgroepen)	Wel	Geen
4.	*Fysieke omgeving*	Beschikbaarheid van gratis publieke fitnessapparatuur in openbare ruimte	Verbeterd	Zoals nu
5.	*Fysieke omgeving*	Beschikbaarheid publieke sportfaciliteiten (Zoals ren- en wandelpaden)	Zoals nu	Verbeterd
6.	*Fysieke omgeving*	Toegang tot sportschool	Zelfde prijs als nu	Met korting

7.	*Digitale omgeving – Beleid*	Beloningen verdienen via een app per activiteit	Niet mogelijk	Wel mogelijk

Voorbeeldvraag stated choice experiment: Hieronder een voorbeeldvraag waarin de respondent een keuze moet maken. In de definitieve enquête komen in dit onderdeel meerdere van dit soort vragen met pakketten aan oplossingen (opties).

Optie A	*Optie B*	*Geen van beide*
Gepersonaliseerde training programma's	*Geen gepersonaliseerde training programma's*	
Sportactiviteit volgen van anderen via een app niet mogelijk	*Sportactiviteit volgen van anderen via een app mogelijk*	
Geen leeftijdsgebonden activiteiten in uw buurt	*Leeftijdsgebonden activiteiten in uw buurt*	
Workshops in uw buurt	*Geen workshops in uw buurt*	
Verbeterde beschikbaarheid van gratis publieke fitnessapparatuur in openbare ruimte	*Beschikbaarheid van gratis publieke fitnessapparatuur zoals nu in openbare ruimte*	
Verbeterde beschikbaarheid publieke sportfaciliteiten (Zoals ren- en wandelpaden)	*Beschikbaarheid publieke sportfaciliteiten zoals nu (Zoals ren- en wandelpaden)*	
Geen autoluw stadscentrum	*Autoluw stadscentrum*	
Toegang tot sportschool zelfde prijs als nu	*Toegang tot sportschool met korting*	
Beloningen verdienen via een app per activiteit niet mogelijk	*Beloningen verdienen via een app per activiteit mogelijk*	
○	○	○

89. Heeft u andere ideeën waarmee de gemeente kan helpen om mensen meer aan het bewegen te krijgen? Indien ja, leg uit
    - Nee
    - Ja, OPEN

Appendix B: Information sheet

Information sheet for research project "Physical activity levels in time of the covid pandemic"

1. Introduction

You have been invited to take part in research project about physical activity in times of the covid pandemic because you are a member of the "gemeentepanel" of the municipality of Venlo. Participation in this research project is voluntary: you decide if you wish to take part. Before you decide to participate, we kindly request you to read the following information, so you know what the research project is about, what we expect from you and how we will process your personal data. Based on this information, you can use the consent form to indicate if you consent in participating in the research project and consent with the processing of your personal data.
You may of course always ask questions to the research project manager via e.boereboom@student.tue.nl or discuss this information with your acquaintances.

2. Objective of the research project

This research project will be led by E. Boereboom at University of Technology Eindhoven. The municipality of Venlo is helping to spread the research.

The objective of this research project is to get insight and a better understanding into the impact of individual determinants, social environment, physical environment and natural environment on physical activity levels. Furthermore, we aim to find out and rank which interventions/solutions motivate the most to exercise more. These insights can help policymakers and municipalities to design a living environment that stimulates and enhances physical activity for all.

The analysed results of the research will be incorporated in the graduation report of E. Boereboom. Furthermore, the research data may also be used for scientific articles/publications and additional (new) research in this topic.

3. What does participation in the research project entail?

- We ask you to complete a one-time questionnaire about your personal situation, your perception of your social environment and your neighbourhood, your physical activity levels and possible solutions that stimulate you to exercise more.
- You will be taking part in a research project in which we will collect information by:

  - Provide you with a questionnaire which you can complete online. In this questionnaire, some personal information will be asked (see paragraph 4). In addition, statements are presented where you can indicate to what extent you agree or disagree with these statements. The statements are about your personality, dealing with corona, your social environment and your neighbourhood. Followed by open questions about your physical activity levels. The questionnaire ends with questions that offer packages of solutions that may motivate you to exercise more. Here you can indicate which package motivates you the most.

4. Which of your personal data do we collect and process?

Regular personal data

- Age
- Gender
- Education level
- Income
- Employment status
- Dwelling type/garden
- Years in neighbourhood
- Household composition
- Postal code
- Membership gym/sport association
- Personality
- Physical activity levels
- Perception of social and physical environment

Special categories of personal data:

- Ethnicity
- Self-perceived health
- Lifestyle

Collecting this combination of personal data is critical for obtaining meaningful research results and propose possible solutions.

5. Potential risks and inconveniences

- Your participation in this research project does not involve any physical, legal or economic risks. You do not need to answer any questions you do not wish to. Your participation is voluntary. This means you may cancel your participation at any moment you choose by communicating this to the researcher. You do not need to explain your reasons for cancelling your participation in the research.

6. Refunds

You will receive no refund for your participation in this research project.

7. Confidentiality of the data

We will do everything possible to protect your privacy. The research results that will be published will not in any way include confidential information or personal data through which anyone can recognize you, unless you explicitly give permission for mentioning your name, for example in a quote.

The personal data that were collected in the form of an online questionnaire within the framework of this research are stored on the storage solutions offered by the IT department of TU/e.

The data will also be shared with the TU/e supervisors. TU/e supervisors will have access to all the data after the study has been finished for reasons of scientific integrity, possibly writing a publication/scientific article and possible additional research in which the data is re-analysed. The data will be made publicly available, this will take place in an anonymized form only. If you give your permission, your anonymised data will be made available for future research via the institutional repository of the TU Eindhoven.

The research data will if necessary (e.g. for a check of academic integrity) and only in anonymized form, be put at the disposal of persons outside the research group.

The research data will be retained for a period of 10 years. At the latest after expiration of this time period, the data will either be deleted or anonymized so they can no longer be traced to an individual person. The research data may be used in pseudonymised/anonymised form for future studies in unrban planning.

Finally, this research project has been assessed and approved on the 9th of May 2022 by the Ethical Review Board of Eindhoven University of Technology.

8. Voluntariness

Participation in this research project is entirely voluntary. As participant, you may end your cooperation with the research project at any moment, or refuse permission for your data to be used for the research, without providing any reason. Cancelling your participation will have no negative consequences for you or for any refund you may already have received.

If you decide to cancel your cooperation while the research project is ongoing, data you already provided up to your cancellation may be used for the research.
Do you wish to cancel your participation in the research project, or do you have any questions and/or complaints? Contact the research project manager.

E. Boereboom via e.boereboom@student.tue.nl

This research is performed from Eindhoven University of Technology, which is controller in the sense of the General Data Protection Regulation (GDPR). If you have specific questions concerning the handling of personal data you may direct these to the data protection officer of TU/e by sending a mail to dataprotectionofficer@tue.nl. Furthermore, you have the right to file a complaint with the Data Protection Authority (in Dutch: *Autoriteit Persoonsgegevens*).

Finally, you have the right to submit a request for access, rectification, erasure or adjustment of your data. For further information go to https://www.tue.nl/storage/privacy/. You can submit your request via privacy@tue.nl.

Consent form for participation by an adult

We ask you to participate in a study conducted by TU Eindhoven on physical activity at the time of the Covid pandemic. The aim of this study is to gain insight in whether variables such as personal characteristics, social environment, physical environment (such as the neighbourhood where you live) and natural environment influence physical activity. Furthermore, we want to find out which solutions

motivate people most to exercise more. These insights can help policy makers and municipalities to design a living environment that stimulates and promotes physical activity for all.

Participation in this research is voluntary: you decide whether you want to participate. Before you decide to participate, we would like to ask you to read the information letter of the study.

Through this consent form I agree to the following:

1. I am sufficiently informed about the research through a separate information sheet. I have read the information sheet and have subsequently had the opportunity to ask questions. These questions have been answered satisfactorily.
2. I take part in this research project voluntarily. I do not take part under any kind of explicit or implicit duress. It is clear to me that I can cancel my participation at any moment without having to provide any reason. I do not have to answer a question against my wish.

Beside the above, you can below give your specific permission for various parts of the research. You can give or withhold your permission for each part.

3. I give permission to process the personal data that are collected from me during the research in the way described in the attached information sheet. (read more under sections 3 an 4 of the Information Letter).

   YES ☐ NO ☐

4. I give permission for processing of special categories of personal data as described in section 3 of the information sheet. (read more under sections 3 and 4 of the Information Letter).

   YES ☐ NO ☐

5. I give permission to store the research data collected from me for use in future research in the field of urban planning with due regard for recognized ethical standards for scientific research, and for education purposes. (read more under section 7 of the Information Letter).

   YES ☐ NO ☐

6. I give permission to make the anonymised results of the research collected from me available via the institutional repository of TU Eindhoven in order to be saved and for use in future research as described above (read more under section 7 of the Information Letter).

   YES ☐ NO ☐

Appendix C: Phyton code

```
import csv

package_name_to_index = {
 'Package A': 0,
 'Package B': 1,
 'None of these': 2,
}

set_question_profiles = {
 'S1Q1': [7,5,0],
 'S1Q2': [3,6,0],
 'S1Q3': [8,1,0],
 'S1Q4': [4,2,0],
 'S2Q1': [8,2,0],
 'S2Q2': [1,5,0],
 'S2Q3': [6,7,0],
 'S2Q4': [3,4,0]
}

profile_attribute = {
 0: [0,0,0,0,0,0,0],
 1: [1,1,1,1,1,1,1],
 2: [1,1,1,-1,-1,-1,-1],
 3: [1,-1,-1,1,1,-1,-1],
 4: [1,-1,-1,-1,-1,1,1],
 5: [-1,1,-1,1,-1,1,-1],
 6: [-1,1,-1,-1,1,-1,1],
 7: [-1,-1,1,1,-1,-1,1],
 8: [-1,-1,1,-1,1,1,-1],
}

headers = ['Profile', 'Chosen',
'Constant','Support','Track','AgeActivity','PublicFitness','PublicSport','Gym','R
ewards']

with open('data.csv', 'r') as input_csv:
 with open('output.csv', 'w', newline='') as output_csv:
 csv_writer = csv.writer(output_csv, delimiter=';')
 csv_reader = csv.reader(input_csv, delimiter=';')
 index = 0
 for row in csv_reader:
 if index == 0:
 # write header to output
 row.insert(3, 'variant')
```

```
row.insert(4, 'choiceset')
csv_writer.writerow([*row, *headers])
else:
# add question and variant to row
row.insert(3, row[2][1])
question_number = (int((row[2][1]))-1)*4+int(row[2][3])
row.insert(4, question_number)
rows = []
# loop over profiles for each row
profiles = set_question_profiles[row[2]]
for profile in profiles:
# rename
# set chosen 1 when the respondent has chosen this profile on this question
chosen = 0
if profiles[package_name_to_index[row[5]]] == profile:
chosen = 1
# add constant for profile 0
constant = 0
if profile == 0:
constant = 1
# add row to rows
rows.append([*row, profile, chosen, constant, *profile_attribute[profile]])
# add rows to csv
csv_writer.writerows(rows)
index += 1
```

Appendix D: MNL model output

```
|->
NLOGIT;Lhs=CHOSEN;Choices=0,1,2;Rhs=CONSTANT,SUPPORT,TRACK,AGEACTIV,PUBLICFI,
PUBLICSP,GYM,REWARDS;pds=4;CheckData;Show model;Describe:List$
------------------------------------------------------------------------------
Discrete choice (multinomial logit) model
Dependent variable Choice
Log likelihood function -1146.96490
Estimation based on N = 1300, K = 8
Inf.Cr.AIC = 2309.9 AIC/N = 1.777
--------------------------------------
 Log likelihood R-sqrd R2Adj
Constants only -1195.7202 .0408 .0378
Note: R-sqrd = 1 - logL/Logl(constants)
Warning: Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
--------------------------------------
Response data are given as ind. choices
Number of obs.= 1300, skipped 0 obs
--------+---------------------------------------------------------------------
 | Standard Prob. 95% Confidence
 CHOSEN| Coefficient Error z |z|>Z* Interval
--------+---------------------------------------------------------------------
CONSTANT| 1.31489*** .06149 21.38 .0000 1.19437 1.43540
 SUPPORT| .24302*** .05565 4.37 .0000 .13396 .35208
 TRACK| -.02238 .05287 -.42 .6721 -.12599 .08123
AGEACTIV| .17802*** .05566 3.20 .0014 .06892 .28712
PUBLICFI| .23941*** .05561 4.30 .0000 .13040 .34841
PUBLICSP| -.10478* .05506 -1.90 .0570 -.21271 .00314
 GYM| -.23020*** .05557 -4.14 .0000 -.33911 -.12128
 REWARDS| -.12460** .05287 -2.36 .0184 -.22823 -.02097
--------+---------------------------------------------------------------------
***, **, * ==> Significance at 1%, 5%, 10% level.
Model was estimated on Jun 10, 2022 at 11:22:37 AM
------------------------------------------------------------------------------
```

Appendix E: LC model output

LC model 2 classes

```
|->
LCLOGIT;Lhs=CHOSEN;Choices=0,1,2;Rhs=CONSTANT,SUPPORT,TRACK,AGEACTIV,PUBLICFI
,PUBLICSP,GYM,REWARDS;pds=4;NClass=2;Parameters$
------------------------------------------------------------------------------
Latent Class Logit Model
Dependent variable CHOSEN
Log likelihood function -859.76136
Restricted log likelihood -1428.19598
Chi squared [ 17](P= .000) 1136.86923
Significance level .00000
McFadden Pseudo R-squaredd .3980088
Estimation based on N = 1300, K = 17
Inf.Cr.AIC = 1753.5 AIC/N = 1.349
--------------------------------------
 Log likelihood R-sqrd R2Adj
No coefficients -1428.1960 .3980 .3940
Constants only -1195.7202 .2810 .2762
At start values -1146.9518 .2504 .2455
Note: R-sqrd = 1 - logL/Logl(constants)
Warning: Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
--------------------------------------
Response data are given as ind. choices
Number of latent classes = 2
Average Class Probabilities
 .608 .392
LCM model with panel has 325 groups
Fixed number of obsrvs./group= 4
Number of obs.= 1300, skipped 0 obs
--------+---------------------------------------------------------------------
 | Standard Prob. 95% Confidence
 CHOSEN| Coefficient Error z |z|>Z* Interval
--------+---------------------------------------------------------------------
 |Random utility parameters in latent class -->> 1...................
CONSTA|1| 3.54383*** .27444 12.91 .0000 3.00593 4.08172
SUPPOR|1| .03571 .20298 .18 .8604 -.36213 .43354
 TRACK|1| -.24226 .19698 -1.23 .2187 -.62833 .14381
AGEACT|1| .00372 .20779 .02 .9857 -.40354 .41099
PUBLIC|1| -.16793 .18578 -.90 .3660 -.53205 .19619
PUBLI1|1| .01569 .19558 .08 .9361 -.36764 .39902
 GYM|1| -.39285* .21504 -1.83 .0677 -.81431 .02862
REWARD|1| .05692 .19587 .29 .7714 -.32698 .44082
 |Random utility parameters in latent class -->> 2...................
CONSTA|2| -1.01423*** .18731 -5.41 .0000 -1.38135 -.64712
SUPPOR|2| .36066*** .09553 3.78 .0002 .17343 .54788
 TRACK|2| -.03612 .06807 -.53 .5957 -.16952 .09729
AGEACT|2| .19701** .08909 2.21 .0270 .02239 .37163
PUBLIC|2| .21606*** .08277 2.61 .0090 .05383 .37830
PUBLI1|2| -.17714** .07483 -2.37 .0179 -.32380 -.03047
 GYM|2| -.22226** .09037 -2.46 .0139 -.39937 -.04514
REWARD|2| -.20796*** .07471 -2.78 .0054 -.35440 -.06153
 |Estimated latent class probabilities..............................
 PrbCls1| .60828*** .03154 19.29 .0000 .54646 .67009
```

```
 PrbCls2| .39172*** .03154 12.42 .0000 .32991 .45354
--------+--------------------------------------------------------------------
***, **, * ==> Significance at 1%, 5%, 10% level.
Model was estimated on Jun 12, 2022 at 06:47:17 PM
-----------------------------------------------------------------------------
```

LC model 3 classes

```
|->
LCLOGIT;Lhs=CHOSEN;Choices=0,1,2;Rhs=CONSTANT,SUPPORT,TRACK,AGEACTIV,PUBLICFI
,PUBLICSP,GYM,REWARDS;pds=10;NClass=3$

Iterative procedure has converged
Normal exit: 79 iterations. Status=0, F= .1070553D+04

-----------------------------------------------------------------------------
Latent Class Logit Model
Dependent variable CHOSEN
Log likelihood function -841.75050
Restricted log likelihood -1428.19598
Chi squared [ 26](P= .000) 1172.89095
Significance level .00000
McFadden Pseudo R-squaredd .4106197
Estimation based on N = 1300, K = 26
Inf.Cr.AIC = 1735.5 AIC/N = 1.335
--------------------------------------
 Log likelihood R-sqrd R2Adj
No coefficients -1428.1960 .4106 .4047
Constants only -1195.7202 .2960 .2889
At start values -1146.9741 .2661 .2587
Note: R-sqrd = 1 - logL/Logl(constants)
Warning: Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
--------------------------------------
Response data are given as ind. choices
Number of latent classes = 3
Average Class Probabilities
 .501 .218 .281
LCM model with panel has 325 groups
Fixed number of obsrvs./group= 4
BHHH estimator used for asymp. variance
Number of obs.= 1300, skipped 0 obs
--------+--------------------------------------------------------------------
 | Standard Prob. 95% Confidence
 CHOSEN| Coefficient Error z |z|>Z* Interval
--------+--------------------------------------------------------------------
 |Random utility parameters in latent class -->> 1...................
CONSTA|1| 14.9697 .6603D+07 .00 1.0000 *********** ***********
SUPPOR|1| -3.68772 .4641D+08 .00 1.0000 *********** ***********
 TRACK|1| -10.6734 .6603D+07 .00 1.0000 *********** ***********
AGEACT|1| -3.51542 .4641D+08 .00 1.0000 *********** ***********
PUBLIC|1| 2.36319 .4659D+07 .00 1.0000 *********** ***********
PUBLI1|1| -3.16642 .5393D+08 .00 1.0000 *********** ***********
 GYM|1| 3.01621 .4659D+07 .00 1.0000 *********** ***********
REWARD|1| -2.83621 .5393D+08 .00 1.0000 *********** ***********
```

```
 |Random utility parameters in latent class -->> 2...................
CONSTA|2| 1.11290*** .34061 3.27 .0011 .44532 1.78049
SUPPOR|2| .13355 .17734 .75 .4514 -.21403 .48112
 TRACK|2| .19016 .21565 .88 .3779 -.23250 .61282
AGEACT|2| .07892 .15404 .51 .6084 -.22299 .38083
PUBLIC|2| .15348 .23012 .67 .5048 -.29754 .60450
PUBLI1|2| .07588 .16604 .46 .6477 -.24956 .40132
 GYM|2| -.60490*** .14665 -4.12 .0000 -.89232 -.31747
REWARD|2| -.14845 .17302 -.86 .3909 -.48757 .19067
 |Random utility parameters in latent class -->> 3...................
CONSTA|3| -2.34076*** .52892 -4.43 .0000 -3.37743 -1.30408
SUPPOR|3| .37380*** .13769 2.71 .0066 .10393 .64368
 TRACK|3| -.08147 .09634 -.85 .3978 -.27030 .10736
AGEACT|3| .27170** .13164 2.06 .0390 .01369 .52972
PUBLIC|3| .28629** .13319 2.15 .0316 .02524 .54735
PUBLI1|3| -.24635*** .08083 -3.05 .0023 -.40478 -.08792
 GYM|3| -.09647 .12509 -.77 .4406 -.34165 .14870
REWARD|3| -.22071** .08800 -2.51 .0121 -.39319 -.04823
 |Estimated latent class probabilities..............................
 PrbCls1| .50098*** .04246 11.80 .0000 .41775 .58421
 PrbCls2| .21841*** .04051 5.39 .0000 .13902 .29781
 PrbCls3| .28060*** .03504 8.01 .0000 .21192 .34929
--------+------------------------------------------------------------------
nnnnn.D-xx or D+xx => multiply by 10 to -xx or +xx.
***, **, * ==> Significance at 1%, 5%, 10% level.
Model was estimated on Jun 12, 2022 at 06:50:03 PM
-------------------------------------------------------------------------------
```

Appendix F: Results bivariate analysis class membership

This appendix shows the complete output of the bivariate analysis between the individual determinants (independent variable) and class membership (dependent variable).

Table F1: Complete bivariate analysis class membership

	Sample (%)	No preference class (%)	Preference class (%)	X^2 or t.	Sig.
Age				**X^2**	
18-40 years	9.9	9.2	10.9	4.113	0.128
41-64 years	49.2	45.4	55.0		
>65	40.9	45.4	34.1		
Gender				**X^2**	
Female	36.9	34.2	41.1	1.732	0.188
Male	62.8	65.8	58.1		
Education				**X^2**	
Low	16.3	15.3	17.8	0.448	0.799
Moderate	26.8	26.5	27.1		
High	56.9	58.2	55.0		
Income				**X^2**	
<2000 euros per month	6.8	4.6	10.1	6.533	0.258
2001-3000 euros per month	25.5	26.5	24.0		
3001-4000 euros per month	24.6	27.6	20.2		
4001-5000 euros per month	20.3	18.9	22.5		
More than 5000 euros per month	16.3	15.3	17.8		
I do not know / I would rather not say	6.5	7.1	5.5		
Employment				**X^2**	
Fulltime (36 hours or more)	27.1	27.0	27.1	5.815	0.213
Parttime (21-35 hours)	15.4	13.3	18.6		
Parttime (1-20 hours)	5.2	4.6	6.2		
Retired	46.2	50.5	39.5		
No paid work	6.2	4.6	8.5		
Ethnicity				**X^2**	
Dutch	96.6	97.4	95.3	1.049	0.306
Other	3.4	2.6	4.7		
Household composition				**X^2**	
One-person household	13.2	12.8	14.0	**4.819***	0.090
Couple without children	58.1	62.8	51.1		
Couple with children & single-parent family	28.6	24.5	34.9		
Years in the neighbourhood				**X^2**	
0-4 years	14.2	15.8	11.6	4.468	0.215
5-19 years	35.4	31.1	41.9		
20-29 years	19.1	20.9	16.3		
>30 years	31.4	32.1	30.2		
Self-perceived health	**Sample (Mean)**	**No preference class (Mean)**	**Preference class (mean)**	**t.**	
	2.51	2.57	2.43	1.620	0.106
Gym membership				**X^2**	

Both	5.5	4.1	7.8	3.835	0.280
Sport association	23.4	22.4	24.8		
Fitness centre	15.1	13.8	17.1		
None	56.0	59.7	50.4		
Lifestyle				**X^2**	
Smoking				2.337	0.126
No	92.6	90.8	95.3		
Yes	7.4	9.2	4.7		
Drinking				0.249	0.618
No	92.9	92.3	93.8		
Yes	7.1	7.7	6.2		
Vegetables				0.014	0.907
No	8.3	8.2	8.5		
Yes	91.7	91.8	91.5		
Fruit				0.000	0.983
No	31.3	31.1	31.0		
Yes	68.9	68.9	69.0		
Personality				**X^2**	
Agreeableness	50.2	48.5	52.7	**8.767***	0.070
Conscientiousness	32.3	34.7	28.7		
Extraversion	5.5	7.1	3.1		
Imagination	10.2	9.2	11.6		
Neuroticism	1.8	0.5	3.9		
Dwelling type				**X^2**	
Apartment	14.2	14.3	14.7	0.857	0.931
Rowhouse	27.4	27.0	27.9		
Semi-detached dwelling	25.5	27.0	23.3		
Detached dwelling	25.2	25.0	25.6		
Other	7.4	6.6	8.5		
Outdoor space				**X^2**	
Balcony	12.0	12.2	11.6	0.085	0.994
Garden less than <50 m2	36.3	35.7	37.2		
Garden 51 m2 or more	50.2	50.5	49.6		
No outside space	1.5	1.5	1.6		

Appendix G: Bivariate analysis output 1 & 2

This appendix shows the complete output of the bivariate analysis between the all independent variables and the Dutch standard for healthy exercise (dependent variable). In addition, it shows the bivariate analysis between all independent variables and sport minutes only as dependent variable.

Table G1: Complete bivariate analysis 1 & 2

Variable			**Dutch standard for healthy exercise (continuous)**				**Physical activity sports minutes only (continuous)**			
ANOVA			**Mean**	**St. Dev.**	**F.**	**Sig.**	**Mean**	**St. Dev.**	**F.**	**Sig.**
Age	18-40 years		1.41	0.837	**2.993***	0.052			0.401	0.670
	41-64 years		1.65	0.711						
	>65		1.74	0.626						
Education level					0.488	0.615			1.777	0.171
Income					0.282	0.923			1.639	0.149
Employment					1.197	0.312			0.794	0.530
Household composition					0.590	0.555			0.173	0.841
Years in neighbourhood					1.523	0.208			0.598	0.617
Gym membership	Both		1.83	0.514	**2.122***	0.097	407.67	499.00	**12.939*****	0.000
	Sport association		1.76	0.596			253.75	191.44		
	Fitness centre		1.76	0.596			223.77	250.09		
	None		1.58	0.767			108.68	229.68		
Dwelling type					1.437	0.222			0.893	0.468
Outdoor space	Balcony				0.232	0.874	146.92	303.82	**2.762****	0.042
	Garden less than <50 m2						141.52	170.94		
	Garden 51 m2 or more						201.82	267.19		
	No outside space						408.00	846.83		
Density					0.655	0.624			0.477	0.753
Usage of app					0.008	1.000			1.741	0.141
Reward app					0.612	0.543			0.309	0.734
Independent samples t-test			**Mean**	**St. Dev.**	**t.**	**Sig.**	**Mean**	**St. Dev.**	**t.**	**Sig.**
Gender	Female				-0.043	0.966			-0.134	0.894
	Male									
Ethnicity	Dutch				1.448	0.149			-0.089	0.846
	Other									
Lifestyle	Smoking	No	5.45	1.864	0.877	0.381	184.102	265.10	**2.829*****	0.008
		Yes	4.38	2.392			82.500	159.05		
	Drinking				0.067	0.947			0.311	0.765
	Vegetables	No	4.63	2.306	**-1.698***	0.090			-0.533	0.581
		Yes	5.44	1.876						
	Fruit	No			-0.657	0.512	137.485	174.28	**-2.182****	0.030
		Yes					194.114	289.05		

'I have found other ways of exercising due to COVID'	No	5.14	2.015	-1.357	0.176	151.031	227.23	**-2.163****	0.031
	Yes	5.72	1.733			214.256	298.92		
Pearson's Correlation		**Mean**	**St. Dev.**	**r.**	**Sig.**	**Mean**	**St. Dev.**	**r.**	**Sig.**
Self-perceived health				0.048	0.393	2.51	0.764	**0.126****	0.023
Personality				0.014	0.799			0.007	-0.065
Sporty friends/family				0.053	0.345			**0.171*****	0.002
Sporty neighbours				-0.039	0.484			0.035	0.533
Social support				-0.026	0.641			0.053	0.338
Social support family				0.049	0.382			0.034	0.544
Social support significant others				-0.084	0.130			0.074	0.056
Social support friends				-0.033	0.554			0.102	0.037
Social cohesion				0.063	0.254			0.013	0.017
Perceived walkability		28.49	5.585	**0.097***	0.080			0.036	0.512
Satisfaction parks/sport facilities		12.22	3.286	**0.167*****	0.003			0.047	0.396
Maintenance infrastructure	Maintenance cycling lanes			-0.019	0.739			-0.014	0.799
	Alternative routes to get from place to place			0.049	0.379			0.037	0.511
Neighbourhood safety				0.059	0.292			0.011	0.846
COVID sum score				-0.037	0.511			0.052	0.360
'If the coronavirus had not been an obstacle at all, I would have exercised more'				-0.023	0.685			0.085	0.127
Leefbarometer: Safety				0.036	0.522			0.065	0.242
Leefbarometer: Physical environment				0.024	0.662	0.024	0.028	**0.118****	0.033
Leefbarometer: facilities				-0.027	0.632			-0.086	0.121

Appendix H: Results post hoc test

This appendix shows the results of the post hoc text executed on the variable gym membership and physical activity.

Table H1: Results post hoc test Gym membership paragraph 7.1.3.

Gym membership (I - J)		Mean Difference (I-J)	Std. Error	Sig.
Both	Sport association	153,91	64,66	0,107
	Fitness centre	183.90*	67,99	0,043
	None	298.99*	60,95	0,000
Sport association	Both	-153.92	64,66	0,107
	Fitness centre	29.98	45,19	1,000
	None	145.07*	33,69	0,000
Fitness centre	Both	-183.90*	67,99	0,043
	Sport association	-29,98	45,19	1,000
	None	115.08*	39,70	0,024
None	Both	-298.99*	60,95	0,000
	Sport association	-145.07*	33,69	0,000
	Fitness centre	-115.08*	39,70	0,024

Appendix I: Bivariate analysis output 3 & 4

This appendix shows the complete output of the bivariate analysis between the all independent variables and the Dutch standard for healthy exercise (dependent variable). Both interpreted as categorical and dichotomous variable.

Table I1: Complete bivariate analysis 3 & 4

Variable		**Dutch standard for healthy exercise (categorical)**				**Dutch standard for healthy exercise (dichotomous)**			
Chi-square test		**Mean**	**St. Dev.**	**X^2**	**Sig.**	**Mean**	**St. Dev.**	**X^2**	**Sig.**
Age				7.155	0.128			3.548	0.170
Education level				6.898	0.141			3.295	0.193
Income				6.157	0.802			2.805	0.730
Employment				5.251	0.730			3.653	0.455
Household composition				2.703	0.722			1.742	0.419
Years in neighbourhood				10.562	0.103			3.100	0.376
Gym membership	Both			6.670	0.352	0.94	0.236	**6.294***	0.098
	Sport association					0.92	0.271		
	Fitness centre					0.92	0.277		
	None					0.83	0.377		
Dwelling type				8.679	0.370			3.248	0.517
Outdoor space				8.732	0.189			1.035	0.793
Density									
Usage of app (Q94)				5.529	0.700			0.999	0.910
Reward app (Q95)				3.461	0.484			0.197	0.906
Gender				0.086	0.958			0.023	0.879
Ethnicity				2.174	0.337			2.083	0.149
Lifestyle	Smoking			1.160	0.560			0.323	0.570
	Drinking			0.017	0.991			0.000	0.986
	Vegetables			2.900	0.235			2.263	0.133
	Fruit			0.911	0.634			0.115	0.735
'I have found other ways of exercising due to COVID'				1.879	0.391			1.755	0.185
ANOVA / Independent samples t-test		**Mean**	**St. Dev.**	**F.**	**Sig.**	**Mean**	**St. Dev.**	**t.**	**Sig.**
Self-perceived health				0.585	0.558			-0.530	0.596
Personality				0.065	0.938			-0.334	0.739
Sporty friends/family				1.653	0.193	2.00	0.663	**-1.693***	0.096
						2.19	0.798		
Sporty neighbours				0.886	0.413			0.266	0.826
Social support				0.255	0.775			0.220	0.826
Social support family				0.417	0.659			-0.910	0.363
Social support significant others				1.185	0.307			1.289	0.198

Social support friends				0.489	0.614		0.237	0.812
Social cohesion				0.752	0.472		-0.878	0.380
Perceived walkability	0	26.64	6.044	**3.100****	0.046	26.64	6.044	**-2.308****	0.022
	1	29.73	5.710			28.76	5.472		
	2	28.66	5.449						
Satisfaction parks/sport facilities	0	10.81	3.743	**4.790*****	0.009	10.81	3.743	**-3.028*****	0.003
	1	12.04	3.504			12.43	3.167		
	2	12.47	3.135						
Maintenance infrastructure	Maintenance cycling lanes			0.629	0.534		-0.109	0.914
	Alternative routes to get from place to place			2.045	0.131		-1.519	0.130
Neighbourhood safety				1.708	0.183		-1.564	0.119
COVID sum score				1.588	0.206		-0.035	0.972
'If the coronavirus had not been an obstacle at all, I would have exercised more'				0.633	0.531		-0.033	0.974
Leefbarometer: Safety				0.699	0.498		-0.204	0.838
Leefbarometer: Physical environment				0.507	0.603		-0.050	0.960
Leefbarometer: facilities				1.696	0.185		-0.246	0.806

Appendix J: Bivariate analysis output 5 & 6

This appendix shows the complete output of the bivariate analysis between the all independent variables and the physical activity in minutes according to the WHO (dependent variable). Both interpreted as continuous variable without categories and as continuous variable with categories.

Table J1: Complete bivariate analysis 5 & 6

Variable		**Physical activity in minutes (continuous)**				**Physical activity in minutes (categorical)**			
ANOVA		**Mean**	**St. Dev.**	**F.**	**Sig.**	**Mean**	**St. Dev.**	**F.**	**Sig.**
Age	18-40 years	688.75	772.72	**3.121****	0.045	2.72	1.508	**2.943***	0.054
	41-64 years	937.78	1040.82			3.33	1.435		
	>65	690.85	704.86			3.02	1.588		
Education level				2.014	0.135			1.466	0.232
Income				0.315	0.904			0.678	0.640
Employment	Fulltime (36 hours or more)			1.580	0.179	3.10	1.398	**2.437****	0.047
	Parttime (21-35 hours)					3.38	1.338		
	Parttime (1-20 hours)					3.82	1.334		
	Retired					3.11	1.591		
	No paid work					2.40	1.759		
Household composition	One-person household			0.514	0.598	2.84	1.632	**2.325***	0.073
	Couple without children					3.09	1.600		
	Couple with children & single-parent family					3.40	1.235		
Years in neighbourhood	0-4 years	661.28	625.99	**3.418***	0.067			1.260	0.288
	5-19 years	689.86	627.58						
	20-29 years	778.00	706.96						
	>30 years	1039.01	1259.40						
Gym membership	Both			1.842	0.139	3.50	0.985	**5.585*****	0.001
	Sport association					3.61	1.357		
	Fitness centre					3.39	1.304		
	None					2.85	1.613		
Dwelling type				1.254	0.288			1.518	0.197
Outdoor space				1.502	0.214			1.786	0.150
Density	Not urban	857.75	876.31	**2.065***	0.085			1.717	0.146
	Little urban	752.65	720.69						
	Moderately urban	612.34	755.94						
	Strongly urban	807.53	841.09						
	Very strong urban	1144.61	1434.82						
Usage of app				0.785	0.535			0.710	0.359
Reward app				0.789	0.455			0.687	0.504

Independent samples t-test		**Mean**	**St. Dev.**	**t.**	**Sig.**	**Mean**	**St. Dev.**	**t.**	**Sig.**
Gender				-1.214	0.226			-0.962	0.337
Ethnicity				-0.381	0.704			0.929	0.354
Lifestyle	Smoking			-0.979	0.428			0.345	0.730
	Drinking			-0.519	0.604			-0.524	0.601
	Vegetables			-0.564	0.573			-0.915	0.361
	Fruit			-1.202	0.230			-1.554	0.121
'I have found other ways of exercising due to COVID'				-1.109	0.268			-1.650	0.100
Pearson's Correlation		**Mean**	**St. Dev.**	**r.**	**Sig.**	**Mean**	**St. Dev.**	**r.**	**Sig.**
Self-perceived health				0.024	0.672			0.088	0.114
Personality		812.21	898.05	**0.100***	0.073			0.029	0.605
Sporty friends/family				0.004	0.944			0.013	0.809
Sporty neighbours				-0.028	0.614			-0.022	0.689
Social support				-0.021	0.704			0.045	0.423
Social support family				0.011	0.847			0.072	0.197
Social support significant others				-0.022	0.694			0.015	0.786
Social support friends				-0.044	0.433			0.015	0.787
Social cohesion				-0.051	0.364			0.080	0.152
Perceived walkability				-0.048	0.392			-0.007	0.907
Satisfaction parks/sport facilities				0.020	0.717			0.042	0.446
Maintenance infrastructure	Maintenance cycling lanes			-0.039	0.481			-0.039	0.485
	Alternative routes to get from place to place			-0.055	0.321			0.012	0.832
Neighbourhood safety				-0.050	0.366			0.005	0.936
COVID sum score				0.080	0.152			0.079	0.156
'If the coronavirus had not been an obstacle at all, I would have exercised more'				0.065	0.242	1.82	1.238	**0.162*****	0.003
Leefbarometer: Safety				0.075	0.180			0.034	0.545
Leefbarometer: Physical environment				0.079	0.153			0.031	0.580
Leefbarometer: facilities				-0.071	0.201			-0.062	0.265

Appendix K: Bivariate analysis output 7

This appendix shows the complete output of the bivariate analysis between the all independent variables and Q92 “In an average week, on how many days do you spend at least half an hour walking, cycling, doing odd jobs, gardening, sports or other strenuous activities?” (dependent variable). This is the dependent variable used for the regression analysis.

Table K1: Complete bivariate analysis 7

Variable						
ANOVA			**Mean**	**St. Dev.**	**F.**	**Sig.**
Age					2.060	0.129
Education level					0.527	0.591
Income					0.795	0.554
Employment					1.679	0.155
Household composition					1.118	0.328
Years in neighbourhood					0.524	0.666
Gym membership					1.492	0.217
Dwelling type					1.165	0.326
Outdoor space					0.928	0.427
Density					0.707	0.588
Usage of app					1.741	0.141
Reward app					1.420	0.243
Independent samples t-test			**Mean**	**St. Dev.**	**t.**	**Sig.**
Gender	Female		5.65	1.986	**2.037****	0.042
	Male		5.20	1.874		
Ethnicity	Dutch		5.41	1.892	**2.098****	0.037
	Other		4.18	2.523		
Lifestyle	Smoking	No	5.45	1.864	**2.154****	0.041
		Yes	4.38	2.392		
	Drinking				0.288	0.774
	Vegetables	No	4.63	2.306	**-2.105****	0.036
		Yes	5.44	1.876		
	Fruit				-0.538	0.593
‘I have found other ways of exercising due to COVID’	No		5.14	2.015	**-2.762*****	0.006
	Yes		5.72	1.733		
Pearson’s Correlation			**Mean**	**St. Dev.**	**r.**	**Sig.**
Self-perceived health			2.51	0.764	**0.212*****	0.000
Personality					0.007	0.897
Sporty friends/family			2.17	0.784	**0.137****	0.014
Sporty neighbours					-0.009	0.875
Social support			33.18	7.795	**0.130****	0.019
Social support family			10.57	3.616	**0.132****	0.017
Social support significant others					0.074	0.184
Social support friends					0.102	0.066
Social cohesion					0.013	0.813
Perceived walkability					0.081	0.145
Satisfaction parks/sport facilities					0.083	0.134
Maintenance infrastructure	Maintenance cycling lanes				0.061	0.271

	Alternative routes to get from place to place	2.77	0.811	**0.128****	0.021
Neighbourhood safety				0.040	0.474
COVID sum score				0.008	0.889
'If the coronavirus had not been an obstacle at all, I would have exercised more'				-0.032	0.566
Leefbarometer: Safety				-0.021	0.709
Leefbarometer: Physical environment				-0.030	0.595
Leefbarometer: facilities				0.002	0.971

Appendix L: Multicollinearity check

As seen in Table L1, there is multicollinearity between social support and social support family. Hence, the variable social support family is excluded for the regression analysis.

Table L1: Multicollinearity

	Gender	Ethnicity	Self-perceived health	Lifestyle: Smoking	Lifestyle: Vegetables	Sporty friends/family	Social support	Social support family	infrastructure: Getting from place to place	COVID: Other ways of exercising	COVID: Time spent on physical activity
Gender	1	0,100	-0,044	0,071	-0,069	-.122*	-.229**	-.126*	0,005	-0,032	0,024
Ethnicity	0,100	1	-0,040	.142*	-0,005	-.083	-0,090	-.161**	-0,052	0,089	0,026
Self-perceived health	-0,044	-0,040	1	-0,040	0,106	.181**	.265**	.220**	.152**	.118*	.112*
Lifestyle: smoking	0,071	.142*	-0,040	1	-0,043	-.150**	-.144**	-0,093	0,079	-0,040	-0,073
Lifestyle: vegetables	-0,069	-0,005	0,106	-0,043	1	.164**	0,081	0,060	0,067	.156**	-0,015
	-.122*	-.083	.181**	-.150**	.164**	1	.273**	.265**	.035	.074	.036
Social support sum score	-.229**	-0,090	.265**	-.144**	0,081	.273**	1	.825**	.280**	.126*	0,070
Social support family	-.126*	-.161**	.220**	-0,093	0,060	.265**	.825**	1	.259**	0,079	0,045
Infrastructure: getting from place to place	0,005	-0,052	.152**	0,079	0,067	.035	.280**	.259**	1	0,053	0,087
COVID: Other ways of exercising	-0,032	0,089	.118*	-0,040	.156**	.074	.126*	0,079	0,053	1	.208**
COVID: Time spent on physical activity	0,024	0,026	.112*	-0,073	-0,015	.036	0,070	0,045	0,087	.208**	1

Appendix M: Multiple linear regression assumptions check

The following assumptions are distinguished and checked (Lund Research Ltd, 2018):

Assumption 1: Independence of observations √

This can be checked by the Durbin-Watson statistics. A value between 1.5 and 2.5 is sufficient, since in that case autocorrelation is likely not there. The value is 1.480, which means that autocorrelation is not very likely.

Assumption 2: Linearity √

The relationship between each independent variable and dependent variable needs to be linear. This is checked by scatterplots. As seen in Table 85, the linearity assumption is most of the time met, except for self-perceived health and physical activity compare to before the COVID-pandemic. However, the latter variable is dummy coded for the regression analysis, hence there will be a linear relation. Self-perceived health is not as it is interpreted as continuous variable, therefore this variable is recoded for the regression analysis.

Table M1: Linearity check

Variable		Mean per category	Recoded
Gender	Female	5.65	
	Male	5.20	
Ethnicity	Dutch	5.41	
	Other	4.18	
Self-perceived health	Very bad	5.33	-
	Bad	4.73	4.79
	Average	4.93	4.91
	Good	5.73	5.73
	Very good	6.11	6.11
Lifestyle: smoking	No	5.45	
	Yes	4.38	
Lifestyle: Vegetable intake	No	4.63	
	Yes	5.44	
Sporty friends/family	Fully disagree	4.57	
	Disagree	5.08	
	Neutral	5.27	
	Agree	5.69	
	Fully agree	6.00	
Social support			
Infrastructure: Alternative routes to get from place to place	Fully disagree	4.50	
	Disagree	4.50	
	Neutral	5.21	
	Agree	5.49	
	Fully agree	5.55	
COVID: Other ways of exercising	No	5.14	

	Yes	5.72	

Assumption 3: Homoscedasticity √

The variances of the residual should be constant. This can be checked by a scatterplot. Figure M1 shows that there is homoscedasticity.

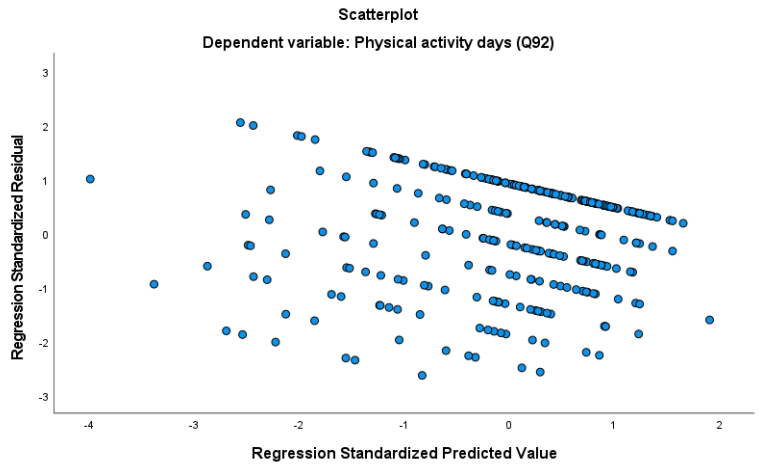

Figure M1: Scatterplot

Assumption 4: No multicollinearity √

Multicollinearity is already checked before starting with the regression. Hence, the output can be seen in Appendix G. The variables social support and social support family highly correlated with each other, hence the social support family variable was removed, since the social support variable is a combination of the elements social support family, friends and significant others.

Assumption 5: No outliers √

This can be checked by looking at the Cook's distance values. Values over 1 can be considered outliers. The output showed that there were no values above 1, hence there are no outliers.

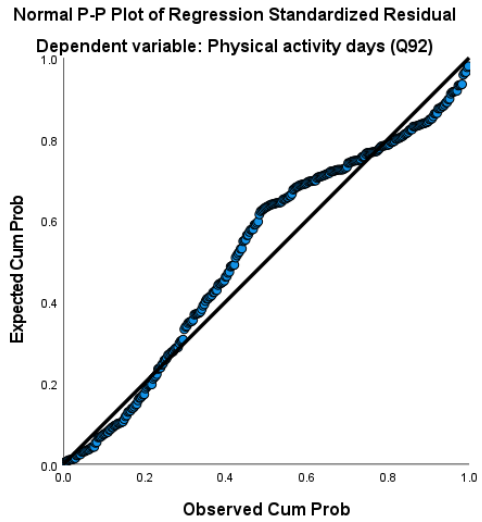

Figure M2: P-P plot

Assumption 6: Normal distribution x

This can be checked by using the P-P plot. The points must lie to the diagonal line, the closer to the normal, the better. From Figure M2 can be seen that the points deviate from the normal distribution. Hence, the results should be interpreted carefully.

Appendix N: Regression base model output

This appendix shows the output of the base model of the regression analysis.

Table N1: Coefficients multiple linear regression base model

Variable	Unstandardized beta coefficient	St. error	t.	Sig.
Constant	3.657	0.649	5.381	0.000
Gender	-0.290	0.218	-1.392	0.165
Ethnicity	-1.269	0.605	-2.098	0.037
Lifestyle: Smoking	-0.812	0.403	-2.016	0.045
Lifestyle: Vegetable intake	0.364	0.379	0.962	0.337
Other ways of exercising due to the COVID-pandemic	0.470	0.213	2.204	0.028
Self-perceived health	0.468	0.146	3.209	0.001
Social support	-0.004	0.015	-0.307	0.759
Sporty friends/family	0.133	0.139	0.958	0.339
Infrastructure: Alternative routes to get from place to place	0.225	0.133	1.694	0.091

Appendix O: Result bivariate analysis 'other ways of exercising'

This appendix shows the complete output of the bivariate analysis between the all independent variables and the variable 'other ways of exercising' (dependent variable). This is the dependent variable used in a bivariate analysis to show the characteristics of people who have found other ways of exercising due to the COVID-pandemic.

Table O1: Bivariate analysis 'other ways of exercising'

Variable			
Chi-square test		**X^2**	**Sig.**
Age		1.544	0.462
Education level		**6.932****	0.031
Income		3.440	0.632
Employment		1.492	0.828
Household composition		0.711	0.701
Years in neighbourhood		0.928	0.819
Gym membership		3.053	0.384
Dwelling type		1.520	0.823
Outdoor space		3.560	0.313
Density		2.260	0.688
Usage of app		0.745	0.101
Reward app		3.227	0.199
Gender		0.338	0.561
Ethnicity		2.575	0.109
Lifestyle	Smoking	0.524	0.469
	Drinking	0.103	0.748
	Vegetables	**7.954*****	0.005
	Fruit	**8.188*****	0.004
Independent samples t-test			
Self-perceived health		**-2.194****	0.029
Personality		0.584	0.560
Sporty friends/family		-1.334	0.183
Sporty neighbours		-0.176	0.860
Social support		**-2.284****	0.023
Social support family		-1.423	0.156
Social support significant others		**-1.763***	0.079
Social support friends		**-2.319****	0.021
Social cohesion		-0.844	0.400
Perceived walkability		-1.100	0.272
Satisfaction parks/sport facilities		-0.183	0.855
Maintenance infrastructure	Maintenance cycling lanes	-0.727	0.468

	Alternative routes to get from place to place	-0.952	0.342
Neighbourhood safety		0.505	0.614
COVID sum score		0.201	0.840
'If the coronavirus had not been an obstacle at all, I would have exercised more'		**-3.742*** **	0.000
Leefbarometer: Safety		0.260	0.795
Leefbarometer: Physical environment		0.234	0.815
Leefbarometer: facilities		-0.381	0.703
Physical activity		**-2.762*** **	0.006