

# AN ACTIVITY-FRIENDLY ENVIRONMENT FOR ALL?

Research into the impact of neighbourhood characteristics on physical activity patterns of families with low socioeconomic status in the city of Groningen



D.P. SCHOLTE

MASTER SOCIO-SPATIAL PLANNING

FACULTY OF SPATIAL SCIENCES

UNIVERSITY OF GRONINGEN

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university of  
 groningen

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**MASTER THESIS SOCIO-SPATIAL PLANNING  
FACULTY OF SPATIAL SCIENCES  
UNIVERSITY OF GRONINGEN**

**D.P. SCHOLTE (S3402126)  
DIANNESCHOLTE@OUTLOOK.COM**

**THESIS SUPERVISOR: DR. B.J. WIND  
SECOND SUPERVISOR: DR. E. PUERARI**

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# ABSTRACT

Obesity and physical inactivity are growing issues, especially among children since childhood obesity is likely to have lifelong consequences. Striking is that people with lower education or that live in a poor neighbourhood (low socioeconomic status) are often more physically inactive and more overweight than people with high SES. Despite growing political attention for these issue(s), the problem keeps growing and becomes apparent in a growing health inequality between high and low socioeconomic groups. However, it is not only individual or socioeconomic factors that influence one's physical activity patterns: neighbourhood characteristics (e.g. green and the availability of facilities) also play a role in this. For children, the role and behaviour of their parents are of importance as well. Spatial planning and design can play a major role in countering this trend, as this field is responsible for shaping the living environment. This thesis studies the impact of neighbourhood characteristics on physical activity patterns of families with low SES. To compare neighbourhoods regarding their physical and social characteristics, 25 low-SES neighbourhoods in the city of Groningen were selected and analysed, with a distinction between neighbourhoods with an above-average and below-average physical activity score. Outcomes show that the neighbourhoods are very diverse. However, only eight out of thirty variables turned out significantly associated with PA behaviour. As five of these are satisfaction scores, this indicates that it is not only physical or social characteristics of the environment that are important for people to become physically active. Even more important turned out to be people's own opinions about their environment. This has theoretical as well as practical implications.

**Key words:** physical activity, healthy neighbourhood, activity-friendly environment, socioeconomic status, neighbourhood characteristics, health inequality

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## Abbreviations

SES	Socioeconomic status
PA	Physical activity
PA score	Physical activity score, i.e. the score for the variable [% meets physical activity guideline]
METs	Metabolic Equivalents
CBS	Centraal Bureau voor de Statistiek (Statistics Netherlands)
RIVM	Rijksinstituut voor Volksgezondheid en Milieu (Dutch Institute for Public Health and the Environment)
[between brackets]	A variable is placed between brackets
(in)Sufficient PA neighbourhoods	A neighbourhood that is (in)sufficiently physically active (i.e. with a below- or above-average score for the variable [% meets physical activity guideline])
SAD (Dutch: <i>OAD</i> )	Surrounding address density (Dutch: <i>Omgevingsadressendichtheid</i> )

# 1. INTRODUCTION

## 1.1. RELEVANCE

*“Overweight parents and children often go together”* published Statistics Netherlands (CBS) in 2016. An alarming headline, because childhood obesity is likely to have lifelong consequences: overweight and obese children are more likely to develop noncommunicable diseases (e.g. diabetes) and cardiovascular diseases (e.g. a stroke) at a younger age, and they are likely to stay overweight into adulthood (Salois, 2012; WHO, n.d.a.).

The Dutch study (CBS, 2016) revealed that overweight and obesity is more common in children whose parents or caretakers are overweight. The study also shows that children from low-income families are more likely to be overweight than children from high-income families: in the lowest income quantile, 1 out of 5 children were overweight, compared to 1 out of 20 in the highest income quantile.

Spatial planning and design can play a major role in countering this trend. It is this field that is responsible for shaping the living environment, which affects health behaviour and health outcomes. Traditionally, spatial planning collaborated with the public health sector in for example reducing the impacts of industrialization. This collaboration changed when planning shifted towards e.g. car-oriented cities (sprawl, separation of functions), which negatively affects health. Today, health is found to be the outcome of the interaction between the individual, built and social environment (Pereira et al., 2019; Tran, 2016), indicating a (re)new(ed) role for spatial planning.

Despite growing political attention (e.g. policies focused on healthy lives), overweight and obesity remain growing issues. Since 1990, the percentage of adults with overweight increased from one in three towards half of the population (adults) in 2019. Over 13% of the children from 4 to 17 years old were overweight in 2019 (Zantinge, 2019; 2020). However, this Dutch trend concerning overweight has not just appeared from nowhere.

### 1.1.1. OVERWEIGHT AND OBESITY: A GROWING WORLDWIDE ISSUE

Since 1975, worldwide obesity rates have almost tripled. In 2016, over 1.9 billion adults (18+ years old) were overweight (39%), of which more than 650 million were obese (13%). 340 million children in the age of 5-19 were overweight or obese and 41 million children under the age of 5 were overweight or obese (WHO, 2018a). In numbers, this means that, in 2016, around 25% of the world population was overweight and around 9% was obese (UN, 2019; WHO, 2018a).

Related to overweight and obesity is physical activity (PA). Physical inactivity is a key risk factor for diseases like diabetes, cancer and cardiovascular diseases and one of the leading risk factors for death worldwide. Increasing physical inactivity is seen, next to an increased intake of energy-dense foods that are high in fat, as a fundamental cause of overweight and obesity (WHO, 2018a).

The European Health Interview Survey (2013-2015) indicated that *“substantial inequalities exist in the EU concerning the proportion of adults (15+ years old) who are overweight or obese in terms of region, gender and socio-economic background.”* For instance, the percentage of women who were overweight was lower among those with higher levels of education (Eurostat, 2014a). Next to the level of education, income has proved to be another important factor linked to the prevalence of PA, as the proportion of adults exercising at least 2.5 hours a week increased from the lowest to the highest income group (Eurostat, 2014b).

However, it is not only individual or socioeconomic factors that influence PA and overweight, physical factors play an important role as well. The presence of green and the proximity to facilities,

for example, have a positive effect on health outcomes (Ferdinand et al., 2012; Gordon-Larsen et al., 2006; Zhang, 2017).

### 1.1.2. THE DUTCH SITUATION

The Netherlands also faces issues concerning overweight, obesity and physical inactivity (Harbers, 2018). The European trend concerning overweight related to educational level also applies to The Netherlands: relatively more low-educated people than high-educated people are overweight and obese (Kelfkens et al., 2018).

In 2014, the Dutch Minister of Health, Welfare and Sport appointed the 'Key indicators sport and physical activity'. One of these indicators is the activity-friendly environment: this is an environment that encourages and invites people to be physically active and to exercise in this environment.<sup>1</sup> Figure 1 shows the score (on a five-point scale) per municipality in 2017. The average score in The Netherlands is 2.61 per 10.000 inhabitants in 2017. Non-urban municipalities score, on average, higher (2.85 per 10.000 inhabitants) than very urban municipalities (2.45 per 10.000 inhabitants) (Wezenberg-Hoenderkamp & Van der Poel, 2017).

The greatest part of the Dutch population (57%) sports at least once a week. On the other hand, Dutch people lead a very sedentary life compared to the EU average: 32% (NL) compared to 12% (EU) of the population sits at least 8.5 hours a day (Van der Wilk & Harbers, 2018). Only 47% of the Dutch population of 4+ years old conformed to the physical activity guideline (Dutch: *beweegrichtlijn*) in 2018 (fig. 2).

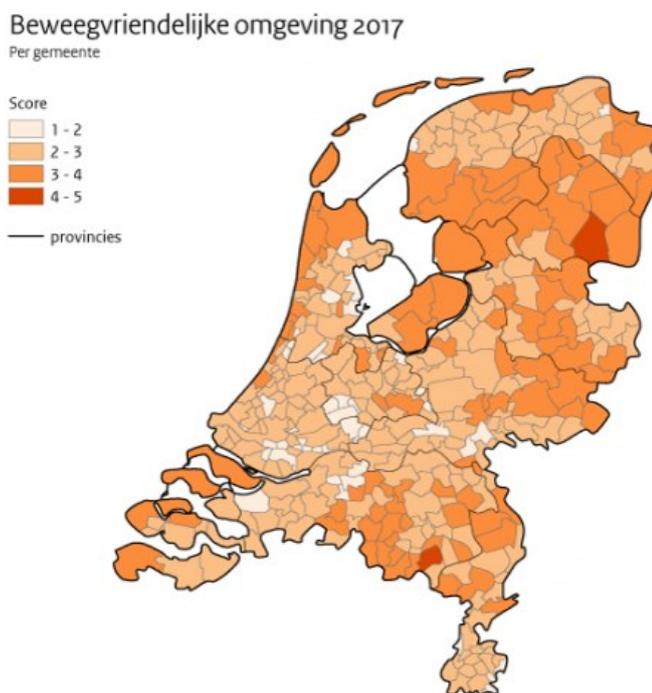


Figure 1. Activity-friendly environment 2017.

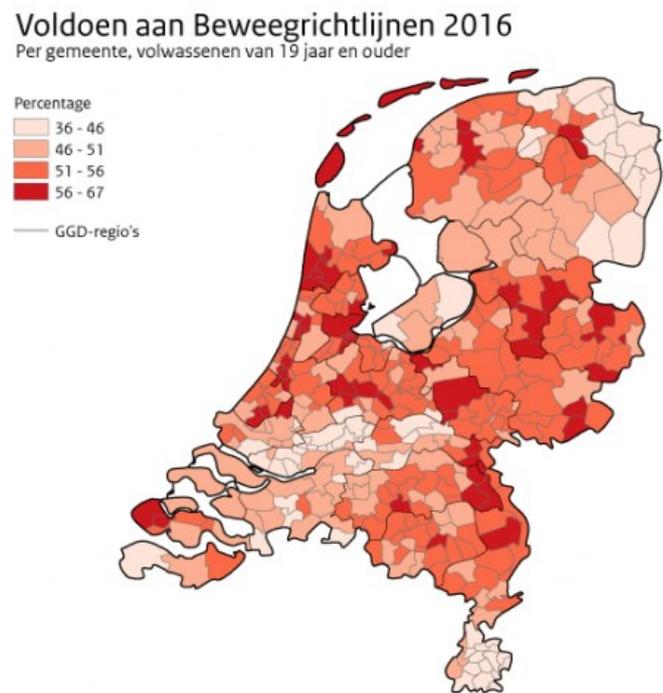


Figure 2. Meets physical activity guideline (%) per municipality in 2016 (Sporten en bewegen in cijfers, 2016).

<sup>1</sup> The indicators used to measure the environment's activity-friendliness are public sports facilities, sports- and playgrounds, sports, play and exercise areas, routes, rural areas and proximity to facilities (Sporten en bewegen in cijfers, n.d.).

However, when zooming in on these maps, it becomes visible that there are many differences regarding the scores in provinces and municipalities. For example, some municipalities only consist of sub-neighbourhoods<sup>2</sup> whose score differs little from the municipality's average. But some municipalities do have a diversity of scores across the sub-neighbourhoods. Figure 3 illustrates this by showing the score per sub-neighbourhood in the municipality of Groningen. While according to figure 2, 60% of the population of Groningen meets the PA guideline, figure 3 shows that many sub-neighbourhoods in the municipality score lower.

#### Beweegrichtlijnen 2016 Per buurt in Groningen

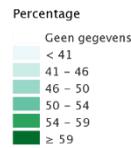


Figure 3. Meets physical activity guideline (%) per sub-neighbourhood in Groningen 2016 (RIVM, 2016).

### 1.1.3. THE CHANGING DUTCH POLICY LANDSCAPE

Health is becoming an increasingly important topic in Dutch policy. In 2022, the Environment and Planning Act (*Omgevingswet*) will be implemented. This Act bundles current legislation for spatial planning subjects such as land-use planning, housing, infrastructure, the environment, nature and water, forming the basis for an integral approach to the physical living environment. One of the objectives of the act is to achieve and maintain a safe and healthy physical environment (Aan de slag met de Omgevingswet, n.d.a.; VSG, 2018).

The act prescribes that governments should think as early as possible about creating a healthy physical living environment. They are given space to set their ambitions for a healthy living environment and elaborate them in the various instruments of the Act (e.g. the Strategy on Spatial Planning and the Environment (*Dutch: omgevingsvisie*)). Because tasks are decentralized, municipalities have the opportunity to create tailor-made plans (Aan de slag met de Omgevingswet, n.d.b.).

## 1.2. PROBLEM STATEMENT

To summarize, the worldwide, national and local issue is that an increasing share of the population is physically inactive and a growing number of people get overweight or obese. Striking is that people with a lower educational level or who live in a poor neighbourhood (low socioeconomic status (SES)) often are more physically inactive and more overweight than people with high SES. Despite the growing political attention for these issue(s) (for example, more policies aimed at healthy environments), the problem keeps growing and becomes apparent in growing health inequality between high and low socioeconomic groups. This indicates that general (wide-scale) policies regarding these issues do not work: policies need to be focussed on the different groups in society to meet everyone's needs and preferences and to reduce health inequalities between these groups.

<sup>2</sup> Neighbourhoods refer to the Dutch 'wijk', sub-neighbourhoods refer to the Dutch 'buurt', which is a smaller scale than a 'wijk' (i.e. a neighbourhood can consist of multiple sub-neighbourhoods).

Much is already known about individual (e.g. income and education) and environmental factors (e.g. the amount of green space) influencing people's PA patterns (see chapter 2). However, the figures used to provide insight into the problem regarding PA patterns and overweight (as in figures 1-3) are based on averages in neighbourhoods, municipalities or regions. But, neighbourhoods have a wide variety of (groups of) people, such as singles, families, working people, unemployed people, natives, immigrants, men and women. These different groups likely have different PA patterns (Ferdinand et al., 2012; Gidlow et al., 2006). This diversity of groups is often not taken into account, resulting in (policy)plans at national, provincial, municipal or neighbourhood level that do not reach everyone. This eventually leads to the preservation of health differences.

The introduction of the Environment and Planning Act is a step in the right direction: municipalities are given the opportunity to create and promote a healthy living environment, on a local level. However, because municipalities are free to determine how they interpret the health aspect in their environmental strategy, this is not yet self-evident everywhere: municipalities struggle with creating and implementing their health policy (RIVM, 2019). To guide municipalities in this process, a variety of (national) programs has been set up to which municipalities can join (e.g. 'Gezonde School', 'Agenda Fiets', 'JOGG'). However, these often include general advises, while it is important to design policies that include and reach every group in society. And for this to be possible, the issues, needs and preferences of every group need to be evident.

### 1.3. RESEARCH OBJECTIVE

This research aims to gain insight into the impact of neighbourhood characteristics on the PA patterns of families with low SES. This group is chosen because childhood obesity is a growing problem, with (possible) major consequences in later life. The cause of this problem often lies not only with the children, but the parents also play a major role in this. For example, parents determine what children eat, whether children can go to a sports club etc. But, the behaviour of parents themselves is also influential: parents are often the role model of their child (CBS, 2016; Curtis et al., 2011). When environments are designed in such a way that they invite and encourage PA or healthy behaviour, much can be gained for this specific group.

With the insights of this research, governments, planners and policymakers can design activity-friendly environments that fit the needs of the local people in that area. When the environments are designed following the needs and preferences of the people living in these areas, it is expected that they will use the environment to exercise, i.e. the environment will be approachable, appealing and inviting to everyone (Pereira et al., 2019; Taylor et al., 2012; Tran, 2016). This insight (about this specific group) may also be valuable in guiding municipalities towards a healthy living environment, as prescribed in the Environment and Planning Act.

## 1.4. RESEARCH QUESTIONS

To achieve the research objective, the following research question has been formulated:

*Which impact do physical and social neighbourhood characteristics have on the physical activity patterns of families with low socioeconomic status?*

To answer the main research question, the following secondary research questions have been formulated:

- How do the physical activity patterns differ between the selected neighbourhoods?
- To what extent do the selected neighbourhoods that are sufficiently active differ from the ones that are insufficiently active regarding their infrastructure?
- To what extent do the selected neighbourhoods that are sufficiently active differ from the ones that are insufficiently active regarding their public green areas?
- To what extent do the selected neighbourhoods that are sufficiently active differ from the ones that are insufficiently active regarding their social environment?

## 1.5. OUTLINE

This research is structured as follows. Chapter 2 describes the theoretical framework of this research, which elaborates on factors related to health and physical activity. Chapter 3 describes how this research was conducted by introducing the research area and by elaborating on the research design, data collection and analysis. Chapter 4 describes the results, followed by a discussion of these results in chapter 5. This final chapter also answers the research question, reflects on the conducted research and ends with suggestions for further research.

## 2. THEORETICAL FRAMEWORK

The fields of health (e.g. overweight), the environment (in a broad sense, e.g. the built, (socio)economic and social environment) and human behaviour (e.g. physical activity) are highly studied research fields. One of the most important facts on which this research is based is that the health of people with low SES is, in general, worse than the health of people with high SES. The gap between the health of these groups is also referred to as health gap or health inequality. However, it is not only individual-level factors that influence a person's health behaviour and health status. These are also influenced by wider contextual factors (such as neighbourhood characteristics). Or, in other words, health behaviour is often not only determined by individual factors (such as income and education), but also by social and environmental factors (such as social networks and land-use) (Ball et al., 2015; Cohen et al., 2006; McGinn et al., 2008; McNeill et al., 2006; Prins et al., 2014 & 2016; Veitch et al., 2006).

This chapter provides an overview of the research conducted so far. It explains the factors related to health and PA and ends with the conceptual model of this research. For clarity, a distinction is made between the individual-level factors (section 2.2.) and neighbourhood-level factors (section 2.4.).

### 2.1. PHYSICAL ACTIVITY EXPLAINED

The World Health Organization defines physical activity as *“any bodily movement produced by skeletal muscles that requires energy expenditure”*. It has been (sub)divided into several categories and includes activities done as part of working, playing, recreation, active transportation and household chores (WHO, 2018b).

Another categorization is between structured and incidental PA. Structured PA is planned, structured and repetitive and purposeful undertaken to improve or maintain health. Incidental PA is not planned but the result of daily activities at home, work or during transport (Caspersen et al., 1985; Strath et al., 2013). One can also categorize PA by looking at PA dimensions and domains.

There are four dimensions of PA (Strath et al., 2013):

- Mode: the type of activity performed (e.g. walking, cycling, aerobic vs. anaerobic activity)
- Frequency: the number of sessions performed per day or week
- Duration: the time of the activity performed in a specified timeframe
- Intensity: the rate of energy expenditure

Next to this, there are four domains in which PA occurs (Strath et al., 2013):

- Occupational: work-related, including e.g. labour tasks, carrying objects and walking
- Domestic: including e.g. household chores, child care, gardening and shopping
- Transportation: the purpose of going somewhere, including e.g., walking, taking stairs to public transportation, standing while riding public transportation
- Leisure time: recreational activities, including e.g. exercise, sports and hobbies.

Activities relating to PA can also be subdivided by using Metabolic Equivalent (METs). This is a unit commonly used to express the intensity of activities (Strath et al., 2013; WHO, n.d.b.). One MET represents the energy cost of sitting quietly and equals a one kcal/kg/hour caloric consumption. Table 1 shows the division between PA levels by using METs (Gezondheidsraad, 2017; WHO, n.d.b.).

Table 1. Physical activity levels divided by METs.

	<b>Light-intensity</b>	<b>Moderate-intensity</b>	<b>Vigorous-intensity</b>
<b>METs</b>	1-3	3-6	>6
<b>Description</b>	Activities where someone is standing up or is slightly moving	Requires a moderate amount of effort Accelerates the heart rate noticeably	Requires a large amount of effort Substantial increase in heart rate, rapid breathing
<b>Examples</b>	Cooking, grocery shopping, playing darts	Brisk walking, gardening, easy swimming, domestic chores, carrying loads <20kg	Running, fast cycling, aerobics, competitive sports, carrying loads >20kg

However, the intensity of different forms of PA varies between individuals. Factors such as age, sex and body composition will affect measures of resting energy expenditure and thus may the MET values vary between individuals (Strath et al., 2013; WHO, n.d.b.).

PA can be measured both subjectively and objectively. Subjective measures include individual perceptions, e.g. self-reported health status and PA behaviour through questionnaires. Objective measures include wearable devices that record e.g. heart rate and the number of steps per day (Strath et al., 2013).

The 'Global Recommendations on Physical Activity for Health' gives guidance on PA behaviour for three age groups. This is visualized in table 2 (WHO, 2010).

Table 2. Global recommendations on physical activity for health.

<b>5-17 years old</b>	<b>18-64 years old</b>	<b>65+ years old</b>
At least 60 minutes of moderate to vigorous-intensity per day	At least 150 minutes of moderate-intensity throughout the week <i>or</i> at least 75 minutes of vigorous-activity throughout the week	At least 150 minutes of moderate-intensity throughout the week <i>or</i> at least 75 minutes of vigorous-activity throughout the week
Most of the daily PA should be aerobic	Aerobic activity should have a duration of at least 10 minutes straight	Aerobic activity should have a duration of at least 10 minutes straight
Vigorous-intensity at least three times per week (including activities that strengthen muscles and bones)	For additional health benefits: increase moderate-intensity to 300 minutes or vigorous-intensity to 150 minutes per week	For additional health benefits: increase moderate-intensity to 300 minutes or vigorous-intensity to 150 minutes per week
	Muscle-strengthening activities on at least two days a week	Muscle-strengthening activities on at least two days a week Adults with poor mobility should add balance exercises on at least three days a week

The Dutch Health Council (*Gezondheidsraad*) advises for all age categories that being physically active is good, but being more physically active is even better and that sedentary behaviour should be avoided as much as possible. The Dutch PA guidelines (Gezondheidsraad, 2017) are partly similar to the WHO recommendations:

- Adults: At least 150 minutes of moderate or vigorous activity throughout the week + muscle- and bone-strengthening activities (for the elderly also balance exercises) at least 2 times a week.
- Children: at least 1 hour of moderate or vigorous activity per day + muscle- and bone-strengthening activities as least 3 times a week.

## 2.2. INDIVIDUAL-LEVEL FACTORS, PHYSICAL ACTIVITY AND HEALTH

An individual's SES is only one of the individual-level factors that link to health outcomes. Other factors include age, sex, ethnicity, education and income (McNeill et al., 2006; Prince et al., 2011). The literature study showed several links between individual-level factors and PA levels and health outcomes.

People with low **SES** are more frequently exposed to risk factors, such as unfavourable living and working conditions, an unhealthy lifestyle and high unemployment. In turn, poorer health can lead to a worse off social position (Busch & van der Lucht, 2012). There are also differences between SES groups and the type of PA one engages in. Ford et al. (1997, in McNeill et al., 2006) found that high-SES individuals are more likely to engage in leisure-time PA, while low-SES individuals are more likely to engage in job-related PA. However, the study does not provide explanations for this difference.

Individuals at the highest **level of education, income and job classification** are more likely to engage in healthy behaviours compared to those in the lower levels (Lindstrom et al., 2001 & Lynch et al., 1997, in McNeill et al., 2006). A Finnish study showed a positive association between both a high family income and a high parent's educational level and PA behaviour of adolescents. For example, the higher the parent's educational level, the lower the time spent watching TV and the higher the family income, the higher the chance of being an active sports club member (Kantomaa et al., 2007). The other way around, participation in PA in adolescence predicted higher educational levels and higher SES in adulthood (age group 28-38 years old) (Koivusilta et al., 2012).

Individuals that were **active during childhood** are likely to stay active into adulthood as well. A PA-tracking study by Friedmann (2008), spanning around six decades, showed that children that are active in their younger years are likely to stay active during their life course and tended to remain active. A study by Trudeau et al. (2004) also showed an association between childhood PA and adulthood PA. A suggested explanation is that adults had positive impressions of their physical education program during childhood.

Another individual-level factor related to health outcomes is **sex-differences**. For example, a Canadian study showed that females were less likely to be overweight/obese in neighbourhoods with high green space, in contrast to males. Considering the food environment, females living in neighbourhoods with a high amount of speciality food stores had increased odds of being overweight/obese, while males had a lower chance of being overweight/obese when living in neighbourhoods with a high number of restaurants. A stronger neighbourhood sense of community belonging was associated with being physically active for males, however, the social environment showed no impact on PA or overweight/obesity status for females (Prince et al., 2011). This study

indicates that individual differences (i.e. sex) are shaped by contextual factors (such as green space and food stores) as well.

### 2.2.1. HOME ENVIRONMENT

The home or family environment relates to health outcomes in several ways.

First, the **degree of organization** in the home environment impacts on a child's weight status. Less-structured home environments (e.g. no family routines) and household chaos are found as risk factors for child overweight. The influence of the home environment is considered more powerful for low-SES children, due to fewer opportunities provided by other settings (Bates et al., 2018).

Second, parents are considered **role models** for their children. Their behaviour, whether it is e.g. their PA or eating behaviour, is taken over by their child (Curtis et al., 2011; Ferreira et al., 2006). However, some studies show mixed outcomes regarding the relationship between PA levels of parents and those of their children. Some studies showed no association (Trudeau et al., 2004), some studies showed that fathers are more important role models compared to mothers and some studies showed that the PA level of mothers is more often associated with girls' PA compared to boys' PA (Ferreira et al., 2006).

Third, **restrictions or limitations** set by parents can have negative effects on health outcomes. Parents may limit their child to play outside due to safety concerns (Kneeshaw-Price et al., 2015; Weir et al., 2006). Also, the PA level of children changes during their growth, as participation in physical activities might become more costly with increasing age (for instance, during childhood children play in freely-accessible playgrounds but when they are older, they join sports clubs, for which contribution has to be paid). This may lead to decreasing PA of adolescents from lower-income families (Ferreira et al., 2006).

These three reasons are combined in a model developed by Davison & Birch (2001), which visualizes the complexity of the development of childhood obesity and the important role of the home environment herein. The model (appendix I.i.) includes three factors that place children at risk for developing overweight ('child risk factors'): dietary intake, PA and sedentary behaviour. These factors interact with different contexts: parenting styles and family characteristics directly influence the child risk factors; the community, demographic and societal characteristics directly influence the parenting styles and family characteristics and indirectly influence the child risk factors. They conclude that parents play an important role in shaping children's dietary, PA and sedentary behaviour through their behaviour and parental practices. For example, the participation of a child's parent in PA is positively related to the child's PA, as well as a parent's encouragement and support. In turn, this is influenced by community, demographic and societal characteristics, including for example the time available, the accessibility of facilities and (neighbourhood) crime rates.

This model implies that individual-level factors are influenced by contextual factors such as community characteristics. Gidlow et al. (2006) came to a similar conclusion. They found that the people at the top of the socio-economic scale appear to perform more leisure-time activity than those at the bottom of this scale. However, they also point to the outcome that differences regarding the relationship between SES and PA exist between countries, cultures, gender and ethnicity and environmental variables. Or, in other words, the relationship differs per specific context. This implies that individual health behaviour does not stand on its own, but is influenced by contextual factors as well.

## 2.3. THE NEIGHBOURHOOD EXPLAINED: CHARACTERISTICS

Since this research focuses on neighbourhoods, it is important to define what a neighbourhood is and what it constitutes. However, scholars define a neighbourhood in a variety of ways. One way of describing a neighbourhood is that it is a physical space, bounded in some way, with physical characteristics such as the environment, transport and housing. Nevertheless, most scholars do agree that neighbourhoods are both physical and social (Keller, 1968, in Lupton & Power, 2004). This includes a list of a variety of characteristics, which Galster (2001; 2012) provided in his attempt to conceptualise ‘neighbourhood’.

Galster (2001) defines a neighbourhood as *“a bundle of spatially based attributes associated with clusters of residences, sometimes in conjunction with other land uses”* (p. 2112). These spatially based attributes include infrastructural-, demographic-, (non-)residential building-, class-status-, tax/public service package-, environmental-, proximity-, political-, sentimental-, and social-interactive characteristics. He emphasises that attributes of these characteristics can only be observed and measured after a particular location has been specified (since they are spatially based). Also, the composition and quantity of these attributes vary across neighbourhoods.

In another research, Galster (2012) argues that there is substantial evidence that a variety of variables that measure neighbourhood-level indicators correlate with a variety of behavioural and health outcomes for individuals. He identifies 15 mechanisms of neighbourhood effects on health outcomes, grouped into four categories: social interactive, environmental, geographical and institutional mechanisms. By using the metaphor ‘dosage-response’, he argues how the ‘dose of neighbourhood’ might cause the observed ‘individual response’.

One can look at neighbourhoods from different perspectives. In research on neighbourhood change, three often-used perspectives can be found: (1) within neighbourhood, (2) neighbourhoods as related elements within urban and regional systems, and (3) neighbourhoods within wider social and economic movements. Next to this, it has been found that neighbourhood (change) can impact on individuals, but neighbourhood (change) can also impact on (change in) other neighbourhoods (Lupton & Power, 2004).

## 2.4. NEIGHBOURHOOD-LEVEL FACTORS, PHYSICAL ACTIVITY AND HEALTH

Many studies show that people from low-SES neighbourhoods are unhealthier and less physically active than people from high-SES neighbourhoods (e.g. Lakerveld et al., 2015). As explained in section 2.3., a neighbourhood consists of both social and physical characteristics. Across the literature, a variety of neighbourhood-level characteristics can be identified that explain the relation between PA levels and health outcomes and the difference herein between the different SES groups.

### 2.4.1. PHYSICAL CHARACTERISTICS

Many aspects of the living environment are intertwined and have a combined effect on PA and health outcomes. A pattern called “deprivation amplification” was discovered by Macintyre (2000) when looking at different features of the local environment in Glasgow, Scotland. This means that in places where people are poor, ill and have few personal resources, local facilities that may enable people to live healthy lives are also poorer. About PA, for example, they found that socially deprived areas had fewer resources for healthy physical recreation (including, amongst others, fewer sports centres, fewer safe green spaces or playgrounds, sparse public transport and more perceived threats such as litter and graffiti). Residents in areas like this were less likely to engage in physical activities

than residents in areas with a better provision of facilities. Or, as Salois (2012) concludes: the impact of the built environment on obesity geographically varies and is being influenced by “*the complex array of socioeconomic and physical forces at play within communities*” (p. 526). These forces are explained below.

**Street design and good connectivity** are considered as having a beneficial relationship with PA or obesity. Street design and connectivity includes sidewalks, bicycle paths, roads, trails, urban design (e.g. the year in which the neighbourhood was built) and public transport. It promotes recreational PA and transport-related PA to for example work or school (Ferdinand et al., 2012).

Also, it is argued that the best environment for promoting physical activity has land-use diversity, population density and a street design conducive to PA. This comprises having bicycle lanes, sidewalks and traffic calming features (Taylor et al., 2012). Contrary to the study by Macintyre (2000), Taylor et al. (2012) found that features of PA-promoting environments are found in every income level (low, middle, high) neighbourhood. Low-income neighbourhoods had a greater density and land-use diversity than high-income neighbourhoods, which implies that they should be more conducive to PA.

On the other hand, some studies show negative relationships between urban design and PA and health outcomes. Grafova (2008) found that living in a newer neighbourhood (built after 1969) that has a less pedestrian-friendly urban design is associated with a higher probability of children (age 5-18) being overweight.

**Food stores**, such as supermarkets, greengrocer's stores and restaurants, are both positively and negatively associated with PA and health outcomes. As stated before, Taylor et al. (2012) found that low-income neighbourhoods have a higher land-use diversity than high-income neighbourhoods. Land-use diversity means that a neighbourhood has a variety of functions, such as residential areas, shopping areas or other related business areas, and it facilitates walking towards these stores or businesses. This implicitly means that, according to Taylor et al. (2012), low-income neighbourhoods are more conducive to PA behaviour. There are namely more stores available within this neighbourhood (high diversity), and time and distance to reach these are shorter than in areas with low land-use diversity. Residents are more eligible to walk or bike to these stores instead of using the car, which positively impacts PA levels.

However, a high convenience store density is also associated with a higher probability of children (age 5-18) being overweight. The reason for this is that these stores sell energy-dense foods that provide a barrier to a healthy diet (Grafova, 2008).

The presence of **recreational facilities**, such as playgrounds and sports areas, has a positive relationship with PA and health outcomes as well (Ferdinand et al., 2012). Playgrounds and trees for climbing are important facilities that support children's PA. However, playgrounds have to be interesting to children. When the playground is poorly equipped, age-inappropriate or damaged, it will not be used. Sports areas, such as basketball courts and soccer fields, have to be accessible and suitable for different ages (McCormack et al., 2010). For recreational facilities to be conducive to PA they not only have to be available but affordable, accessible and of good quality as well (Gordon-Larsen et al., 2006).

Another important factor that impacts PA behaviour is **disorder** of the living environment. When an area is well maintained and there is no graffiti, litter and buildings are in a good condition people are more likely to be physically active (Grafova, 2008; McCormack et al., 2010). High- and middle-income neighbourhoods are found to have a lower level of physical disorder than low-income neighbourhoods (Taylor et al., 2012).

Also highly associated with PA and health outcomes is the presence of **green**. Green areas are considered as positively influencing one's physical and mental wellbeing (Zhang, 2017). Green spaces make people more relaxed and vitalized and people choose routes because of the presence of green

(Ettema & Smajic, 2015). Accessibility, usability and perceived quality of green are important characteristics of a green area that positively influences one's wellbeing (Zhang, 2017). Parks, in particular, are seen as important opportunities for PA: they are accessible and provide opportunities for a variety of users. Proximity to parks is associated with improved physical and mental health and healthy weight among children. Also, users of parks are more likely to achieve PA guidelines compared to non-users (McCormack et al., 2010).

Next to the proximity and accessibility of green, quality and the presence of a variety of attributes is of importance as well. The presence of attributes such as playgrounds, trails, benches and sports fields, aesthetics and a good condition of the park (i.e. well maintained and no disorder such as graffiti and litter) may encourage PA. However, the importance of park features differs per type of user. For example, trails are considered important for adult users, playgrounds are considered important for children, dog bins are considered important for dog-owners and seating equipment, water equipment and the presence of shade are considered important regardless of age (McCormack et al., 2010).

But there is also, although limited, research that shows no association between green space and PA behaviour. Possible explanations are that greener environments are more sparsely designed, thereby decreasing the density of facilities and increasing the availability of parking places near homes (Maas et al., 2006).

However, research suggests that inequalities exist between the effect of features of the physical environment on PA behaviour and health outcomes between for example regions and socioeconomic backgrounds (Eurostat, 2014a; Gordon-Larsen et al., 2006). Taylor et al. (2012) found that interventions specific to the local area (i.e. the social, cultural and environmental context of that area) are essential to promoting active living.

Also, many studies point to the relevance of not only the physical environment but also the social environment in explaining PA behaviour and health outcomes. Prins et al. (2016; 2019) show that interventions in both the physical and social environment contribute to walking compared to neighbourhoods where no interventions were implemented. In their study on park use, McCormack et al. (2010) highlight the importance of the social environment since their review suggests that perceptions of the social environment are intertwined with perceptions of the physical environment. Both the physical attributes of parks, as well as perceptions of these attributes, can influence PA behaviour. Macintyre (2000) also states that a key issue in reducing inequalities in health and levels of PA is the reduction of both physical and social barriers to everyday opportunities for physical activities in people's local environment.

#### 2.4.2. SOCIAL CHARACTERISTICS

It is argued that the social environment can influence PA levels, both by directly influencing it through e.g. safety of facilities and social support for healthy behaviours or indirectly by mediating the effects of the built environment (Cohen, 2004; McNeill et al., 2006; Prince et al., 2011, Prins et al., 2014).

Many PA studies focus on individual-level or environmental factors but only a few address the social environment (McNeill et al., 2006). As McNeill et al. (2006) argue, greater attention to social environmental factors is necessary because PA *"is a behaviour that is inherently shaped by one's social environment in that most activity occurs within the bounds of families, communities, and neighbourhoods"* (Li et al., 2005, in McNeill et al., 2006, p. 1020).

However, many studies use different definitions and measurements of the social environment, which makes it difficult to compare studies and draw conclusions from it. To bring clarity and guide future research, McNeill et al. (2006) identified three dimensions of the social environment related to PA behaviour: (1) interpersonal relationships (social supports and networks), (2) social inequalities

(socio-economic position, income inequality, racial discrimination), (3) neighbourhood and community characteristics (social cohesion, social capital, neighbourhood factors).

Kepper et al. (2019) updated McNeill's research by conducting a systematic scoping review focussing on the neighbourhood's social environment and its association with PA. They developed a categorization of how the neighbourhood social environment is defined and measured concerning PA. This included nine dimensions grouped into three domains: (1) social inequalities ((a) economic and social disadvantage; (b) discrimination and segregation), (2) neighbourhood and community characteristics ((a) crime and safety; (b) social cohesion and social capital; (c) sense of place/belonging; (d) disorder and incivilities), (3) social interactions in the neighbourhood ((a) social relationships and norms; (b) civic participation/engagement) (appendix I.ii). However, because the article focused on measures of the social environment in relation to PA, it does not provide information about the kind of relationships between the identified dimensions and PA behaviour (Kepper et al., 2019).

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#### 2.4.2.1. CRIME AND SAFETY

An important factor associated with PA is (neighbourhood) safety. Neighbourhood crime and safety can affect PA behaviour both directly and indirectly. It can be measured both objectively (e.g. police-reported crime rates) and subjectively (e.g. perceived safety). However, the relationship between crime and PA may differ depending on how crime is measured (objectively or subjectively) (Kneeshaw-Price et al., 2015; McGinn et al., 2008; Prince et al., 2011), but both measurements are considered important correlates of PA (McGinn et al., 2008).

A direct effect of crime and safety is that individuals who live in neighbourhoods with the lowest crime and the lowest incivility levels are more likely to be physically active (Rachele et al., 2016). For children specifically, crime can directly affect a child's PA through increased exposure to crime in neighbourhoods with high crime rates (including (witnessed) victimization) (Kneeshaw-Price et al., 2015).

Indirect effects of crime and safety are mostly associated with parents' perceptions. A high number of studies shows that parents' perceptions of neighbourhood safety and quality are strong predictors of child PA and obesity risk (Ferdinand et al., 2012). Parents' worries and perceptions of neighbourhood safety may lead them to limit their child to play outside, thereby indirectly affecting their child's PA (Kneeshaw-Price et al., 2015). Differences also exist between different types of residences. Poor inner-city parents have much higher anxiety about safety in their neighbourhood compared to middle-class suburban parents and inner-city children are less physically active compared to suburban children. This suggests that inner-city parents restrict their children's physical activities because of safety concerns. However, the same study also notes that this anxiety of parents is just one of the factors that determines children's PA, as the correlation turned out low (Weir et al., 2006).

Neighbourhood crime and safety may also influence social networks and social cohesion in a neighbourhood, as they promote distrust among residents and limit opportunities for social interactions (Suglia et al., 2016).

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#### 2.4.2.2. SOCIAL CAPITAL AND SOCIAL COHESION

Social capital and social cohesion are two related but slightly different concepts, although they also overlap. Some studies use one of the two concepts, some make a distinction and use both and others use both concepts interchangeably (Chan et al., 2006; Forrest & Kearns, 2001).

Social capital can be defined as "*features of social life -networks, norms, trust – that enable participants to act together more effectively to pursue shared objectives*" (Putnam, 2000, p. 664-665).

Social cohesion can be defined as “a state of affairs concerning both the vertical and the horizontal interactions among members of society as characterized by a set of attitudes and norms that includes trust, a sense of belonging and the willingness to participate and help, as well as their behavioural manifestations” (Chan et al., 2006, p. 298).

The main difference between these two concepts is their analytical level. Social capital focuses on individual and group level, while social cohesion is more about society in general. This implies that high social capital does not necessarily lead to high social cohesion. For example, there may be high social capital within different groups, but that does not mean that this is a cohesive society (Chan et al., 2006).

Social capital can have effects on PA behaviour and health outcomes on both individual and neighbourhood level (Mohnen et al., 2015). Individual social capital includes contacts with neighbours and contacts with people outside the neighbourhood. Neighbourhood social capital comprises whether people in the neighbourhood know each other, whether neighbours are kind to each other and whether there is a friendly atmosphere in the neighbourhood (Mohnen et al., 2015).

An individual’s self-perceived health is positively associated with both their individual and neighbourhood social capital. However, individuals that have a low level of individual social capital, but who live in a neighbourhood with much neighbourhood social capital still experience good health (Mohnen et al., 2015).

Neighbourhood social capital is also associated with fit norm compliance (i.e. sports participation at least three times a week). When there is a higher neighbourhood social capital, adolescents might better translate their cognitions (e.g. attitude and intention) towards PA into actual behaviour (Prins et al., 2014).

Also, cohesive societies are found to experience better health outcomes (Chan et al., 2006; McNeill et al., 2006). A high sense of community belonging is associated with PA as well (Prince et al., 2011). Reasons for this are that cohesive and trusting neighbourhoods can influence behaviour, for example by setting positive norms for health behaviour and restrict other behaviours (such as selling drugs). Also, neighbours that trust each other are more likely to provide help and support. Social support interventions and walking groups, “buddy systems” or exercise agreements with other persons have the ability to increase PA levels (McNeill et al., 2006). Suglia et al. (2016) add the importance of social ties, which contribute to the establishment of social norms and social support that provide for example healthy eating and PA behaviour.

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#### 2.4.2.3. COLLECTIVE EFFICACY

Another social environmental factor associated with health is collective efficacy. Collective efficacy can be described as a combination of social cohesion and informal social control and is often defined as the willingness of people to intervene on behalf of the common good. It largely depends on mutual trust and solidarity among neighbours. It has been found to predict neighbourhood crime (Sampson et al., 1997), but it has also been associated with health by indirect effects on obesity-related factors (Cohen et al., 2003 & Lochner et al., 2003, in Cohen et al., 2006). Research by Cohen et al. (2006) showed a significant relationship between collective efficacy and BMI, at-risk for overweight and overweight status. However, because the design of their research did not provide any causal pathways, they speculate on several possible indirect pathways through which collective efficacy can influence obesity-related factors such as diet and PA. For example, people living in neighbourhoods with a low level of collective efficacy might experience greater stress (as they find lower levels of social support). Another possible reason is that adults in high collective efficacy neighbourhoods may be willing to show (dis)approval for certain behaviours (e.g. exercise, delinquency and dietary patterns), leading towards (norms about) more healthy behaviour. Suglia et al. (2016) add that high levels of collective efficacy and social cohesion prevent deterioration of the physical environment, promote safety and provide opportunities for guiding healthy behaviours.

## 2.5. ACTIVITY-FRIENDLY ENVIRONMENTS

A healthy living environment is becoming an increasingly important topic for countries and municipalities. To improve the health of citizens, governments can make use of a variety of strategies. One of them is the activity-friendly environment. These are environments that offer a variety of opportunities to be(come) active. This can include both small-scale as well as large-scale changes, and preferences for such an environment may differ between age groups (Harvard School of Public Health, n.d.).

The realisation of a healthy neighbourhood asks for the involvement of a variety of sectors. Research into important aspects of a healthy neighbourhood revealed five factors that are seen, in general (i.e. for all age groups), as the most important priorities for a healthy neighbourhood: social cohesion, green areas, safety, quality of housing and sports and play facilities. Different sectors that should be involved in realizing these priorities are urban planning, wellbeing and health organizations, schools, sports organizations, housing associations and neighbourhood residents and businesses (Van der Klauw et al., 2015).

### 2.5.1. DIFFERENT AGE GROUPS AND ACTIVITY-FRIENDLINESS

The needs and preferences for an activity-friendly environment differ per age group (Harvard School of Public Health, n.d.).

The PA behaviour of elderly consists of light-intensive activities like walking and cycling only, they are sedentary for most of the day. Research showed that participants walked more when the environment contained more facilities and better aesthetics. For the elderly, the environment can be made more conducive to PA by focussing on the number of facilities and the aesthetics of the environment (Lenthe et al., 2017).

For adolescents, the most important perceived determinants of an activity-friendly environment are related to the physical (e.g. clean, well maintained, proximity) and economic (e.g. affordability of opportunities for PA) domains (Hidding et al., 2018).

The most prominent environmental factors for the activity friendliness for children are the distance to parks and playground and the access to private gardens or yards. Other identified influential factors were related to traffic and road safety, land use and the social environment (Schicketanz et al., 2018). Another related study showed the importance of safety as well. This study advises that at the (re)design of neighbourhoods more attention should be given to the creation of good and safe walking and cycling connections to schools and sports facilities and apply speed limiting measures where necessary (De Vries et al., 2011).

## 2.5.2. CHILD-FRIENDLY ENVIRONMENTS

The conclusions of the research regarding children and activity-friendly environments show similarities with research about child-friendly environments.

Child-friendly environments are described in a variety of ways, and often include recurring themes such as safety, green space, social cohesion and possibilities for independent mobility (Broberg et al., 2013). Kyttä (2008, in Broberg et al., 2013) developed a model to assess the child-friendliness of an area: the Bullerby model. This model is based on the covariation of children's possibilities for independent mobility and the number of actualized affordances (fig. 4). Independent mobility can be described as children's possibility to explore public space on their own (Broberg et al., 2013). Affordances are generally described as *"the physical opportunities and dangers which the organism perceives while acting in a specific setting"* (Kyttä, 2004, p. 181). Actualized affordances are the ones that a person perceives, uses or shapes and are revealed through actions of the person (Kyttä, 2004).

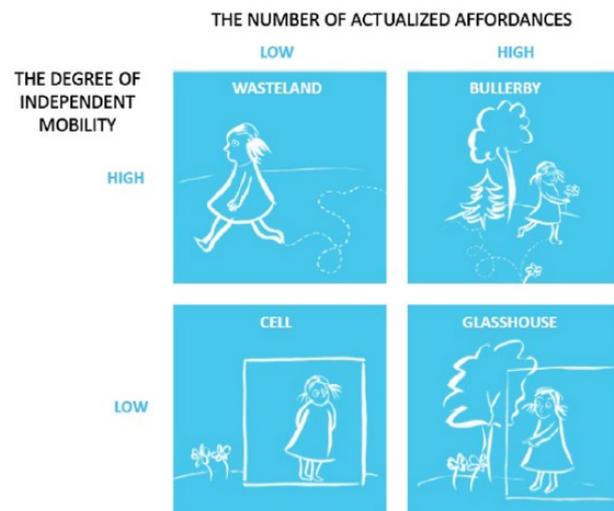


Figure 4. The Bullerby model describing four levels of child-friendly environments (Broberg et al., 2013).

Studies on the relationship between independent mobility and PA of children showed that children who are free to play outside and travel actively (e.g. walking to school) without the supervision of an adult have higher PA levels than those who are less independent (Schoeppe et al., 2013).

The degree of independent mobility of a child is dependent on a range of factors, including aspects of the social and physical environment. However, another important factor is the parents (Broberg et al., 2013; Christian et al., 2015; Schoeppe et al., 2013). Floyd et al. (2011, in Broberg et al., 2013) found, for example, that the presence of other children in a park was strongly positively associated with a child being active, while parental supervision had a strong negative effect on children's activity. Mackett et al. (2007) showed that a child's independent mobility is restricted by parental concerns about safety and security. The main safety concerns are about road traffic and fear of strangers (Mackett et al., 2007; Veitch et al., 2006). Veitch et al. (2006) add that parents from low-SES neighbourhoods specifically have additional safety concerns about teenagers hanging in public spaces such as parks.

## 2.6. CONCEPTUAL MODEL

Figure 5 shows the conceptual model of this research. Both individual-level factors and neighbourhood-level factors influence PA behaviour (Ball et al., 2015; Cohen et al., 2006; McGinn et al., 2008; McNeill et al., 2006; Prins et al., 2014 & 2016). PA can be conceptualised in different categories, including leisure time and transport-related PA (Strath et al., 2013).

Individual-level factors, such as age, socio-economic status (SES), education and income influence an individual's PA behaviour: individuals that have low levels of education, income and SES are, in general, less physically active than people with higher levels. Also, differences between male/female concerning PA behaviour exist (McNeill et al., 2006; Prince et al., 2011). However, an individual's PA behaviour is influenced by contextual factors as well (Davison & Birch, 2001; Gidlow et al., 2006).

Neighbourhood-level factors (physical and social characteristics) can influence PA both directly and indirectly (McNeill et al., 2006). Physical environment characteristics, such as parks, facilities and no physical disorder are positively associated with PA (Ferdinand et al., 2012; Gordon-Larsen et al., 2006; Grafova, 2008; Macintyre, 2000). Social environment characteristics, including social capital, social cohesion, collective efficacy and crime and safety are associated with PA as well (Kepper et al., 2019; Kneeshaw-Price et al., 2015; McNeill et al., 2006; Mohnen et al., 2015; Prince et al., 2011; Prins et al., 2014;2016;2019; Rachele et al., 2016; Weir et al., 2006).

Next to the direct effects of both individual and neighbourhood-level factors on PA behaviour, there are also indirect effects. An individual's behaviour (i.e. physical activity) is often shaped by contextual factors (Galster, 2012; Li et al., 2005, in McNeill et al., 2006). For example, a child's PA behaviour is directly influenced by their parents, but the parents, in turn, are directly influenced by community characteristics, which in this way indirectly influence a child's PA (Davison & Birch, 2001).

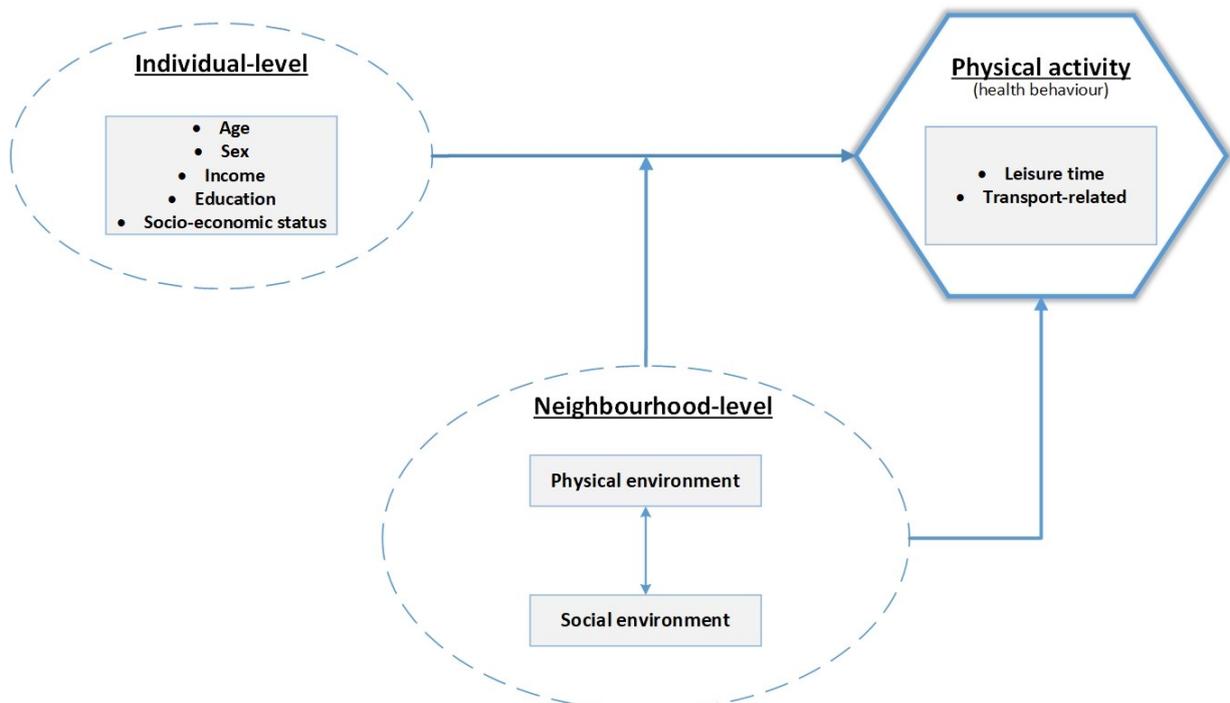


Figure 5. Conceptual model.

## 3. METHODOLOGY

This chapter explains how this research was conducted. It describes the research area, how physical activity, socioeconomic status and neighbourhood characteristics were measured, it elaborates on the neighbourhood selection process and describes how the data was collected and analysed.

*Note: originally the approach for this research was qualitative with semi-structured interviews to get insight into the 'why'-questions (e.g. why people choose to use (or not use) places in their neighbourhood for their activities). However, during the stage of recruiting participants it became clear that, due to COVID-19, this would not work out. Therefore, it was decided to switch to a quantitative approach by the means of spatial analysis. More on this can be found in appendix II and section 5.5.*

### 3.1. RESEARCH AREA

Groningen is a province, municipality and city located in the northern part of the Netherlands. The municipality is the 6<sup>th</sup> largest in The Netherlands and consists of 231.309 citizens in 2019. Groningen is a typical student city, with a relatively high amount of people in the age groups 20-24 and 25-29 (Basismonitor Groningen, 2019a).

On many health-related aspects, Groningen scores better than The Netherlands in general. More people are satisfied with their health, fewer people are overweight and obese and more people meet the PA guideline compared to the national average (Basismonitor Groningen 2018; 2019b; 2019c). However, Groningen also faces major issues. The city has, after Rotterdam and Amsterdam, the most people who live in poverty (Kloosterman & De Vries, 2018). Poverty is negatively associated with health (e.g. Busch & van der Lucht, 2012; CBS, 2016; Lindstrom et al., 2001). This is also expressed in the Groningen situation. Obesity among low-educated adults is four times more common than among high-educated adults. There are also significant differences between neighbourhoods: age structure, family composition and the average SES of households are reflected in the geographical pattern concerning overweight and PA patterns (Basismonitor Groningen, 2018).

A healthy municipality is an important point of attention in the municipality's policy. In 2016, the municipality published their long-range programme 'sport and physical activity 2016-2020'. They set the general goal to increase the percentage of youth and adults that meet the PA guideline and increase the percentage participating in sports activities (Gemeente Groningen, 2016). The coalition agreement 'Healthy, Green, Happy Groningen 2019-2022' focusses on an attractive and healthy living environment where citizens can sport, play, exercise and meet. They explicitly state that attention is being paid to the still inactive citizens with low incomes or financial worries (Gemeente Groningen, 2019). In the Strategy on Spatial Planning and the Environment is stated that PA in public spaces will be stimulated by making public space more activity-friendly and by making sports parks more public (Gemeente Groningen, 2018). However, there are still big improvements needed in the process towards a healthy municipality (Steinberg et al., 2019).

## 3.2. RESEARCH DESIGN

This section provides an overview of the indicators that are used in this research to measure physical activity and physical and social neighbourhood characteristics. Since much of the discussed literature (chapter 2) includes a variety of PA measurements and neighbourhood characteristics, appendix III provides an overview of all the indicators used in the discussed literature. Based on this, several PA measurements and physical and social neighbourhood characteristics<sup>3</sup> were selected to be included in this research. These indicators and their measurements<sup>4</sup> (tables 3-6) are used in (1) the neighbourhood selection process (section 3.4.) and (2) the data collection and analysis (section 3.5.). Because SES is complicated to measure and because this is an important part of the neighbourhood selection process, this is further elaborated on in section 3.3.

Neighbourhoods are in this research looked at from a within-neighbourhood perspective (Lupton & Power, 2004), due to the type of data (at sub-neighbourhood level). This implies that the different functions of a neighbourhood, relative to others (e.g. a centre function), or the proximity to facilities (that might be in other neighbourhoods) are not taken into account in this research. Neighbourhood borders correspond to the borders as defined by the municipality of Groningen and the CBS.

### 3.2.1. PHYSICAL ACTIVITY

The most frequently used indicators for measuring physical activity (levels) are (>5 out of 19 studies): walking; active transport; leisure-time; moderate-vigorous activity. This includes indicators of both the intensity of activities and the domains in which PA occurs (Strath et al., 2013; WHO, n.d.b.) (appendix III.i.). Table 3 provides an overview of the indicators used in this research and how it is measured. It includes moderate-vigorous intensity activities in two domains.

Table 3. Overview of the physical activity indicators and measurements.

Indicator	Measured by	Source*
<b>Leisure-time physical activity</b> <ul style="list-style-type: none"> <li>• Recreational activities, e.g.:               <ul style="list-style-type: none"> <li>▪ Walking</li> <li>▪ Cycling</li> <li>▪ Running</li> <li>▪ Swimming</li> <li>▪ Gardening</li> <li>▪ Engaging in sports activities / sports clubs</li> <li>▪ Playing</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Meets PA guideline</li> <li>• Exercising</li> <li>• Exercising (weekly)</li> <li>• Member of a sports club</li> <li>• Observation of park use (section 3.5.2.)</li> </ul>	<ul style="list-style-type: none"> <li>• RIVM</li> <li>• Municipality of Groningen</li> </ul>
<b>Transport-related physical activity</b> <ul style="list-style-type: none"> <li>• Walking (to somewhere, e.g. shops, work, friends, public transport)</li> </ul>	<ul style="list-style-type: none"> <li>• Meets PA guideline</li> <li>• Observation of park use (section 3.5.2.)</li> </ul>	<ul style="list-style-type: none"> <li>• RIVM</li> </ul>

<sup>3</sup> From this section on the neighbourhood characteristics as described in the theoretical framework (where a distinction is made between physical and social characteristics) are re-arranged according to the sub-questions. This comprises the subjects infrastructure, public green areas and the social environment.

<sup>4</sup> A complete overview of the used data (both spatial and statistical) can be found in appendix V.

<ul style="list-style-type: none"> <li>• Cycling (to somewhere, e.g. shops, work, friends, public transport)</li> </ul>		
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\*See for detailed sources appendix V.

\*\*The Dutch PA guideline makes no distinction between PA domains (Strath et al., 2013), as it focuses on intensity. This, however, encompasses activities in all domains (e.g. walking and cycling can be both leisure-time as well as transport-related activities).

### 3.2.2. NEIGHBOURHOOD CHARACTERISTICS

The most frequently used physical neighbourhood characteristics are (>5 out of 15 studies): (accessibility of) recreational facilities; (accessibility of) food stores and restaurants; sidewalks; parks (appendix III.ii.). The most frequently used social neighbourhood characteristics are (>5 out of 21 studies): crime rates (neighbourhood safety); social norms; social support; social capital; social cohesion (appendix III.iii.).

Tables 4-6 provide an overview of the indicators used in this research and how they are measured. The neighbourhood characteristics are arranged according to the subjects of the sub-questions (infrastructure, public green areas and the social environment). Only the characteristics for which quantitative data is available are included.

#### 3.2.2.1. INFRASTRUCTURE

Table 4. Overview of the indicators, measurements and sources for infrastructure.

Indicator	Measured by	Source*
<b>Street design** (pedestrian- and bicycle-friendly)</b> <ul style="list-style-type: none"> <li>• Sidewalks</li> <li>• Bicycle lanes</li> <li>• Traffic calming features</li> <li>• Public transport</li> </ul>	<ul style="list-style-type: none"> <li>• Public transport spots (map)</li> <li>• Public lighting (map)</li> <li>• Building ownership (map)</li> <li>• Open topo (map)</li> </ul>	<ul style="list-style-type: none"> <li>• ArcGIS</li> </ul>
<b>Recreational facilities</b> <ul style="list-style-type: none"> <li>• Playgrounds</li> <li>• (Free-accessible) sports areas (e.g. tennis courts, fitness gardens, soccer fields, sports clubs)</li> </ul>	<ul style="list-style-type: none"> <li>• Playgrounds (map)</li> <li>• Sports areas (map)</li> </ul>	<ul style="list-style-type: none"> <li>• ArcGIS</li> </ul>
<b>Food stores</b> <ul style="list-style-type: none"> <li>• Supermarkets</li> <li>• Restaurants</li> </ul>	<ul style="list-style-type: none"> <li>• Supermarkets (map)</li> <li>• Restaurants, cafes, snack bars (map)</li> </ul>	<ul style="list-style-type: none"> <li>• ArcGIS</li> </ul>
<b>Maintenance and (no) physical disorder***</b> <ul style="list-style-type: none"> <li>• Garbage</li> <li>• Broken glass</li> <li>• Cigarettes, drugs</li> </ul>	<ul style="list-style-type: none"> <li>• Satisfaction maintenance sidewalks (%)</li> <li>• Satisfaction maintenance bicycle paths (%)</li> <li>• Satisfaction maintenance roads (%)</li> <li>• Satisfaction maintenance playgrounds (%)</li> <li>• Satisfaction maintenance green (%)</li> <li>• Satisfaction cleanness of living environment (%)</li> </ul>	<ul style="list-style-type: none"> <li>• Gronometer</li> </ul>

	<ul style="list-style-type: none"> <li>Deterioration score (1=low, 10=high)</li> <li>Observation</li> </ul>	
<b>Primary schools****</b>	<ul style="list-style-type: none"> <li>Primary schools (map)</li> </ul>	<ul style="list-style-type: none"> <li>ArcGIS</li> </ul>

\*See for detailed sources appendix V.

\*\*Unfortunately, there was no data available about streets, bicycle paths, sidewalks etc. at a sub-neighbourhood level. Therefore, as the best alternative, a base map that provides a comprehensive overview of the street layout was used.

\*\*\*Although less than five times included in the literature, it is included in this research since physical disorder is associated with a higher probability of children being overweight (Grafova, 2008).

\*\*\*\*Although less than five times included in the literature, it is included in this research since the focus is on families with children, who (most likely) go school.

### 3.2.2.2. PUBLIC GREEN AREAS

Table 5. Overview of the indicators, measurements and sources for public green areas.

Indicator	Measured by	Source*
<b>Parks</b>	<ul style="list-style-type: none"> <li>Availability of parks (map)</li> </ul>	<ul style="list-style-type: none"> <li>ArcGIS</li> </ul>
<b>Green</b>	<ul style="list-style-type: none"> <li>Trees (map)</li> <li>Terrain type (map)</li> </ul>	<ul style="list-style-type: none"> <li>ArcGIS</li> </ul>

\*See for detailed sources appendix V.

### 3.2.2.3. SOCIAL ENVIRONMENT

Although some studies make no distinction between social capital and social cohesion, this research does make a distinction following considerations by Chan et al. (2006) and the available data.

Table 6. Overview of the indicators, measurements and sources for the social environment.

Indicator	Measured by	Source*
<b>Neighbourhood safety</b> <ul style="list-style-type: none"> <li>Crime records</li> <li>Perceived neighbourhood safety</li> </ul>	<ul style="list-style-type: none"> <li>People who feel unsafe in own neighbourhood (%)</li> <li>Nuisance score (1 = low, 10 = high)</li> <li>Police reports vandalism</li> <li>Police reports physical abuse</li> </ul>	<ul style="list-style-type: none"> <li>Gronometer</li> </ul>
<b>Social capital</b>	<ul style="list-style-type: none"> <li>Contact with neighbours perceived as good (%)</li> <li>Contact with neighbours at least once a week (%)</li> <li>Self-perceived sufficient social contacts (%)</li> </ul>	<ul style="list-style-type: none"> <li>Gronometer</li> </ul>
<b>Social cohesion</b>	<ul style="list-style-type: none"> <li>Neighbourhood cohesion (score 1=low, 10=high)</li> <li>Attachment to neighbourhood (%)</li> <li>Feels co-responsible for neighbourhood (%)</li> <li>Participation in activities in community centre</li> </ul>	<ul style="list-style-type: none"> <li>Gronometer</li> <li>Municipality of Groningen neighbourhood survey leisure activities and physical activity</li> </ul>

\*See for detailed sources appendix V.

### 3.3. SOCIOECONOMIC STATUS: CONSTRUCTION OF THE VARIABLE

Because the focus of this research is on families with low SES, the first criterion of the neighbourhood selection is that neighbourhoods with a high amount of people that have low SES are selected. However, a person's or area's SES is often measured by a mix of, or multiple separate variables. In the theoretical framework of this research (see appendix III.iv. for an overview), in other research (e.g. Reynders et al., 2005) and by the Dutch government (Volksgezondheidszorg.info, n.d.), three indicators of SES that are often used are found. These are education, income and occupational status. This section describes the construction of a SES-variable based on multiple SES-indicators, which will be used in the neighbourhood selection process (section 3.4.).

#### 3.3.1. AVAILABLE DATA

Table 7 provides an overview of the data that is available (openly accessible) and suitable (at sub-neighbourhood level) to measure education, income and occupational status for this research. Datasets are chosen based on the most recent year in which data was available for most of the datasets and which were available at a sub-neighbourhood level.

Table 7. Overview data SES indicators.

Indicator	Variable	Source
Education*	Low educational level <i>(Percentage of low-educated (Vmbo-TL, Mavo) people in the population aged 18 and over)</i>	Gronometer (Bevolking – opleidingsniveau 2018 – buurten)
	Medium educational level <i>(Percentage of medium-educated (Mbo, Havo, Vwo) people in the population aged 18 and over)</i>	
	High educational level <i>(Percentage of high-educated (Hbo/WO) people in the population aged 18 and over)</i>	
Income	Average income per person with an income (1000 euro) <i>(Average gross income less social security and wealth tax and other paid transfers, converted per person with a full year's income)</i>	Gronometer (Sociale zorg en inkomen 2017 – buurten)
	Households below the social minimum <i>(percentage of private households with an income up to 110% of the social minimum, excluding student households)</i>	
	Average household income (1000 euro) <i>(Average gross income less social security and wealth tax and other paid transfers per household)</i>	
Occupational status	GWU (registered job-seekers UWV) <i>(Percentage of registered job-seekers registered with the UWV at the end of the year compared to the potential labour force (aged 15 to 64 years))</i>	Gronometer (Werk en economie – werkloosheid 2018 – buurten)
	Benefit according to the Participation Act <i>(Percentage of people with benefits under the Participation Act compared to the total population)</i>	Gronometer (Sociale zorg en inkomen – WWB 2018 – buurten)

\*Data for educational level is available at neighbourhood level only, not at sub-neighbourhood level. Due to this, multiple sub-neighbourhoods have the same score because they belong to the same neighbourhood. It is nevertheless included, because educational level is an important indicator of SES (Reynders et al., 2005; Volksgezondheidszorg.info, n.d.).

### 3.3.2. STEP-BY-STEP DESCRIPTION

This section shortly describes the taken steps in the construction of the SES variable. A detailed overview can be found in appendix IV(a).

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#### 3.3.2.1. STEP 1: RELATED TO PA GUIDELINE?

Because this research is looking at the PA patterns of families with low SES, a first step is to test whether the independent variables of table 7 relate to the dependent variable [% meets physical activity guideline]. Therefore, a simple linear regression was calculated for each separate independent variable. Based on this, the variables for calculating the SES score were selected.

Out of the regression analysis, the two variables [% low-educated people] and [% of registered job-seekers UWV] appeared to be related to the percentage that meets the PA guideline. Therefore, these two variables were used to calculate the SES variable.

When performing a multiple regression analysis on these variables, it shows that both models<sup>5</sup> significantly improved the ability to predict the outcome variable compared to not fitting the model.

---

#### 3.3.2.2. STEP 2: CATEGORIZING INTO LOW – MIDDLE – HIGH SCORES

The next step was to make a total SES-score out of the two variables selected in step 1. There are two often-used ways to do so: (a) construction based on factor scores (factor analysis), and (b) construction based on allocating equal scores to the sub-variables (Reynders et al., 2005).

Because of the limited variables and the nature of the data (percentage-scores, i.e. ratio and not ordinal), factor analysis is not the most appropriate method for this research (Field, 2014). Therefore, the scores per sub-variable are divided into low – middle – high and given new scores.

First, the statistics of the variables were explored. Out of the total 105 cases, 30 cases were excluded from the dataset, because they were missing data for both variables and were neighbourhoods where little to no people live (e.g. industrial areas).

Second, tables with the score per variable per neighbourhood were sorted ascending and divided into low-middle-high SES scores by using the 33.33333 and 66.66666 percentiles<sup>6</sup>. These were then given a new score: 3 indicating high SES, 2 indicating middle SES and 1 indicating low SES.

---

#### 3.3.2.3. STEP 3: CALCULATING THE SES VARIABLE

In the final step, the scores of the previous step were added and divided by two, which resulted in a score range of 1-3 for the new variable [SES\_Total]. The percentiles 33.33333 and 66.66666 were again requested to find out what the boundaries between low, middle and high scores are. Low SES-scores range from 1 up to and including 1.5, middle SES-scores range from 1.5 to 2.5 and high SES-scores range from 2.5 up to and including 3.

Figure 6 shows the SES-score per neighbourhood.

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<sup>5</sup> Model 1: [% low-educated people], Model 2: [% low-educated people], [% of registered job-seekers UWV]

<sup>6</sup> For both variables applies: below the 33.33333 percentile means high (i.e. good) SES (i.e. low % of low-educated people / low % of registered job-seekers), above the 66.66666 percentile means low (i.e. bad) SES (i.e. high % of low-educated people / high % of registered job-seekers).

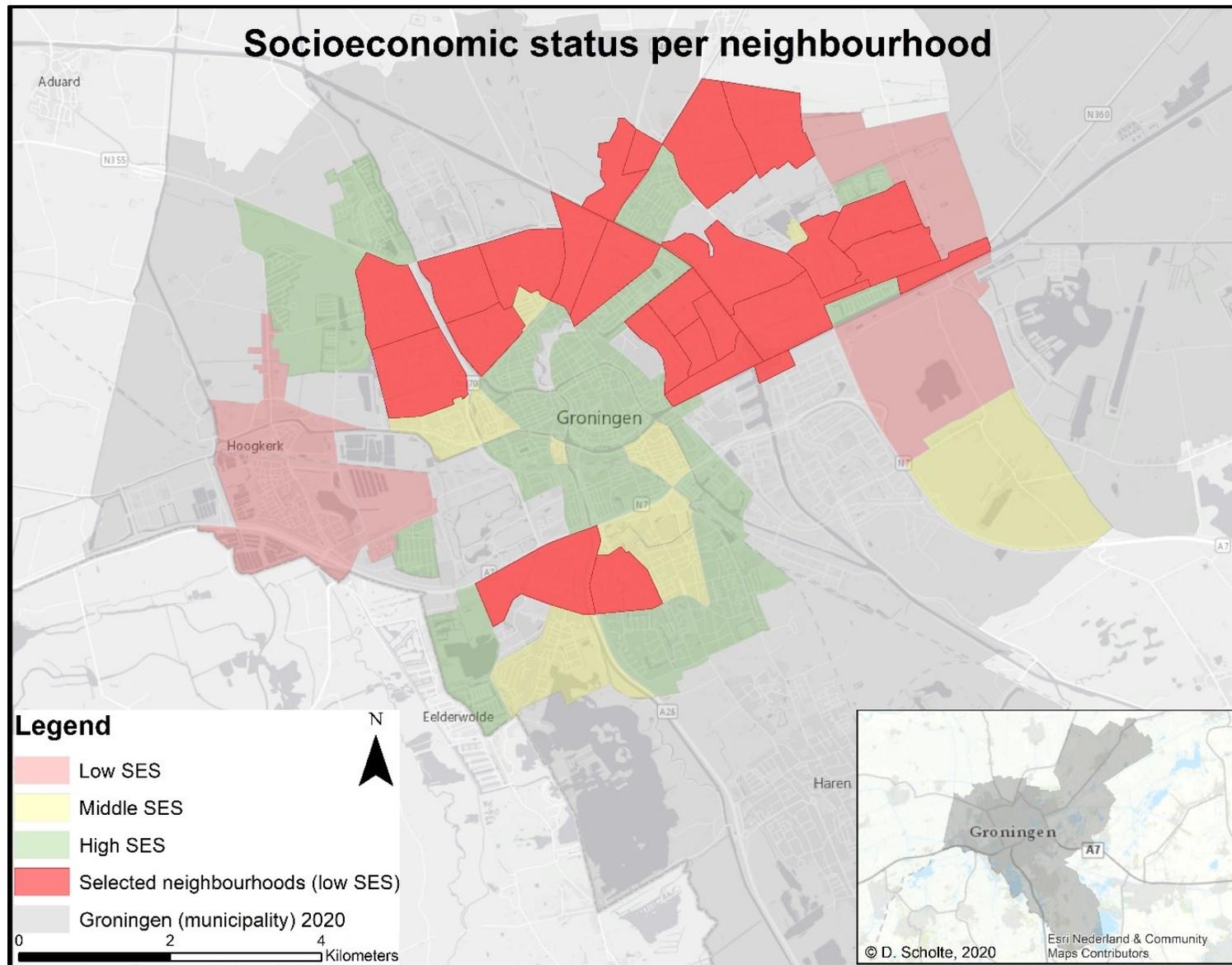


Figure 6. Overview of the socioeconomic status per neighbourhood, including the selected neighbourhoods for this research (section 3.4.).

### 3.4. NEIGHBOURHOOD SELECTION

#### 3.4.1. STEP 1: LOW SOCIOECONOMIC STATUS NEIGHBOURHOODS

Because the focus of this research is on neighbourhoods that have a high number of inhabitants with low SES, a first step is to select neighbourhoods that score low on [SES\_Total]. The division between high, middle and low SES-scores made in step 3 of the SES calculation showed that a total of 32 neighbourhoods have a low SES-score.

#### 3.4.2. STEP 2: SIMILAR PHYSICAL NEIGHBOURHOOD CHARACTERISTICS

When further investigating the low-SES neighbourhoods, it became apparent that there are differences between the neighbourhoods regarding their physical structure. Most of the neighbourhoods are located within the city, however, there are also a number of neighbourhoods that are villages surrounding the city.

Because the focus of this research is on getting insight in the impact of neighbourhood characteristics on PA patterns, neighbourhoods that are similar in terms of their structure have to be selected in order to make a good comparison. Therefore, another criterion was added to the neighbourhood selection process: the degree of urbanisation<sup>7</sup>.

First, the relation between the degree of urbanisation and the percentage that meets the PA guideline was explored. The scatterplot (fig. 7) and simple linear regression indicate a decreasing linear relationship between these two variables ( $R = -0.737$ ,  $R^2 = 0.543$ ,  $p < .001$ ). This implies that the higher the degree of urbanisation gets (i.e. an increasing value, so the less urbanised an area gets), the lower the percentage of people that meets the PA guideline.

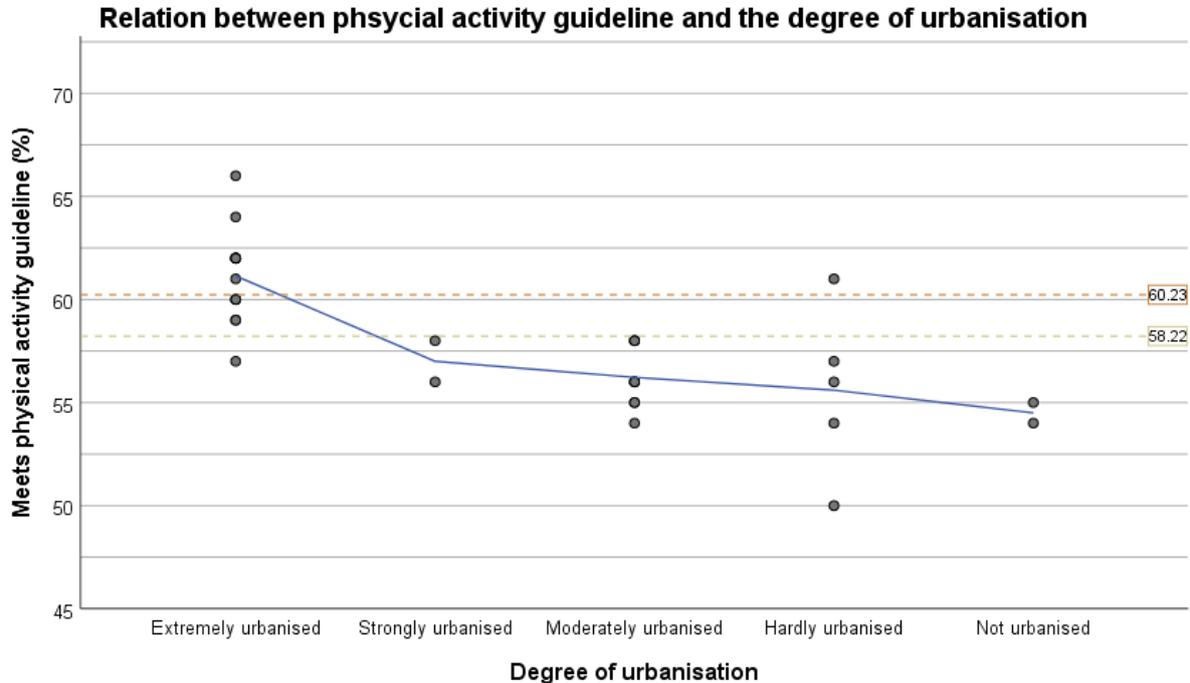


Figure 7. Scatterplot of the relation between the percentage of people that meets the PA guideline and the degree of urbanisation. The 60.23 line represents the average (PA guideline) score for all neighbourhoods, the 58.22 line represents the average score for the low-SES neighbourhoods only. Note: not every dot represents a single case (i.e.  $N$  is greater than the number of dots displayed in the graph).

<sup>7</sup> The degrees of urbanisation are a standard for the concentration of human activities based on the surrounding address density (SAD). There are five categories: (1) Extremely urbanised: SAD of 2500 or more addresses per km<sup>2</sup> (2) Strongly urbanised: SAD of 1500-2500 addresses per km<sup>2</sup> (3) Moderately urbanised: SAD of 1000-1500 addresses per km<sup>2</sup> (4) Hardly urbanised: SAD of 500-1000 addresses per km<sup>2</sup> (5) Not urbanised: SAD of less than 500 addresses per km<sup>2</sup> (CBS, n.d.).

The frequency table for the variable [degree of urbanisation] shows that there are seven cases among the low-SES neighbourhoods that are hardly or not urbanised (fig. 8). These are all neighbourhoods that are villages or areas where little people live. These cases are therefore excluded from the dataset. The new mean for [% meets physical activity guideline] in the adjusted dataset ( $N = 25$ ) is 59.04 ( $SD = 3.08$ ).

Degree of urbanisation			
	Frequency	Percent	Valid Percent
Extremely urbanised	14	43,8	43,8
Strongly urbanised	2	6,3	6,3
Moderately urbanised	9	28,1	28,1
Hardly urbanised	5	15,6	15,6
Not urbanised	2	6,3	6,3

Figure 8. Frequency table of the degree of urbanisation.

### 3.4.3. STEP 3: DIFFERENCES IN PHYSICAL ACTIVITY PATTERNS?

The next step is to find out whether there are differences in the percentage of people that meets the PA guideline in these low-SES neighbourhoods. In order to get insight into the impact of neighbourhood characteristics on PA patterns, a distinction is made between high and low scoring neighbourhoods regarding the PA guideline.

The average score for the municipality of Groningen is 60.23% (appendix IV(a).i.). Figure 9 shows the PA score per neighbourhood and eight neighbourhoods seem to score above the average score of the municipality.

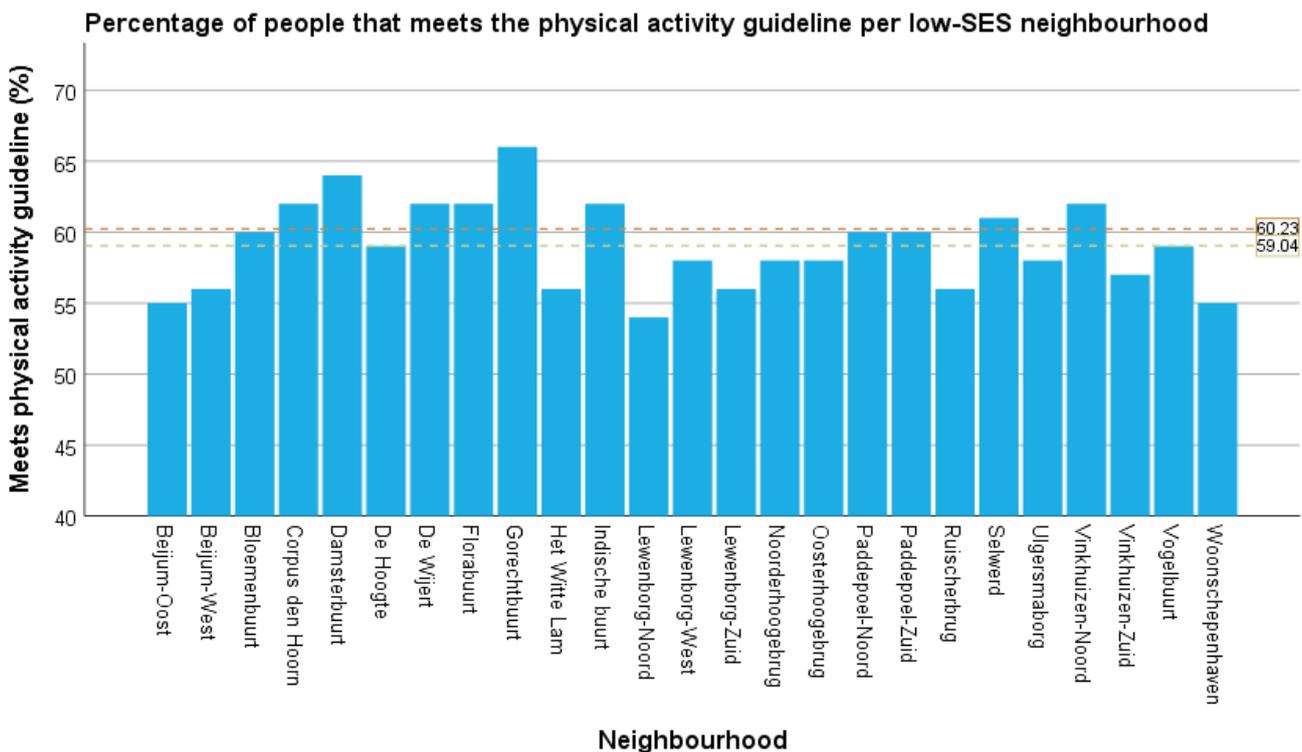
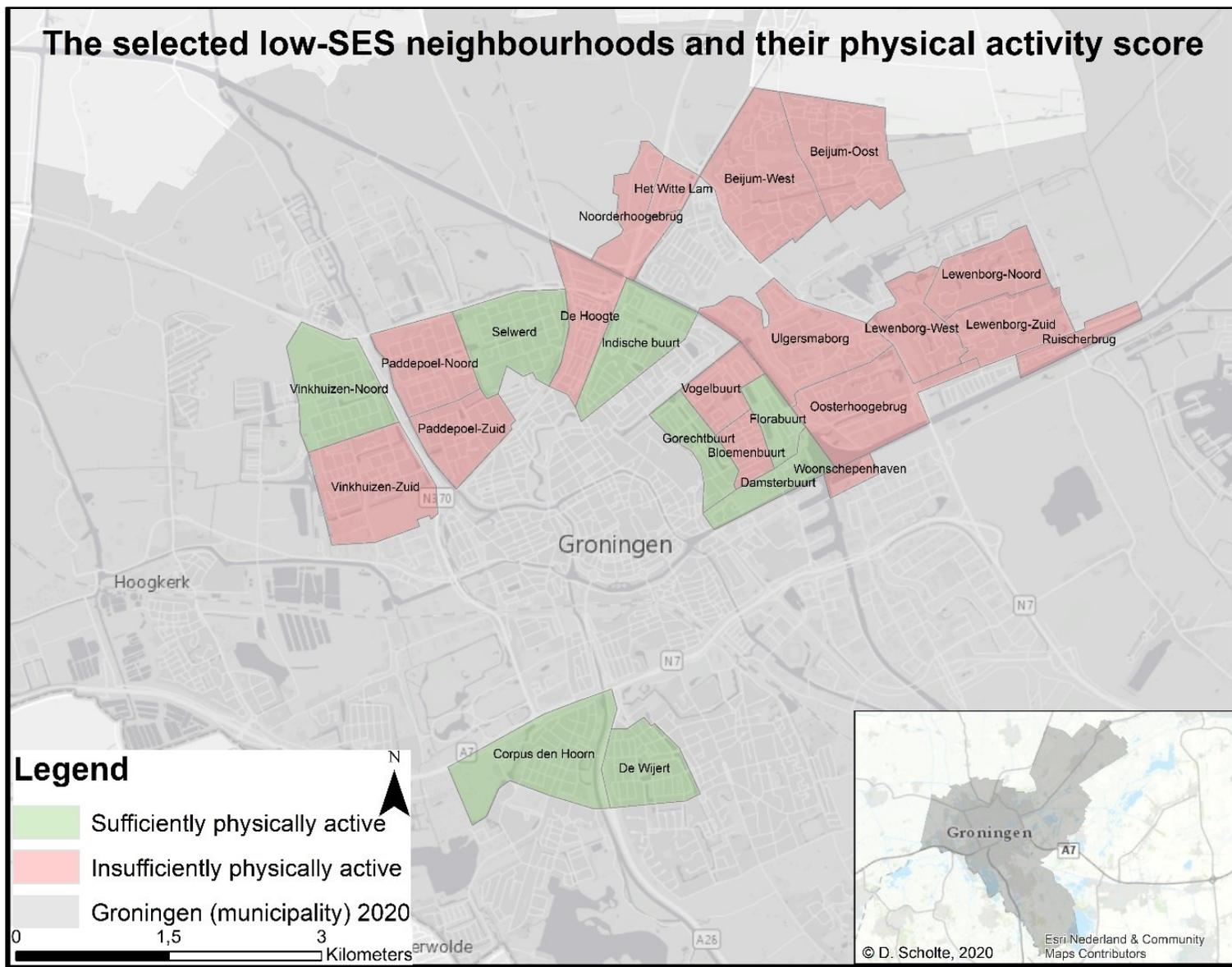


Figure 9. Overview of the percentage of people that meets the physical activity guideline per low-SES neighbourhood. The 60.23 line represents the average score for all neighbourhoods in the municipality of Groningen, the 59.04 line represents the average score for the low-SES neighbourhoods only.

Figure 10 shows the percentage of people that meets the PA guideline per neighbourhood. The neighbourhoods that score above the municipality's average are marked with green, and represent low-SES neighbourhoods in which people are sufficiently physically active ( $N = 8$ ). The neighbourhoods that score below the municipality's average are marked with red, and represent low-SES neighbourhoods in which people are insufficiently physically active ( $N = 17$ ) (fig. 11).



	Meets physical activity guideline (%) Mean
Lewenborg-Noord	54
Beijum-Oost	55
Woonschepenhaven	55
Beijum-West	56
Het Witte Lam	56
Lewenborg-Zuid	56
Ruischerbrug	56
Vinkhuizen-Zuid	57
Lewenborg-West	58
Noorderhoogebrug	58
Oosterhoogebrug	58
Ulgersmaborg	58
De Hoogte	59
Vogelbuurt	59
Bloemenbuurt	60
Paddepoel-Noord	60
Paddepoel-Zuid	60
Selwerd	61
Corpus den Hoorn	62
De Wijert	62
Florabuur	62
Indische buurt	62
Vinkhuizen-Noord	62
Damsterbuurt	64
Gorechtbuurt	66

Figure 11. Physical activity scores per selected low-SES neighbourhood.

Figure 10. Overview of the selected low-SES neighbourhoods that are sufficiently and insufficiently physically active.

## 3.5. DATA COLLECTION AND ANALYSIS

### 3.5.1. SPATIAL ANALYSIS

In the neighbourhood selection process (section 3.4.), neighbourhoods with low SES and a similar physical structure (degree of urbanisation), but that differ regarding the PA guidelines (above or below the municipality's average) were selected. One of the possibilities to reach the research objective (insight in the impact of neighbourhood characteristics on PA patterns) is to compare whether the neighbourhoods that score below the average PA score of the municipality differ from the neighbourhoods that score above this average. Research showed that there are a variety of neighbourhood characteristics that influence the PA levels of an individual (chapter 2). For most of these characteristics, the data that is available is often not only statistical but also spatial. Spatial analysis, therefore, provides a suitable way to reach the research objective. Spatial analysis is helpful in visualizing demographic and physical neighbourhood patterns, such as green areas, playgrounds and roads, that may be hard to recognize in just statistical (tabular) data (Haining, 2009).

#### 3.5.1.1. DATA COLLECTION

This research made use of secondary data, primarily because of time constraints (due to the late shift to a quantitative approach) and because the available data provided detailed information at a sub-neighbourhood level (Bryman, 2016).

Most of the used data was derived from open data sources, both spatially (GIS data) and statistically (statistics from e.g. the CBS and the municipality of Groningen). A complete overview of the used data can be found in appendix V. To add spatial understanding to the statistical data, some of this data was imported into ArcGIS by joining the data to the neighbourhood codes.

However, not for all indicators as described in section 3.2. was data available. Therefore, contact was sought with the Geo & Data department of the municipality of Groningen. They provided additional data about leisure activities and PA (from a neighbourhood survey) and house-ownership.

*Note:* The focus of this research is on families with low SES. Families are a specific group that includes children. This analysis uses survey data, which is filled in by adults and makes no distinction regarding the characteristics of the respondent. In other words, there is no direct data available for children and/or families. However, parents' behaviour influences that of their child (CBS, 2016; Curtis et al., 2011; Davison & Birch, 2001; Ferdinand et al., 2012; Mackett et al., 2007). Survey data about e.g. PA is therefore only an indirect indicator for a child's PA (since the parents, that filled in the survey, influence the child with their behaviour). More direct information about possibilities for a child to be physically active can be found in neighbourhood characteristics such as playgrounds and sports fields. These are namely indicators of a child-friendly environment and outside playing (in e.g. playgrounds) is an important component of children's overall PA (Broberg et al., 2013; Schicketanz et al., 2018; Veitch et al., 2006). In addition, parent's perceptions about neighbourhood safety are strong predictors of children's PA (Ferdinand et al., 2012; Kneeshaw-Price et al., 2015). Playgrounds and safety are therefore an important part of the analysis.

### 3.5.1.2. DATA ANALYSIS

#### ARCGIS

ArcGIS was used to create maps which gave insight into the distribution of a variable per neighbourhood. In addition, new variables were constructed by making use of a combination of datasets (table 8). Densities of variables (either per area or population) were calculated to better compare between neighbourhoods. Also, it is argued that the density of e.g. jobs or facilities improves transportation options and walkability in an area (Campoli, 2012; Tran, 2016). These constructed variables were, together with the other variables, imported into SPSS for additional analysis.

Table 8. Overview of the constructed variables and the input datasets.

Constructed variable*	Input datasets**	Calculation (summarized)
Number of playgrounds	<ul style="list-style-type: none"> <li>▪ 'OSM Vrije Tijd – vlakken – playgrounds'</li> <li>▪ 'OSM Vrije Tijd – punten – playgrounds'</li> <li>▪ 'Speelplekken_GemeenteGroningen'</li> </ul>	<ul style="list-style-type: none"> <li>▪ Feature To Point</li> <li>▪ Spatial Join with low-SES neighbourhoods (output: count_playgrounds)</li> </ul>
Playground density (no. of playgrounds per hectare)	<ul style="list-style-type: none"> <li>▪ 'OSM Vrije Tijd – vlakken – playgrounds'</li> <li>▪ 'OSM Vrije Tijd – punten – playgrounds'</li> <li>▪ 'Speelplekken_GemeenteGroningen'</li> </ul>	<ul style="list-style-type: none"> <li>▪ Calculate Field, expression: count_playgrounds / area_hectare</li> </ul>
Number of sports areas	<ul style="list-style-type: none"> <li>▪ 'OSM Vrije Tijd – punten – sports centre'</li> <li>▪ 'OSM Sport – punten'</li> <li>▪ 'OSM Sport – vlakken'</li> </ul>	<ul style="list-style-type: none"> <li>▪ Feature To Point</li> <li>▪ Spatial Join with low-SES neighbourhoods (output: 'count_sport')</li> </ul>
Sport density (no. of sports areas per hectare)	<ul style="list-style-type: none"> <li>▪ 'OSM Vrije Tijd – punten – sports centre'</li> <li>▪ 'OSM Sport – punten'</li> <li>▪ 'OSM Sport – vlakken'</li> </ul>	<ul style="list-style-type: none"> <li>▪ Calculate Field, expression: count_sport / area_hectare</li> </ul>
Number of food stores	<ul style="list-style-type: none"> <li>▪ 'OSM Winkels – punten – supermarket'</li> <li>▪ 'OSM EtenDrinken – punten'</li> <li>▪ 'OSM EtenDrinken – vlakken'</li> </ul>	<ul style="list-style-type: none"> <li>▪ Feature To Point</li> <li>▪ Spatial Join with low-SES neighbourhoods (output: 'count_foodstores')</li> </ul>
Food store density (no. of food stores per hectare)	<ul style="list-style-type: none"> <li>▪ 'OSM Winkels – punten – supermarket'</li> <li>▪ 'OSM EtenDrinken – punten'</li> <li>▪ 'OSM EtenDrinken – vlakken'</li> </ul>	<ul style="list-style-type: none"> <li>▪ Calculate field, expression: count_foodstores / area_hectare</li> </ul>
Green area (hectares)	<ul style="list-style-type: none"> <li>▪ 'Terrein_Top10nl'</li> <li>▪ 'Buurten2016_RIVM_GezondheidWijkBuurt'</li> </ul>	<ul style="list-style-type: none"> <li>▪ Summarize Within with low-SES neighbourhoods</li> <li>▪ Calculate Field for total green area, expression: area_forest_hectare + area_grass_hectare</li> <li>▪ Calculate Field for percentage forest, expression: area_forest_hectare / area-hectare *100</li> </ul>

		<ul style="list-style-type: none"> <li>Calculate Field for percentage grass, expression: <math>\text{area\_grass\_hectare} / \text{area\_hectare} * 100</math></li> <li>Calculate Field for m<sup>2</sup> forest per citizen, expression: <math>\text{area\_forest\_hectare} / \text{number\_of\_citizens} * 10000</math></li> <li>Calculate Field for m<sup>2</sup> forest per citizen, expression: <math>\text{area\_grass\_hectare} / \text{number\_of\_citizens} * 10000</math></li> </ul>
Percentage of green	▪ 'Terrein_Top10nl'	▪ Calculate Field, expression: $\text{percentage\_forest} + \text{percentage\_grass}$
M <sup>2</sup> of green per citizen	▪ 'Terrein_Top10nl'	▪ Calculate Field, expression: $\text{m2\_forest\_citizen} + \text{m2\_grass\_citizen}$
Number of trees	▪ 'GemeenteGroningen_Bomen'	▪ Spatial Join with low-SES neighbourhoods (output: 'count_trees')
Tree density (no. of trees per hectare)	▪ 'GemeenteGroningen_Bomen'	▪ Calculate Field, expression: $\text{count\_trees} / \text{area}$
Number of trees per citizen	▪ 'GemeenteGroningen_Bomen' ▪ 'Buurten2016_RIVM_GezondheidWijkBuurt'	▪ Calculate Field, expression: $\text{count\_trees} / \text{number\_of\_citizens}$

\*Per sub-neighbourhood, unless mentioned otherwise.

\*\*See appendix V for sources.

## SPSS

A simple linear regression was calculated for each of the variables to check which variables significantly predict the value of [% meets physical activity guideline]. The outcomes were put together in one table and sorted based on their *p*-value (appendix IV(c)). This showed which variables significantly predict the percentage of people that meets the PA guideline and which do not. It also shows the kind of relationship and how much of the variation in [% meets physical activity guideline] can be explained by each of the variables.

The next step would usually be to calculate a multiple regression with the significant variables. However, because of the limited sample size of only 25 neighbourhoods, this would give unreliable outcomes (Field, 2014). Therefore, it was decided to not calculate a multiple regression model.

## End scores

In the results chapter, all neighbourhoods are ranked based on their score per variable (from 'best' to 'worst') (sections 4.2., 4.3. and 4.4.). These rankings were added to create an average score per neighbourhood. These scores were then ranked again from low (i.e. best) to high (i.e. worst) to create a final score. The highest-ranked neighbourhood represents a neighbourhood that should be most conducive to PA behaviour, with e.g. a high amount of green, the most recreational facilities or a high safety score.

### 3.5.2. OBSERVATIONS

Observations are supportive to the spatial analysis. Observations provide information about the demographic characteristics of the users (age category and gender), the type of activity of the users and characteristics of the specific area (McKenzie et al., 2006). According to Sirard & Pate (2001), direct observation is “*the most practical and appropriate criterion measure of physical activity and patterns of activity*” (p. 441).

Six neighbourhoods were observed, three with an above-average PA score and three with a below-average PA score<sup>8</sup>. The observations were conducted in two ways: (1) a walk through the neighbourhood to get a first impression of the neighbourhood: e.g. how the neighbourhood is used, to observe how streets and sidewalks are maintained and whether there is physical disorder, and (2) several spots in the selected neighbourhoods (e.g. parks) were observed during a certain time span to see if and how the area is used. Table 9 provides an overview of the observation process.

Table 9. Overview observation process.

	<b>Oosterparkwijk (Damsterbuurt, Florabuurt, Bloemenbuurt, Gorechtbuurt and Vogelbuurt)</b>	<b>De Hoogte</b>
<b>(1) Walk through the neighbourhood</b>	Date: 31-03-2020 (Tuesday) Time: 14:30 – 15:40 (afternoon) Total of 5 kilometres (appendix VII.i)	Date: 06-04-2020 (Monday) Time: 13:30 – 14:30 (afternoon) Total of 3 kilometres (appendix VIII.i)
<b>(2) Observation parks (see also appendix VII.ii, VII.iii. and VIII.ii.)</b>	Date: 06-04-2020 (Monday) Time: 9:30 – 10:00 (morning) Location: Oosterpark, Vogelbuurt (1)  Date: 08-04-2020 Time: 14:00 – 14:30 (afternoon) Location: Oosterpark, Vogelbuurt (2)  Date: 06-04-2020 (Monday) Time: 10:15 – 10:45 (morning) Location: Pioenpark, Florabuurt (1)  Date: 08-04-2020 (Wednesday) Time: 13:20 – 13:50 (afternoon) Location: Pioenpark, Florabuurt (2)	Not possible, because there is no park in the neighbourhood (see section 3.6. for considerations).

<sup>8</sup> These neighbourhoods were already selected and observed for the initial qualitative research. Because of time constraints, and because these neighbourhoods represent both sufficient and insufficient PA neighbourhoods, no other neighbourhoods were observed after the shift to a quantitative approach.

A list of important points for observation was made in advance (appendix VI), based on the conducted literature study (chapter 2) and (a simplified form of) the SOPARC<sup>9</sup> method (McKenzie & Cohen, 2006). SOPARC is an observation tool developed to observe the use of parks and other recreational places in a structured way. It differs from other, more often used, instruments to study PA since it uses direct observation (rather than self-reported data) and focuses on a target area (rather than an individual) (McKenzie et al., 2006). In addition, pictures were taken to visualize the observations, however in accordance with the Dutch privacy legislation. People on the picture were avoided as much as possible. When this was not possible, it was tried to take the pictures from such a distance that the people on it are unrecognizable. When this was also not possible, people and number plates of cars or scooters were blurred (Bryman, 2016). For the same reason, there were also no photos taken that are close-ups of e.g. one's house or garden. Insights from the observations were used to visualise the spatial analysis (chapter 4).

### 3.6. ETHICS

According to Punch (2014), there are two important considerations in the collection of observational data. The first one is deciding what has to be observed (approaching the observation), the second one is how to record the observation. In this process, it is important that the presence of the observer changes the action (i.e. that what is being observed) as little as possible. Schensul et al. (1999) add that the people that are being observed should not notice the observer and that the observation has to take place in public areas so that the observations pose no threat to both the observer or the observed people. With these considerations in mind, it was decided to first take a walk through the neighbourhood to get an impression of how the neighbourhood is being used and to find out which places may be suitable (i.e. open and publicly accessible with seating areas) for additional observation. Suitable areas turned out to be primarily parks since these are accessible to everyone and provide seating areas. Playgrounds and sports fields were considered not suitable because it might come across strange or weird that an adult (without a child) is watching a playground.

Another important ethical principle is confidentiality. This means, amongst others, not disclosing identities of participants (Hay, 2010). Therefore, the pictures taken to support the observation and spatial analysis were taken and used according to a few 'rules' (section 3.5.2.), also to respect people's privacy and to conform to the Dutch privacy legislation. In addition, only data that is not traceable to specific individuals was used in the spatial analysis (the highest data level that is used is sub-neighbourhood level).

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<sup>9</sup> System for Observing Play and Recreation in Communities

## 4. RESULTS

This chapter describes the results of the conducted spatial analysis and observations. It is structured as follows: first, a short description of the selected low-SES neighbourhoods is given. Then the results from the spatial analysis per subject from the sub-questions are described (infrastructure, public green areas and the social environment). This is supported by insights from the observations, for which Oosterparkwijk (consisting of Florabuurt, Gorechtbuurt, Damsterbuurt (sufficient PA), Bloemenbuurt and Vogelbuurt (insufficient PA)) and De Hoogte (insufficient PA) were observed.

### 4.1. NEIGHBOURHOOD DESCRIPTIONS

Recently, an analysis has been conducted on the current situation concerning physical activity opportunities in the public space of Groningen (Steinberg et al., 2019). It has been found that the construction of new exercise locations makes the people who were already physically active, become more active. However, it also explicitly states that for the inactive people to become active, a suitable design per area and the target group is necessary. Steinberg et al. (2019) argue that participation plays an important role in this, as centralizing the wishes of the end-user is essential. Next to this, it has become clear that activation is just as important to tempt people to become active.

By looking at four themes (playing, sports participation, meeting and being physically active), a manual has been created for design, activation and participation in public space, to create an attractive, activity-friendly and healthy living environment (Schrijver et al., 2020; Steinberg et al., 2019). However, despite that the book is full of examples, trends, images and advice for improvement, it lacks concrete guidelines on how to turn the inactive people into active people.

What the analysis does provide, and what is of particular use for this research, is an overview of the current situation of all neighbourhoods in Groningen concerning five indicators related to health and PA. Indicators are contact with neighbours, opportunities for sports, playing and PA, good health, actively engaging in sports activities and member of a sports club or fitness centre. They conclude that health inequalities appeared to be the greatest in Corpus den Hoorn, De Hoogte, Hoogkerk, Lewenborg, Oosterparkwijk, Paddepoel, Selwerd, Ten Boer and Vinkhuizen (Steinberg et al., 2019). These neighbourhoods correspond, for the greatest part, to the selected neighbourhoods (section 3.4.) in this research.

Figure 12 and table 10 provide short key information about the population composition, household type, housing ownership, health and PA per neighbourhood.

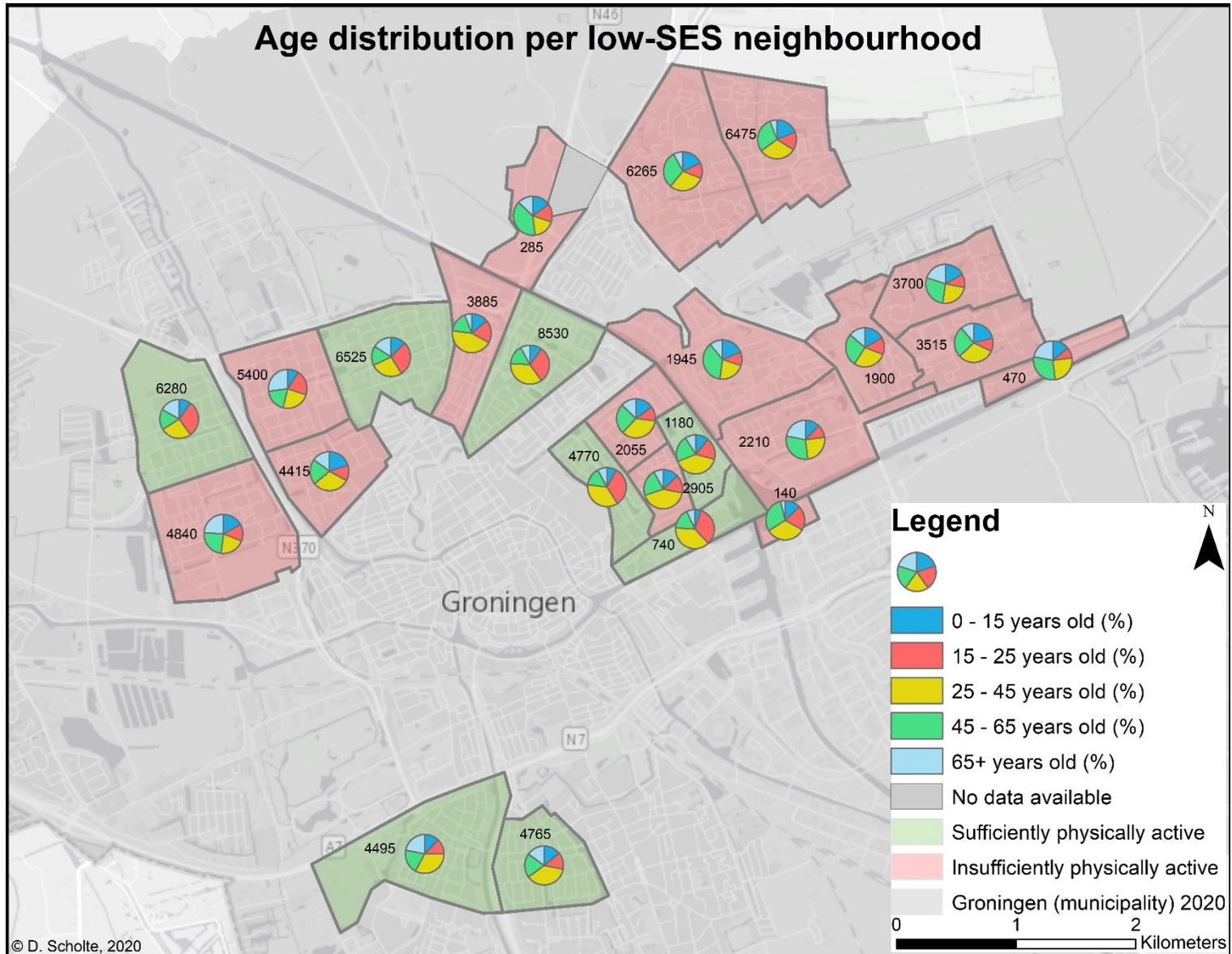
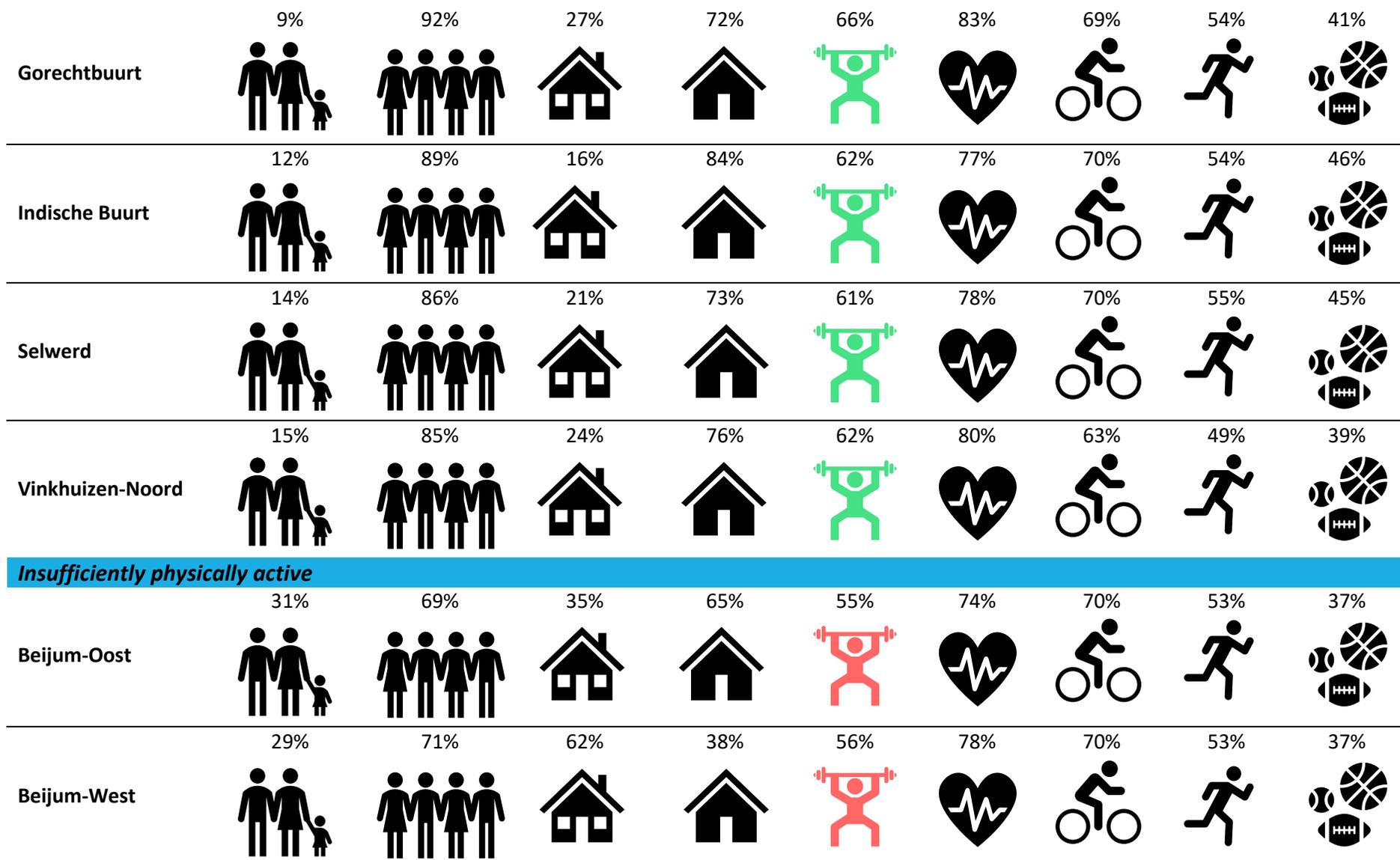


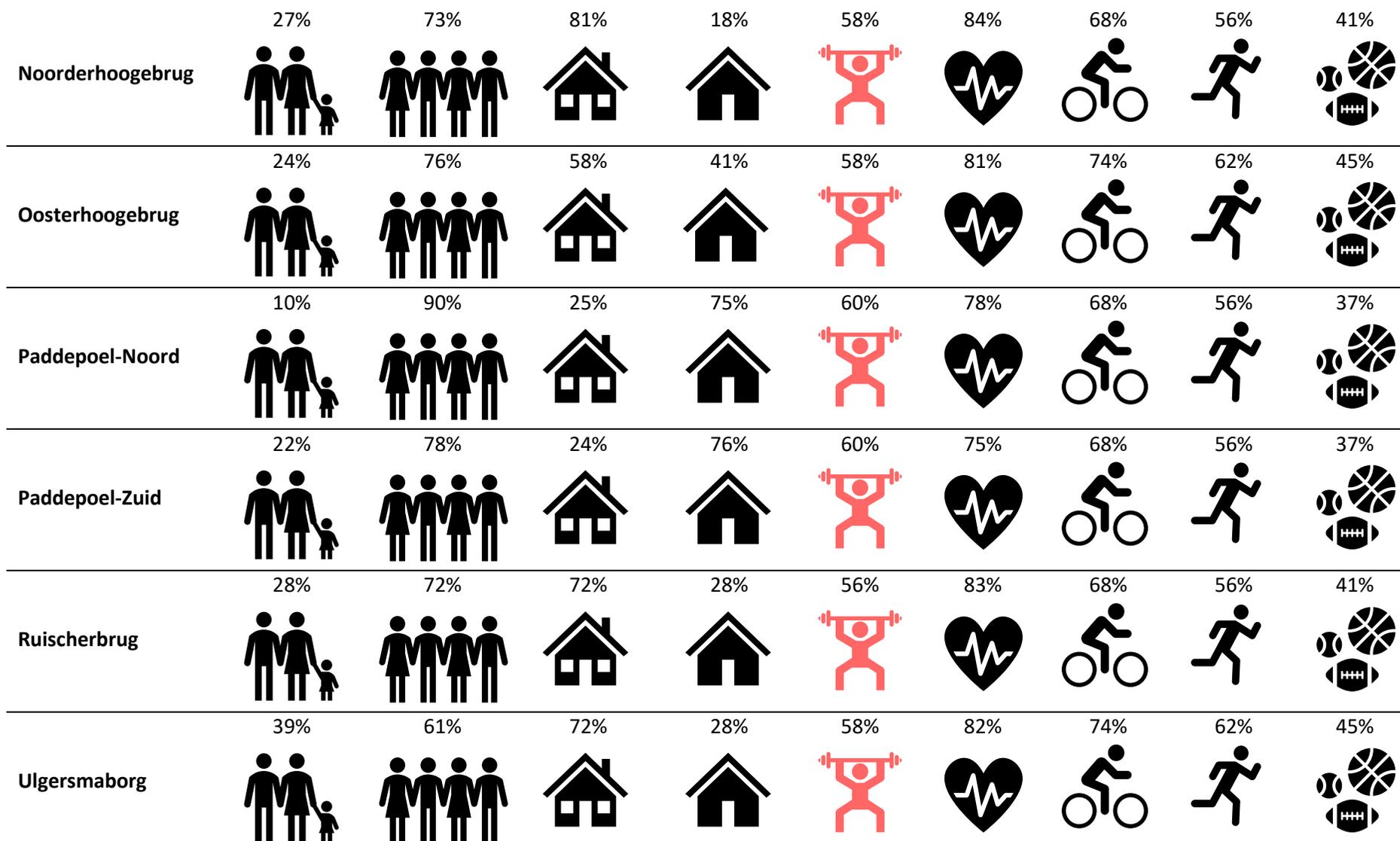
Figure 12. Age distribution per low-SES neighbourhood.

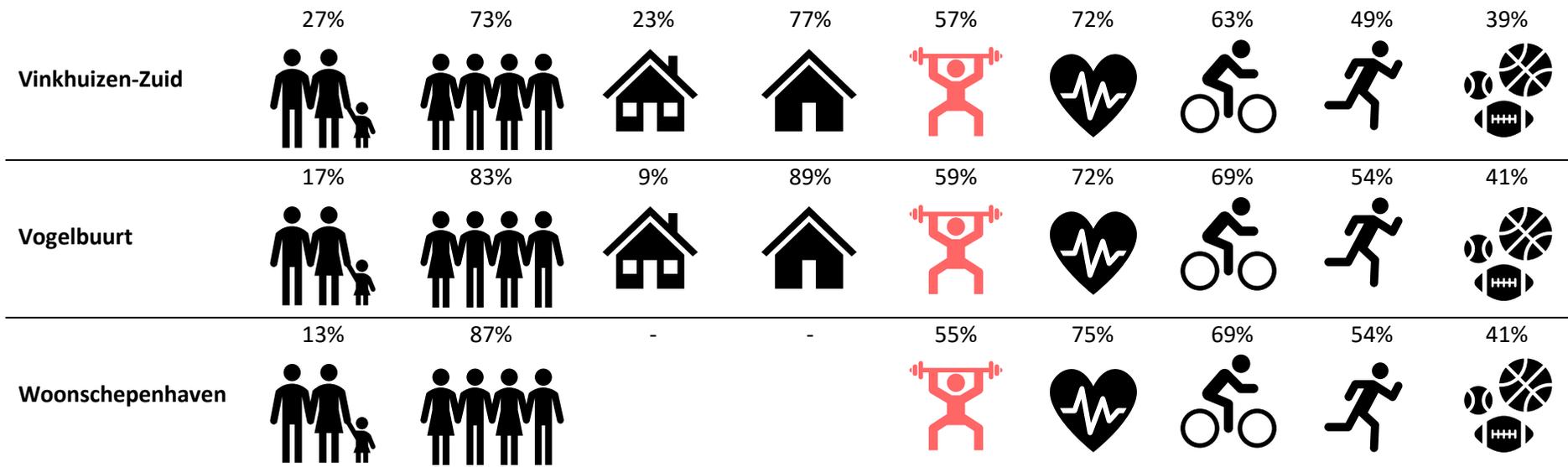
Table 10. Key information per neighbourhood.

	Households		Housing ownership		Meets the physical activity guideline	Good self-perceived health	Exercising	Exercising weekly	Member of a sports club
	With children	Without children	Owner-occupied	Rented					
<b>Sufficiently physically active</b>									
	14%	86%	30%	70%	62%	79%	67%	58%	42%
Corpus den Hoorn									
	6%	94%	19%	81%	64%	81%	69%	54%	41%
Damsterbuurt									
	18%	82%	27%	73%	62%	77%	71%	59%	45%
De Wijert									
	17%	83%	45%	55%	62%	80%	69%	54%	41%
Florabuurt									



Bloemenbuurt	19%	81%	21%	79%	60%	74%	69%	54%	41%
									
De Hoogte	17%	83%	9%	91%	56%	74%	69%	50%	39%
									
Het Witte Lam	13%	88%	-	-	56%	84%	68%	56%	41%
									
Lewenborg-Noord	28%	72%	37%	63%	54%	73%	65%	51%	34%
									
Lewenborg-West	30%	70%	80%	20%	58%	83%	65%	51%	34%
									
Lewenborg-Zuid	35%	66%	56%	44%	56%	76%	65%	51%	34%
									





## 4.2. INFRASTRUCTURE

### 4.2.1. STREET DESIGN

#### 4.2.1.1. STREET DESIGN PER NEIGHBOURHOOD

Figures 13-15 show streets<sup>10</sup>, building ownership, public lighting<sup>11</sup>, public transport and primary schools in the selected low-SES neighbourhoods that have an above-average (fig. 13) and below-average (fig. 14 & 15) PA score.

For both the sufficient and insufficient active neighbourhoods applies that the greatest part of the neighbourhood consists of rented housing. Only Beijum-West, Lewenborg-West, Lewenborg-Zuid, Noorderhoogebrug, Oosterhoogebrug, Ruischerbrug, Ulgersmaborg (insufficient PA) and Florabuurt (sufficient PA) appear to have a higher amount of owner-occupied housing.

All neighbourhoods are accessible by public transport, and in most of the neighbourhoods the bus crosses the neighbourhood. Only Florabuurt (sufficient PA), Noorderhoogebrug, Het Witte Lam, Vogelbuurt and Bloemenbuurt (insufficient PA) do not have bus stops within the neighbourhood.

Streets in the neighbourhoods, especially between buildings, seem to be well-lit in all neighbourhoods. However, open spaces in neighbourhoods, such as parks or sports areas, appear to have less lighting. Florabuurt (sufficient PA) and Vogelbuurt (insufficient PA), for example, both have a large park which only has a few street lights, mostly surrounding the park and not along the paths crossing the park.

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<sup>10</sup> Unfortunately, there was no data available about streets, bicycle paths, sidewalks at a sub-neighbourhood level. Therefore, as the best alternative, a base map that provides a comprehensive overview of the street layout was used.

<sup>11</sup> Because public lighting overlaps with streets, it is chosen to not show both on the same map. A map of the street design with public lighting can be found in appendix IX.

## Street design in low-SES neighbourhoods with an above-average PA score

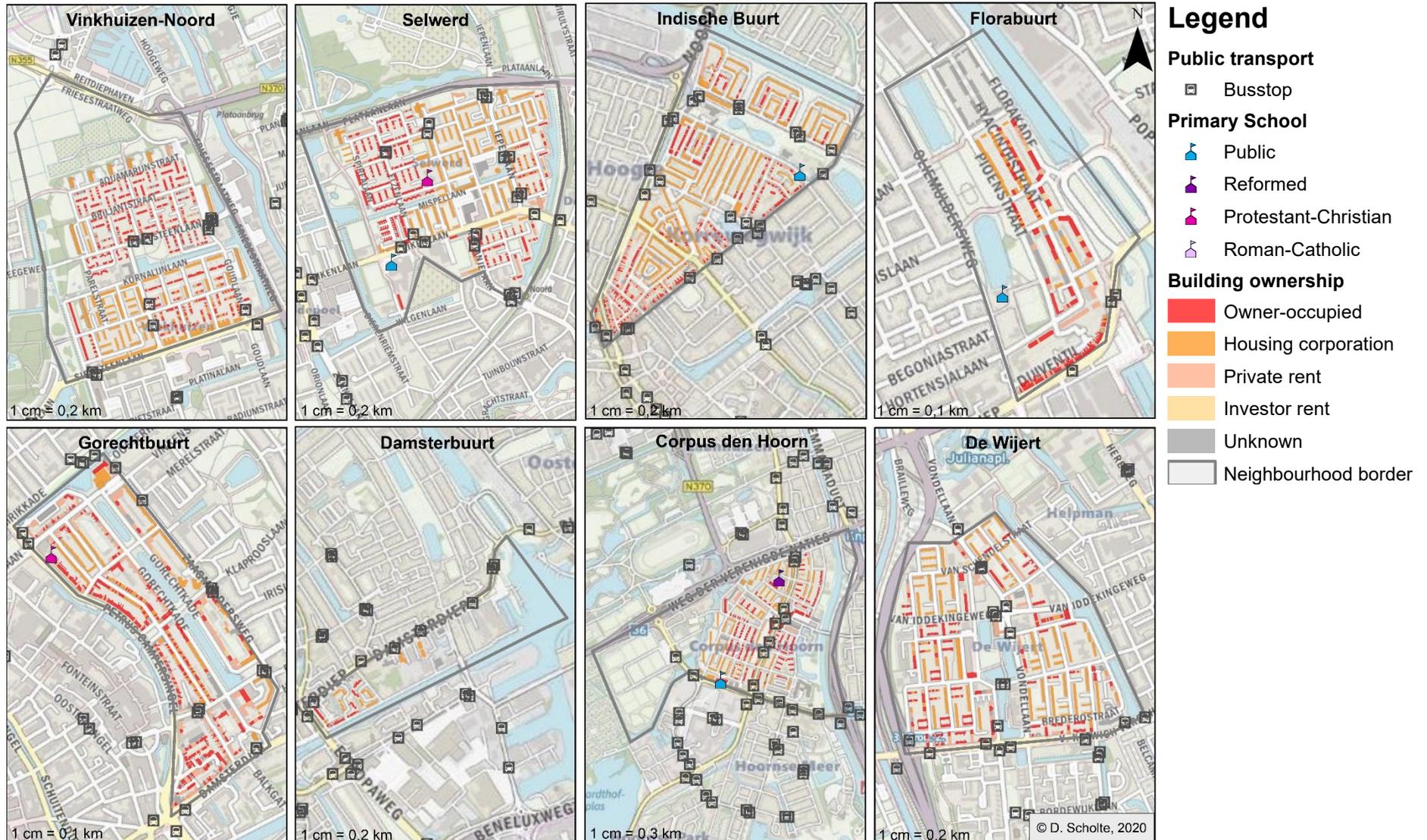


Figure 13. Street design in the selected low-SES neighbourhoods that are sufficiently physically active.

## Street design in low-SES neighbourhoods with a below-average PA score (1)

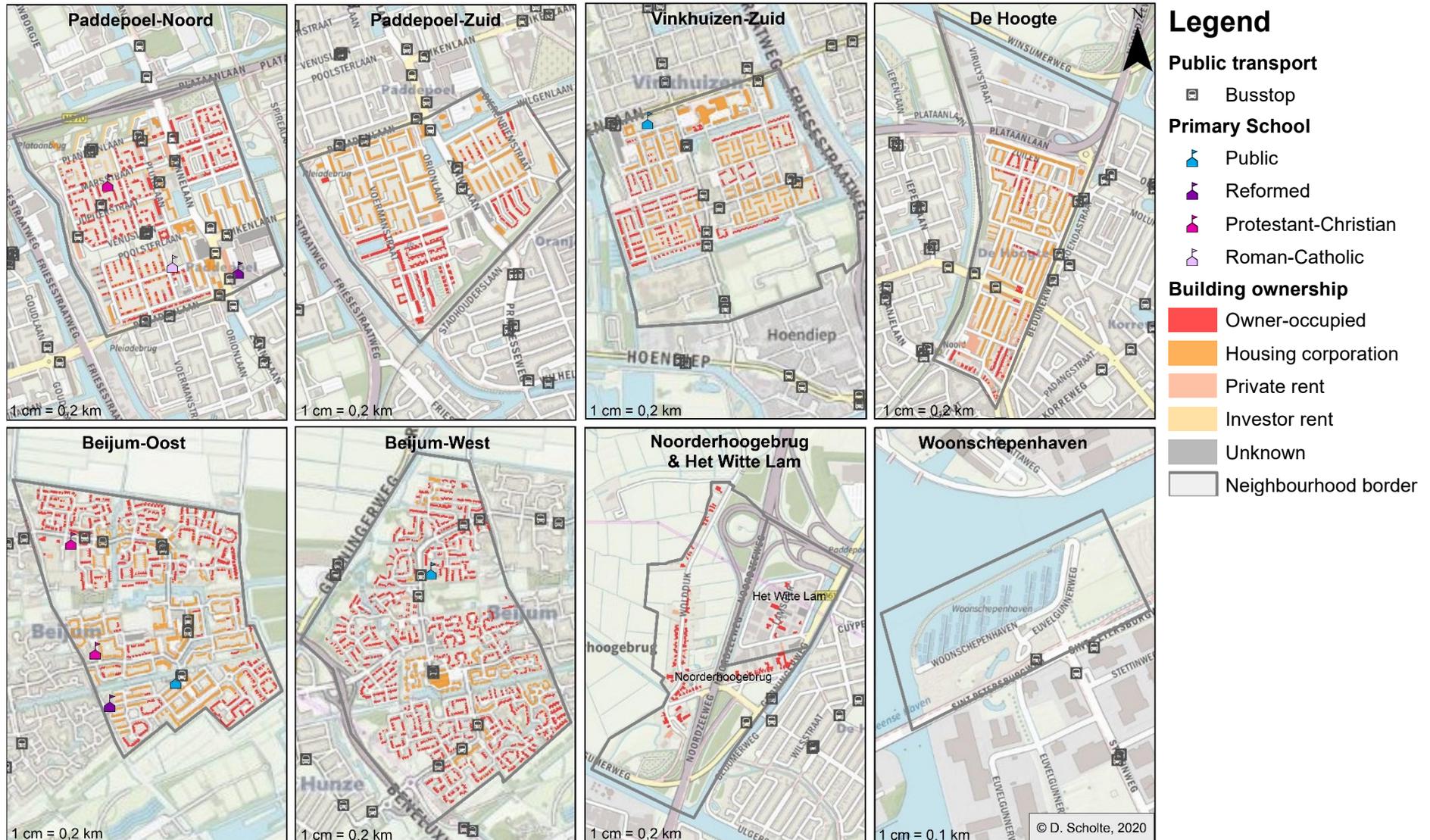


Figure 14. Street design in the selected low-SES neighbourhoods that are insufficiently physically active (part 1).

## Street design in low-SES neighbourhoods with a below-average PA score (2)

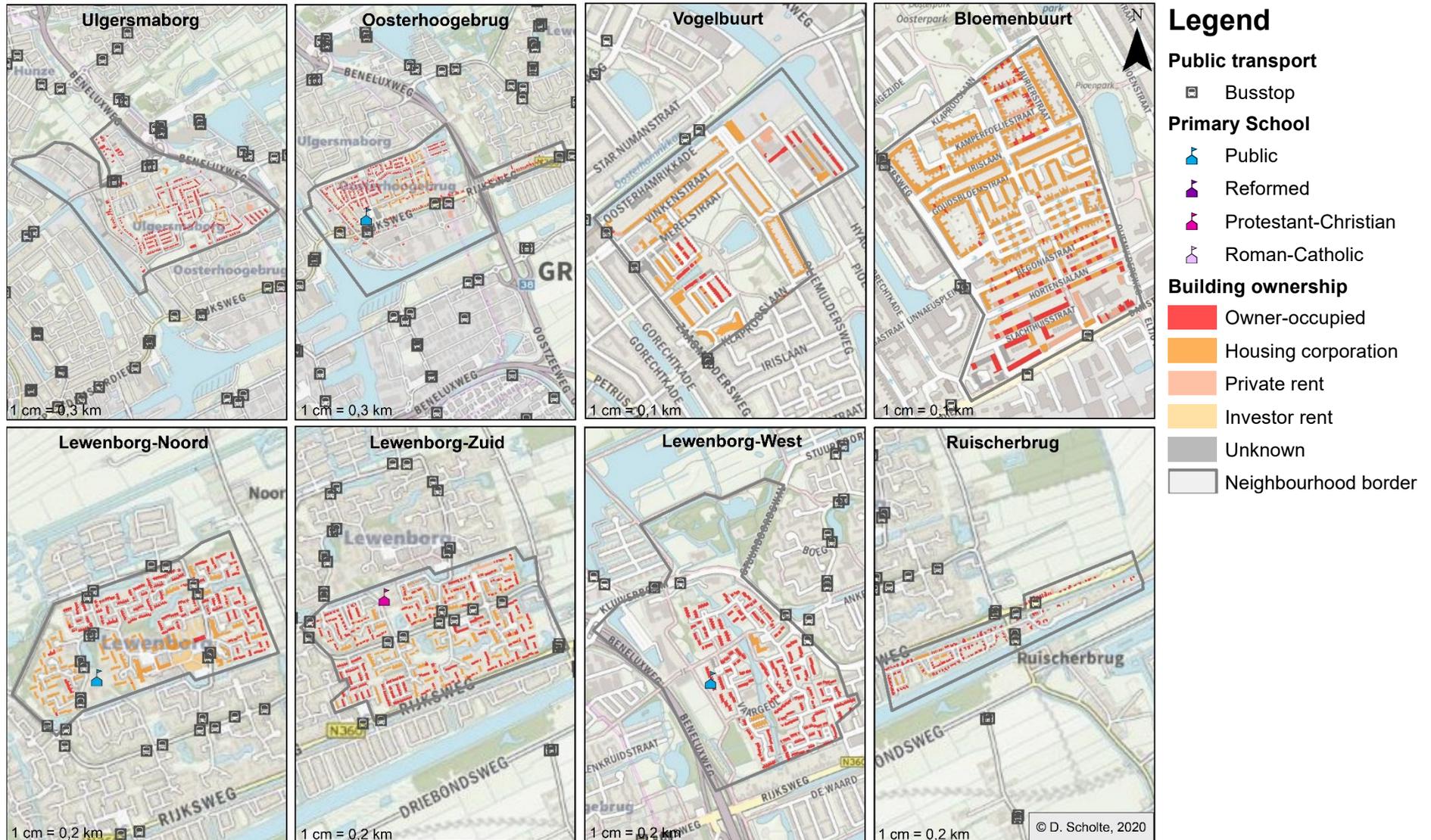


Figure 15. Street design in the selected low-SES neighbourhoods that are insufficiently physically active (part 2).

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#### 4.2.1.2. OBSERVATION

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##### STREETS, BICYCLE PATHS AND SIDEWALKS

Most of the streets in Oosterparkwijk are made of brick pavement, meant to slow the speed of vehicles. Only a few larger roads, for ongoing traffic (e.g. Zaagmuldersweg, Klaprooslaan and Oliemuldersweg), are made of asphalt. These are often access roads, connected to the Damsterdiep, which in turn is connected to the ring road and the city centre. Many of the other, smaller streets are one-way streets (fig. 16 & 18). Next to this, traffic calming features such as zebra crossings, speed bumps and narrowing of roads can be found frequently across the neighbourhood. People can most of the time park in front of their house (along the road) or at special small parking lots in their street. Streets with asphalt, such as the Zaagmuldersweg, have special marked bicycle paths (fig. 17).



Figure 16. An example of a one-way street with parking lot on the border of Vogelbuurt and Florabuurt (own photo – taken on 31-03-2020 PM).



Figure 17. Zaagmuldersweg (border between Vogelbuurt, Bloemenbuurt and Gorechtbuurt): special bicycle paths, wide sidewalk, a zebra crossing and parking spots along the road (own photo – taken on 31-03-2020 PM).



Figure 18. An example of a one-way street with road narrowing, speed bumps and a parking lot (Nachttegaalstraat, Vogelbuurt) (own photo – taken on 31-03-2020 PM).

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#### HOUSING

Regarding housing, differences between the neighbourhoods that are sufficiently and insufficiently physically active were observed.

##### Sufficient PA

Gorechtbuurt seems to inhabit the wealthier people. The H.A. Kooykerplein, for example, consists of newly-built houses with an underground car park (fig. 19). In this part of the neighbourhood, houses and gardens looked better maintained compared to other parts of the neighbourhood. The parked cars and bicycles in front of the houses also indicated wealthier people, with mainly newer cars, electrical bicycles and (electrical) freight bicycles. In the Gerbrand Bakkerstraat (fig. 20) for example, a lot of people were sitting in front of their house with their children playing on the sidewalk. This indicates that (most of) the houses in the street are mainly single-family houses.



Figure 19. Houses H.A. Kooykerplein, taken from the Gorechtkade (Staat in Groningen, n.d.).



Figure 20. Gerbrand Bakkerstraat (own photo – taken on 31-03-2020 PM).

Florabuurt consists out of a mixture of both old and newly-built apartment buildings. Noticeable is the difference in the accessibility of (the backyards of) these buildings: the older buildings were publicly accessible (fig. 22), while the newly-built buildings were closed off by a gate (fig. 21).



Figure 21. Newly-built houses closed off by a gate (own photo – taken on 31-03-2020 PM).



Figure 22. Older buildings openly accessible by a sidewalk (own photo – taken on 31-03-2020 PM).

### Insufficient PA

Vogelbuurt consists of a large park (the Oosterpark) surrounded by older ground floor- and upstairs flats on the north, east and south side (fig. 23). The buildings on the west side of the park (De Velden) have been built recently, on the same location as the formerly Oosterpark stadium. Maintenance of gardens, no disorder on the street, and a car on every driveway suggests that this block of houses also inhabits wealthier people.

De Hoogte consist mostly out of ground floor- and upstairs flats (fig. 25). Newer buildings can be found in the northern part of the neighbourhood (fig. 24).



Figure 23. Ground floor- and upstairs flats on the north and east side of the Oosterpark, with parking places in front of the houses (own photo – taken on 31-03-2020 PM).



Figure 24. Housing at the Zuilen (De Hoogte) with the recently built De Helix at the background (own photo – taken on 06-04-2020 PM).



Figure 25. Housing at the Jacob Catsstraat (De Hoogte) (own photo – taken on 06-04-2020 PM).

## 4.2.2. RECREATIONAL FACILITIES

### 4.2.2.1. DISTRIBUTION OF RECREATIONAL FACILITIES

Figures 26-28 show playgrounds and sports areas in the selected low-SES neighbourhoods that have an above-average (fig. 26) and below-average (fig. 27 & 28) PA score. Noticeable is the diversity in the number of playgrounds and sports areas per neighbourhood.

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#### SUFFICIENT PA

Vinkhuizen-Noord has no sports areas but does have playgrounds in almost every street. Selwerd has a combination of both sports areas and playgrounds, on the eye the largest amount of all the neighbourhoods. Indische Buurt also has a variety of playgrounds, with a few sports areas. Florabuurtt, Gorechtbuurt and Damsterbuurt have a little number of playgrounds and sports areas. Florabuurtt only has playgrounds and sports areas on the south side of the neighbourhood, while in Gorechtbuurt and Damsterbuurt they are more spread. Corpus den Hoorn has a variety of playgrounds and sports areas, which are mostly located on the West side of the neighbourhood. The large sports area contains, amongst others, the training location of FC Groningen. In De Wijert, playgrounds are mostly located on the West side of the neighbourhood.

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#### INSUFFICIENT PA

Ruischerbrug and Het Witte Lam do not have any playgrounds or sports areas. Noorderhoogebrug and Woonschepenhaven have a few playgrounds, Woonschepenhaven has a soccer field as well. De Hoogte and Oosterhoogebrug only have playgrounds, but no sports areas. All other neighbourhoods have both sports areas and playgrounds. Beijum-Oost, Beijum-West, Lewenborg-Noord and Lewenborg-Zuid contain the most playgrounds. Vinkhuizen-Zuid and Lewenborg-West are the only neighbourhoods with large sports areas. The other neighbourhoods have smaller sports areas. In all neighbourhoods, playgrounds are scattered around the neighbourhood. However, in Bloemenbuurt the playgrounds are located more in the northern part, the south side of the neighbourhood only has one playground.

## Recreational facilities in low-SES neighbourhoods with an above-average PA score



Figure 26. Recreational facilities in the selected low-SES neighbourhoods that are sufficiently physically active.

## Recreational facilities in low-SES neighbourhoods with a below-average PA score (1)



Figure 27. Recreational facilities in the selected low-SES neighbourhoods that are insufficiently physically active (part 1).

## Recreational facilities in low-SES neighbourhoods with a below-average PA score (2)



Figure 28. Recreational facilities in the selected low-SES neighbourhoods that are insufficiently physically active (part 2).

#### 4.2.2.2. THE NUMBERS BEHIND THE MAPS

Table 13 shows the ranking of scores for the variables [number of playgrounds], [playground density], [number of sports areas] and [sports area density]. Most of the neighbourhoods with an above-average PA score are in the bottom part of the ranking for both the number of playgrounds and playground density. For sports areas, however, half of the sufficient PA neighbourhoods are in the top 10 for these variables.

Table 11, which shows the average scores per variable for both the sufficiently and insufficiently physically active neighbourhoods, indicates the same. The neighbourhoods with a below-average PA score have, on average, more playgrounds and a higher playground density compared to the neighbourhoods with an above-average PA score. The latter, however, has more sports areas and a higher density of sports areas.

Table 11. Descriptives of the variables [number of playgrounds], [playground density], [number of sports areas] and [sports area density].

Variable	Above-average PA score (N = 8)			Below-average PA score (N = 17)		
	Min. / Max.	Mean	Std. Deviation	Min. / Max.	Mean	Std. Deviation
<b>Number of playgrounds</b>	2 – 27	13.63	10.70	0 – 60	18.53	16.46
<b>Playground density</b>	0.05 – 0.37	0.19	0.12	0 – 0.64	0.28	0.18
<b>Number of sports areas</b>	0 – 30	6.63	10.14	0 – 19	3.53	5.00
<b>Sports area density</b>	0 – 0.26	0.08	0.09	0 – 0.18	0.05	0.05

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on number of playgrounds, playground density, number of sports areas and sports area density.

The outcomes of the regression correspond to insights from the spatial analysis. For example, *R* shows a negative relationship between the number of playgrounds and PA behaviour ( $R = -0.346$ ), which corresponds to the pattern that the maps (fig. 26-28) already indicated: insufficient PA neighbourhoods have more playgrounds. However, there was no significant regression found for none of these variables (table 12). This might be because of the limited number of cases ( $N = 25$ ) (Field, 2014).

Table 12. Output of the simple linear regression for the dependent variable [% meets physical activity guideline] and the independent variables representing recreational facilities.

Variable	<i>b</i>	<i>SE B</i>	$\beta$	<i>p</i>	<i>F(1,23)=</i>	<i>R</i> <sup>2</sup>	<i>95% CI</i>
<b>Number of playgrounds</b>	-0.072	0.041	-0.346	0.090	3.123	0.120	(-0.156, 0.012)
<b>Playground density</b>	-6.018	3.677	-0.323	0.115	2.679	0.104	(-13.623, 1.588)
<b>Number of sports areas</b>	0.017	0.092	0.038	0.858	0.033	0.001	(-0.173, 0.206)
<b>Sports area density</b>	-0.531	9.708	-0.011	0.957	0.003	0.000	(-20.613, 19.552)

Table 13. Ranking of the low-SES neighbourhood scores for the variables [number of playgrounds], [playground density], [number of sports areas] and [sports area density]. The scores are ranked from high (i.e. much recreational facilities) to low (i.e. few recreational facilities). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Number of playgrounds	Neighbourhood	Playground density	Neighbourhood	Number of sports areas	Neighbourhood	Sports area density
1.	Beijum-Oost	60	Beijum-Oost	0.64	Corpus den Hoorn	30	Corpus den Hoorn	0.26
2.	Beijum-West	49	Lewenborg-Noord	0.54	Vinkhuizen-Zuid	19	Vinkhuizen-Zuid	0.18
3.	Lewenborg-Noord	32	Lewenborg-Zuid	0.47	Beijum-Oost	10	Woonschepenhaven	0.17
4.	Lewenborg-Zuid	29	Bloemenbuurt	0.43	Beijum-West	10	Selwerd	0.12
5.	Indische buurt	27	Beijum-West	0.41	Selwerd	10	Indische buurt	0.11
6.	Selwerd	26	Indische buurt	0.37	Indische buurt	8	Beijum-Oost	0.11
7.	Vinkhuizen-Noord	25	Paddepoel-Zuid	0.36	Lewenborg-West	4	Beijum-West	0.08
8.	Ulgersmaborg	21	Lewenborg-West	0.33	Paddepoel-Noord	3	Lewenborg-West	0.07
9.	Paddepoel-Zuid	20	Selwerd	0.32	Lewenborg-Noord	2	Florabuurt	0.07
10.	Vinkhuizen-Zuid	20	Vogelbuurt	0.29	Lewenborg-Zuid	2	Vogelbuurt	0.05
11.	Lewenborg-West	18	Vinkhuizen-Noord	0.29	Paddepoel-Zuid	2	Paddepoel-Noord	0.04
12.	Paddepoel-Noord	16	Paddepoel-Noord	0.24	De Hoogte	2	Bloemenbuurt	0.04
13.	De Hoogte	12	De Hoogte	0.21	Vogelbuurt	2	Paddepoel-Zuid	0.04
14.	Vogelbuurt	11	Ulgersmaborg	0.20	Florabuurt	2	De Hoogte	0.03
15.	Bloemenbuurt	10	Vinkhuizen-Zuid	0.19	Woonschepenhaven	2	Lewenborg-Noord	0.03
16.	Corpus den Hoorn	10	Gorechtbuurt	0.18	Ulgersmaborg	1	Lewenborg-Zuid	0.03
17.	De Wijert	10	De Wijert	0.17	Bloemenbuurt	1	Damsterbuurt	0.03
18.	Oosterhoogebrug	10	Woonschepenhaven	0.17	De Wijert	1	Gorechtbuurt	0.03
19.	Gorechtbuurt	7	Oosterhoogebrug	0.10	Gorechtbuurt	1	De Wijert	0.02
20.	Noorderhoogebrug	3	Corpus den Hoorn	0.09	Damsterbuurt	1	Ulgersmaborg	0.01
21.	Damsterbuurt	2	Ruischerbrug	0.08	Vinkhuizen-Noord	0	Vinkhuizen-Noord	0.00
22.	Florabuurt	2	Florabuurt	0.07	Oosterhoogebrug	0	Oosterhoogebrug	0.00
23.	Ruischerbrug	2	Noorderhoogebrug	0.06	Noorderhoogebrug	0	Ruischerbrug	0.00
24.	Woonschepenhaven	2	Damsterbuurt	0.05	Ruischerbrug	0	Noorderhoogebrug	0.00
25.	Het Witte Lam	0	Het Witte Lam	0.00	Het Witte Lam	0	Het Witte Lam	0.00
<i>Descriptives (N = 25)</i>		<i>M = 16.96, SD = 14.81</i>		<i>M = 0.25, SD = 0.17</i>		<i>M = 4.52, SD = 6.99</i>		<i>M = 0.06, SD = 0.07</i>

#### 4.2.2.3. OBSERVATION

Playgrounds are scattered around the Oosterparkwijk, differing in size. Larger playgrounds can be found in or near parks (e.g. north and south side of the Pioenpark, south side of the Oosterpark (fig. 29 – 32)). Smaller playgrounds can be found within residential areas, surrounded by houses (e.g. H.A. Kooykerplein (fig. 33), Lindenhof (fig. 34), Holtstek, Geraniumhof, Seringenhof (fig. 35)). All of these playgrounds are publicly accessible.



Figure 29. One of the larger playgrounds in the Oosterparkwijk, located on the south side of the Oosterpark (Vogelbuurt). Mostly asphalt, with a special surface around the playground attributes and surrounded by trees and bushes. Also provided with benches and trash cans (own photo – taken on 08-04-2020 PM).



Figure 30. Playground at the west side of the Oosterpark (Vogelbuurt), with grass as foundation and provided with a bench and trash can (own photo – taken on 31-03-2020 PM).



Figure 31. Kids playing/hanging out at a fallen tree, while the playground next to it (fig. 29) is almost empty (Oosterpark, Vogelbuurt) (own photo, taken on 08-04-2020 PM).



Figure 32. Playground at the north side of the Oosterpark (Vogelbuurt), with grass as foundation and provided with benches (own photo – taken on 08-04-2020 PM).



Figure 33. Playground at H.A. Kooykerplein (Gorechtbuurt), with the UMCG at the background, surrounded with a fence and box trees and provided with a special surface and benches. Also a sign with 'smoke-free area' (own photo – taken on 31-03-2020 PM).



Figure 34. Playground at Lindenhof (Blauwe Dorp, Bloemenbuurt), publicly accessible surrounded by box trees (own photo – taken on 31-03-2020 PM).



Figure 35. Playground at Seringenhof (Vogelbuurt), with grass as foundation and benches (own photo – taken on 31-03-2020 PM).

Next to this, there are three other playgrounds across the neighbourhood. These playgrounds are managed by a neighbourhood- and playground association, which are affiliated with the *Speeltuinentrale Groningen*.

- Neighbourhood and playground association (B.S.V.) Oosterpark – South side of the Pioenpark (Florabuurt)  
Diversity of playground equipment, with a special surface for a softer landing while falling and a number of benches and garbage cans. It is enclosed by fences, box trees and trees, but however (publicly) accessible by shortcuts through the box trees (fig. 36). During the observation, the playground equipment was just been cleaned by neighbours to decrease the chance of infection with COVID-19 (fig. 37).



Figure 36. Playground B.S.V. Oosterpark (Florabuurt). Grass as foundation, a special surface around the playground attributes and provided with benches and trash cans (own photo – taken on 08-04-2020 PM).



Figure 37. Information sign about the cleaning action (own photo – taken on 08-04-2020 PM).

- Neighbourhood and playground association (B.S.V.) Ons Belang – Behind closed building block at Zaagmuldersweg/Gorechtkade (Gorechtbuurt)  
A lawn with a couple of playground attributes, benches and a small building (fig. 39). It is accessible by a small path in between houses, but closed off by a gate which can be locked (fig. 38). Contact with the association made clear that the focus shifted towards elderly, and that they are not active as a playground association anymore. This might be why the gate was open during the observation.



Figure 38. Entry of the playground of B.S.V. Ons Belang (Gorechtbuurt) (own photo – taken on 06-04-2020 AM).



Figure 39. Playground B.S.V. Ons Belang (Gorechtbuurt) (own photo – taken on 06-04-2020 AM).

- Neighbourhood and playground association (B.S.V.) F.E.O. – Behind closed building block at Gorechtkade/A.P.Fokkerstraat (Gorechtbuurt)  
A large, rectangular-shaped lawn with a diversity of playground equipment (fig. 40 & 41) and benches, including a soccer/basketball field. Most of the playground equipment is made of wood and designed in a somewhat hilly landscape. This playground is publicly accessible via an alley, but it was closed off during the observation because of COVID-29 (fig. 42).



Figure 40. Playground B.S.V. F.E.O. (Gorechtbuurt) (own photo – taken on 06-04-2020 AM).



Figure 41. Playground B.S.V. F.E.O. (Gorechtbuurt) (De Speeltuincentrale, n.d.).



Figure 42. Explanation why the playground is closed (own photo – taken on 06-04-2020 AM).

In addition to playgrounds, there are also several other spots in Oosterparkwijk that facilitates people to be active. North of the Pioenpark is a publicly accessible tennis court and a lawn with two soccer goals (fig. 43). South of the Pioenpark, next to the playground of B.S.V. Oosterpark is also a lawn with two soccer goals and a Cruyff court (fig. 44). Both the north (fig. 46) and south side of the Oosterpark have a soccer field as well. The south side of the Oosterpark also has a basketball field and a panna cage (fig. 45).



Figure 43. Tennis court, playground and soccer field north of the Pioenpark (Vogelbuurt/Florabuurt) (own photo – taken on 31-03-2020 PM).



Figure 44. Soccer field and Cruyff Court at the corner of Pioenstraat and Resedastraat (Florabuurt) (own photo – taken on 08-04-2020 PM).



Figure 45. Basketball field and panna cage on the south side of the Oosterpark (Vogelbuurt) (own photo – taken on 08-04-2020 PM).



Figure 46. Soccer field at the north side of the Oosterpark, viewing the corner of Parkzijde and Merelstraat (Vogelbuurt) (own photo – taken on 08-04-2020 PM).

In De Hoogte, there is one large playground (fig. 47) and a few smaller playgrounds scattered around the neighbourhood. Next to the large playground is a multisport field (Krajicek Foundation) (fig. 48). There are a few other sports areas in the neighbourhood (fig. 51). While in Oosterparkwijk most playgrounds are green, the playgrounds in De Hoogte are mostly grey (fig. 49 & 50). The observation showed that children found other opportunities to play as well (fig. 52). Also, people in the neighbourhood can join a quest by following tiles on the sidewalks (fig. 53 – 55).



Figure 47. Playground De Hoogte. Playground attributes on special surfaces or sand surrounded by a grass field and a broad pavement (own photo – taken on 06-04-2020 PM).



Figure 48. Multisport field Krajicek Foundation in De Hoogte (own photo – taken on 06-04-2020 PM).



Figure 49. Swing on the corner of Allersmastraat and Bedumerstraat (De Hoogte), provided with a special surface and a bench, but no green and not enclosed from the street (own photo – taken on 06-04-2020 PM).



Figure 50. Playground at the Johan de Wittstraat (De Hoogte), provided with a special surface and a fence, but no green (own photo – taken on 06-04-2020 PM).



Figure 51. Soccer cage at the Van Oldenbarneveltpaan (De Hoogte) (own photo – taken on 06-04-2020 PM).



Figure 52. Sidewalk chalk saying 'hi, this is a quest. Go that way.' (own photo – taken on 06-04-2020 PM).



Figure 53. Start of the tile quest (own photo – taken on 06-04-2020 PM).



Figure 54. One of the quest-tiles saying 'do you know your neighbour's name?' (own photo – taken on 06-04-2020 PM).



Figure 55. One of the quest-tiles saying 'don't be shy, do a crazy move' (own photo – taken on 06-04-2020 PM).

## 4.2.3. FOOD STORES

### 4.2.3.1. DISTRIBUTION OF FOOD STORES

Figures 56-58 show food stores such as supermarkets, restaurants and snack bars in the selected low-SES neighbourhoods that have an above-average (fig. 56) and below-average (fig. 57 & 58) PA score. As with the recreational facilities, the map for food stores shows a diversity per neighbourhood as well.

*Note:* As shown on the maps, food stores are unevenly spread around the neighbourhoods, with often either no food stores or many food stores. This might be because some neighbourhoods possibly have a centre-function. An example: Vinkhuizen-Noord has no food stores at all, while Vinkhuizen-Zuid has a cluster of food stores close to the border with Vinkhuizen-Noord. This implies that the food stores in Vinkhuizen-Zuid have a centre-function and intend to serve people from both Vinkhuizen-Noord and Vinkhuizen-Zuid (and people from other surrounding neighbourhoods). Because of the within-neighbourhood perspective of this research, this is not taken into account (see section 3.2.).

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#### SUFFICIENT PA

Vinkhuizen-Noord, Florabuurt and Damsterbuurt have no food stores at all. In De Wijert, Corpus den Hoorn and Selwerd supermarkets and restaurants are clustered in the middle of the neighbourhood. Food stores in Gorechtbuurt are spread around the neighbourhood. Indische Buurt has the highest number of food stores, mostly clustered on the South. This part of the neighbourhood is on the boundary of the city centre and the Noorderplantsoen.

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#### INSUFFICIENT PA

Noorderhoogebrug, Het Witte Lam, Woonschepenhaven, Lewenborg-West and Ruischerbrug have no food stores at all. In Lewenborg-Noord, Paddepoel-Noord, Vinkhuizen-Zuid, Beijum-Oost and Beijum-West, supermarkets and other food stores are clustered in the middle of the neighbourhood. In De Hoogte, food stores are clustered along the southern border. In Oosterhoogebrug, the food stores are clustered on the west side while supermarkets are clustered on the eastern side of the neighbourhood. Paddepoel-Zuid, Ulgersmaborg, Vogelbuurt, Bloemenbuurt and Lewenborg-Zuid have few food stores.

## Food stores in low-SES neighbourhoods with an above-average PA score



Figure 56. Overview of the food stores in the selected low-SES neighbourhoods that are sufficiently physically active.

## Food stores in low-SES neighbourhoods with a below-average PA score (1)



Figure 57. Overview of the food stores in the selected low-SES neighbourhoods that are insufficiently physically active (part 1).

## Food stores in low-SES neighbourhoods with a below-average PA score (2)



Figure 58. Overview of the food stores in the selected low-SES neighbourhoods that are insufficiently physically active (part 2).

#### 4.2.3.2. THE NUMBERS BEHIND THE MAPS

Table 16 shows the ranking of scores for the variables [number of food stores] and [food store density]. Most of the neighbourhoods with an above-average PA score are in the top 10 of the ranking for both number the number of food stores and the food store density.

Table 14, which shows the average scores per variable for both the sufficiently and insufficiently physically active neighbourhoods, indicates the same. The average score of the sufficient PA neighbourhoods is twice as high as the average of the insufficient PA neighbourhoods.

Table 14. Descriptives of the variables [number of food stores] and [food store density].

Variable	Above-average PA score (N = 8)			Below-average PA score (N = 17)		
	Min. / Max.	Mean	Std. Deviation	Min. / Max.	Mean	Std. Deviation
<b>Number of food stores</b>	0 – 23	6.38	7.73	0 – 18	3.88	4.78
<b>Food store density</b>	0 – 0.32	0.10	0.11	0 – 0.27	0.06	0.07

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the number of food stores and food store density. There was no significant regression found for none of these variables (table 15). As with the recreational facilities, this might be because of the limited number of cases (Field, 2014).

Table 15. Output of the simple linear regression for the dependent variable [% meets physical activity guideline] and the independent variables representing food stores.

Variable	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>	<i>F(1,23)=</i>	<i>R<sup>2</sup></i>	<i>95% CI</i>
<b>Number of food stores</b>	0.093	0.108	0.177	0.397	0.746	0.031	(-0.130, 0.317)
<b>Food stores density</b>	10.460	7.098	0.294	0.154	2.172	0.086	(-4.223, 25.142)

Table 16. Ranking of the low-SES neighbourhood scores for the variables [number of food stores] and [food store density]. The scores are ranked from high (i.e. much food stores) to low (i.e. few food stores). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Number of food stores	Neighbourhood	Food store density
1.	Indische buurt	23	Indische buurt	0.32
2.	Paddepoel-Noord	18	Paddepoel-Noord	0.27
3.	Selwerd	10	Gorechtbuurt	0.18
4.	Beijum-Oost	9	Lewenborg-Noord	0.13
5.	Lewenborg-Noord	8	Bloemenbuurt	0.13
6.	Vinkhuizen-Zuid	7	Selwerd	0.12
7.	De Wijert	7	De Wijert	0.12
8.	Gorechtbuurt	7	De Hoogte	0.10
9.	De Hoogte	6	Beijum-Oost	0.10
10.	Oosterhoogebrug	6	Vinkhuizen-Zuid	0.07
11.	Corpus den Hoorn	4	Oosterhoogebrug	0.06
12.	Beijum-West	4	Vogelbuurt	0.05
13.	Bloemenbuurt	3	Corpus den Hoorn	0.04
14.	Vogelbuurt	2	Beijum-West	0.03
15.	Lewenborg-Zuid	1	Paddepoel-Zuid	0.02
16.	Paddepoel-Zuid	1	Lewenborg-Zuid	0.02
17.	Ulgersmaborg	1	Ulgersmaborg	0.01
18.	Lewenborg-West	0	Woonschepenhaven	0.00
19.	Florabuurt	0	Lewenborg-West	0.00
20.	Woonschepenhaven	0	Florabuurt	0.00
21.	Damsterbuurt	0	Damsterbuurt	0.00
22.	Vinkhuizen-Noord	0	Vinkhuizen-Noord	0.00
23.	Noorderhoogebrug	0	Ruischerbrug	0.00
24.	Ruischerbrug	0	Noorderhoogebrug	0.00
25.	Het Witte Lam	0	Het Witte Lam	0.00
<i>Descriptives (N = 25)</i>		<i>M = 4.68, SD = 5.84</i>		<i>M = 0.07, SD = 0.09</i>

## 4.2.4. MAINTENANCE AND DISORDER

### 4.2.4.1. SATISFACTION PER NEIGHBOURHOOD

The previous sections showed both the location and amount of several aspects of the physical environment per neighbourhood. The liveability survey (by OIS Groningen, 2018) provides insight into the satisfaction of citizens about the maintenance of these aspects.

#### SUFFICIENT PA

For the low-SES neighbourhoods that are sufficiently physically active, the scores per variable are quite similar distributed (fig. 59). In all neighbourhoods, the percentage of people that is satisfied with the maintenance of bicycle paths and roads is around 80% ( $M = 80$ ,  $SD = 1.77$  and  $M = 79.25$ ,  $SD = 1.58$  respectively). This is higher than the municipality's average, which is 78% and 77% respectively.

In all neighbourhoods, people are not that satisfied with the cleanness of the environment, as all neighbourhoods score below ( $M = 59.88$ ,  $SD = 4.36$ ) the municipality's average (66%).

Opinions on the maintenance of green and playgrounds are divided. Around 77% of the people in Damsterbuurt, De Wijert, Florabuur, Gorechtbuurt and Indische Buurt are satisfied with the maintenance of playgrounds, while in Corpus den Hoorn, Selwerd and Vinkhuizen-Noord this is only 69% ( $M = 74.13$ ,  $SD = 4.16$ ). Regarding the maintenance of green, around 64% of the people are satisfied in Selwerd and Vinkhuizen-Noord, compared to 77% in Indische Buurt ( $M = 69.38$ ,  $SD = 4.27$ ).

The overall deterioration score (in which 1 is little and 10 is much deterioration) ranges from 2.6 in Corpus den Hoorn to 4 in Vinkhuizen-Noord ( $M = 3.37$ ,  $SD = 0.45$ ).

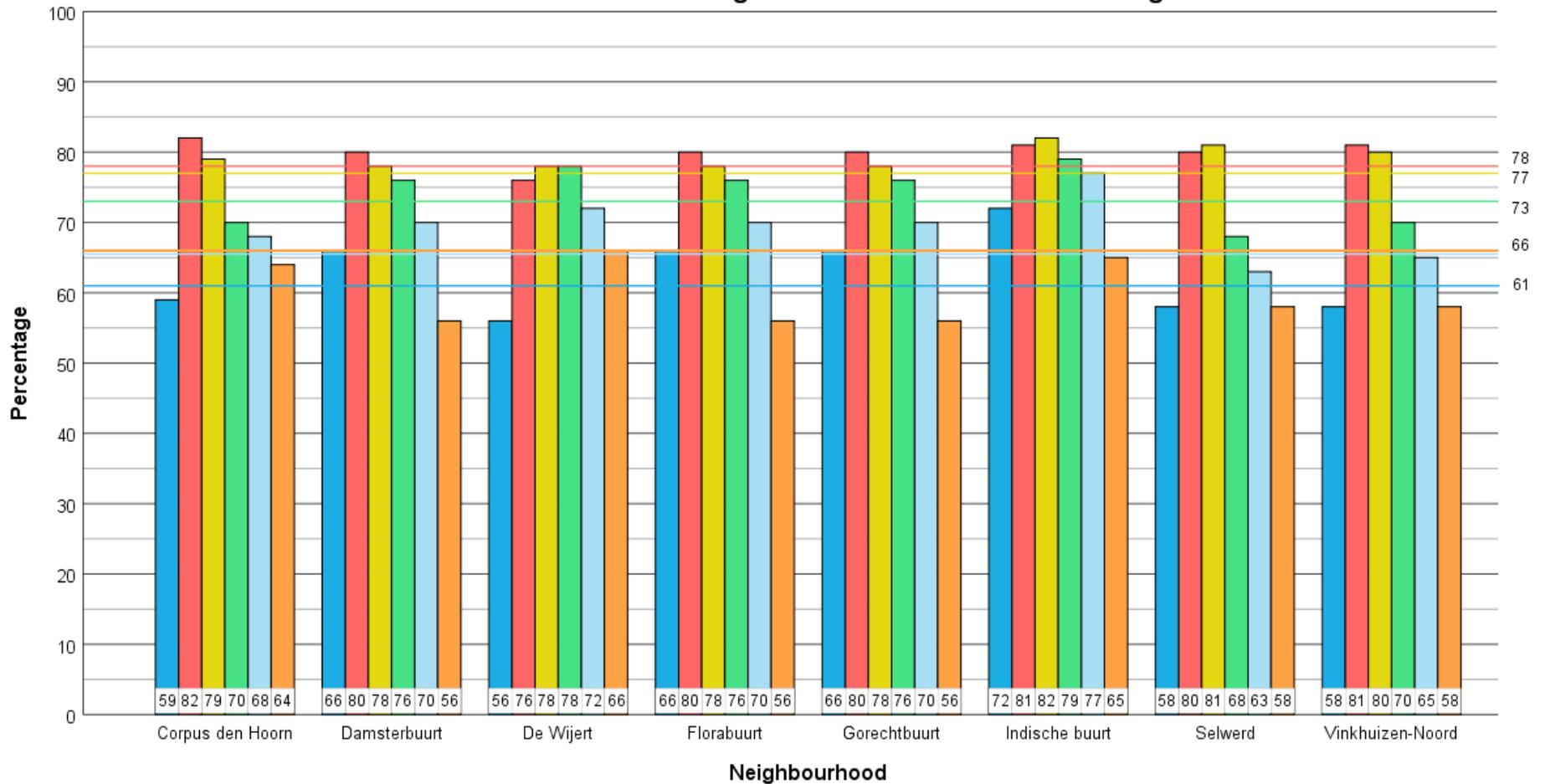
#### INSUFFICIENT PA

Figure 60 shows that for the low-SES neighbourhoods that are insufficiently physically active the distribution of scores per variable differs. Half of the neighbourhoods (including e.g. Paddepoel-Noord and Bloemenbuurt) are very satisfied (around 80%) with the maintenance of bicycle paths, while the other half (e.g. Lewenborg-Noord) is less satisfied (around 67%) ( $M = 74.78$ ,  $SD = 6.41$ ). Large differences exist also for the satisfaction about the maintenance of roads, ranging from around 80% in Paddepoel-Noord to 64% in Het Witte Lam ( $M = 72.94$ ,  $SD = 6.08$ ). For all neighbourhoods, people are least satisfied with the maintenance of sidewalks, ranging from 49% in Lewenborg-Zuid to 66% in Bloemenbuurt ( $M = 57.11$ ,  $SD = 5.84$ ).

Around 70% of the people are satisfied with the maintenance of playgrounds in all neighbourhoods ( $SD = 3.77$ ). Regarding the maintenance of green, opinions are divided. In Lewenborg, only 43% is satisfied with the maintenance of green, while in Paddepoel 72% is satisfied ( $M = 60.39$ ,  $SD = 10.11$ ).

The overall deterioration score (in which 1 is little and 10 is much deterioration) ranges from 1.70 in Noorderhoogebrug, Het Witte Lam and Ruischerbrug to 4.10 in De Hoogte ( $M = 3.18$ ,  $SD = 0.90$ ).

Maintenance and disorder in low-SES neighbourhoods with an above-average PA score



- Satisfaction maintenance sidewalks (%)
- Satisfaction maintenance bicycle paths (%)
- Satisfaction maintenance roads (%)
- Satisfaction maintenance playgrounds (%)
- Satisfaction maintenance green (%)
- Satisfaction cleanness of living environment (%)

Figure 59. Satisfaction scores (%) about the maintenance of several aspects of the physical environment per low-SES neighbourhood that is sufficiently physically active. The horizontal lines represent the municipality's average score per variable.

Maintenance and disorder in low-SES neighbourhoods with a below-average PA score

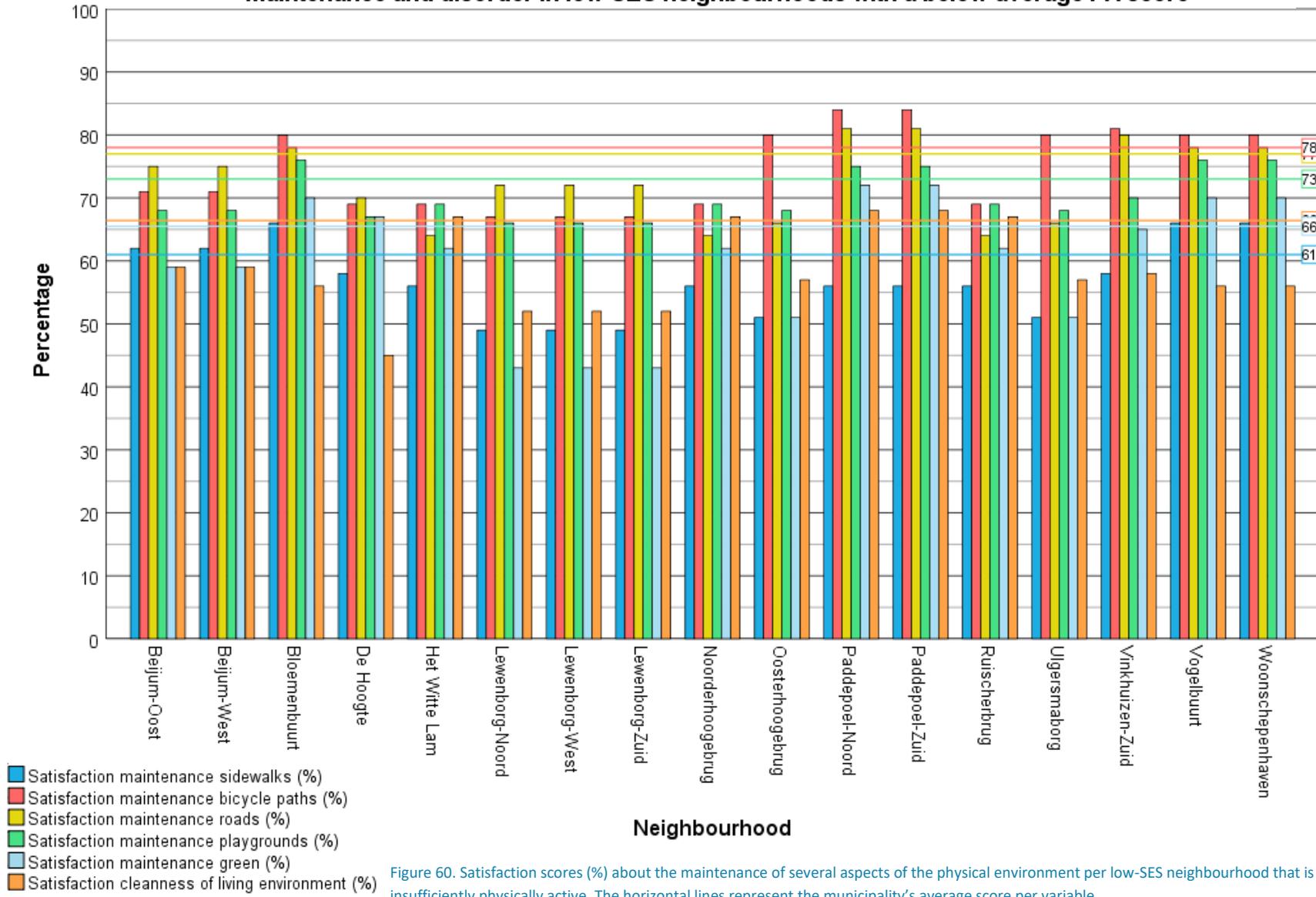


Figure 60. Satisfaction scores (%) about the maintenance of several aspects of the physical environment per low-SES neighbourhood that is insufficiently physically active. The horizontal lines represent the municipality's average score per variable.

#### 4.2.4.2. THE NUMBERS BEHIND THE GRAPHS

Tables 19 & 20 show the ranking of scores for the variables representing maintenance and disorder. Most of the neighbourhoods with an above-average PA score are ranked at the top of the ranking. Only for the variable [satisfaction cleanness of living environment], the insufficient PA neighbourhoods make up most of the top 10. The average scores per variable (table 17) indicate this as well: for all variables, the average scores are higher for the neighbourhoods with an above-average PA score compared to the neighbourhoods with a below-average PA score.

Table 17. Descriptives of the variables representing maintenance and disorder.

Variable	Above-average PA score (N = 8)			Below-average PA score (N = 17)		
	Min. / Max.	Mean	Std. Deviation	Min. / Max.	Mean	Std. Deviation
Satisfaction maintenance sidewalks (%)	56 – 72	62.63	5.63	49 – 66	56.88	5.94
Satisfaction maintenance bicycle paths (%)	76 – 82	80.00	1.77	67 – 84	74.59	6.56
Satisfaction maintenance roads (%)	78 – 82	79.25	1.58	64 – 81	72.71	6.18
Satisfaction maintenance playgrounds (%)	68 – 79	74.13	4.15	66 – 76	70.12	3.82
Satisfaction maintenance green (%)	63 – 77	69.38	4.27	43 – 72	60.06	10.32
Satisfaction cleanness of living environment (%)	56 – 66	59.88	4.36	45 – 68	58.59	6.76
Deterioration score (scale 1 – 10)	2.60 – 4.00	3.37	0.45	1.70 – 4.10	3.18	0.90

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on satisfaction maintenance sidewalks (%), satisfaction maintenance bicycle paths (%), satisfaction maintenance roads (%), satisfaction maintenance playgrounds (%), satisfaction maintenance green (%), satisfaction cleanness of living environment (%) and deterioration score.

The outcomes (positive *R*) correspond to the insights from the graphs: sufficient PA neighbourhoods are more satisfied than the insufficient PA neighbourhoods. Significant regression equations were found for each variable, except for the variables [satisfaction cleanness living environment] and [deterioration score] (table 18).  $R^2$  indicates that each of the variables, separately, explains around 30% of the variance in [% meets physical activity guideline].

Table 18. Output of the simple linear regression for the dependent variable [% meets physical activity guideline] and the independent variables representing maintenance and disorder.

Variable	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>	<i>F(1,23)=</i>	<i>R<sup>2</sup></i>	<i>95% CI</i>
Satisfaction maintenance sidewalks (%)	0.219	0.090	0.451	0.023	5.888	0.204	(0.032, 0.406)
Satisfaction maintenance bicycle paths (%)	0.307	0.085	0.600	0.002	12.960	0.360	(0.130, 0.483)
Satisfaction maintenance roads (%)	0.266	0.092	0.518	0.008	8.443	0.269	(0.077, 0.455)
Satisfaction maintenance playgrounds (%)	0.427	0.120	0.595	0.002	12.636	0.355	(0.178, 0.675)
Satisfaction maintenance green (%)	0.185	0.053	0.590	0.002	12.301	0.348	(0.076, 0.294)
Satisfaction cleanness living environment (%)	0.050	0.106	0.099	0.638	0.227	0.010	(-0.169, 0.269)
Deterioration score	0.277	0.802	0.072	0.733	0.119	0.005	(-1.381, 1.935)

#### 4.2.5. SUMMARIZATION INFRASTRUCTURE

Both the spatial analysis as well as the observation showed that the selected low-SES neighbourhoods are very diverse regarding their infrastructure. Not only are there differences between the sufficient and insufficiently active neighbourhoods, but also between neighbourhoods within the same subgroup<sup>12</sup>.

- **Street design**  
No large differences found between neighbourhoods. The greatest part of most neighbourhoods consists of rented housing, are accessible by public transport and the streets seem to be well-lit.
- **Recreational facilities**  
The sufficient PA neighbourhoods have, on average, more sports areas than the insufficient PA neighbourhoods. The latter have, however, more playgrounds. Observation showed that differences exist between the design and attributes of playgrounds, with mostly 'green' playgrounds in Oosterparkwijk and 'grey' playgrounds in De Hoogte.
- **Food stores**  
In both subgroups are neighbourhoods that have little to no food stores or cluster of food stores. This might be because some neighbourhoods have a centre-function.
- **Maintenance and disorder**  
The sufficient PA neighbourhoods are more satisfied with the maintenance of aspects of the living environment but are slightly more deteriorated than the insufficient PA neighbourhoods.
- Out of all the variables regarding infrastructure, only five variables are significant predictors of PA behaviour. These are all satisfaction scores about maintenance.

<sup>12</sup> The overarching group low-SES neighbourhoods is divided into two subgroups: the sufficient and insufficient PA neighbourhoods.

Table 19. Ranking of the low-SES neighbourhood scores for the variables representing maintenance and disorder (part 1). The scores are ranked from high (i.e. very satisfied) to low (i.e. less satisfied). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Satisfaction maintenance sidewalks (%)	Neighbourhood	Satisfaction maintenance bicycle paths (%)	Neighbourhood	Satisfaction maintenance roads (%)
1.	Indische Buurt	72	Paddepoel-Noord	84	Indische Buurt	82
2.	Bloemenbuurt	66	Paddepoel-Zuid	84	Paddepoel-Noord	81
3.	Damsterbuurt	66	Corpus den Hoorn	82	Paddepoel-Zuid	81
4.	Florabuurt	66	Indische Buurt	81	Selwerd	81
5.	Gorechtbuurt	66	Vinkhuizen-Noord	81	Vinkhuizen-Noord	80
6.	Vogelbuurt	66	Vinkhuizen-Zuid	81	Vinkhuizen-Zuid	80
7.	Woonschepenhaven	66	Bloemenbuurt	80	Corpus den Hoorn	79
8.	Beijum-Oost	62	Damsterbuurt	80	Bloemenbuurt	78
9.	Beijum-West	62	Florabuurt	80	Damsterbuurt	78
10.	Corpus den Hoorn	59	Gorechtbuurt	80	Florabuurt	78
11.	De Hoogte	58	Vogelbuurt	80	Gorechtbuurt	78
12.	Selwerd	58	Woonschepenhaven	80	Vogelbuurt	78
13.	Vinkhuizen-Noord	58	Selwerd	80	Woonschepenhaven	78
14.	Vinkhuizen-Zuid	58	Oosterhoogebrug	80	De Wijert	78
15.	De Wijert	56	Ulgersmaborg	80	Beijum-Oost	75
16.	Het Witte Lam	56	De Wijert	76	Beijum-West	75
17.	Noorderhoogebrug	56	Beijum-Oost	71	Lewenborg-Noord	72
18.	Paddepoel-Noord	56	Beijum-West	71	Lewenborg-West	72
19.	Paddepoel-Zuid	56	De Hoogte	69	Lewenborg-Zuid	72
20.	Ruischerbrug	56	Het Witte Lam	69	De Hoogte	70
21.	Oosterhoogebrug	51	Noorderhoogebrug	69	Oosterhoogebrug	66
22.	Ulgersmaborg	51	Ruischerbrug	69	Ulgersmaborg	66
23.	Lewenborg-Noord	49	Lewenborg-Noord	67	Het Witte Lam	64
24.	Lewenborg-West	49	Lewenborg-West	67	Noorderhoogebrug	64
25.	Lewenborg-Zuid	49	Lewenborg-Zuid	67	Ruischerbrug	64
<i>Descriptives (N = 25)</i>		<i>M = 58.72, SD = 6.34</i>		<i>M = 76.32, SD = 6.02</i>		<i>M = 74.80, SD = 5.99</i>

Table 20. Ranking of the low-SES neighbourhood scores for the variables representing maintenance and disorder (part 2). The scores are ranked from high (i.e. very satisfied) to low (i.e. less satisfied). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Satisfaction maintenance playgrounds (%)	Neighbourhood	Satisfaction maintenance green (%)	Neighbourhood	Satisfaction cleanness of living environment (%)
1.	Indische Buurt	79	Indische Buurt	77	Paddepoel-Noord	68
2.	De Wijert	78	De Wijert	72	Paddepoel-Zuid	68
3.	Bloemenbuurt	76	Paddepoel-Noord	72	Het Witte Lam	67
4.	Damsterbuurt	76	Paddepoel-Zuid	72	Noorderhoogebrug	67
5.	Florabuurt	76	Bloemenbuurt	70	Ruischerbrug	67
6.	Gorechtbuurt	76	Damsterbuurt	70	De Wijert	66
7.	Vogelbuurt	76	Florabuurt	70	Indische Buurt	65
8.	Woonschepenhaven	76	Gorechtbuurt	70	Corpus den Hoorn	64
9.	Paddepoel-Noord	75	Vogelbuurt	70	Beijum-Oost	59
10.	Paddepoel-Zuid	75	Woonschepenhaven	70	Beijum-West	59
11.	Vinkhuizen-Noord	70	Corpus den Hoorn	68	Vinkhuizen-Noord	58
12.	Vinkhuizen-Zuid	70	De Hoogte	67	Vinkhuizen-Zuid	58
13.	Corpus den Hoorn	70	Vinkhuizen-Noord	65	Selwerd	58
14.	Het Witte Lam	69	Vinkhuizen-Zuid	65	Oosterhoogebrug	57
15.	Noorderhoogebrug	69	Selwerd	63	Ulgersmaborg	57
16.	Ruischerbrug	69	Het Witte Lam	62	Bloemenbuurt	56
17.	Selwerd	68	Noorderhoogebrug	62	Damsterbuurt	56
18.	Beijum-Oost	68	Ruischerbrug	62	Florabuurt	56
19.	Beijum-West	68	Beijum-Oost	59	Gorechtbuurt	56
20.	Oosterhoogebrug	68	Beijum-West	59	Vogelbuurt	56
21.	Ulgersmaborg	68	Oosterhoogebrug	51	Woonschepenhaven	56
22.	De Hoogte	67	Ulgersmaborg	51	Lewenborg-Noord	52
23.	Lewenborg-Noord	66	Lewenborg-Noord	43	Lewenborg-West	52
24.	Lewenborg-West	66	Lewenborg-West	43	Lewenborg-Zuid	52
25.	Lewenborg-Zuid	66	Lewenborg-Zuid	43	De Hoogte	45
<i>Descriptives (N = 25)</i>		<i>M = 71.40, SD = 4.29</i>		<i>M = 63.04, SD = 9.80</i>		<i>M = 59.00, SD = 6.03</i>

## 4.3. PUBLIC GREEN AREAS

### 4.3.1. DISTRIBUTION OF GREEN

Figures 61-63 show green areas such as grass and trees in the selected low-SES neighbourhoods that have an above-average (fig. 61) and below-average (fig. 62 & 63) PA score. Noticeable is the diversity in the amount and type of green per neighbourhood.

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#### 4.3.1.1. SUFFICIENT PA

Vinkhuizen-Noord, Selwerd, Corpus den Hoorn and De Wijert have (overall) a large amount of green, while Gorechtbuurt and Damsterbuurt have less green. Selwerd, Indische Buurt, Florabuurrt and De Wijert have a park with water features and seating equipment. The location of green also varies per neighbourhood. Vinkhuizen-Noord, for example, is surrounded by green areas, while there is little green in between the building blocks. In Selwerd and Indische Buurt, green areas are scattered around the neighbourhood. Trees are visible in almost every street in Vinkhuizen-Noord, Selwerd, De Wijert, Corpus den Hoorn and Gorechtbuurt (the trees indicate the neighbourhood pattern), while in Florabuurrt and Damsterbuurt the trees are clustered in certain areas.

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#### 4.3.1.2. INSUFFICIENT PA

Beijum-Oost, Beijum-West, Vinkhuizen-Zuid, Paddepoel-Noord, Paddepoel-Zuid, Lewenborg-Noord, Lewenborg-Zuid and Lewenborg-West have (overall) a large amount of green (both trees and grass). Noorderhoogebrug has a large amount of green as well, but with less trees. Vogelbuurt, Bloemenbuurt, Ruischerbrug and Woonschepenhaven have less green. However, Vogelbuurt does have a large park.

In most of the neighbourhoods, the green is spread around the neighbourhood. Trees are visible in almost every street in all neighbourhoods (the trees often indicate the neighbourhood pattern). Bloemenbuurt deviates from the other neighbourhoods since it has little green areas and no trees in every street.

## Green areas in low-SES neighbourhoods with an above-average PA score



Figure 61. Overview of the green areas in the selected low-SES neighbourhoods that are sufficiently physically active. Appendix IX provides a map without trees.

## Green areas in low-SES neighbourhoods with a below-average PA score (1)



Figure 62. Overview of the green areas in the selected low-SES neighbourhoods that are insufficiently physically active (part 1). Appendix IX provides a map without trees.

## Green areas in low-SES neighbourhoods with a below-average PA score (2)



Figure 63. Overview of the green areas in the selected low-SES neighbourhoods that are insufficiently physically active (part 2). Appendix IX provides a map without trees.

### 4.3.2. THE NUMBERS BEHIND THE MAPS

The maps of the green areas (figures 61 – 63) show not only differences between the neighbourhoods that have an above-average PA score or that have a below-average PA score. They also indicate differences and similarities between both of these subgroups. On the eye, Vinkhuizen-Noord and Selwerd (which are sufficiently physically active) have a comparable amount of green as e.g. Lewenborg-West and Beijum-West (which are insufficiently physically active). The calculated percentage of green, m<sup>2</sup> of green per citizen and densities provide more specific information on these similarities and differences.

Figure 64 shows the percentage of green per neighbourhood for all low-SES neighbourhoods. The percentages range from 3.34% in Bloemenbuurt (insufficient PA score) to 56.43% in Noorderhoogebrug (insufficient PA score). The average percentage of green per low-SES neighbourhood is 22.13% (*SD* = 10.27). Noticeable is that the average percentage of green is lower in the neighbourhoods with an above-average PA score (20.8%) compared to the neighbourhoods with a below-average PA score (21.75%). Also noticeable is that six out of the eight neighbourhoods that are sufficiently physically active have less green than the average (21.75%) of the neighbourhoods that are insufficiently active. Out of the sufficient PA neighbourhoods, only Florabuurt and Vinkhuizen-Noord score above this average.

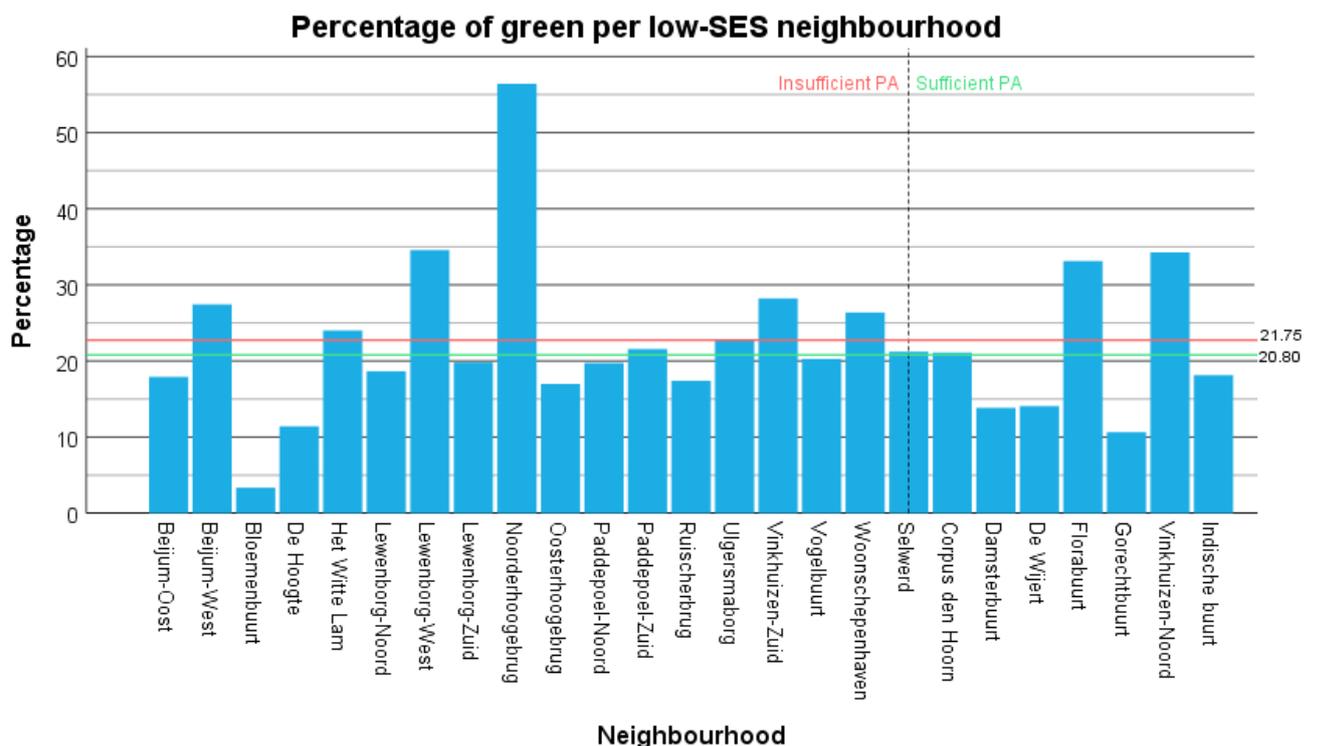


Figure 64. The percentage of green per low-SES neighbourhood. Neighbourhoods on the left side of the vertical dotted line are the neighbourhoods with a below-average PA score, the neighbourhoods on the right side of this line have an above-average PA score. The horizontal lines represent the average scores of the neighbourhoods that are sufficiently physically active (green) and insufficiently physically active (red).

Tables 22 & 23 show that neighbourhoods that are sufficiently physically active do not necessarily have a higher amount of green. Both the top 10 for the variable [percentage of green] and [m<sup>2</sup> of green per citizen] consists of only two neighbourhoods that are sufficiently physically active. Three of the sufficient PA neighbourhoods are among the five neighbourhoods that have the least percentage of green and the least m<sup>2</sup> of green per citizen. Regarding tree density, the sufficient PA neighbourhoods are ranked around the middle positions.

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on green area (hectares), percentage of green, m<sup>2</sup> of green per citizen, tree density, number of trees per citizen and number of trees per neighbourhood.

Noticeable is that all variables have a decreasing linear relationship with [% meets physical activity guideline] (negative  $R$ ). This corresponds to the insights from the maps (fig. 61-63), which show that there are insufficient PA neighbourhoods that are very green, and the graph (fig. 64), which shows that insufficient PA neighbourhoods have (on average) a higher percentage of green than the sufficient PA neighbourhoods. However, a significant regression equation was found for the variable [number of trees per citizen] only (table 21). Although this variable explains a quite amount of the variance in [% meets physical activity guideline],  $R^2$  (0.276) also indicates that there are other factors as well that are important in explaining PA behaviour.

Table 21. Output of the simple linear regression for the dependent variable [% meets physical activity guideline] and the independent variables representing public green areas.

Variable	<i>b</i>	<i>SE B</i>	$\beta$	<i>p</i>	<i>F(1,23)=</i>	<i>R</i> <sup>2</sup>	<i>95% CI</i>
<b>Green area (hectares)</b>	-0.042	0.068	-0.129	0.540	0.387	0.017	(-0.182, 0.098)
<b>Percentage of green</b>	-0.060	0.061	-0.201	0.335	0.970	0.040	(-0.187, 0.066)
<b>M<sup>2</sup> of green per citizen</b>	-0.003	0.002	-0.258	0.212	1.645	0.067	(-0.008, 0.002)
<b>Tree density</b>	-0.058	0.060	-0.200	0.339	0.955	0.040	(-0.182, 0.065)
<b>Number of trees per citizen</b>	-6.940	2.341	-0.526	0.007	8.786	0.276	(-11.783, -2.097)
<b>Number of trees per neighbourhood</b>	-0.001	0.001	-0.265	0.200	1.744	0.070	(-0.002, 0.000)

#### 4.3.3. OBSERVATION

Oosterparkwijk contains two large parks: the Pioenpark (Florabuurt) and the Oosterpark (Vogelbuurt). Another large green area can be found in the west part of the neighbourhood along the Gorechtkade (fig. 65), which has three large ponds surrounded by trees. The Pioenpark (fig. 68 & 69) is a rectangular shaped park located in the eastern part of the neighbourhood. It has two ponds, with a seating area and grass field in between them. People can walk around the two ponds via a footpath. On the south side of the park is the primary school ‘Siebe Jan Boumaschool’ and a large playground. The observation showed that the park is popular by dog owners. A lot of people also use it to go from one side of the neighbourhood to the other: the bicycle path that cuts through the park was frequently used during the observation moments.



Figure 65. One of the three ponds along the Gorechtkade (Gorechtbuurt) (own photo – taken on 31-03-2020 PM).

North-West of the Pioenpark is the Oosterpark (fig. 66 & 67). This park has one pond with two walking paths around it. Along these paths are benches. The south side of the park has a playground, a basketball field and a soccer field. The north side of the park also has a soccer field and a playground.



Figure 66. Oosterpark, viewing the east side (Vogelbuurt) (own photo – taken on 31-03-2020 PM).



Figure 67. Oosterpark, viewing the east side (Vogelbuurt) (own photo – taken on 31-03-2020 PM).



Figure 68. Grassfield and seating area in the Pioenpark (Florabuurt) (own photo – taken on 08-04-2020 PM).



Figure 69. Northern pond in the Pioenpark (Florabuurt) (own photo – taken on 31-03-2020 PM).

Next to the three larger green areas, which are all publicly accessible, there are other smaller-scale green areas as well in the Oosterparkwijk. Trees and bushes are visible in nearly every street: many of the houses have box trees marking their front garden and trees are located at the end of parking spots or along sidewalks. Scattered around the neighbourhood are smaller green areas, for example at Goudenregenplein (Bloemenbuurt) (fig. 70), Koekoekplein (Vogelbuurt) (fig. 71), Linnaeusplein (Gorechtbuurt), Hyacintstraat (Florabuurt) (fig. 72), Heesterpoort (Bloemenbuurt) (fig. 73), Jan Hissink Jansenstraat (Gorechtbuurt) (fig. 74) and Vinkenstraat (Vogelbuurt). These are, however, often not provided with benches.

De Hoogte has no park. Along the west side of the neighbourhood, next to the railway, is a green belt with a walking path (fig. 75). This area is not provided with seating equipment.



Figure 70. Goudenregenplein (Bloemenbuurt) (own photo – taken on 31-03-2020 PM).



Figure 71. Koekoekplein (Vogelbuurt) (own photo – taken on 31-03-2020 PM).



Figure 72. Hyacinthstraat (Florabuurt) (own photo – taken on 31-03-2020 PM).



Figure 73. Heesterpoort (Bloemenbuurt) (own photo – taken on 31-03-2020 PM).



Figure 74. Jan Hissink Jansenstraat (Gorechtbuurt) (own photo – taken on 31-03-2020 PM).



Figure 75. Walking path surrounded by green along the west border of De Hoogte (own photo – taken on 06-04-2020 PM).

#### 4.3.4. SUMMARIZATION PUBLIC GREEN AREAS

Both the spatial analysis as well as the observation showed that the selected low-SES neighbourhoods are diverse, but also have similarities regarding their public green areas.

- On average, all low-SES neighbourhoods seem to have a comparable amount of green: e.g. insufficient PA neighbourhoods consist, on average, for 21.75% out of green compared to 20.80% in the sufficient PA neighbourhoods.
- Regression analysis indicates that the amount of green is lower in the neighbourhoods that are sufficiently active.
- Only one variable is a significant predictor of PA behaviour: the number of trees per citizen. This might be because of the small sample size (Field, 2014).

Table 22. Ranking of the low-SES neighbourhood scores for the variables representing public green areas (part 1). The scores are ranked from high (i.e. much green) to low (i.e. little green). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Green area (hectares)	Neighbourhood	Percentage of green (of total neighbourhood area)	Neighbourhood	M <sup>2</sup> of green per citizen
1.	Beijum-West	32.77	Noorderhoogebrug	56.43	Noorderhoogebrug	988.18
2.	Vinkhuizen-Zuid	29.95	Lewenborg-West	34.57	Het Witte Lam	931.71
3.	Vinkhuizen-Noord	29.48	Vinkhuizen-Noord	34.27	Woonschepenhaven	222.17
4.	Noorderhoogebrug	28.16	Florabuurt	33.13	Ulgersmaborg	122.32
5.	Corpus den Hoorn	24.04	Vinkhuizen-Zuid	28.22	Lewenborg-West	100.32
6.	Ulgersmaborg	23.79	Beijum-West	27.44	Ruischerbrug	96.14
7.	Lewenborg-West	19.06	Woonschepenhaven	26.36	Florabuurt	80.07
8.	Selwerd	17.47	Het Witte Lam	24.00	Oosterhoogebrug	74.62
9.	Beijum-Oost	16.82	Ulgersmaborg	22.75	Damsterbuurt	69.86
10.	Oosterhoogebrug	16.49	Paddepoel-Zuid	21.55	Vinkhuizen-Zuid	61.88
11.	Paddepoel-Noord	13.33	Selwerd	21.22	Corpus den Hoorn	53.48
12.	Indische Buurt	13.10	Corpus den Hoorn	21.11	Beijum-West	52.30
13.	Lewenborg-Zuid	12.24	Vogelbuurt	20.28	Vinkhuizen-Noord	46.95
14.	Paddepoel-Zuid	11.93	Lewenborg-Zuid	19.80	Vogelbuurt	36.88
15.	Lewenborg-Noord	11.05	Paddepoel-Noord	19.75	Lewenborg-Zuid	34.81
16.	Florabuurt	9.45	Lewenborg-Noord	18.65	Lewenborg-Noord	29.87
17.	De Wijert	8.30	Indische Buurt	18.14	Paddepoel-Zuid	27.02
18.	Vogelbuurt	7.58	Beijum-Oost	17.90	Selwerd	26.78
19.	De Hoogte	6.56	Ruischerbrug	17.39	Beijum-Oost	25.98
20.	Damsterbuurt	5.17	Oosterhoogebrug	16.99	Paddepoel-Noord	24.69
21.	Ruischerbrug	4.52	De Wijert	14.08	De Wijert	17.42
22.	Het Witte Lam	4.19	Damsterbuurt	13.84	De Hoogte	16.89
23.	Gorechtbuurt	4.07	De Hoogte	11.41	Indische Buurt	15.36
24.	Woonschepenhaven	3.11	Gorechtbuurt	10.65	Gorechtbuurt	8.54
25.	Bloemenbuurt	0.78	Bloemenbuurt	3.34	Bloemenbuurt	2.70
<i>Descriptives (N = 25)</i>		<i>M = 14.14, SD = 9.39</i>		<i>M = 22.13, SD = 10.27</i>		<i>M = 126.68, SD = 255.17</i>

Table 23. Ranking of the low-SES neighbourhood scores for the variables representing public green areas (part 2). The scores are ranked from high (i.e. much green) to low (i.e. little green). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Tree density	Neighbourhood	Number of trees per citizen	Neighbourhood	Number of trees per neighbourhood
1.	Lewenborg-Zuid	37.98	Noorderhoogebrug	1.02	Lewenborg-Zuid	37.98
2.	Beijum-West	36.21	Lewenborg-West	0.88	Beijum-West	36.21
3.	Lewenborg-Noord	36.16	Ulgersmaborg	0.84	Lewenborg-Noord	36.16
4.	Beijum-Oost	34.37	Beijum-West	0.69	Beijum-Oost	34.37
5.	Lewenborg-West	30.27	Lewenborg-Zuid	0.67	Lewenborg-West	30.27
6.	Paddepoel-Noord	26.03	Lewenborg-Noord	0.58	Paddepoel-Noord	26.03
7.	Vinkhuizen-Noord	25.81	Oosterhoogebrug	0.51	Vinkhuizen-Noord	25.81
8.	Paddepoel-Zuid	24.61	Beijum-Oost	0.50	Paddepoel-Zuid	24.61
9.	Selwerd	24.60	Vinkhuizen-Zuid	0.47	Selwerd	24.60
10.	Indische Buurt	23.25	Florabuurt	0.47	Indische Buurt	23.25
11.	Vinkhuizen-Zuid	21.63	Het Witte Lam	0.47	Vinkhuizen-Zuid	21.63
12.	Florabuurt	19.49	Woonschepenhaven	0.41	Florabuurt	19.49
13.	De Wijert	19.36	Corpus den Hoorn	0.37	De Wijert	19.36
14.	Ulgersmaborg	15.54	Ruischerbrug	0.36	Ulgersmaborg	15.54
15.	De Hoogte	15.01	Vinkhuizen-Noord	0.35	De Hoogte	15.01
16.	Bloemenbuurt	14.92	Paddepoel-Noord	0.33	Bloemenbuurt	14.92
17.	Corpus den Hoorn	14.56	Damsterbuurt	0.32	Corpus den Hoorn	14.56
18.	Vogelbuurt	14.53	Selwerd	0.31	Vogelbuurt	14.53
19.	Gorechtbuurt	14.29	Paddepoel-Zuid	0.31	Gorechtbuurt	14.29
20.	Oosterhoogebrug	11.62	Vogelbuurt	0.26	Oosterhoogebrug	11.62
21.	Ruischerbrug	6.50	De Wijert	0.24	Ruischerbrug	6.50
22.	Damsterbuurt	6.35	De Hoogte	0.22	Damsterbuurt	6.35
23.	Noorderhoogebrug	5.85	Indische Buurt	0.20	Noorderhoogebrug	5.85
24.	Woonschepenhaven	4.83	Bloemenbuurt	0.12	Woonschepenhaven	4.83
25.	Het Witte Lam	1.20	Gorechtbuurt	0.11	Het Witte Lam	1.20
<i>Descriptives (N = 25)</i>		<i>M = 19.40, SD = 0.09</i>		<i>M = 0.44, SD = 0.23</i>		<i>M = 19.40, SD = 10.53</i>

## 4.4. SOCIAL ENVIRONMENT

### 4.4.1. NEIGHBOURHOOD SAFETY

#### 4.4.1.1. SAFETY PER NEIGHBOURHOOD

Figure 76 shows the scores concerning neighbourhood safety for the sufficient PA neighbourhoods. Selwerd, Indische Buurt and Gorechtbuurt have the highest number of police reports regarding both vandalism and physical abuse ( $M = 25.75$ ,  $SD = 12.56$  and  $M = 13$ ,  $SD = 7.46$  respectively). Florabuurt and Damsterbuurt have the least police reports. In Selwerd, most people feel unsafe (30%) compared to the other neighbourhoods ( $M = 21.38$ ,  $SD = 5.83$ ). In Corpus den Hoorn and De Wijert, the least people feel unsafe. Noticeable is that in Florabuurt and Damsterbuurt around 22% feels unsafe, while these neighbourhoods have the least amount of police reports.

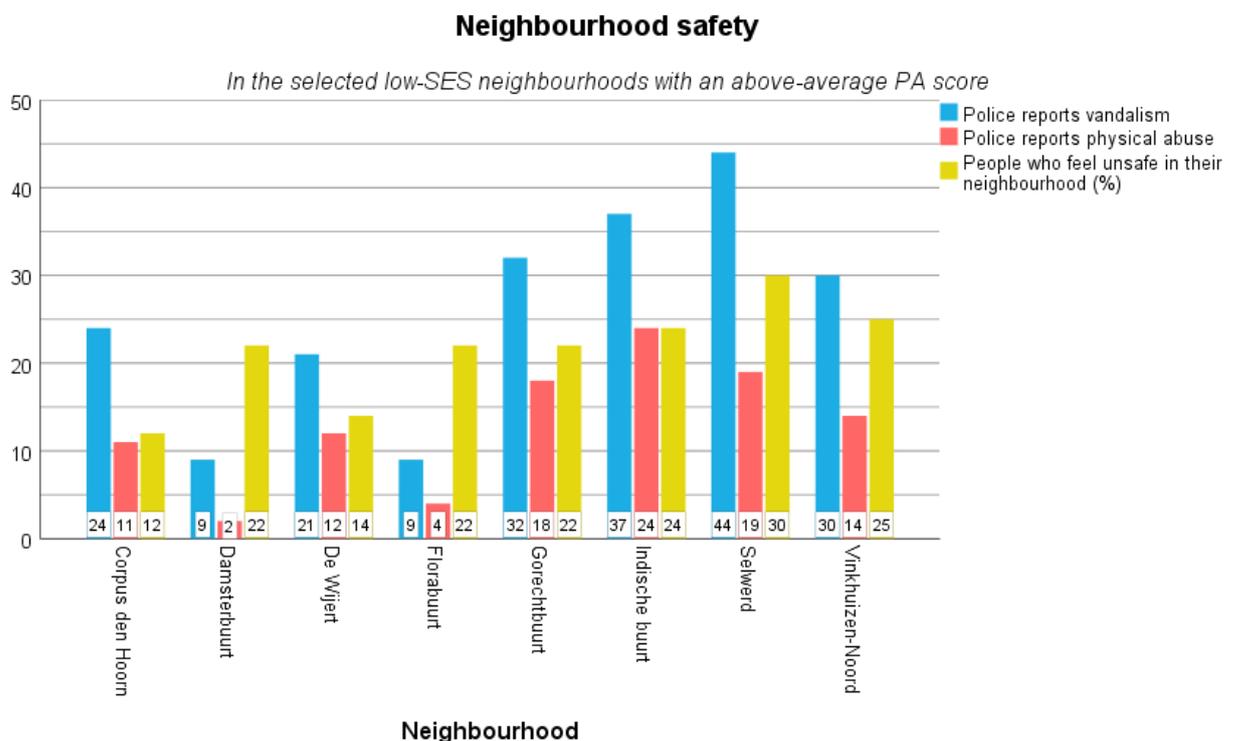


Figure 76. Overview of the neighbourhood safety scores in the selected low-SES neighbourhoods that are sufficiently physically active.

Figure 77 shows the scores concerning neighbourhood safety for the insufficient PA neighbourhoods. Vinkhuizen-Zuid (51), Beijum-Oost (49) and Paddepoel-Zuid (40) have the highest number of police reports regarding vandalism ( $M = 20.71$ ,  $SD = 16.67$ ). The number of police reports regarding physical abuse is the highest in Vinkhuizen-Zuid (26) and De Hoogte (24) ( $M = 9.65$ ,  $SD = 8.51$ ). Ruischerbrug, Woonschepenhaven, Ulgersmaborg and Noorderhoogebrug have the least police reports (there is no data available for Het Witte Lam). Vinkhuizen-Zuid (25%) and De Hoogte (27%) are also the neighbourhoods in which the highest percentage of people feels unsafe ( $M = 16.71$ ,  $SD = 6.97$ ), all other neighbourhoods have slightly lower scores. In Ruischerbrug, Ulgersmaborg, Het Witte Lam, Noorderhoogebrug and Oosterhoogebrug (also the neighbourhoods with the least number of police reports), the least people feel unsafe. However, noticeable is that in Woonschepenhaven around 22% feels unsafe, while this neighbourhood is among the neighbourhoods with the least number of police reports.

## Neighbourhood safety

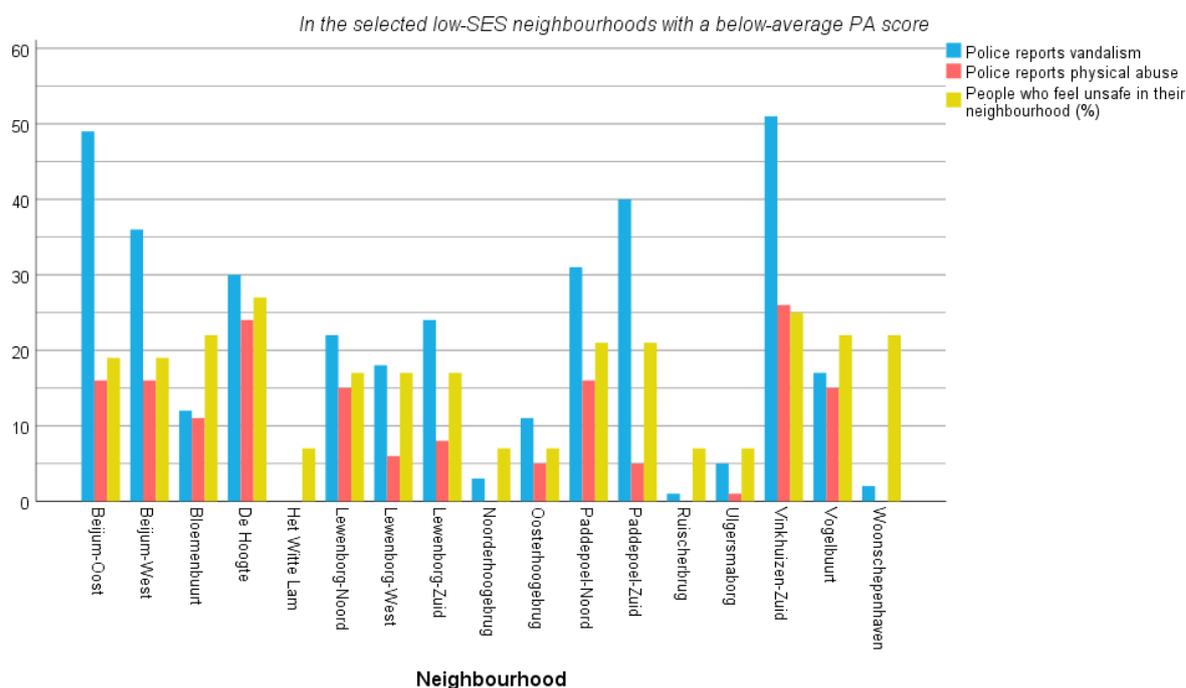


Figure 77. Overview of the neighbourhood safety scores in the selected low-SES neighbourhoods that are insufficiently physically active.

### 4.4.1.2. THE NUMBERS BEHIND THE GRAPHS

Table 26 shows the ranking of scores for the variables representing neighbourhood safety. The top 10 of neighbourhoods with the lowest number of police reports (both vandalism and physical abuse) consists of only two neighbourhoods with an above-average PA score. The same applies to the ranking of the percentage of people who feel unsafe in their neighbourhood. Noticeable is that the average number of police reports (both vandalism and physical abuse) and the average percentage of people who feels unsafe in their neighbourhood is higher in the neighbourhoods with an above-average PA score than in the neighbourhoods with a below-average PA score (table 24).

Table 24. Descriptives of the variables representing neighbourhood safety.

Variable	Above-average PA score (N = 8)			Below-average PA score (N = 17)		
	Min. / Max.	Mean	Std. Deviation	Min. / Max.	Mean	Std. Deviation
<b>Police report vandalism</b>	9 – 44	25.75	12.56	0 – 51	20.71	16.67
<b>Police report physical abuse</b>	2 – 24	13.00	7.46	0 – 26	9.65	8.51
<b>People who feel unsafe in their neighbourhood (%)</b>	12 – 30	21.38	5.83	7 – 27	16.71	6.97
<b>Nuisance score (scale 1 – 10)</b>	2.2 – 3.8	3.16	0.51	1.2 – 4.3	2.72	0.95

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on police report vandalism, police report physical abuse, people who feel unsafe in their neighbourhood (%) and nuisance score.

Noticeable is that all variables have an increasing linear relationship with [% meets physical activity guideline] (positive  $R$ ). This indicates that the higher the crime records, the higher the percentage of people that meets the PA guideline. Although this sounds surprising, this corresponds to the insights from the graphs, which showed that the sufficient PA neighbourhoods have more police reports regarding vandalism and physical abuse and a higher percentage of people that feels unsafe compared to the insufficient PA neighbourhoods. However, there was no significant regression equitation found for none of these variables (table 25).

Table 25. Output of the simple linear regression for the dependent variable [% meets physical activity guideline] and the independent variables representing neighbourhood safety.

Variable	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>	<i>F(1,23)=</i>	<i>R<sup>2</sup></i>	<i>95% CI</i>
Police report vandalism	0.025	0.041	0.127	0.544	0.379	0.016	(-0.060, 0.111)
Police report physical abuse	0.072	0.077	0.191	0.361	0.867	0.036	(-0.087, 0.230)
People who feel unsafe in their neighbourhood (%)	0.153	0.088	0.343	0.094	3.058	0.117	(-0.028, 0.335)
Nuisance score	1.081	0.722	0.298	0.148	2.241	0.089	(-0.413, 2.575)

Table 26. Ranking of the low-SES neighbourhood scores for the variables representing neighbourhood safety. The scores are ranked from low (i.e. safe) to high (i.e. unsafe). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Police reports vandalism	Neighbourhood	Police reports physical abuse	Neighbourhood	People who feel unsafe in their neighbourhood (%)
1.	Het Witte Lam	0	Het Witte Lam	0	Het Witte Lam	7
2.	Ruischerbrug	1	Ruischerbrug	0	Noorderhoogebrug	7
3.	Woonschepenhaven	2	Woonschepenhaven	0	Oosterhoogebrug	7
4.	Noorderhoogebrug	3	Noorderhoogebrug	0	Ruischerbrug	7
5.	Ulgersmaborg	5	Ulgersmaborg	1	Ulgersmaborg	7
6.	Damsterbuurt	9	Damsterbuurt	2	Corpus den Hoorn	12
7.	Florabuurt	9	Florabuurt	4	De Wijert	14
8.	Oosterhoogebrug	11	Oosterhoogebrug	5	Lewenborg-Noord	17
9.	Bloemenbuurt	12	Paddepoel-Zuid	5	Lewenborg-West	17
10.	Vogelbuurt	17	Lewenborg-West	6	Lewenborg-Zuid	17
11.	Lewenborg-West	18	Lewenborg-Zuid	8	Beijum-Oost	19
12.	De Wijert	21	Bloemenbuurt	11	Beijum-West	19
13.	Lewenborg-Noord	22	Corpus den Hoorn	11	Paddepoel-Noord	21
14.	Corpus den Hoorn	24	De Wijert	12	Paddepoel-Zuid	21
15.	Lewenborg-Zuid	24	Vinkhuizen-Noord	14	Bloemenbuurt	22
16.	Vinkhuizen-Noord	30	Vogelbuurt	15	Damsterbuurt	22
17.	De Hoogte	30	Lewenborg-Noord	15	Florabuurt	22
18.	Paddepoel-Noord	31	Paddepoel-Noord	16	Gorechtbuurt	22
19.	Gorechtbuurt	32	Beijum-West	16	Vogelbuurt	22
20.	Beijum-West	36	Beijum-Oost	16	Woonschepenhaven	22
21.	Indische Buurt	37	Gorechtbuurt	18	Indische Buurt	24
22.	Paddepoel-Zuid	40	Selwerd	19	Vinkhuizen-Noord	25
23.	Selwerd	44	De Hoogte	24	Vinkhuizen-Zuid	25
24.	Beijum-Oost	49	Indische Buurt	24	De Hoogte	27
25.	Vinkhuizen-Zuid	51	Vinkhuizen-Zuid	26	Selwerd	30
<i>Descriptives (N = 25)</i>		<i>M = 22.32, SD = 15.40</i>		<i>M = 10.72, SD = 8.19</i>		<i>M = 18.20, SD = 6.87</i>

## 4.4.2. SOCIAL CAPITAL

### 4.4.2.1. SOCIAL CAPITAL PER NEIGHBOURHOOD

Figure 78 shows the scores concerning social capital for the sufficient PA neighbourhoods. In all neighbourhoods, people feel that they have sufficient social contacts ( $M = 96.25$ ,  $SD = 1.04$ ). The majority of people in all neighbourhoods perceives their contact with neighbours as good ( $M = 63.75$ ,  $SD = 2.44$ ). Around 50% has at least once a week contact with their neighbours ( $M = 52.25$ ,  $SD = 4.03$ ). There are no large differences between the neighbourhoods: for all three variables, the scores are similarly distributed per neighbourhood.

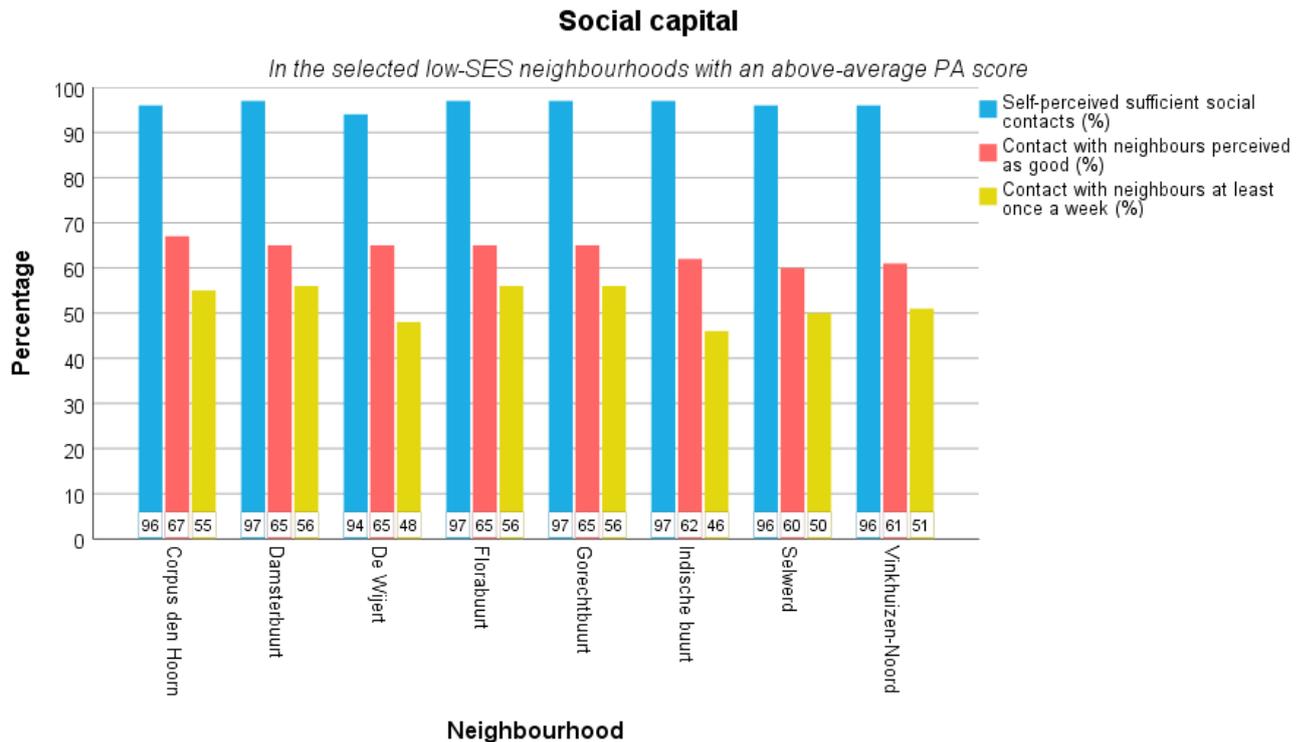


Figure 78. Overview of the social capital scores in the selected low-SES neighbourhoods that are sufficiently physically active.

Figure 79 shows the scores concerning social capital for the insufficient PA neighbourhoods. In all neighbourhoods, people feel that they have sufficient social contacts ( $M = 96.18$ ,  $SD = 1.19$ ). The majority of people in all neighbourhoods perceives their contact with neighbours as good ( $M = 68.59$ ,  $SD = 10.16$ ). However, there are differences between the neighbourhoods as scores range from over 80% in The Witte Lam, Noorderhoogebrug and Ruischerbrug to only 47% in de Hoogte. Around 60% of the people in all neighbourhoods have contact with their neighbours at least once a week ( $M = 59.29$ ,  $SD = 6.33$ ). For this variable, it is again De Hoogte which scores lowest (47%).

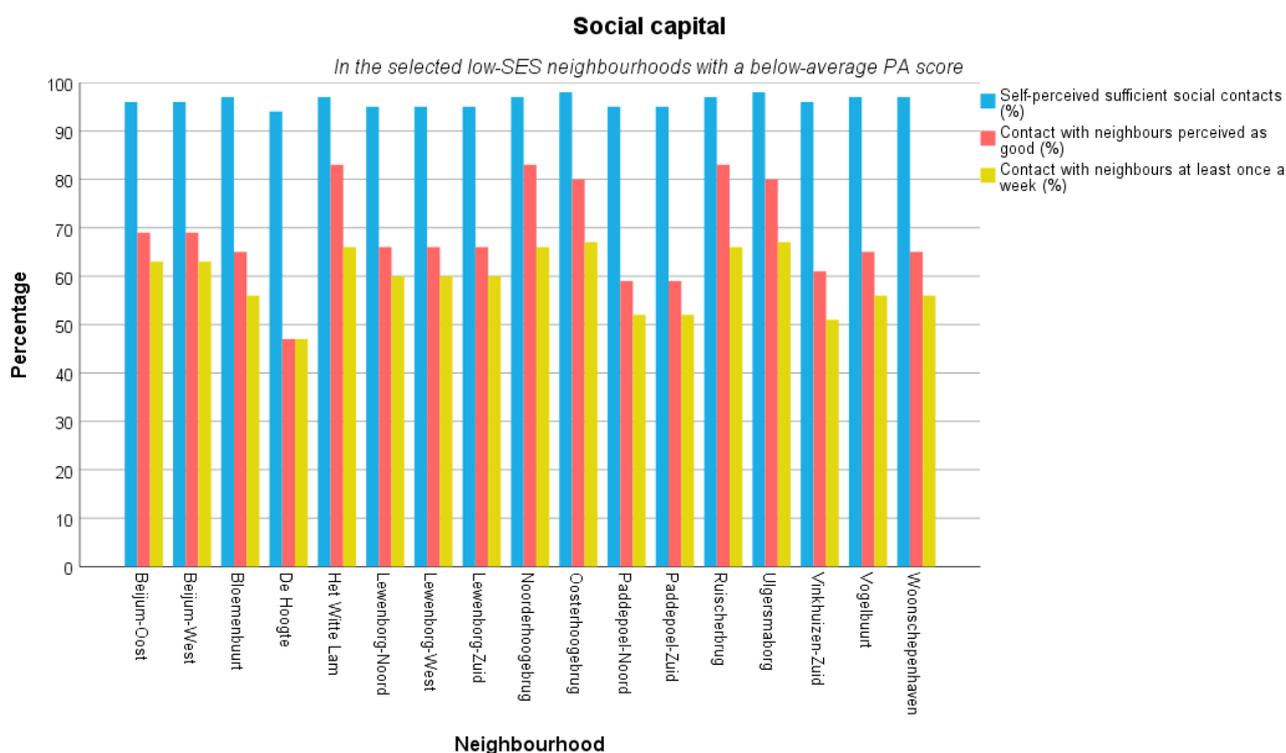


Figure 79. Overview of the social capital scores in the selected low-SES neighbourhoods that are insufficiently physically active.

#### 4.4.2.2. THE NUMBERS BEHIND THE GRAPHS

Table 29 shows the ranking of scores for the variables representing social capital. Most neighbourhoods with an above-average PA score are outside the top 10 for the variable [contact with neighbours perceived as good]. Also, all neighbourhoods with an above-average PA score are among the low-SES neighbourhoods that have the least contact with neighbours. Noticeable is that the average scores for the variables are higher in the neighbourhoods with a below-average PA score than in the neighbourhoods with an above-average PA score (table 27).

Table 27. Descriptives of the variables representing social capital.

Variable	Above-average PA score (N = 8)			Below-average PA score (N = 17)		
	Min. / Max.	Mean	Std. Deviation	Min. / Max.	Mean	Std. Deviation
Self-perceived sufficient social contacts (%)	94 – 97	96.25	1.04	94 – 98	96.18	1.19
Contact with neighbours perceived as good (%)	60 – 67	63.75	2.44	47 – 83	68.59	10.16
Contact with neighbours at least once a week (%)	46 – 56	52.25	4.03	47 – 67	59.29	6.33

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on self-perceived sufficient social contacts (%), contact with neighbours at least once a week (%) and contact with neighbours perceived as good (%).

As the graphs already indicated, is that there is a negative relationship between contact with neighbours and PA behaviour (the insufficient PA neighbourhoods have, on average, more contact). A significant regression equation was found for the variable [contact with neighbours at least once a week] only (table 28). Although this variable explains a quite amount of the variance in [% meets physical activity guideline],  $R^2$  (0.291) also indicates that there are other factors as well that are important in explaining PA behaviour.

Table 28. Output of the simple linear regression for the dependent variable [% meets physical activity guideline] and the independent variables representing social capital.

Variable	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>	<i>F(1,23)=</i>	<i>R<sup>2</sup></i>	<i>95% CI</i>
Self-perceived sufficient social contacts (%)	0.160	0.573	0.058	0.782	0.078	0.003	(-1.024, 1.344)
Contact with neighbours at least once a week (%)	-0.254	0.083	-0.539	0.005	9.426	0.291	(-0.425, -0.083)
Contact with neighbours perceived as good (%)	-0.123	0.069	-0.349	0.088	3.184	0.122	(-0.266, 0.020)

Table 29. Ranking of the low-SES neighbourhood scores for the variables representing social capital. The scores are ranked from high (i.e. high social capital) to low (i.e. low social capital). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Self-perceived sufficient social contacts (%)	Neighbourhood	Contact with neighbours perceived as good (%)	Neighbourhood	Contact with neighbours at least once a week (%)
1.	Oosterhoogebrug	98	Het Witte Lam	83	Oosterhoogebrug	67
2.	Ulgersmaborg	98	Noorderhoogebrug	83	Ulgersmaborg	67
3.	Het Witte Lam	97	Ruischerbrug	83	Het Witte Lam	66
4.	Noorderhoogebrug	97	Oosterhoogebrug	80	Noorderhoogebrug	66
5.	Ruischerbrug	97	Ulgersmaborg	80	Ruischerbrug	66
6.	Bloemenbuurt	97	Beijum-Oost	69	Beijum-Oost	63
7.	Damsterbuurt	97	Beijum-West	69	Beijum-West	63
8.	Florabuurt	97	Corpus den Hoorn	67	Lewenborg-Noord	60
9.	Gorechtbuurt	97	Lewenborg-Noord	66	Lewenborg-West	60
10.	Vogelbuurt	97	Lewenborg-West	66	Lewenborg-Zuid	60
11.	Woonschepenhaven	97	Lewenborg-Zuid	66	Bloemenbuurt	56
12.	Indische Buurt	97	Bloemenbuurt	65	Damsterbuurt	56
13.	Beijum-Oost	96	Damsterbuurt	65	Florabuurt	56
14.	Beijum-West	96	De Wijert	65	Gorechtbuurt	56
15.	Corpus den Hoorn	96	Florabuurt	65	Vogelbuurt	56
16.	Vinkhuizen-Noord	96	Gorechtbuurt	65	Woonschepenhaven	56
17.	Vinkhuizen-Zuid	96	Vogelbuurt	65	Corpus den Hoorn	55
18.	Selwerd	96	Woonschepenhaven	65	Paddepoel-Noord	52
19.	Lewenborg-Noord	95	Indische Buurt	62	Paddepoel-Zuid	52
20.	Lewenborg-West	95	Vinkhuizen-Noord	61	Vinkhuizen-Noord	51
21.	Lewenborg-Zuid	95	Vinkhuizen-Zuid	61	Vinkhuizen-Zuid	51
22.	Paddepoel-Noord	95	Selwerd	60	Selwerd	50
23.	Paddepoel-Zuid	95	Paddepoel-Noord	59	De Wijert	48
24.	De Wijert	94	Paddepoel-Zuid	59	De Hoogte	47
25.	De Hoogte	94	De Hoogte	47	Indische Buurt	46
<i>Descriptives (N = 25)</i>		<i>M = 96.20, SD = 1.12</i>		<i>M = 67.04, SD = 8.71</i>		<i>M = 57.04, SD = 6.54</i>

### 4.4.3. SOCIAL COHESION

#### 4.4.3.1. SOCIAL COHESION PER NEIGHBOURHOOD

Figure 80 shows the scores concerning social cohesion for the sufficient PA neighbourhoods. As with social capital, there are no large differences between the neighbourhoods: for all three variables, the scores are similarly distributed per neighbourhood. A majority of people feels co-responsible for their neighbourhood ( $M = 86.63, SD = 4.53$ ) and is attached to their neighbourhood ( $M = 61, SD = 3.25$ ). However, there is only a small amount of people that participates in activities in their neighbourhood ( $M = 29.88, SD = 3.56$ ). The overall social cohesion score (in which 1 is low and 10 is high cohesion) ranges from 5.5 in Vinkhuizen-Noord to 6.4 in Damsterbuurt, Gorechtbuurt and Florabuurrt ( $M = 5.99, SD = 0.36$ ).

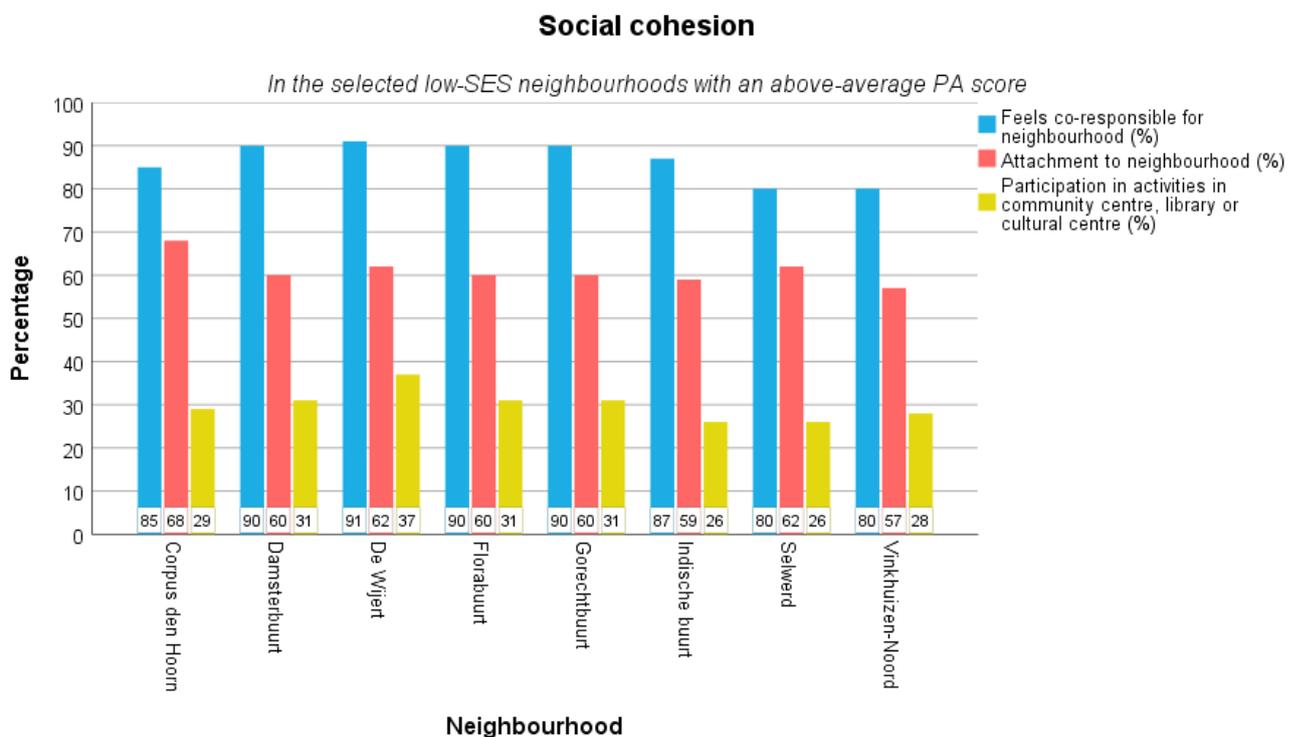


Figure 80. Overview of the social cohesion scores in the selected low-SES neighbourhoods that are sufficiently physically active.

Figure 81 shows the scores concerning social cohesion for the insufficient PA neighbourhoods. A majority of people feels co-responsible for their neighbourhood ( $M = 87.71, SD = 3.80$ ) and is attached to their neighbourhood ( $M = 67.94, SD = 10.50$ ). In Het Witte Lam, Noorderhoogebrug and Ruischerbrug people are most attached (over 80%), while in De Hoogte only 44% is attached to their neighbourhood. In all neighbourhoods, there is only a small amount of people that participate in activities in their neighbourhood ( $M = 31.29, SD = 4.90$ ). The overall social cohesion score (in which 1 is low and 10 is high cohesion) ranges from 5 in De Hoogte to 7,3 in Het Witte Lam, Noorderhoogebrug and Ruischerbrug ( $M = 6.35, SD = 0.64$ ).

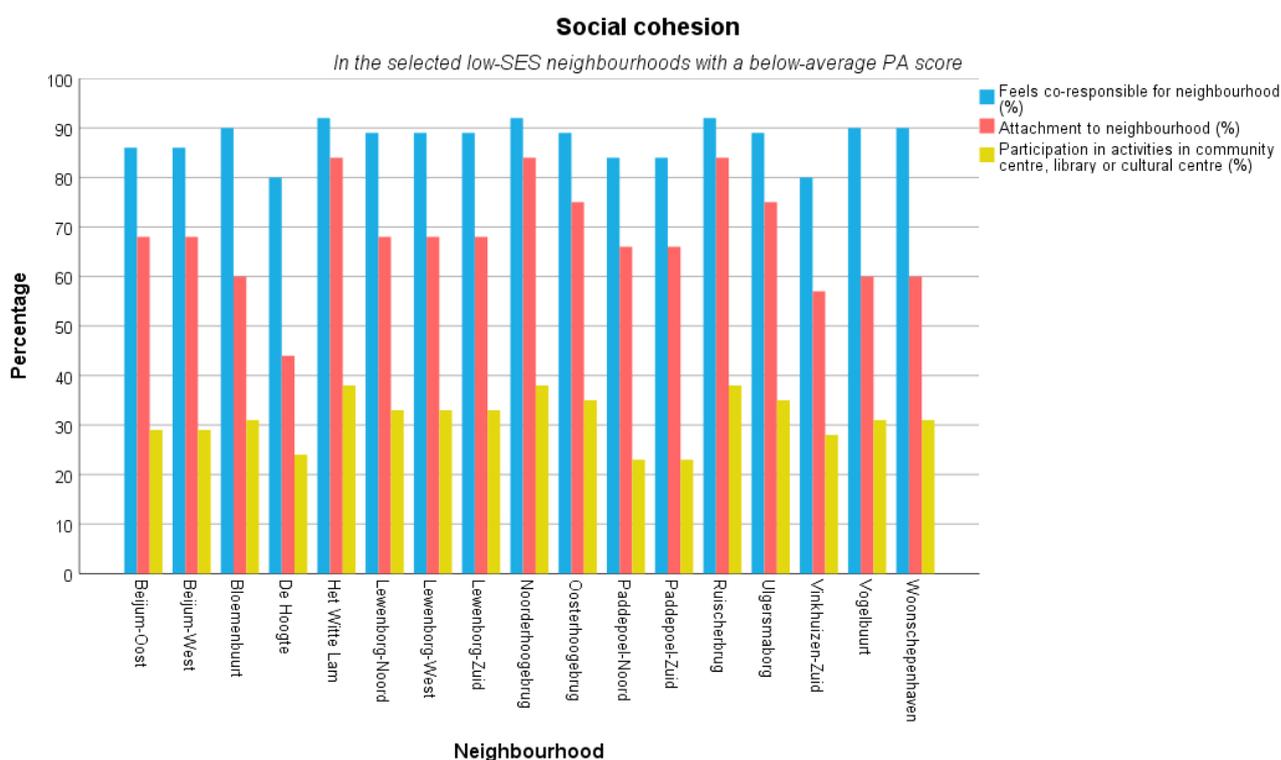


Figure 81. Overview of the social cohesion scores in the selected low-SES neighbourhoods that are insufficiently physically active.

#### 4.4.3.2. THE NUMBERS BEHIND THE GRAPHS

Table 32 shows the ranking of scores for the variables representing social cohesion. Four out of the eight neighbourhoods with an above-average PA score are in the top 10 for the variable [feels co-responsible for neighbourhood]. However, for the other two variables representing social cohesion, only one of the sufficient PA neighbourhoods is in the top 10. Noticeable is that the average scores for the variables are higher in the neighbourhoods with a below-average PA score than in the neighbourhoods with an above-average PA score (table 30).

Table 30. Descriptives of the variables representing social cohesion.

Variable	Above-average PA score (N = 8)			Below-average PA score (N = 17)		
	Min. / Max.	Mean	Std. Deviation	Min. / Max.	Mean	Std. Deviation
Feels co-responsible for neighbourhood (%)	80 – 91	86.63	4.53	80 – 92	87.71	3.80
Attachment to neighbourhood (%)	57 – 68	61.00	3.25	44 – 84	67.94	10.50
Participation in activities in community centre, library or cultural centre (%)	26 – 37	29.88	3.56	23 – 38	31.29	4.90
Social cohesion score (scale 1 – 10)	5.5 – 6.4	5.99	0.36	5.0 – 7.3	6.35	0.64

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on feels co-responsible for neighbourhood (%), attachment to neighbourhood (%), participation in activities in community centre, library or cultural centre (%) and social cohesion score.

As the graphs already indicated, is that there is a negative relationship between the several variables representing social cohesion and PA behaviour (the insufficient PA neighbourhoods score, on average, higher compared to the sufficient PA neighbourhoods). A significant regression equation was found for the variable [attachment to neighbourhood] only (table 31). However, there are other factors as well that are important in explaining PA behaviour, as  $R^2$  is only 0.179.

Table 31. Output of the simple linear regression for the dependent variable [% meets physical activity guideline] and the independent variables representing social cohesion.

Variable	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>	<i>F(1,23)=</i>	<i>R<sup>2</sup></i>	<i>95% CI</i>
Feels co-responsible for neighbourhood (%)	-0.093	0.160	-0.120	0.567	0.337	0.014	(-0.423, 0.238)
Attachment to neighbourhood (%)	-0.139	0.062	-0.423	0.035	5.002	0.179	(-0.268, -0.010)
Participation in activities in community centre, library or cultural centre (%)	-0.192	0.137	-0.280	0.175	1.961	0.079	(-0.476, 0.092)
Social cohesion score	-1.692	1.036	-0.322	0.116	2.666	0.104	(-3.835, 0.452)

#### 4.4.4. SUMMARIZATION SOCIAL ENVIRONMENT

- **Neighbourhood crime and safety**

The sufficient PA neighbourhoods are, on average, less safe than the insufficient PA neighbourhoods. They have a higher number of police reports regarding vandalism and physical abuse, a higher percentage of people that feels unsafe in their neighbourhood and a higher nuisance score compared to the insufficient PA neighbourhoods.

- **Social capital**

The sufficient PA neighbourhoods have, on average, slightly more self-perceived sufficient social contacts but less contact with neighbours compared to the insufficient PA neighbourhoods.

- **Social cohesion**

The sufficient PA neighbourhoods score, on average, lower on all variables representing social cohesion compared to the insufficient PA neighbourhoods. The latter has a higher percentage of people that feels co-responsible for the neighbourhood, that is attached to the neighbourhood and that participate in activities in the neighbourhood.

- Out of all the variables regarding the social environment, only two variables (representing social capital and cohesion) are significant predictors of PA behaviour. This might be because of the small sample size (Field, 2014).

Table 32. Ranking of the low-SES neighbourhood scores for the variables representing social cohesion. The scores are ranked from high (i.e. high social cohesion) to low (i.e. low social cohesion). Red marked fields represent neighbourhoods with a below-average PA score, green fields represent neighbourhoods with an above-average PA score.

Ranking	Neighbourhood	Feels co-responsible for neighbourhood (%)	Neighbourhood	Attachment to neighbourhood (%)	Neighbourhood	Participation in activities in community centre (%)
1.	Het Witte Lam	92	Het Witte Lam	84	Het Witte Lam	38
2.	Noorderhoogebrug	92	Noorderhoogebrug	84	Noorderhoogebrug	38
3.	Ruischerbrug	92	Ruischerbrug	84	Ruischerbrug	38
4.	De Wijert	91	Oosterhoogebrug	75	De Wijert	37
5.	Bloemenbuurt	90	Ulgersmaborg	75	Oosterhoogebrug	35
6.	Damsterbuurt	90	Beijum-Oost	68	Ulgersmaborg	35
7.	Florabuurt	90	Beijum-West	68	Lewenborg-Noord	33
8.	Gorechtbuurt	90	Corpus den Hoorn	68	Lewenborg-West	33
9.	Vogelbuurt	90	Lewenborg-Noord	68	Lewenborg-Zuid	33
10.	Woonschepenhaven	90	Lewenborg-West	68	Bloemenbuurt	31
11.	Oosterhoogebrug	89	Lewenborg-Zuid	68	Damsterbuurt	31
12.	Ulgersmaborg	89	Paddepoel-Noord	66	Florabuurt	31
13.	Lewenborg-Noord	89	Paddepoel-Zuid	66	Gorechtbuurt	31
14.	Lewenborg-West	89	De Wijert	62	Vogelbuurt	31
15.	Lewenborg-Zuid	89	Selwerd	62	Woonschepenhaven	31
16.	Indische Buurt	87	Bloemenbuurt	60	Beijum-Oost	29
17.	Beijum-Oost	86	Damsterbuurt	60	Beijum-West	29
18.	Beijum-West	86	Florabuurt	60	Corpus den Hoorn	29
19.	Corpus den Hoorn	85	Gorechtbuurt	60	Vinkhuizen-Noord	28
20.	Paddepoel-Noord	84	Vogelbuurt	60	Vinkhuizen-Zuid	28
21.	Paddepoel-Zuid	84	Woonschepenhaven	60	Indische Buurt	26
22.	Selwerd	80	Indische Buurt	59	Selwerd	26
23.	Vinkhuizen-Noord	80	Vinkhuizen-Noord	57	De Hoogte	24
24.	Vinkhuizen-Zuid	80	Vinkhuizen-Zuid	57	Paddepoel-Noord	23
25.	De Hoogte	80	De Hoogte	44	Paddepoel-Zuid	23
<i>Descriptives (N = 25)</i>		<i>M = 87.36, SD = 3.99</i>		<i>M = 65.72, SD = 9.35</i>		<i>M = 30.84, SD = 4.49</i>

## 5. DISCUSSION AND CONCLUSION

This chapter will discuss and conclude this research. In the first section, the outcomes of this research are linked with the literature. The second section answers the research question, followed by the theoretical and practical implications of the outcomes. The fifth section reflects on the executed research, the outcomes and suggests further research inquiries.

### 5.1. MAIN FINDINGS

Overweight and obesity are growing issues, on every scale. A widely recognised cause is physical inactivity. Striking is the difference in PA behaviour and health outcomes between different socioeconomic groups in society (e.g. CBS, 2016; Eurostat, 2014a; Prince et al., 2011). However, health behaviour and outcomes are not only influenced by individual-level factors (e.g. Ball et al., 2015; Cohen et al., 2006). Nowadays, health is considered as the outcome of the interaction between the individual, built and social environment. This implies that a variety of sectors are involved in the process towards a healthy environment and society (e.g. McNeill et al., 2006; Tran, 2016). Spatial planning and design play a major role in this, as this is the field responsible for shaping the living environment.

#### 5.1.1. PA PATTERNS

In this research, a distinction has been made between neighbourhoods that are sufficiently and insufficiently physically active. This is based on the score for the Dutch physical activity guideline and the municipality's average score for this guideline. Selected low-SES neighbourhoods that score above the municipality's average score (60.23%) are considered neighbourhoods that are sufficiently physically active, neighbourhoods that score below this average are considered insufficiently physically active.

First of all, this distinction shows that, contrary to what is generally found in most literature, there can be low-SES neighbourhoods that are sufficiently active. Nonetheless, there are differences between the selected low-SES neighbourhoods. The sufficient PA neighbourhoods exercise, on average, slightly more than the insufficient PA neighbourhoods ( $M = 68.50$  compared to  $M = 68.35$ ). More people are a member of a sports club in the sufficient PA neighbourhoods ( $M = 42.50$ ) than in the insufficient PA neighbourhoods ( $M = 39.06$ ). However, these indicators for physical activity also show that people in the selected low-SES neighbourhoods are less active than on average in the municipality.

Unfortunately, the data do not provide information into the PA domain (occupational, domestic, transportation and leisure time, (Strath et al., 2013)). Observation showed that the parks in Vogelbuurt and Florabuurt are both frequently used throughout the day and that they are popular for dog walking.

However, to design environments that encourage people to obtain a healthy lifestyle it is important to know how the individual, built and social environment interact. Across the literature, many mechanisms can be found. This research focused on infrastructure, public green areas and the social environment and the differences herein between the sufficient and insufficiently active low-SES neighbourhoods. The outcomes are discussed below.

### 5.1.2. NEIGHBOURHOOD CHARACTERISTICS

The literature study showed that the presence of **physical aspects**, such as sidewalks and bicycle lanes, recreational facilities and green are, in general, positively associated with PA (e.g. Ferdinand et al., 2012; McCormack et al., 2010). This research shows that the selected low-SES neighbourhoods are very diverse, both in the type of facilities as well as the distribution of facilities.

On average, the sufficiently active neighbourhoods have more sports areas and more food stores but fewer playgrounds compared to the insufficiently active neighbourhoods. The design and attributes of playgrounds differ as well between the neighbourhoods. The observation showed that playgrounds in Oosterparkwijk (consisting of both sufficient and insufficient PA sub-neighbourhoods) are mostly green (with e.g. grass, trees or surrounded by box trees), while playgrounds in De Hoogte (insufficient PA) are mostly grey (e.g. located on sidewalks).

Overall, the amount of green is quite similar for both the sufficiently and insufficiently active neighbourhoods. In both subgroups, there are neighbourhoods with many green (e.g. Vinkhuizen-Noord (sufficient PA) and Beijum-West (insufficient PA)) and neighbourhoods with little green (e.g. Gorechtbuurt (sufficient PA) and Bloemenbuurt (insufficient PA)). This indicates that public green areas do not necessarily affect PA behaviour in this research. This corresponds to the findings of Maas et al. (2008), who found that the amount of green space is not related to one's PA behaviour (in The Netherlands specifically).

On the other hand, this research found only one aspect of the physical environment to be significantly related to PA behaviour: the number of trees per citizen per neighbourhood. This indicator was negatively related to PA behaviour, which implies that the higher the number of trees per citizen, the fewer people meet the PA guideline in that neighbourhood. However, the coefficient of determination indicates that this variable explains only 27% of one's PA behaviour, implying that there are other important factors as well.

Contrary to what one would expect from the literature, there was no significant relation with PA behaviour found for all other physical indicators in this research. Because this is inconsistent with other research, it might be explained by the limited number of cases ( $N = 25$ ) in the regression model (Field, 2014).

Many studies also highlight the importance of the **social environment** in explaining PA behaviour, both solely as well as in conjunction with the physical environment (e.g. McCormack et al., 2010; Prins et al. 2016; 2019). In an unsafe neighbourhood, people are less likely to be physically active (e.g. Rachele et al., 2016). Also, children's PA may be limited by their parents' worries about neighbourhood safety (e.g. Ferdinand et al., 2012; Kneeshaw-Price et al., 2015). A high social capital is positively associated with health status and PA behaviour, for example by providing support or setting positive social norms for healthy behaviour (e.g. McNeill et al., 2006; Mohnen et al., 2015).

However, this research showed that the sufficiently active neighbourhoods score lower on all indicators (representing neighbourhood safety, social capital and social cohesion) for the social environment than the insufficiently active neighbourhoods. But, only two aspects of the social environment, representing social capital and social cohesion, were found to significantly relate to PA behaviour.

According to the literature, one would expect that people who experience high social capital and cohesion are more physically active than those who do not. But the relation found in this research is negative, indicating that people who have contact with their neighbours once a week and who are attached to their neighbourhood have lower levels of PA. There is no supportive research found that might explain this outcome.

Inconsistently with the literature, no relations between neighbourhood crime and safety were found in this research. This might be because the sufficiently active neighbourhoods had higher crime levels than the insufficiently active neighbourhoods. This raises questions about the considerations of people to still be active, even while they live in an unsafe neighbourhood or feel unsafe.

So, despite the differences between the low-SES neighbourhoods that became apparent in this research, none of the physical or social neighbourhood characteristics had a significantly positive relation with PA behaviour. However, **people's perceptions** about the physical aspects of the living environment turned out to have an important impact on PA behaviour.

Overall, the sufficiently active neighbourhoods are more satisfied but are slightly more deteriorated than the insufficiently active neighbourhoods. However, there are a few insufficiently active neighbourhoods that are very satisfied as well (e.g. Paddepoel-Noord), but most insufficiently active neighbourhoods score lower than the sufficiently active neighbourhoods.

This research found that the satisfaction of the maintenance of bicycle paths, sidewalks, roads, playgrounds and green all positively relate to PA behaviour. Although there is myriad literature on the objective aspects of the environment, there is limited research found that focuses on perceptions of these aspects. Literature that does focus on perceptions of environmental aspects is often about parent's perception of safety in relation to their children's PA patterns (e.g. Ferdinand et al., 2012; Kneeshaw-Price et al., 2015). Nevertheless, findings of Hidding et al. (2018) are cohesive with the findings of the present study. They found that, amongst others, a well-maintained environment is an important perceived determinant of an activity-friendly environment. This might explain why the people in the most satisfied neighbourhoods have higher PA levels than people in the less satisfied neighbourhoods.

## 5.2. MAIN QUESTION: THE IMPACT OF NEIGHBOURHOOD CHARACTERISTICS ON PA BEHAVIOUR OF FAMILIES WITH LOW SES

To design environments that encourage people to obtain a healthy lifestyle, it is not only important to know how aspects of the living environment affect health behaviour. It is also important to know what the different groups in society motivate to become active, as these groups have different PA patterns (Ferdinand et al., 2012; Gidlow et al., 2006). This thesis, therefore, focused on the impact of physical and social neighbourhood characteristics on the physical activity patterns of families with low socioeconomic status. The section above discussed the main findings of this research regarding infrastructure, public green areas and the social environment. This section follows up on this by answering the main research question.

This research has shown that neighbourhoods are very diverse. Not only are there differences between the sufficiently and insufficiently active low-SES neighbourhoods, but also between neighbourhoods within the same subgroup.

Many inconsistencies between the Groningen situation and the literature were found in this research. The insufficiently active neighbourhoods have, in general, more playgrounds than the sufficiently active neighbourhoods. The amount of green is, in general, quite similar in both subgroups. The sufficiently active neighbourhoods score lower on all indicators for the social environment compared to the insufficiently active neighbourhoods. They have for example a higher number of police reports for vandalism, less contact with neighbours and they participate less in activities in community centres.

Out of the ranking per variable, which indicated which neighbourhoods e.g. have the most facilities or are the safest, one final ranking has been calculated (average ranking). Although no comprehensive conclusions can be drawn from this table (section 5.5.), it gives insight into which neighbourhoods are, according to literature, most conducive to PA behaviour and which are not (table 33). Again, this shows that the sufficiently active neighbourhoods do not have the best circumstances that promote PA behaviour, as most of the insufficiently active neighbourhoods are ranked higher.

As stated in section 3.5.1., playgrounds and safety are of particular importance in this research as they are important for the PA behaviour of children. When looking at the neighbourhoods with the highest percentage (> 20%) of households with children (table 33), several conclusions can be drawn.

First, the neighbourhoods with the highest percentage of households with children are all insufficiently active.

Second, for half of the neighbourhoods applies that they have many playgrounds and green areas. However, the other half are among the neighbourhoods with the least playgrounds and green. In other words, the neighbourhoods with the highest percentage of households with children do not necessarily have the most opportunities for children to be active (i.e. the most playgrounds).

Third, the satisfaction scores for maintenance and disorder are lower in these neighbourhoods than the averages for all low-SES neighbourhoods. It might be that this dissatisfaction is a reason for parents to restrict their children to play outside.

Fourth, the safety scores for these neighbourhoods are scattered, with neighbourhoods that are among the highest and the lowest-scoring neighbourhoods. It might be that worries about safety are a reason for parents to restrict their children to play outside.

Table 33. End ranking of all selected low-SES neighbourhoods. Red represents insufficiently active neighbourhoods; green represents sufficiently active neighbourhoods. Neighbourhoods with over 20% of households with children are marked grey.

End ranking	Neighbourhood	Meets PA guideline (%)	Average of all rankings	Households with children (%)
1.	Beijum-West	56	10.52	29%
2.	Beijum-Oost	55	10.78	31%
3.	Ulgersmaborg	58	11.33	39%
4.	Corpus den Hoorn	62	11.37	14%
5.	Noorderhoogebrug	58	11.63	27%
6.	Indische buurt	62	11.67	12%
7.	Paddepoel-Noord	60	11.96	10%
8.	Florabuurt	62	12.00	17%
9.	Lewenborg-Noord	54	12.26	28%
10.	Bloemenbuurt	60	12.37	19%
11.	Lewenborg-West	58	12.41	30%
12.	Oosterhoogebrug	58	12.70	24%
13.	Het Witte Lam	56	12.89	13%
14.	Paddepoel-Zuid	60	13.22	22%
15.	Vinkhuizen-Zuid	57	13.22	27%
16.	De Wijert	62	13.41	18%
17.	Lewenborg-Zuid	56	13.67	35%
18.	Vogelbuurt	59	13.67	17%
19.	Selwerd	61	13.74	14%
20.	Ruischerbrug	56	13.93	28%
21.	Damsterbuurt	64	13.96	6%
22.	Woonschepenhaven	55	14.07	13%
23.	Vinkhuizen-Noord	62	14.22	15%
24.	Gorechtbuurt	66	15.30	9%
25.	De Hoogte	59	18.70	17%

However, most of the indicators showed no statistically significant association with PA behaviour. Only eight variables turned out significant (table 34), representing the indicators maintenance and disorder (infrastructure), public green areas, social capital and social cohesion.<sup>13</sup>

Table 34. Overview of the significant predictors for PA behaviour with their correlation coefficient, significance level and coefficient of determination.

Variable	Pearson correlation	Coefficient of determination ( $R^2$ )
Satisfaction maintenance bicycle paths (%)	0.600**	0.360
Satisfaction maintenance playgrounds (%)	0.595**	0.355
Satisfaction maintenance green (%)	0.590**	0.348
Contact with neighbours at least once a week (%)	-0.539**	0.291
Number of trees per citizen	-0.526**	0.276
Satisfaction maintenance roads (%)	0.518**	0.269
Satisfaction maintenance sidewalks (%)	0.451*	0.204
Attachment to neighbourhood (%)	-0.423*	0.179

\*Significance levels: \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

Five variables are satisfaction scores about the maintenance of the environment. This implies that it might not be the physical or social characteristics of the environment only that are important for people to become physically active. Maybe even more importantly are people's own opinions about their environment. For example, are they happy with their living environment? This can widely differ, because some people might be satisfied with only one playground or small park while others like to see more green or playgrounds.

Noticeable as well is that, in general, the sufficiently active neighbourhoods are more satisfied, but have less or a similar number of facilities than the insufficiently active neighbourhoods. As satisfaction about aspects of the living environment cannot be seen without the presence of these aspects, this raises several questions. For example, when are people satisfied and when does their satisfaction make them physically active? However, it is beyond the scope of this research to examine the relations between several neighbourhood characteristics, as the focus is on relations between PA and neighbourhood characteristics. But it does indicate that it is not about the quantity, but, more importantly, about the quality of the living environment that impacts on PA behaviour.

### 5.3. THEORETICAL IMPLICATIONS

The fields of health, the environment and human behaviour are highly studied research fields. The literature study has shown that a person's health status and health behaviour is influenced by many factors. These are not only individual but also social and environmental factors. Most of these studies focus on the relation between (aspects of) the environment and physical activity in general. Although there are studies that focus on different age groups or income groups, there is only a limited body of literature that focuses on specific groups such as families. Research that does focus on families often does so in relation to the home environment and not with the living or built environment. Also, there is a limited body of Dutch literature on e.g. healthy neighbourhoods and the relation between the environment and PA. This research adds to the understanding of a specific group, namely low-SES

<sup>13</sup> Because it was not possible to conduct a multiple regression (section 3.5.1.), it is unknown what the combined effect of these indicators is on PA.

families in a city in the Netherlands. Since the outcomes differ from what is generally found in the literature this provides opportunities for further research as well (section 5.5.).

This research also adds that it is not only tangible aspects of the environment (such as the amount of green) that influence one's PA pattern. Maybe even more importantly are, according to the outcomes of this research, the opinions and feelings of people about their living environment.

#### 5.4. PRACTICAL IMPLICATIONS

This research provides important lessons for a range of actors, such as city councils, policymakers and city planners. With a growing health gap between different groups in society, it is key to create conditions that invite, facilitate and encourage people to obtain a healthy lifestyle. Next to important aspects such as a good and accessible healthcare system, the living environment plays a major role as well in this task.

Health is becoming an increasingly important topic for e.g. Dutch municipalities, especially with the upcoming implementation of the Environment and Planning Act. Many municipalities focus on the physical aspects of the living environment in creating a healthy environment. The municipality of Groningen, for example, aims in their coalition agreement to reclaim public space by adding more green to the city and make the city less car-friendly but more bicycle- and walking-friendly (Gemeente Groningen, 2019).

However, the outcomes of this research suggest that there is more than just the physical and social aspects of the living environment. People's perceptions and satisfaction might be even more important in shaping people's PA behaviour. This implies that policymakers and city planners should not only focus on the physical aspects but should also take citizen's needs and preferences into account. One can add more green to an area, but if the people are not satisfied, they will still not use it. For future plans, it is therefore important to first clarify what the people in a neighbourhood like, dislike and would like to change. To eventually design interventions tailored to the local area, based on the needs and preferences of all groups in a neighbourhood.

For the municipality of Groningen specifically, the outcomes of this research have important implications. In the current course towards a healthy municipality, a large focus is on decreasing social inequalities and increasing the amount of green in the city (e.g. policy plan 'Vitamine G'). However, as the outcomes of this research suggest, the focus should be not so much on quantity. Instead, the quality of the environment is important, as people's perceptions about their living environment are related to their PA behaviour.

#### 5.5. CRITICAL REFLECTION AND SUGGESTIONS FOR FURTHER RESEARCH

During the writing of this thesis, the focus and especially the method changed over time due to circumstances. Originally, this research was designed to be qualitative. Through semi-structured interviews with families with low socioeconomic status, I hoped to gain insight into the 'why'-question(s). Questions such as 'why are people being physically (in)active', 'what (indicators) influences their physical activity pattern and why', 'why do they use or do they not use their living environment', 'what would they like to see to change for them to become physically active' etc.

However, during April, it became clear that this approach would not work out. Due to COVID-19 and the measures taken by the Dutch government (closure of schools), I could not get into contact with the target group (an overview of this process can be found in appendix II). Because of the Corona-measures (keeping distance and staying home as much as possible), it also was not an option to

approach people in public areas (e.g. in parks and playgrounds). Because there were no signs that the situation would change back to 'normal' soon, I contacted my supervisor and decided to change my method towards spatial analysis.

This shift towards a quantitative approach knows some limitations but also provides opportunities for further research.

First, the theoretical background of this research is mostly based on research conducted in the USA. This country has a different spatial structure than the Netherlands (e.g. suburbs, larger distances to travel). Insights or conclusions from these studies might therefore not apply to the Dutch situation (Lakerveld et al., 2015; Maas et al., 2008). This might explain the different outcomes compared to what is most often found in the literature.

Second, the data that is used in the analysis is secondary data derived from sources such as the municipality of Groningen, CBS and RIVM (e.g. neighbourhood surveys). These provide information on a sub-neighbourhood level. This includes, however, no direct information about the target group of this research (i.e. low-SES families) but only averages per neighbourhood. This implies that the results from this research only indirectly say something about the specific group of families with low SES. For further research it is therefore advised to derive the data directly from the target group via for example surveys, tracking studies or interviews.

Also, there are a few datasets that are not at a sub-neighbourhood level but at neighbourhood level. However, these datasets are still included because they provided important information for this research and because there was no other similar data available.

Third, the literature study showed a variety of neighbourhood characteristics that influence physical activity levels (appendix III). Based on the occurrence of these characteristics it was decided which characteristics to include in this research (section 3.2.2.). Unfortunately, there was no data available for each of these characteristics. Several characteristics, such as social norms and collective efficacy, had, therefore, be excluded from the research.

Fourth, secondary data is available for different years. Since datasets from 2020 and 2019 were often not complete or available, data from 2018 was used for this research. However, for a few variables, the most recent data was 2016 (e.g. physical activity guideline) or 2017. This has a few implications: (1) there might have been a different situation in 2016 and 2018, but the data has nevertheless been analysed together, and (2) the outcome of the analysis implicitly applies to a situation of at least two years old and the situation might be different nowadays.

Fifth, for all calculations and comparisons made in this research it is important to keep in mind that the scores are relative to the other neighbourhoods in Groningen. This implies that it cannot be used to compare with or between other cities.

Sixth, this research relies heavily on the variable [% meets physical activity guideline] as it makes a distinction between 'good' and 'bad' behaving neighbourhoods regarding PA based on this variable. As discussed at the second point, this data might be biased by people other than the target group. For further research, it is therefore advised to track the PA patterns of the target group with for example step or activity trackers. This will create more specific insights into the PA patterns of the target group and will lead to more concrete conclusions.

Seventh, the SES variable has been constructed specially for this research since there is no SES variable available. To create a SES variable, several input variables were given a score which gave a certain outcome. However, there are different ways or formulas to create an SES variable (Reynders et al., 2005). Using other datasets or formulas might give a different outcome and therefore a different neighbourhood selection. And a different neighbourhood selection might create other research

outcomes. Also, missing values in the SES calculation were now filled in based on of the score for [% of low-educated people]. This can also be critiqued. Considerations to do it this way were to not exclude too many neighbourhoods and the most predictive variable was used.

The final and overarching recommendation is to re-do this study but from a qualitative perspective as well. There are several options to do so. However, with the lessons learned during this research the most appropriate option seems to be a study that both tracks the PA of participants and interviews them. The tracking will give insight into the PA patterns of all family members (both parents and children). Interviews will give insight into underlying motives for PA, such as why people choose to be physically active and how and why (or why not) they use the environment for this. This will also give insight into a child's independent mobility and the influence of parents on their child and his/her PA patterns (e.g. why do or do they not allow their child to play outside). This approach may lead to insight into causal pathways between aspects of the living environment and PA behaviour, ultimately leading to a more thorough understanding of the PA patterns of families with low SES and their motives for their behaviours. And this, eventually, may lead to more concrete steps in designing activity-friendly and healthy environments for all and contributing to reducing the health gap.

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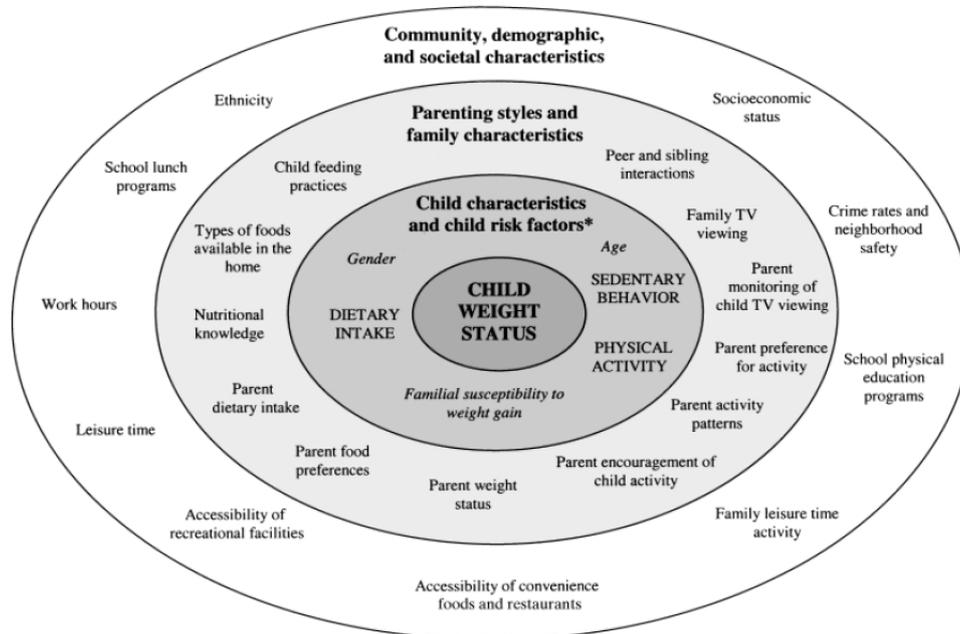
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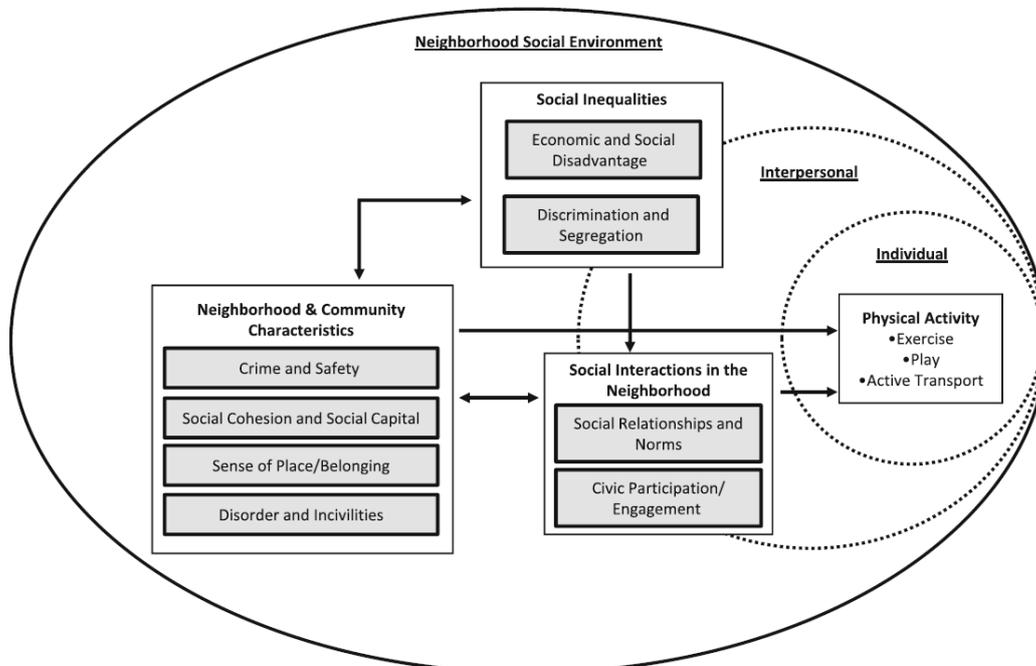
# APPENDIX I – FIGURES CHAPTER 2

## I.I. MODEL DAVISON & BIRCH (2001)



“Ecological model of predictors of childhood overweight. \* =Child risk factors (shown in upper case lettering) refer to child behaviours associated with the development of overweight. Characteristics of the child (shown in italic lettering) interact with child risk factors and contextual factors to influence the development of overweight (i.e. moderator variables).” (Davison & Birch, 2001, p. 161)

## I.II. MODEL KEPPEL ET AL. (2019)



“Conceptual framework for how the neighborhood social environment is related to [individual-level] physical activity. Adapted from McNeill et al. (2006) and Suglia et al. (2016). Grey boxes indicate neighborhood social environment dimensions. Neighborhood measures can either be objectively/directly measured or perceived by individuals” (Kepper et al., 2019, p. 6).

## APPENDIX II – FROM A QUALITATIVE TO A QUANTITATIVE APPROACH

*The decision to switch from a qualitative to a quantitative approach occurred because the process of recruiting participants did not work out as planned. Due to the Coronavirus and the measures taken by the Dutch government, the target group could not be reached. This appendix gives, complementary to the discussion (section 5.5), a short overview of this process.*

Complementary to the observations, and to find out the ‘why’ questions, semi-structured interviews were planned to be conducted. The target group for these interviews were families with low SES living in De Hoogte and Oosterparkwijk. The families had to consist of (at least) one child who attends primary school, because in this age category children often still play in playgrounds or pitches in the neighbourhood.

The two neighbourhoods were selected via a somewhat different selection process than the current one (as described in section 3.4). To gain insight into the role of neighbourhood characteristics on physical activity patterns of families with a low SES, two similar yet different neighbourhoods were selected: similar in terms of the SES of its inhabitants, but different regarding their social and physical neighbourhood characteristics. In this way, the role of neighbourhood characteristics on physical activity patterns can be compared for the two neighbourhoods. The textbox on the right gives a short summary of this process.

The neighbourhood selection process consisted of three steps. A recent analysis by Steinberg et al. (2019) revealed that for nine neighbourhoods in the municipality of Groningen, health inequalities appeared to be the greatest. Therefore, these neighbourhoods were used as starting point for the neighbourhood selection.

Because the focus of this research on families with low SES, the first criteria of the selection process was that neighbourhoods with a high amount of people that have low SES were selected. By using the indicators income status, educational level and occupational status, six neighbourhoods appeared to be suitable for this research.

The final step looked at the scores for different physical and social neighbourhood characteristics per neighbourhood. Out of this analysis, one neighbourhood immediately stood out: De Hoogte scored worst on all indicators compared to the other neighbourhoods. Next was to find a neighbourhood that scored opposite to De Hoogte. This appeared to be Oosterparkwijk.

### **Recruiting participants**

To get into contact with families with children, contact has first been sought with primary schools located both in and surrounding the target neighbourhoods. Because De Hoogte has no primary school within the neighbourhood, primary schools in surrounding neighbourhoods have been contacted. Because the schools were too busy (with arranging home education due to the Coronavirus) to cooperate in this research (table 35), contact has also been sought with other organisations located within the neighbourhoods (table 36). These organizations however could also not cooperate.

Table 35. Timeline contact primary schools.

Primary school	Neighbourhood	E-mail sent at	Response
De Kleine Wereld	Oosterparkwijk	30-03-2020	03-04-2020 (mail) Answer: Not possible at the moment, too busy (home education).
Borgmanschool (location Vinken)	Oosterparkwijk	30-03-2020 06-04-2020 15-04-2020 (reminder)	15-04-2020 (mail) Answer: No. Not possible at the moment, too busy.
Siebe Jan Boumaschool	Oosterparkwijk	30-03-2020	30-03-2020 (mail) Answer: No. Not possible at the moment, too busy.
Oosterhoogebrugschool	Oosterhoogebrug (near Oosterparkwijk)	30-03-2020 07-04-2020 (reminder)	07-04-2020 (mail) Answer: No. None of the students meets the criteria, primarily because the school is located outside the target neighbourhoods.
Karrepad	Korrewegwijk (near De Hoogte)	30-03-2020	30-03-2020 (mail) Answer: No. They fully focus on the process of home education right now.
De Pendinghe	Paddepoel/Selwerd (near De Hoogte)	30-03-2020 06-04-2020 (reminder)	06-04-2020 (mail) Answer: No. They don't want to put an extra burden on parents, next to the home education

\*In addition, there was searched for Facebook groups of the schools. However, only the Borgmanschool has a Facebook group, but this is private.

Table 36. Timeline contact neighbourhood organisations.

Organisation	Neighbourhood	E-mail sent at	Response
Neighbourhood sports coach C. Kamps ( <i>buurtsportcoach</i> )	Oosterparkwijk	03-04-2020	06-04-2020 (phone) Answer: Not possible. They communicate with children via schools (e.g. newsletters) and don't have contact details of families. They advised to contact schools.
Neighbourhood sports coach A. Kuipers ( <i>buurtsportcoach</i> )	De Hoogte	03-04-2020	
Citizens organisation Oosterparkwijk ( <i>bewonersorganisatie Oosterparkwijk</i> )	Oosterparkwijk	03-04-2020	04-04-2020 (mail) Answer: Not possible to get in touch with target group through them.

Neighbourhood and playground association Oosterpark	Oosterparkwijk	06-04-2020 15-04-2020 (reminder)	
Neighbourhood and playground association Ons Belang	Oosterparkwijk	06-04-2020 15-04-2020 (reminder)	17-04-2020 (mail) Answer: They aren't active as a playground association anymore; they are now focused on elderly.
Neighbourhood and playground association F.E.O.	Oosterparkwijk	06-04-2020 15-04-2020 (reminder)	
Neighbourhood and playground association De Hoogte	De Hoogte	06-04-2020	06-04-2020 (mail) Answer: referred to the WIJ-team
WIJ-team Oosterparkwijk	Oosterparkwijk	07-04-2020 15-04-2020 (reminder)	15-04-2020 (mail) Answer: referred to the right person within their organization
WIJ-team Korrewegwijk	De Hoogte	07-04-2020 15-04-2020 (reminder)	16-04-2020 (mail) Answer: forwarded it internally to the right person.

## APPENDIX III – OVERVIEW NEIGHBOURHOOD CHARACTERISTICS LITERATURE

### III.I. PHYSICAL ACTIVITY INDICATORS

Physical activity indicator	Ferdinand et al. (2012)	Ferreira et al. (2006)	Gidlow et al. (2006)	Gordon-Larsen et al. (2006)	Lakerveld et al. (2015)	Weir et al. (2006)	Caspersen et al. (1985)	Ball et al. (2015)	Friedmann et al. (2008)	Kantomaa et al. (2007)	Kepper et al. (2019)	Kneeshaw-Price et al. (2015)	McGinn et al. (2008)	Prince et al. (2011)	Prins et al. (2014)	Prins et al. (2016)	Rachele et al. (2016)	Strath et al. (2013)	Total
Walking																			5
Running																			1
Biking																			1
Active transport																			9
Time spent outdoors (/outside play)																			3
Leisure-time																			9
Moderate-vigorous activity (e.g. skating, cycling, exercise, , walking,																			9

basketball, softball, active sports)																			
Work-related activity																			4
Household activity																			4
Car/bicycle ownership																			1
Garden/yard or access to allotment/city garden																			3
(access to) Play equipment (e.g. basketball hoop, swing set, bike, jump rope)																			1
Membership of sports club																			1
Sports participation																			2

### III.II. PHYSICAL NEIGHBOURHOOD INDICATORS

Neighbourhood characteristic indicator (physical)	Research by															
	Davison & Birch (2001)	Ferdinand et al. (2012)	Ferreira et al. (2006)	Gordon-Larsen et al. (2006)	Grafova (2008)	Lakerveld et al. (2015)	Macintyre (2000)	Salois (2012)	Taylor et al. (2012)	Weir et al. (2006)	Galster (2001)	Ball et al. (2015)	Prince et al. (2011)	Prins et al. (2016; 2019)	Suglia et al. (2016)	Total
(Accessibility of) recreational facilities																11
(Accessibility of) food stores and restaurants (density)																7
Sidewalks (well-lit)																5
Parks																6
Playgrounds																3
Trails (bike/walk paths)																2
Traffic safety																2
Schools (playgrounds)																4
Public facilities (incl. public beach,																2



Residential area density (RAD)																	<b>1</b>
Public transport																	<b>3</b>
Primary care provision																	<b>1</b>
Social work provision																	<b>1</b>
Natural amenity index (incl. water, mountains, sunny weather)																	<b>2</b>
Environmental quality (air quality index)																	<b>2</b>
Land use diversity																	<b>2</b>
Street design (pedestrian & bicycle friendly) (incl. sidewalks, bicycle lanes, traffic calming features)																	<b>3</b>
Characteristics (non-) residential buildings																	<b>1</b>

### III.III. SOCIAL NEIGHBOURHOOD INDICATORS

Neighbourhood characteristic indicator (social)	Research by																				Total		
	Davison & Birch (2001)	Ferreira et al. (2006)	Grafova (2008)	Lakerveld et al. (2015)	Macintyre (2000)	Salois (2012)	Weir et al. (2006)	Galster (2001)	Ball et al. (2015)	Cohen (2004)	Cohen et al. (2006)	Kepper et al. (2019)	Kneeshaw-Price et al. (2015)	McGinn et al. (2008)	McNeill et al. (2006)	Mohnen et al. (2015)	Prince et al. (2011)	Prins et al. (2014)	Prins et al. (2016; 2019)	Rachele et al. (2016)		Suglia et al. (2016)	
Crime rates (neighbourhood safety)																						14	
Social norms																							5
Social support																							5
Encouragement																							1
Informal social control																							2
Social capital																							8
Social cohesion																							5
Local friend and kin networks																							2
Participation in local voluntary associations																							1





## APPENDIX IV(A) – CONSTRUCTION SES VARIABLE

### IV(A).I. STEP 1: RELATED TO PHYSICAL ACTIVITY GUIDELINE?

Because this research is looking at the PA patterns of families with a low SES, a first step is to test whether the independent variables of table 7 (section 3.3.1.) relate to the dependent variable [% meets physical activity guideline]. Therefore, a simple linear regression has been conducted for each separate independent variable. Based on this, the variables for calculating the SES score were selected.

#### DEPENDENT VARIABLE: PHYSICAL ACTIVITY GUIDELINE

This variable was measured in the Gezondheidsmonitor by the RIVM and comprises the percentage of the population that meets the PA guideline in the year 2016 per sub-neighbourhood. The average score for all neighbourhoods in the municipality of Groningen is 60.23 percent (fig. 82). Figure 83 shows the boxplot of this variable, indicating that there are no outliers in the data.

Statistics		
VoldoetAanBeweegrichtlijn (%)		
N	Valid	92
	Missing	13
Mean		60,23
Median		60,50
Mode		62
Std. Deviation		5,231
Variance		27,365
Range		25
Minimum		47
Maximum		72
Percentiles	25	56,00
	50	60,50
	75	64,00

Figure 82. Statistics of the variable [% meets physical activity guideline].

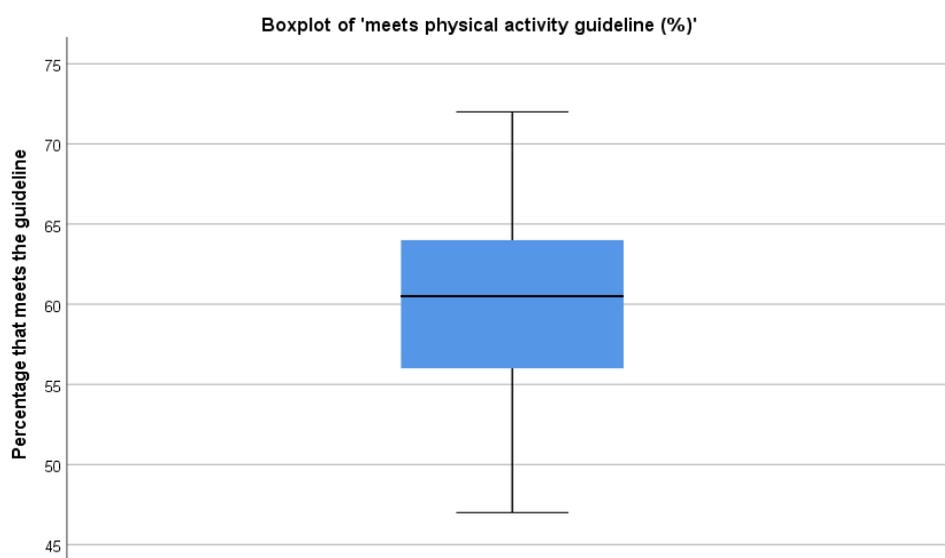


Figure 83. Boxplot of the variable [% meets physical activity guideline].

#### EDUCATIONAL LEVEL

The boxplots (appendix IV(b).i.) of the three variables belonging to the indicator 'education' show no outliers. However, both the scatterplots and casewise diagnostics (reporting outliers outside 3 standard deviations) indicate an outlier (case number 68 – neighbourhood De Kring) in all three variables. This may be explained by the fact this case is a caravan park. Therefore it is decided to keep this case in the dataset.

		Statistics		
		Laag opgeleide inwoners (%)	Middelhoog opgeleide inwoners (%)	Hoog opgeleide inwoners (%)
N	Valid	75	75	75
	Missing	30	30	30
Mean		17,51	41,41	41,12
Median		17,00	41,00	41,00
Mode		8	31	33
Std. Deviation		8,815	6,965	11,594
Variance		77,713	48,516	134,431
Range		31	25	44
Minimum		5	31	18
Maximum		36	56	62
Percentiles	25	9,00	34,00	33,00
	50	17,00	41,00	41,00
	75	23,00	47,00	51,00

Figure 84. Statistics of the variables for educational level.

LOW EDUCATIONAL LEVEL

**Relation between physical activity guideline and the percentage of low-educated people(%)**

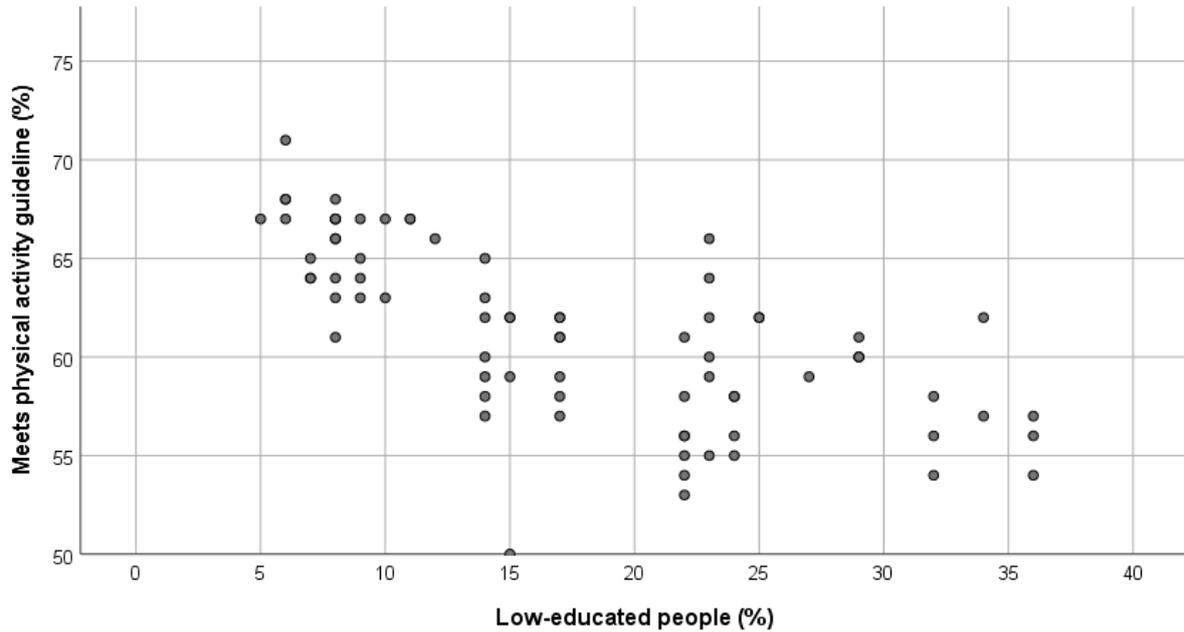


Figure 85. Scatterplot of the relation between the percentage of people that meets the PA guideline and the percentage of low-educated people.

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the percentage of low-educated people. Both the scatterplot (fig. 85) and  $R$  (-0.686) indicate a decreasing linear relationship. A significant regression equation was found ( $F(1,73) = 65.003, p < .001$ ), with an  $R^2$  of 0.471 (table 37).

Table 37. Output of the linear regression for the dependent variable [% meets physical activity guideline] and the independent variable [% low-educated people].

	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Low-educated people	-0.350	0.043	-0.686	<0.001

MEDIUM EDUCATIONAL LEVEL

Relation between physical activity guideline and the percentage of medium-educated people(%)

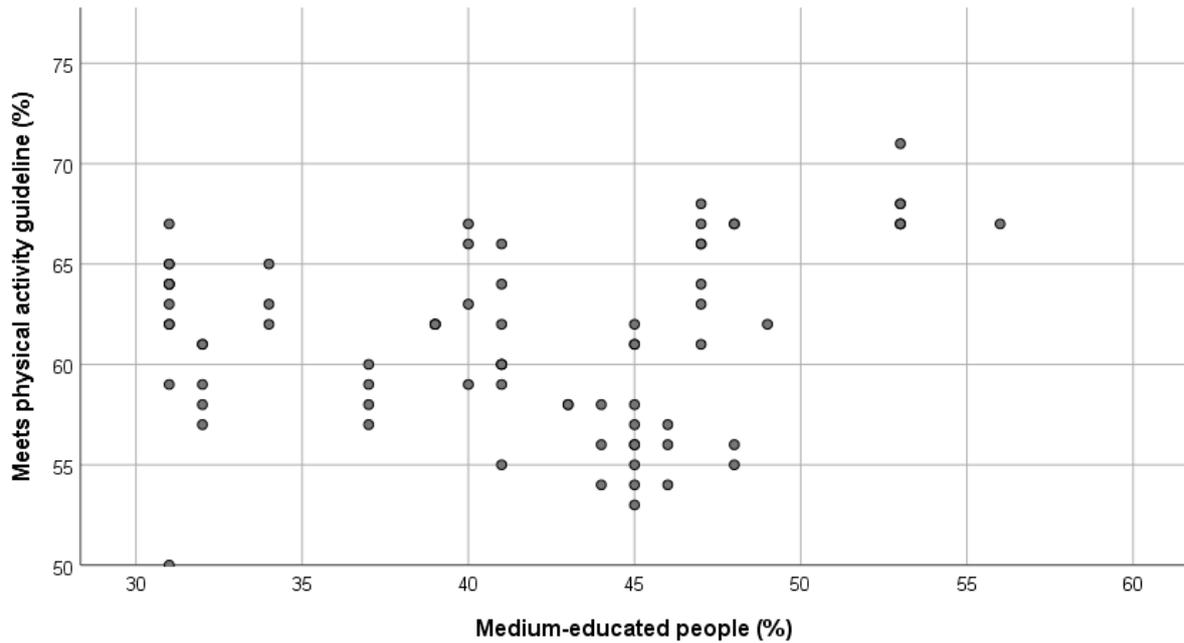


Figure 86. Scatterplot of the relation between the percentage of people that meets the PA guideline and the percentage of medium-educated people.

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the percentage of medium-educated people. Both the scatterplot (fig. 86) and  $R$  (0.173) indicate a slightly increasing linear relationship. There was no significant regression equation found ( $F(1,73) = 2.243, p = 0.139$ ), with an  $R^2$  of 0.030 (table 38).

Table 38. Output of the linear regression for the dependent variable [% meets physical activity guideline] and the independent variable [% medium-educated people].

	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Medium-educated people	0.111	0.074	0.173	0.139

HIGH EDUCATIONAL LEVEL

Relation between physical activity guideline and the percentage of high-educated people(%)

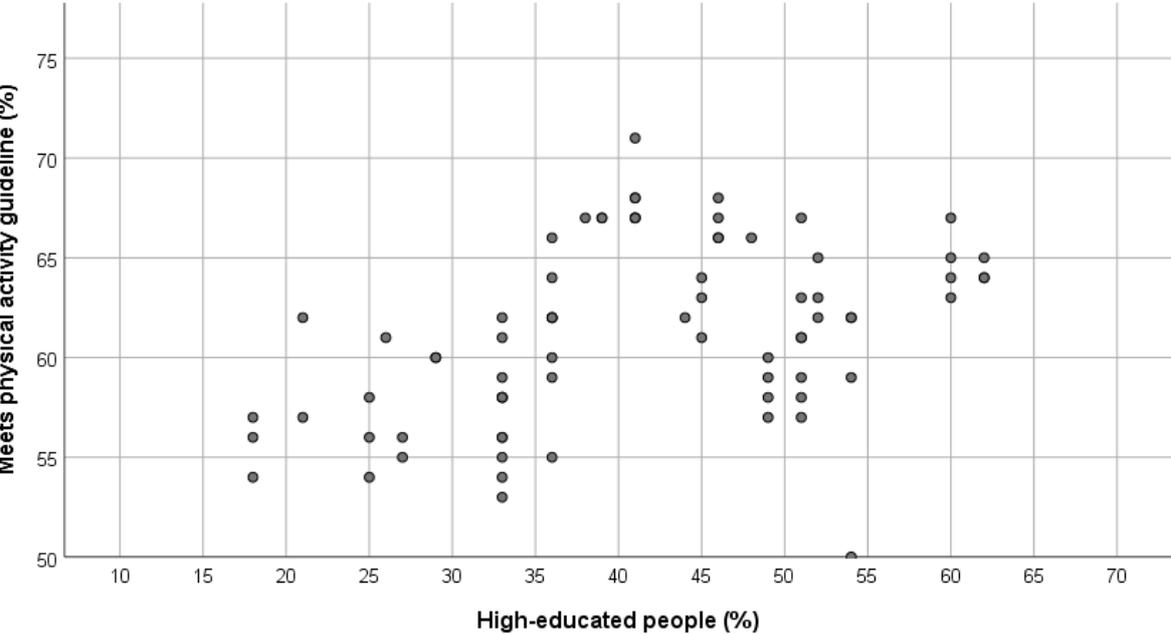


Figure 87. Scatterplot of the relation between the percentage of people that meets the PA guideline and the percentage of high-educated people.

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the percentage of high-educated people. Both the scatterplot (fig. 87) and *R* (0.424) indicate an increasing linear relationship. A significant regression equation was found ( $F(1,73) = 15.965, p < .001$ ), with an  $R^2$  of 0.179 (table 39).

Table 39. Output of the linear regression for the dependent variable [% meets physical activity guideline] and the independent variable [% high-educated people].

	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
High-educated people	0.164	0.041	0.424	<0.001

OVERALL CONCLUSION EDUCATIONAL LEVEL

There is a significant correlation between both low- and high-educated people and the percentage of people that meets the PA guideline. However, the correlation is the greatest for [% of low-educated people] ( $R^2 = 0.471$  vs.  $R^2 = 0.179$ ). Therefore, the variable [% of low-educated people] will be used as indicator for educational level in calculating the SES score.

## INCOME

The boxplots (appendix IV(b).ii) of the three variables belonging to the indicator 'income' show several outliers (located above the interquartile range). For the variable [households below the social minimum] this is again case number 68 (neighbourhood De Kring) and this may be explained by the fact that this is a caravan park.

For the variable [average income per person], the outliers are the neighbourhoods Piccardthof (nr. 54), Klein Martijn (nr. 45) and Villabuurt (nr. 46). For the variable [average household income], the outliers are Piccardthof (nr. 54) and Villabuurt (nr. 46). This may be explained by the average dwelling value (which is, on average, above €400.000 (Alle cijfers, 2018a-c)), indicating that these neighbourhoods inhabit wealthy people.

		Statistics		
		Gemiddeld inkomen per persoon met inkomen (€1.000)	Percentage minimaalhuishoudens (%)	Gemiddeld huishoudensinkomen (€1.000)
N	Valid	72	66	67
	Missing	33	39	38
Mean		30,335	15,847	38,648
Median		26,600	14,400	33,500
Mode		21,6 <sup>a</sup>	3,4 <sup>a</sup>	29,4
Std. Deviation		9,8196	11,4148	13,3092
Variance		96,424	130,297	177,136
Range		47,5	59,5	56,9
Minimum		15,4	,5	23,8
Maximum		62,9	60,0	80,7
Percentiles	25	23,125	6,725	29,400
	50	26,600	14,400	33,500
	75	35,175	22,775	47,500

Figure 88. Statistics of the variables for income

However, both the scatterplots and casewise diagnostics (reporting outliers outside 3 standard deviations) do not indicate any outliers in all three variables. Therefore it is decided to keep all the cases in the dataset.

## AVERAGE INCOME PER PERSON WITH AN INCOME (1000 EURO)

### Relation between physical activity guideline and the average income per person (€1.000)

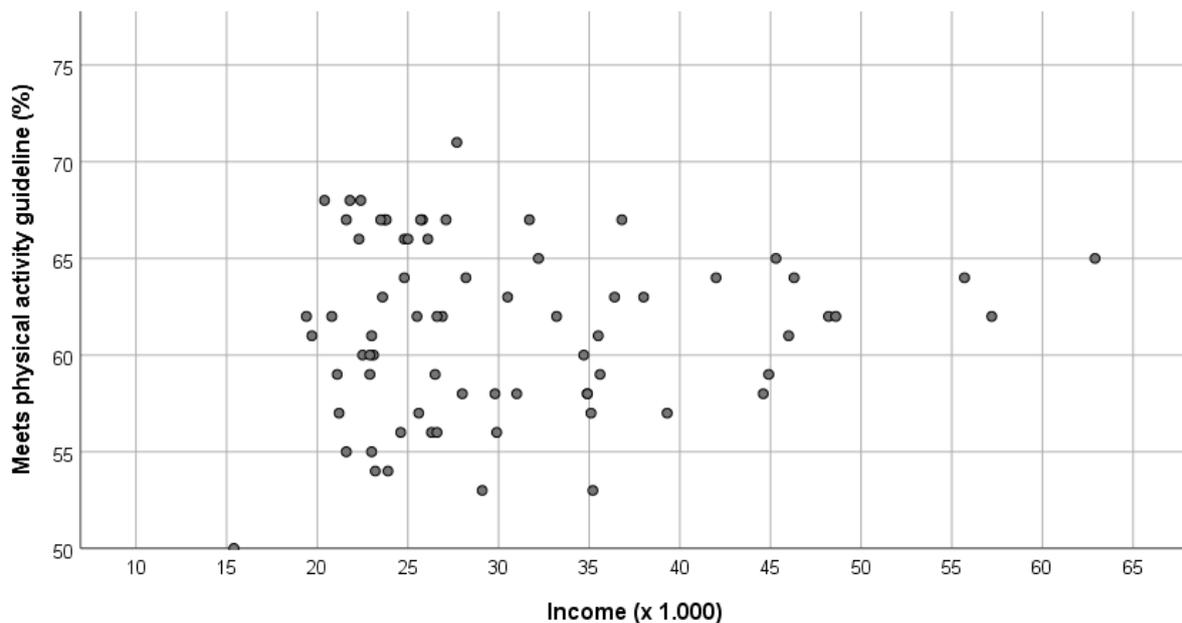


Figure 89. Scatterplot of the relation between the percentage of people that meets the PA guideline and the average income per person.

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the average income per person. The scatterplot (fig. 89) hardly indicates a relationship, however  $R$  (0.066) indicates a slightly increasing linear relationship. There was no significant regression equation found ( $F(1,70) = 0.307, p = 0.581$ ), with an  $R^2$  of 0.004 (table 40).

Table 40. Output of the linear regression for the dependent variable [% meets physical activity guideline] and the independent variable [average income per person].

	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Average income per person	0.030	0.055	0.066	0.581

HOUSEHOLDS BELOW THE SOCIAL MINIMUM

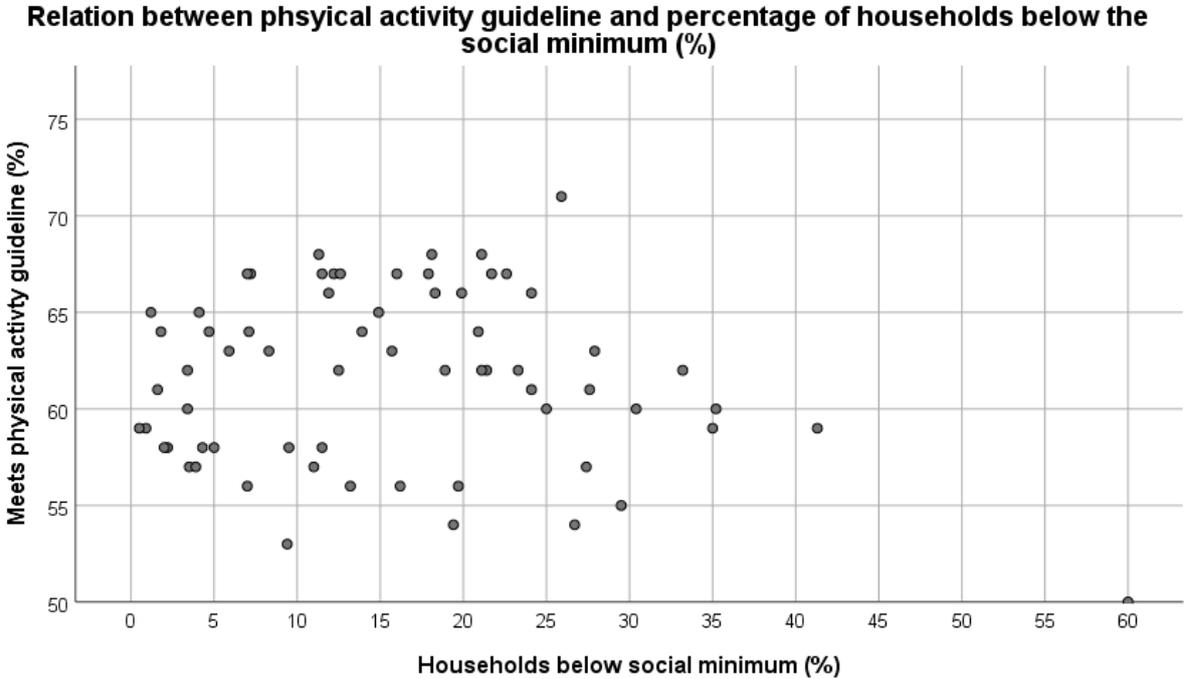


Figure 90. Scatterplot of the relation between the percentage of people that meets the PA guideline and the percentage of households below the social minimum.

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the percentage of households below the social minimum. Both the scatterplot (fig. 90) and  $R$  (-0.145) indicate a slightly decreasing linear relationship. There was no significant regression equation found ( $F(1,64) = 1.384, p = 0.244$ ), with an  $R^2$  of 0.021 (table 41).

Table 41. Output of the linear regression for the dependent variable [% meets physical activity guideline] and the independent variable [% households below social minimum].

	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Households below the social minimum	-0.057	0.049	-0.145	0.244

---

## AVERAGE HOUSEHOLD INCOME (1000 EURO)

### Relation between physical activity guideline and the average household income (€1.000)

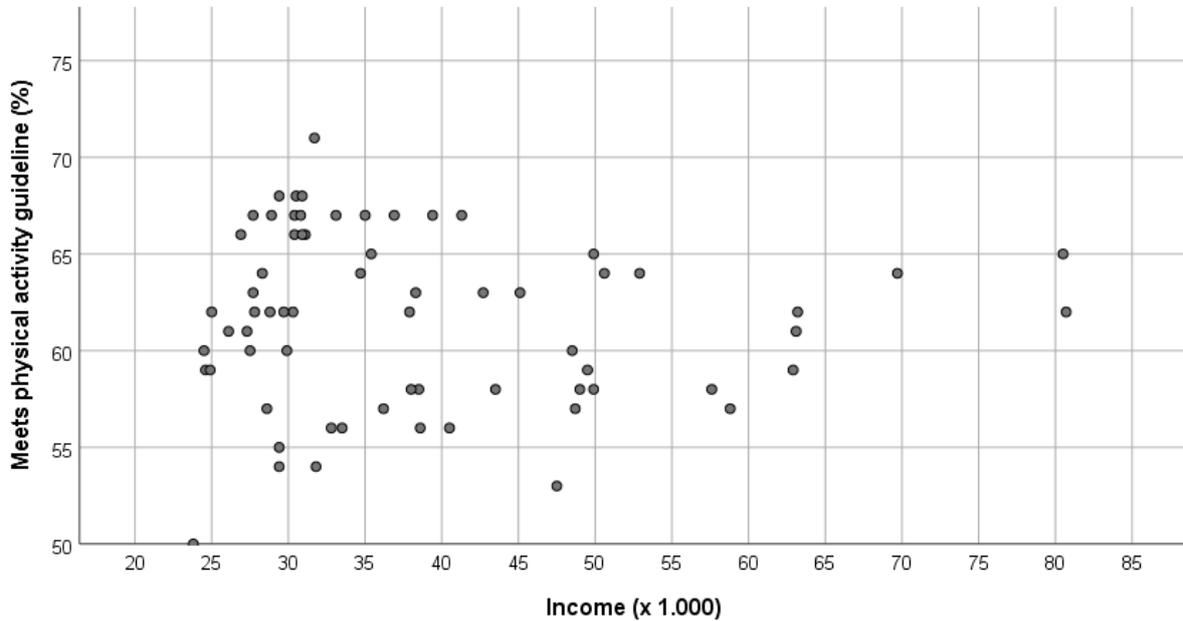


Figure 91. Scatterplot of the relation between the percentage of people that meets the PA guideline and the average household income.

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the average household income. The scatterplot (fig. 91) hardly indicates a relationship, however  $R$  (-0.060) indicates a slightly decreasing linear relationship. There was no significant regression equation found ( $F(1,65) = 0.235$ ,  $p = 0.630$ ), with an  $R^2$  of 0.004 (table 42).

Table 42. Output of the linear regression for the dependent variable [% meets physical activity guideline] and the independent variable [average household income].

	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Average household income	-0.020	0.042	-0.060	0.630

---

## OVERALL CONCLUSION INCOME

There are no significant correlations between the three variables for income and the percentage that meets the PA guideline. Therefore, none of these variables will be used in calculating the SES score. This is also common in other research: often it is only education and occupation that prove to have the greatest predictive value (Reynders et al., 2005; Volksgezondheidszorg.info).

## OCCUPATIONAL STATUS

The boxplots (appendix IV(b).iii.) of the two variables belonging to the indicator 'occupational status' show several outliers (located above the interquartile range). For the variable [registered job seekers UWV] this is (again) case number 68 (neighbourhood De Kring) and case number 39 (neighbourhood Winschoterdiep), which is an extreme outlier. For the variable [people with a benefit according to the Participation Act], case numbers 68 (De Kring) and 76 (Westpark) are outliers, and case numbers 39 (Winschoterdiep) and 53 (Van Swieten) are extreme outliers. However, casewise diagnostics (reporting outliers outside 3 standard deviations) does not indicate any outliers in the two variables. Therefore it is decided to keep all the cases in the dataset.

		Statistics	
		Geregistreerd werkzoekenden UWV (%)	Mensen met uitkering Participatiewet (%)
N	Valid	65	82
	Missing	40	23
Mean		10,382	5,304
Median		8,700	3,700
Mode		3,6 <sup>a</sup>	,4 <sup>a</sup>
Std. Deviation		7,3031	6,4678
Variance		53,336	41,832
Range		39,6	41,1
Minimum		1,2	,1
Maximum		40,8	41,2
Percentiles	25	5,100	1,200
	50	8,700	3,700
	75	13,450	7,100

a. Multiple modes exist. The smallest value is

Figure 92. Statistics of the variables for occupational status.

## GWU (REGISTERED JOB-SEEKERS UWV)

### Relation between physical activity guideline and the percentage of registered job-seekers UWV (%)

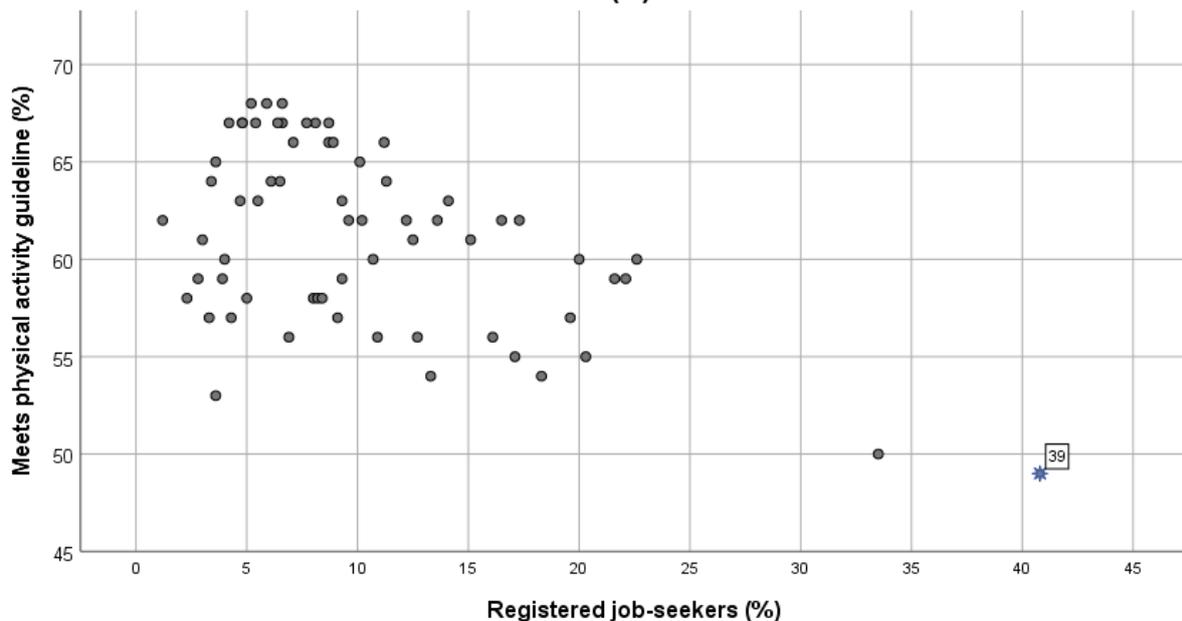


Figure 93. Scatterplot of the relation between the percentage of people that meets the PA guideline and the percentage of registered job-seekers (with the marked extreme outlier).

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the percentage of registered job-seekers. Both the scatterplot (fig. 93) and  $R$  (-0.522) indicate a decreasing linear relationship. A significant regression equation was found ( $F(1,63) = 23.583, p < .001$ ), with an  $R^2$  of 0.272 (table 43).

Table 43. Output of the linear regression for the dependent variable [% meets physical activity guideline] and the independent variable [% registered job-seekers UWV].

	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Registered job-seekers	-0.333	0.069	-0.522	<0.001

## BENEFIT ACCORDING TO THE PARTICIPATION ACT

**Relation between physical activity guideline and the percentage of people with a benefit according to the Participation Act (%)**

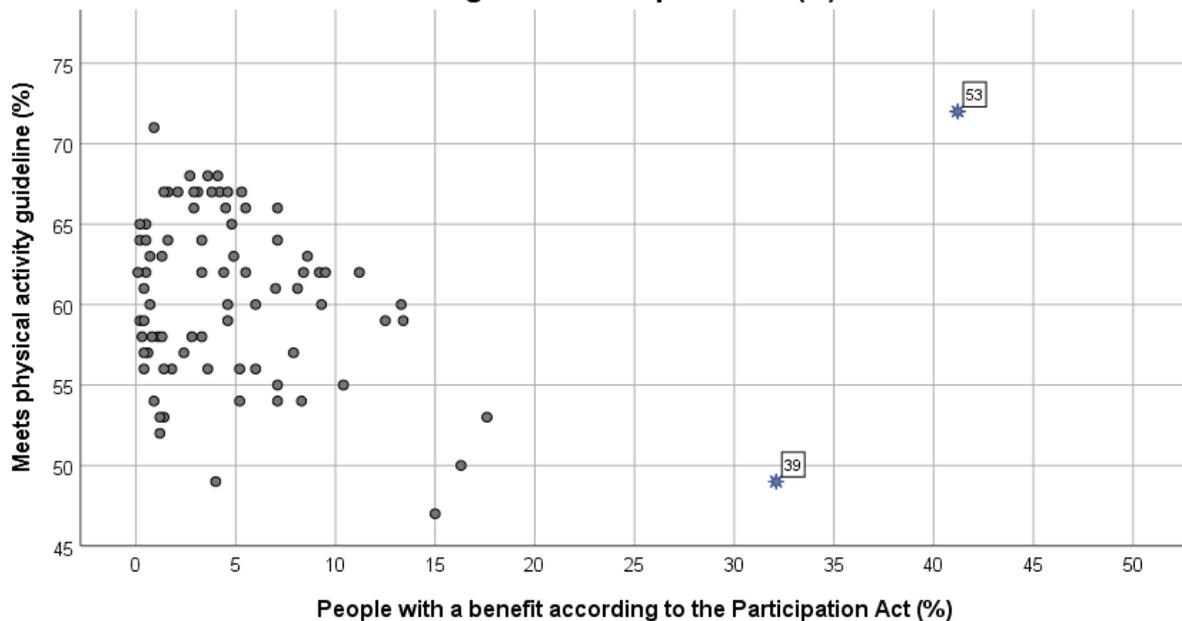


Figure 94. Scatterplot of the relation between the percentage of people that meets the PA guideline and the percentage of people with a benefit according to the Participation Act (with the marked extreme outliers).

A simple linear regression was calculated to predict the percentage of people that meets the PA guideline based on the percentage of people with a benefit (Participation Act). Both the scatterplot (fig. 94) and  $R$  (-0.122) indicate a slightly decreasing linear relationship. There was no significant regression equation found ( $F(1,80) = 1.210, p = 0.275$ ), with an  $R^2$  of 0.015 (table 44).

Table 44. Output of the linear regression for the dependent variable [% meets physical activity guideline] and the independent variable [% people with a benefit according to the Participation Act].

	<i>b</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
People with a benefit (Participation Act)	-0.101	0.092	-0.122	0.275

---

## OVERALL CONCLUSION OCCUPATIONAL STATUS

There is a significant correlation between the percentage of registered job-seekers and the percentage that meets the PA guideline. Therefore, this variable will be used as indicator for occupational status in calculating the SES score.

## CONCLUSION INDEPENDENT VARIABLES

Out of the regression analysis as described above, the two variables [% low-educated people] and [% of registered job-seekers UWV] appeared to be related with the percentage that meets the PA guideline. Therefore, these two variables will be used to calculate the SES score.

When performing a multiple regression analysis on these variables, it shows that both models<sup>14</sup> significantly improved the ability to predict the outcome variable compared to not fitting the model.

Model 1:  $R$  (-0.674) indicates a decreasing linear relationship. A significant regression equation was found ( $F(1,62) = 51.630, p < .001$ , with an  $R^2$  of 0.454).

Model 2:  $R$  (-0.687) indicates a decreasing linear relationship. A significant regression equation was found ( $F(2,61) = 27.255, p < .001$ , with an  $R^2$  of 0.472).

## IV(A).II. STEP 2: CATEGORIZING INTO LOW – MIDDLE – HIGH SCORES

The next step was to make a total SES-score out of the two variables selected in the previous step. There are two often-used ways to do so: (a) construction based on factor scores (factor analysis), and (b) construction based on allocating equal scores to the sub-variables (Reynders et al., 2005).

Because of the limited variables and the nature of the data (percentage-scores, i.e. ratio and not ordinal), factor analysis is not the most appropriate method for this research. Therefore, the scores per sub-variable are divided into low – middle – high and given new scores. This is described in the steps below.

## STEP 2A: EXPLORING THE MISSING VALUES

First, the statistics of the variables were explored. There are 105 sub-neighbourhoods in Groningen (BU\_NAAM  $N = 105$ ), but not for all of these is data available. For the variable [% meets physical activity guideline], 13 cases are missing ( $N = 92$ ).<sup>15</sup> These cases are all neighbourhoods were little to no people live, including e.g. industrial areas, office complexes and natural or agricultural areas. For these cases data is also missing for the variables [% of low-educated people] and [% registered job-seekers UWV]. These cases were therefore excluded from the dataset.

---

<sup>14</sup> Model 1: [% low-educated people]

Model 2: [% low-educated people], [% of registered job-seekers UWV]

<sup>15</sup> These are: Noorderplantsoen, UMCG, Martini Trade Park, Stainkoel'n, Waterhuizen, Westpoort, Suikerfabriekterrein, Kranenburg, Zernike Campus, Selwerderhof, Hunzeboord, Hunzepark and Kardingse.

Next, the scores per variable (that are used to calculate the SES-score) were sorted from low to high scores. This made visible that for 16 cases, data was missing for both variables (fig. 97). Notable is that all cases that do not have data for [% of low-educated people] also do not have data for [% registered job-seekers UWV], except for one case: Winschoterdiep. This case was reported as an extreme outlier in the both boxplot and scatterplot (fig. 93 & appendix IV(b).iii.). Further exploration shows that this neighbourhood is an industrial area as well.

The neighbourhoods for which no data is available for both variables were also excluded from the dataset. Because the case Winschoterdiep has no data for [% of low-educated people] and is an extreme outlier in the variable [% registered job-seekers UWV], this case is excluded as well.

Figure 96 shows the new statistics table for the adjusted dataset, that will be used to calculate the SES-score per neighbourhood.

Statistics					
		Voldoet Aan Beweegrichtlij n (%)	Laag opgeleide inwoners (%)	Geregistreerde Werkzoekende UWV (%)	BU_NAAM
N	Valid	75	75	64	75
	Missing	0	0	11	0
Mean		61,24	17,51	9,906	
Median		62,00	17,00	8,550	
Mode		62 <sup>a</sup>	8	3,6 <sup>a</sup>	
Std. Deviation		4,490	8,815	6,2663	
Variance		20,158	77,713	39,266	
Range		21	31	32,3	
Minimum		50	5	1,2	
Maximum		71	36	33,5	
Percentiles	25	58,00	9,00	5,050	
	33,33333	59,00	11,33	6,300	
	50	62,00	17,00	8,550	
	66,66666	63,67	22,00	11,000	
	75	65,00	23,00	13,150	

a. Multiple modes exist. The smallest value is shown

Figure 96. Statistics table of the adjusted dataset.

Statistics					
		Voldoet Aan Beweegrichtlij n (%)	Laag opgeleide inwoners (%)	Geregistreerde Werkzoekende UWV (%)	BU_NAAM
N	Valid	92	75	65	92
	Missing	0	17	27	0
Mean		60,23	17,51	10,382	
Median		60,50	17,00	8,700	
Mode		62	8	3,6 <sup>a</sup>	
Std. Deviation		5,231	8,815	7,3031	
Variance		27,365	77,713	53,336	
Range		25	31	39,6	
Minimum		47	5	1,2	
Maximum		72	36	40,8	
Percentiles	25	56,00	9,00	5,100	
	33,33333	58,00	11,33	6,400	
	50	60,50	17,00	8,700	
	66,66666	63,00	22,00	11,200	
	75	64,00	23,00	13,450	

Figure 95. Statistics table of the dataset without the 13 missing cases.

		Laag opgeleide inwoners (%)			Geregistreerde Werkzoekende UWV (%)
		Mean			Mean
BU_NAAM	Bruilweering			BU_NAAM	Bruilweering
	Dorkwerd				Dorkwerd
	Driebond				Driebond
	Eemskanaal				Eemskanaal
	Eemspoor				Eemspoor
	Euvelgunne				Euvelgunne
	Friestraatweg				Friestraatweg
	Koningslaagte				Het Witte Lam
	Leegkerk				Hoornse Park
	Peizerweg				Klein Harkstede
	Roodehaan				Klein Martijn
	Stadspark				Koningslaagte
	Van Swieten				Leegkerk
	Vierverlaten				Middelbert
	Westpark				Noorddijk
	Winschoterdiep				Noorderhoogbrug
	Zuidwending				Peizerweg
					Roodehaan
					Stadspark
					Stationsgebied
					Sterrebosbuurt
					Van Swieten
					Vierverlaten
					Villabuurt
					Westpark
					Zilvermeer
					Zuidwending

Figure 97. Overview of the cases for which data was missing for both variables that were used to construct the total SES-score. Corresponding cases are marked with yellow.

## STEP 2B: DIVIDING BETWEEN LOW – MIDDLE – HIGH SCORES

To create a distinction between low, middle and high scores per variable, the scores were divided by 3 by requesting the percentiles 33.33333 and 66.66666 in the statistics table (fig. 96). Table 45 provides an overview of these values.

Table 45. Overview of the values on which the division is made between low, middle and high scores for the variables [% of low-educated people] and [% registered job-seekers UWV].

	<b>[% of low-educated people]</b>	<b>[% registered job-seekers UWV]</b>
Low score (up to and including percentile 33.33333)	≤ 11.33	≤ 6.3
Middle score (between percentile 33.33333 and 66.66666)	11.33 – 22.0	6.3 – 11.0
High score (from percentile 66.66666)	≥ 22.0	≥ 11.0

First, tables were created that show the score per variable per neighbourhood. These were sorted ascending (from low to high scores) and exported to Excel. For both variables applies: below the 33.33333 percentile means high (i.e. good) SES (i.e. low % of low-educated people / low % of registered job-seekers), above the 66.66666 percentile means low (i.e. bad) SES (i.e. high % of low-educated people / high % of registered job-seekers). In the Excel table, these scores were marked red (low score), yellow (middle score) and green (high score). These were then given a new score: 3 indicating high SES, 2 indicating middle SES and 1 indicating low SES (appendix IV(c).i). Then they were sorted in alphabetical order, so the same cases were next to each other for the different variables (appendix IV(c).ii). This Excel table was then imported into SPSS.

## IV(A).III. STEP 3: CALCULATING THE SES VARIABLE

In SPSS, a new variable was computed by adding the scores that were given to the two variables in the previous step and divide them by two.<sup>16</sup> This resulted in a score range of 1-3 for the new variable [SES\_Total]. However, cases for which data was missing for a variable were automatically excluded from this calculation. These cases ( $n = 11$ ) were all missing data for the variable [% registered job-seekers UWV]. They did however have data for [% of low-educated people]. This variable has a higher significant correlation with the dependent variable [% meets physical activity guideline] ( $R = -0.686$ ,  $R^2 = 0.471$ ) compared to the variable [% registered job-seekers UWV] ( $R = -0.522$ ,  $R^2 = 0.272$ ). Therefore, the score that was given to [% of low-educated people] was also given to the new variable [SES\_Total] (fig. 98).

<sup>16</sup> Calculation:  $SES\_Totaal = (Score\_Laagopgeleid + Score\_GWU) / 2$

	OBJECTID	BU_CODE	BU_NAAM	WK_CO DE	VoldoetAan Beweegrich tlijn	Laagopgeleide Inwoners	PercentageGWU	Score_Laagop geleid	Score_GWU	SES_Totaa l
29	34	BU00140503	Kop van Oost	WK001405	65	9	3,6	3	3	3,00
30	35	BU00140504	Woonschepenhaven	WK001405	55	23	17,1	1	1	1,00
31	43	BU00140600	Sterrebosbuurt	WK001406	62	14	.	2	.	.
32	44	BU00140601	Coendersborg	WK001406	63	14	4,7	2	3	2,50
33	45	BU00140602	Klein Martijn	WK001406	64	7	.	3	.	.
34	46	BU00140603	Villabuurt	WK001406	65	7	.	3	.	.
35	47	BU00140604	Helpman	WK001406	65	14	10,1	2	2	2,00

Figure 98. Print screen of the SPSS data viewer. Villabuurt, for example, misses data for [% registered job-seekers] and therefore also misses data for [score\_GWU] and [SES\_Total]. The score '3' (the score for [Score\_Laagopgeleid]) will be entered manually for [SES\_Total].

Figure 99 and 100 show the frequency tables of the variable [SES\_Total] before and after manually entering missing scores.

**SES score (before manually entering missing scores)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
1,00	16	21,3	25,0	25,0
1,50	11	14,7	17,2	42,2
2,00	8	10,7	12,5	54,7
2,50	19	25,3	29,7	84,4
3,00	10	13,3	15,6	100,0
Total	64	85,3	100,0	
Missing	System	11	14,7	
Total	75	100,0		

Figure 99. Frequency table of the variable [SES\_Total] before manually entering the missing scores.

**SES score (after manually entering missing scores)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
1,00	21	28,0	28,0	28,0
1,50	11	14,7	14,7	42,7
2,00	11	14,7	14,7	57,3
2,50	19	25,3	25,3	82,7
3,00	13	17,3	17,3	100,0
Total	75	100,0	100,0	

Figure 100. Frequency table of the variable [SES\_Total] after manually entering the missing scores.

Just as in step 2b, the percentiles 33.33333 and 66.66666 were requested to find out what the boundaries between low, middle and high scores are. Low SES-scores range from 1 up to and including 1.5, middle SES-scores range from 1.5 to 2.5 and high SES-scores range from 2.5 up to and including 3 (fig. 101).

A correlation has been executed to check whether the total SES-score still correlates with [% meets physical activity guideline]: they significantly correlate with each other ( $R = 0.639$ ,  $p < .001$ ).

This distinction between low, middle and high SES scores was the input for the neighbourhood selection as described in section 3.4.

		Statistics	
		BU_NAAM	SES score
N	Valid	75	75
	Missing	0	0
Mean			1,9467
Median			2,0000
Mode			1,00
Std. Deviation			,74695
Variance			,558
Range			2,00
Minimum			1,00
Maximum			3,00
Percentiles	25		1,0000
	33,33333		1,5000
	50		2,0000
	66,66666		2,5000
	75		2,5000

Figure 101. Statistics of the variable [SES\_Total].

# APPENDIX IV(B) – BOXPLOTS STEP 1 SES CALCULATION

## IV(B).I. EDUCATIONAL LEVEL

### LOW EDUCATIONAL LEVEL

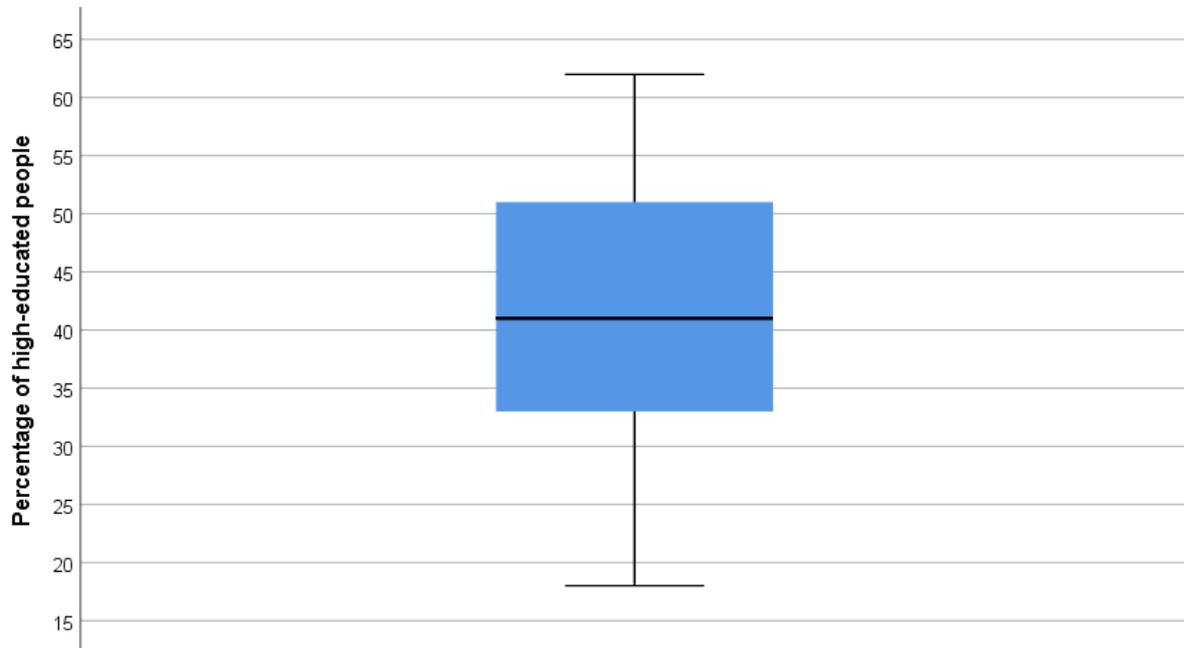


### MEDIUM EDUCATIONAL LEVEL



## HIGH EDUCATIONAL LEVEL

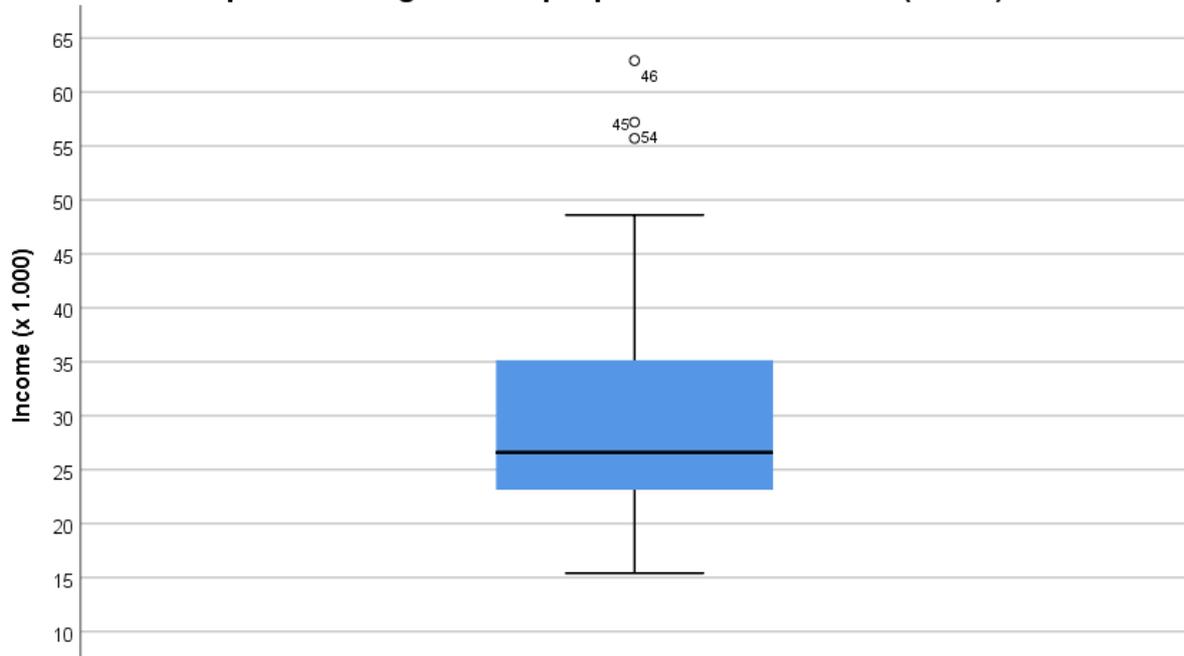
Boxplot of 'high-educated people (%)'



## IV(B).II. INCOME

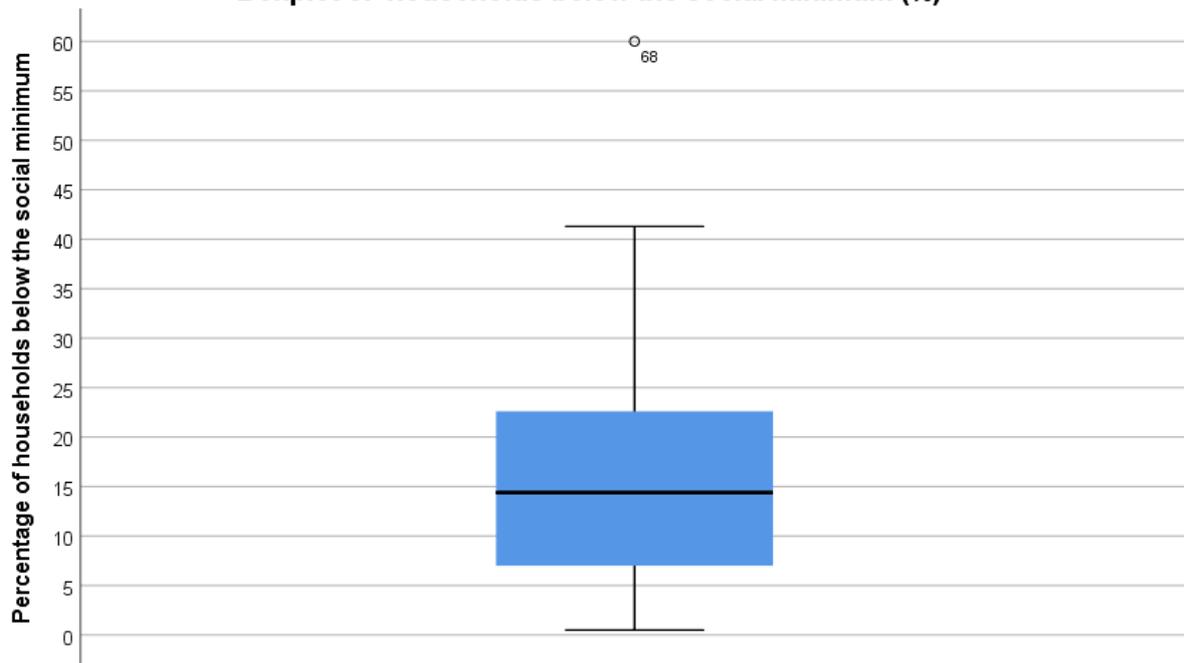
### AVERAGE INCOME PER PERSON WITH AN INCOME (€1000)

Boxplot of 'average income per person with an income (€1.000)'



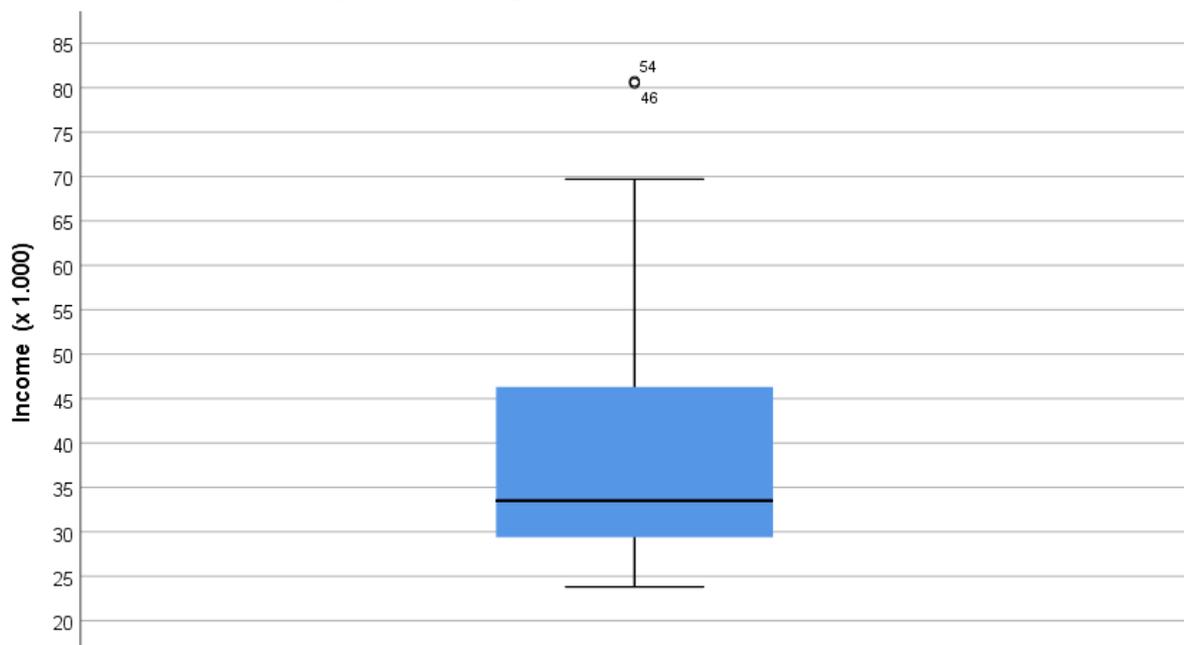
## HOUSEHOLDS BELOW THE SOCIAL MINIMUM

Boxplot of 'households below the social minimum (%)'



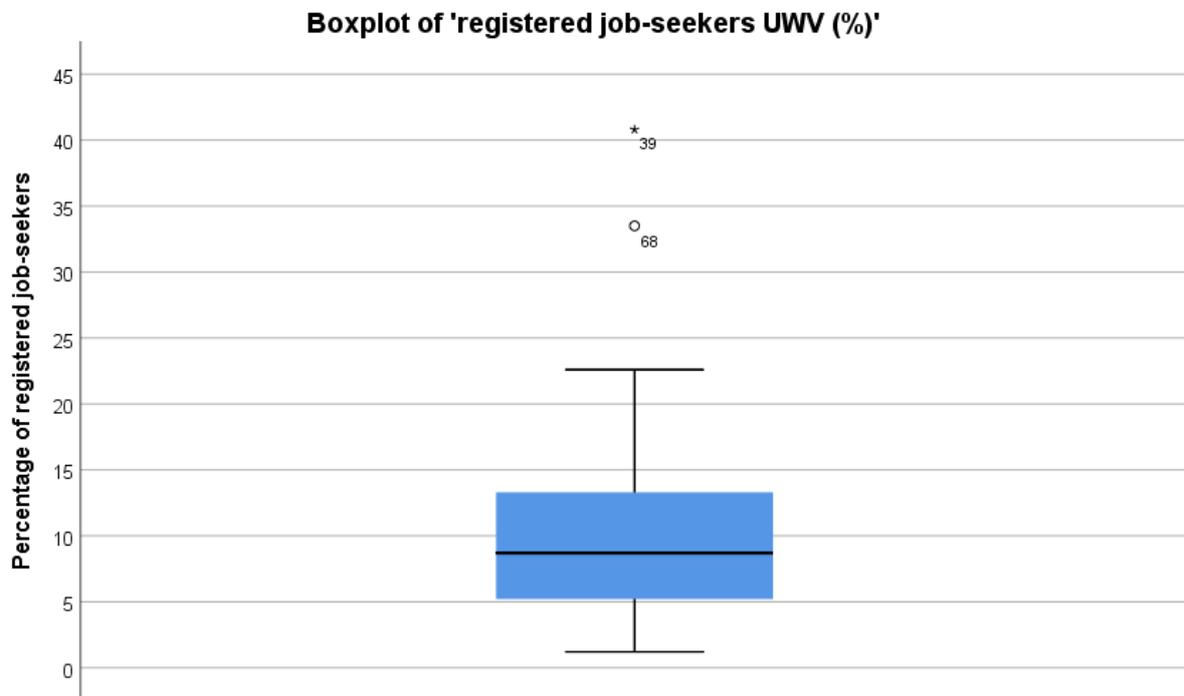
## AVERAGE HOUSEHOLD INCOME (€1000)

Boxplot of 'average household income (€1.000)'

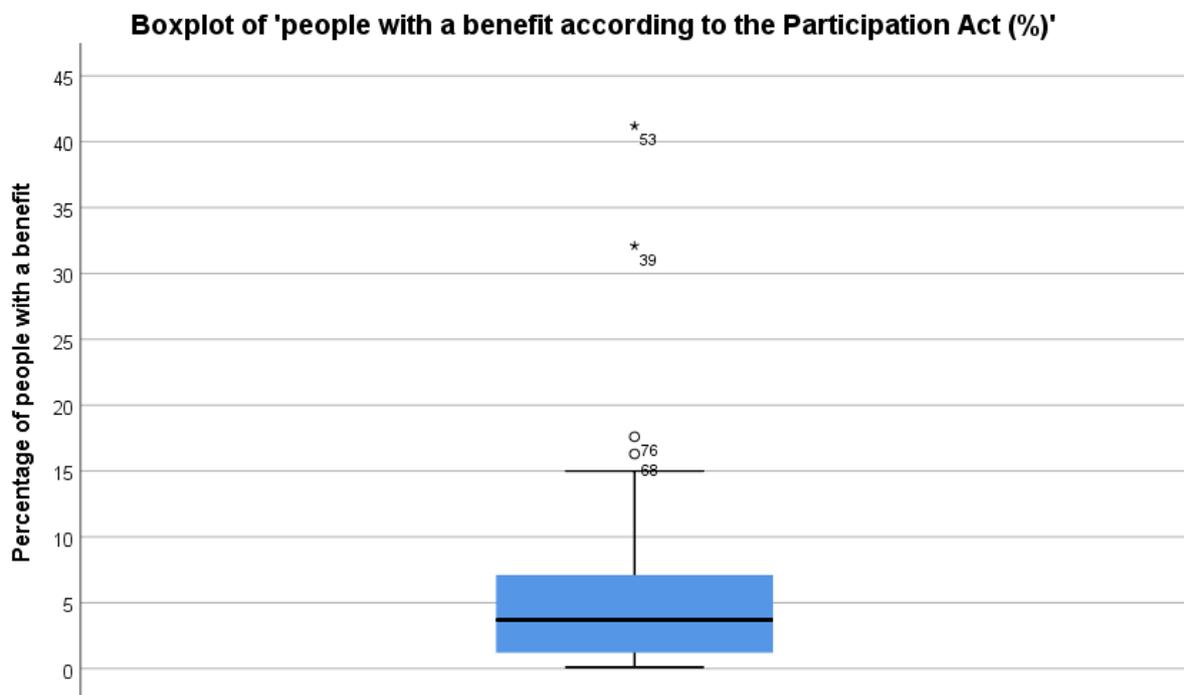


## IV(B).III. OCCUPATIONAL STATUS

### GWU (REGISTERED JOB-SEEKERS UWV)



### BENEFIT ACCORDING TO THE PARTICIPATION ACT



# APPENDIX IV(C) – EXCEL TABLES SES CALCULATION

## IV(C).I. LOW, MIDDLE AND HIGH SES NEIGHBOURHOODS PER VARIABLE

		Laag opgeleide inwoners (%) Mean	Onder 33% is 'goed (hoog) ses', boven 66% is 'slecht (laag) ses' 33=11,33 / 66=22	Score: 1=lage ses / 2 = middel ses / 3=hoge ses			Geregistreerde Werkzoekende UWW (%) Mean	Onder 33% is 'goed (hoog) ses', boven 66% is 'slecht (laag) ses' 33=6,3 / 66=11	Score: 1=lage ses / 2 = middel ses / 3=hoge ses
BU_NAAM	Professorenbuurt	5		3	BU_NAAM	Het Witte Lam			
	Binnenstad-Noord	6		3		Hoornse Park			
	Binnenstad-West	6		3		Klein Harkstede			
	Binnenstad-Zuid	6		3		Klein Martijn			
	Stationsgebied	6		3		Middelbert			
	De Wijert-Zuid	7		3		Noorddijk			
	Klein Martijn	7		3		Noorderhoogebrug			
	Villabuurt	7		3		Stationsgebied			
	Badstratenbuurt	8		3		Sterrebosbuurt			
	Grunobuurt	8		3		Villabuurt			
	Herewegbuurt	8		3		Zilvermeer			
	Laanhuizen	8		3		Piccardthof	1.2		3
	Noorderplantsoenbuurt	8		3		Reitdiep	2.3		3
	Oranjebuurt	8		3		De Buitenhof	2.8		3
	Rivierenbuurt	8		3		Van Starckenborgh	3.0		3
	Tuinwijk	8		3		Gravenburg	3.3		3
	Zeeheldenbuurt	8		3		De Wijert-Zuid	3.4		3
	De Linie	9		3		Engelbert	3.6		3
	De Meeuwen	9		3		Kop van Oost	3.6		3
	Europapark	9		3		De Hunze	3.9		3
	Kop van Oost	9		3		De Held	4.0		3
	Kostverloren	10		3		Schildersbuurt	4.2		3
	Schildersbuurt	10		3		Drielanden	4.3		3
	Binnenstad-Oost	11		3		Coendersborg	4.7		3
	Hortusbuurt- Ebblingekwartier	11		3		De Meeuwen	4.8		3
	Oosterpoort	12		2		Laanhuizen	4.8		3
	Coendersborg	14		2		Ruischerwaard	5.0		3
	De Held	14		2		Zeeheldenbuurt	5.2		3
	Gravenburg	14		2		Professorenbuurt	5.4		3
	Helpman	14		2		Europapark	5.5		3
	Hoendiep	14		2		Binnenstad-Noord	5.9		3
	Reitdiep	14		2		Noorderplantsoenbuurt	6.1		3
	Sterrebosbuurt	14		2		Herewegbuurt	6.4		2
	De Buitenhof	15		2		De Linie	6.5		2
	De Kring	15		2		Binnenstad-West	6.6		2
	Hoornse Park	15		2		Binnenstad-Zuid	6.6		2
	Piccardthof	15		2		Ruischerbrug	6.9		2
	De Hunze	17		2		Grunobuurt	7.1		2
	Drielanden	17		2		Rivierenbuurt	7.7		2
	Hoornse Meer	17		2		Lewenborg-West	8.0		2
	Indische buurt	17		2		Binnenstad-Oost	8.1		2
	Ruischerwaard	17		2		Oosterhoogebrug	8.2		2
	Van Starckenborgh	17		2		Ulgersmaborg	8.4		2
	Zilvermeer	17		2		Hortusbuurt- Ebblingekwartier	8.7		2
	Engelbert	22		1		Oosterpoort	8.7		2
	Het Witte Lam	22		1		Gorechtbuurt	8.9		2
	Klein Harkstede	22		1		Hoogkerk-Zuid	9.1		2
	Middelbert	22		1		Hoendiep	9.3		2
	Noorddijk	22		1		Oranjebuurt	9.3		2
	Noorderhoogebrug	22		1		Hoornse Meer	9.6		2
	Ruischerbrug	22		1		Helpman	10.1		2
	Bloemenbuurt	23		1		Vinkhuizen-Noord	10.2		2
	Damsterbuurt	23		1		Paddepoel-Noord	10.7		2
	Florabuurt	23		1		Bangeweer	10.9		2
	Gorechtbuurt	23		1		Badstratenbuurt	11.2		1
	Vogelbuurt	23		1		Damsterbuurt	11.3		1
	Woonschepenhaven	23		1		Corpus den Hoom	12.2		1
	Beijum-Oost	24		1		Tuinwijk	12.5		1
	Beijum-West	24		1		Beijum-West	12.7		1
	Oosterhoogebrug	24		1		Hoogkerk Dorp	13.3		1
	Ulgersmaborg	24		1		Florabuurt	13.6		1
	Corpus den Hoom	25		1		Kostverloren	14.1		1
	De Wijert	25		1		Selwerd	15.1		1
	De Hoogte	27		1		Lewenborg-Zuid	16.1		1
	Paddepoel-Noord	29		1		De Wijert	16.5		1
	Paddepoel-Zuid	29		1		Woonschepenhaven	17.1		1
	Selwerd	29		1		Indische buurt	17.3		1
	Lewenborg-Noord	32		1		Lewenborg-Noord	18.3		1
	Lewenborg-West	32		1		Vinkhuizen-Zuid	19.6		1
	Lewenborg-Zuid	32		1		Paddepoel-Zuid	20.0		1
	Vinkhuizen-Noord	34		1		Beijum-Oost	20.3		1
	Vinkhuizen-Zuid	34		1		Vogelbuurt	21.6		1
	Bangeweer	36		1		De Hoogte	22.1		1
	Hoogkerk Dorp	36		1		Bloemenbuurt	22.6		1
	Hoogkerk-Zuid	36		1		De Kring	33.5		1

## IV(C).II. SES SCORES PER VARIABLE PER NEIGHBOURHOOD, SORTED IN ALFABETHICAL ORDER

	Laag opgeleide inwoners (%)	Onder 33% is 'goed (hoog) ses', boven 66% is 'slecht (laag) ses'	Score: 1=lage ses / 2 = middel ses / 3=hoge ses			Geregistreerde Werkzoekende UWW (%)	Onder 33% is 'goed (hoog) ses', boven 66% is 'slecht (laag) ses'	Score: 1=lage ses / 2 = middel ses / 3=hoge ses
BU_NAAM	Mean	33=11,33 / 66=22			BU_NAAM	Mean	33=6,3 / 66=11	
Badstratenbuurt	8			3	Badstratenbuurt	11.2		1
Bangeweer	36			1	Bangeweer	10.9		2
Beijum-Oost	24			1	Beijum-Oost	20.3		1
Beijum-West	24			1	Beijum-West	12.7		1
Binnenstad-Noord	6			3	Binnenstad-Noord	5.9		3
Binnenstad-Oost	11			3	Binnenstad-Oost	8.1		2
Binnenstad-West	6			3	Binnenstad-West	6.6		2
Binnenstad-Zuid	6			3	Binnenstad-Zuid	6.6		2
Bloemenbuurt	23			1	Bloemenbuurt	22.6		1
Coendersborg	14			2	Coendersborg	4.7		3
Corpus den Hoom	25			1	Corpus den Hoom	12.2		1
Damsterbuurt	23			1	Damsterbuurt	11.3		1
De Buitenhof	15			2	De Buitenhof	2.8		3
De Held	14			2	De Held	4.0		3
De Hoogte	27			1	De Hoogte	22.1		1
De Hunze	17			2	De Hunze	3.9		3
De Kring	15			2	De Kring	33.5		1
De Linie	9			3	De Linie	6.5		2
De Meeuwen	9			3	De Meeuwen	4.8		3
De Wijert	25			1	De Wijert	16.5		1
De Wijert-Zuid	7			3	De Wijert-Zuid	3.4		3
Drielanden	17			2	Drielanden	4.3		3
Engelbert	22			1	Engelbert	3.6		3
Europapark	9			3	Europapark	5.5		3
Florabuurt	23			1	Florabuurt	13.6		1
Gorechtbuurt	23			1	Gorechtbuurt	8.9		2
Gravenburg	14			2	Gravenburg	3.3		3
Grunobuurt	8			3	Grunobuurt	7.1		2
Helpman	14			2	Helpman	10.1		2
Herewegbuurt	8			3	Herewegbuurt	6.4		2
Het Witte Lam	22			1	Het Witte Lam			
Hoendiep	14			2	Hoendiep	9.3		2
Hoogkerk Dorp	36			1	Hoogkerk Dorp	13.3		1
Hoogkerk-Zuid	36			1	Hoogkerk-Zuid	9.1		2
Hoomse Meer	17			2	Hoomse Meer	9.6		2
Hoomse Park	15			2	Hoomse Park			
Hortusbuurt-Ebbingekwartier	11			3	Hortusbuurt-Ebbingekwartier	8.7		2
Indische buurt	17			2	Indische buurt	17.3		1
Klein Harkstede	22			1	Klein Harkstede			
Klein Martijn	7			3	Klein Martijn			
Kop van Oost	9			3	Kop van Oost	3.6		3
Kostverloren	10			3	Kostverloren	14.1		1
Laanhuizen	8			3	Laanhuizen	4.8		3
Lewenborg-Noord	32			1	Lewenborg-Noord	18.3		1
Lewenborg-West	32			1	Lewenborg-West	8.0		2
Lewenborg-Zuid	32			1	Lewenborg-Zuid	16.1		1
Middelbert	22			1	Middelbert			
Noorddijk	22			1	Noorddijk			
Noorderhoogbrug	22			1	Noorderhoogbrug			
Noorderplantsoenbuurt	8			3	Noorderplantsoenbuurt	6.1		3
Oosterhoogbrug	24			1	Oosterhoogbrug	8.2		2
Oosterpoort	12			3	Oosterpoort	8.7		2
Oranjebuurt	8			3	Oranjebuurt	9.3		2
Paddepoel-Noord	29			1	Paddepoel-Noord	10.7		2
Paddepoel-Zuid	29			1	Paddepoel-Zuid	20.0		1
Piccardthof	15			2	Piccardthof	1.2		3
Professorenbuurt	5			3	Professorenbuurt	5.4		3
Reitdiep	14			2	Reitdiep	2.3		3
Rivierenbuurt	8			3	Rivierenbuurt	7.7		2
Ruischerbrug	22			1	Ruischerbrug	6.9		2
Ruischerwaard	17			2	Ruischerwaard	5.0		3
Schildersbuurt	10			3	Schildersbuurt	4.2		3
Selwerd	29			1	Selwerd	15.1		1
Stationsgebied	6			3	Stationsgebied			
Sterrebosbuurt	14			2	Sterrebosbuurt			
Tuinwijk	8			3	Tuinwijk	12.5		1
Ulgersmaborg	24			1	Ulgersmaborg	8.4		2
Van Starckenborgh	17			2	Van Starckenborgh	3.0		3
Villabuurt	7			3	Villabuurt			
Vinkhuizen-Noord	34			1	Vinkhuizen-Noord	10.2		2
Vinkhuizen-Zuid	34			1	Vinkhuizen-Zuid	19.6		1
Vogelbuurt	23			1	Vogelbuurt	21.6		1
Woonschepenhaven	23			1	Woonschepenhaven	17.1		1
Zeeheldenbuurt	8			3	Zeeheldenbuurt	5.2		3
Zilvermeer	17			2	Zilvermeer			

### IV(C).III. TOTAL SES-SCORE PER NEIGHBOURHOOD

		SES score
		Mean
BU_NAAM	Beijum-Oost	1.00
	Beijum-West	1.00
	Bloemenbuurt	1.00
	Corpus den Hoom	1.00
	Damsterbuurt	1.00
	De Hoogte	1.00
	De Wijert	1.00
	Florabuurt	1.00
	Het Witte Lam	1.00
	Hoogkerk Dorp	1.00
	Klein Harkstede	1.00
	Lewenborg-Noord	1.00
	Lewenborg-Zuid	1.00
	Middelbert	1.00
	Noordijk	1.00
	Noorderhoogebrug	1.00
	Paddepoel-Zuid	1.00
	Selwerd	1.00
	Vinkhuizen-Zuid	1.00
	Vogelbuurt	1.00
	Woonschepenhaven	1.00
	Bangeweer	1.50
	De Kring	1.50
	Gorechtbuurt	1.50
	Hoogkerk-Zuid	1.50
	Indische buurt	1.50
	Lewenborg-West	1.50
	Oosterhoogebrug	1.50
	Paddepoel-Noord	1.50
	Ruischerbrug	1.50
	Ulgersmaborg	1.50
	Vinkhuizen-Noord	1.50
	Badstratenbuurt	2.00
	Engelbert	2.00
	Helpman	2.00
	Hoendiep	2.00
	Hoomse Meer	2.00
	Hoomse Park	2.00
	Kostverloren	2.00
	Oosterpoort	2.00
	Sterrebosbuurt	2.00
	Tuinwijk	2.00
	Zilvermeer	2.00
	Binnenstad-Oost	2.50
	Binnenstad-West	2.50
	Binnenstad-Zuid	2.50
	Coendersborg	2.50
	De Buitenhof	2.50
	De Held	2.50
	De Hunze	2.50
	De Linie	2.50
	Drielanden	2.50
	Gravenburg	2.50
	Grunobuurt	2.50
	Herewegbuurt	2.50
	Hortusbuurt- Ebbingekwartier	2.50
	Oranjobuurt	2.50
	Piccardthof	2.50
	Reitdiep	2.50
	Rivierenbuurt	2.50
	Ruischerwaard	2.50
	Van Starckenborgh	2.50
	Binnenstad-Noord	3.00
	De Meeuwen	3.00
	De Wijert-Zuid	3.00
	Europapark	3.00
	Klein Martijn	3.00
	Kop van Oost	3.00
	Laanhuizen	3.00
	Noorderplantsoenbuurt	3.00
	Professorenbuurt	3.00
	Schildersbuurt	3.00
	Stationsgebied	3.00
	Villabuurt	3.00
	Zeeheldenbuurt	3.00

## APPENDIX V – DATA OVERVIEW

Data	Source	Form (tabular or map)
General information		
Age distribution	RIVM 2016 <ul style="list-style-type: none"> <li>Health per neighbourhood/sub-neighbourhood (at sub-neighbourhood level)</li> </ul> <a href="https://statline.rivm.nl/portal.html?_la=nl&amp;_catalog=RIVM&amp;tableId=50052NED&amp;theme=72">https://statline.rivm.nl/portal.html?_la=nl&amp;_catalog=RIVM&amp;tableId=50052NED&amp;theme=72</a>	Map
Households	Gronometer 2020 (at sub-neighbourhood level) <ul style="list-style-type: none"> <li>Households – per type (%)</li> </ul>	Tabular
Housing ownership	Gronometer 2018 (at sub-neighbourhood level) <ul style="list-style-type: none"> <li>Housing accommodation ownership (%)</li> </ul>	Tabular
Health (general information)		
Good self-perceived health (%)	RIVM 2016 <ul style="list-style-type: none"> <li>Health per neighbourhood/sub-neighbourhood (at sub-neighbourhood level)</li> </ul> <a href="https://statline.rivm.nl/portal.html?_la=nl&amp;_catalog=RIVM&amp;tableId=50052NED&amp;theme=72">https://statline.rivm.nl/portal.html?_la=nl&amp;_catalog=RIVM&amp;tableId=50052NED&amp;theme=72</a>	Tabular
Physical activity		
Meets physical activity guideline (%)	RIVM 2016 <ul style="list-style-type: none"> <li>Health per neighbourhood/sub-neighbourhood (at sub-neighbourhood level)</li> </ul> <a href="https://statline.rivm.nl/portal.html?_la=nl&amp;_catalog=RIVM&amp;tableId=50052NED&amp;theme=72">https://statline.rivm.nl/portal.html?_la=nl&amp;_catalog=RIVM&amp;tableId=50052NED&amp;theme=72</a>	Tabular
Exercising (%)	Municipality of Groningen 2016 + 2018 <ul style="list-style-type: none"> <li>Neighbourhood survey leisure activities and physical activity</li> </ul>	Tabular
Exercising (weekly) (%)		
Member of a sports club (%)		
Socioeconomic status		
SES_Total	Outcome of the construction of the SES variable (section 3.3.)	
Infrastructure		
Playgrounds	ArcGIS server* <ul style="list-style-type: none"> <li>OSM Vrije Tijd – Vlakken – playgrounds</li> <li>OSM Vrije Tijd – Punten – playgrounds</li> </ul> Municipality of Groningen 2018 <ul style="list-style-type: none"> <li>Playgrounds</li> </ul> <a href="https://groningen.dataplatform.nl/#/data/83751786-62a8-4806-aff9-f8dc7abf70c1?totalViews=21">https://groningen.dataplatform.nl/#/data/83751786-62a8-4806-aff9-f8dc7abf70c1?totalViews=21</a>	Map Map Map  <i>(combined to 1 feature)</i>
Sports accommodations	ArcGIS server* <ul style="list-style-type: none"> <li>OSM Vrije Tijd – Punten – sports centre</li> </ul>	Map Map

	<ul style="list-style-type: none"> <li>OSM Sport – Punten</li> <li>OSM Sport – Vlakken</li> </ul>	Map Map  <i>(combined to 1 feature)</i>
Supermarket	ArcGIS server* <ul style="list-style-type: none"> <li>OSM Winkels – Punten – Supermarket</li> </ul>	Map
Restaurants, cafes, snack bars	ArcGIS server* <ul style="list-style-type: none"> <li>OSM EtenDrinken – Punten</li> <li>OSM EtenDrinken – Vlakken</li> </ul>	Map Map  <i>(combined to 1 feature)</i>
Primary schools	DUO, University of Groningen [via ArcGis online] <ul style="list-style-type: none"> <li>Primary Schools 2016</li> </ul>	Map
Public transport	Geodienst University of Groningen, NDOV [via ArcGis online] <ul style="list-style-type: none"> <li>Public transport spots Netherlands</li> </ul>	Map
Maintenance and (no) physical disorder	Gronometer 2018 (at sub-neighbourhood level) <ul style="list-style-type: none"> <li>Satisfaction maintenance sidewalks (%)</li> <li>Satisfaction maintenance bicycle paths (%)</li> <li>Satisfaction maintenance roads (%)</li> <li>Satisfaction maintenance playgrounds (%)</li> <li>Satisfaction maintenance green (%)</li> <li>Satisfaction upkeeping living environment (%)</li> <li>Deterioration score (1=low, 10=high)</li> </ul>	Tabular
Building ownership	Municipality of Groningen <ul style="list-style-type: none"> <li>Building register</li> </ul>	Map
Streets	BGT <ul style="list-style-type: none"> <li>Open topo background  <a href="https://www.nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search?node=geonetwork#/metadata/2891cc29-0a79-46d1-8649-287046d621c7">https://www.nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search?node=geonetwork#/metadata/2891cc29-0a79-46d1-8649-287046d621c7</a> </li> </ul>	
Public lighting	Municipality of Groningen 2019 <ul style="list-style-type: none"> <li>Public lighting  <a href="https://groningen.dataplatform.nl/#/data/0c65c19e-27a6-4d79-87f3-f58acf7ddc8d">https://groningen.dataplatform.nl/#/data/0c65c19e-27a6-4d79-87f3-f58acf7ddc8d</a> </li> </ul>	Map
Public green areas		
Parks	ArcGIS server* <ul style="list-style-type: none"> <li>OSM Vrije Tijd – Vlakken – Parks</li> </ul>	Map
Trees	Municipality of Groningen 2020 <ul style="list-style-type: none"> <li>Trees  <a href="https://groningen.dataplatform.nl/#/data/9861d295-21cd-4ece-8648-88b141dc3532?totalViews=27">https://groningen.dataplatform.nl/#/data/9861d295-21cd-4ece-8648-88b141dc3532?totalViews=27</a> (2018) </li> </ul>	Map
Water	BRT Top10NL – waterdeel vlak [via ArcGIS Online → exported to feature]	Map
Terrain type	BRT Top10NL – Terrein [via ArcGIS Online → exported to feature]	Map
Social environment		
Neighbourhood safety	Gronometer 2018 (at sub-neighbourhood level) <ul style="list-style-type: none"> <li>People who feel unsafe in own neighbourhood (%)</li> <li>Nuisance score (1 = low, 10 = high)</li> </ul>	Tabular

	<ul style="list-style-type: none"> <li>▪ Police reports vandalism</li> <li>▪ Police reports physical abuse</li> </ul>	
Social capital	<p>Gronometer 2018 (at sub-neighbourhood level)</p> <ul style="list-style-type: none"> <li>▪ Contact with neighbours perceived as good (%)</li> <li>▪ Contact with neighbours at least once a week (%)</li> <li>▪ Self-perceived sufficient social contacts (%)</li> </ul>	Tabular
Social cohesion	<p>Gronometer 2018 (at sub-neighbourhood level)</p> <ul style="list-style-type: none"> <li>▪ Neighbourhood cohesion (score 1=low, 10=high)</li> <li>▪ Attachment to neighbourhood (%)</li> <li>▪ Feels co-responsible for neighbourhood (%)</li> </ul> <p>Municipality of Groningen neighbourhood survey leisure activities and physical activity (2016 + 2018)</p> <ul style="list-style-type: none"> <li>▪ Participation in activities in community centre, library or cultural centre</li> </ul>	Tabular

## APPENDIX VI – OBSERVATION CHECKLIST

Location:

Date:

Time:

Weather conditions: sunny / cloudy / rainy / stormy / other

### Area characteristics

			Notes
<b>Short description of the area: green, pathways, water features, disorder etc.</b>			
<b>Accessible E.g. not locked or rented to others</b>	Yes	No	
<b>Usable E.g. not wet</b>	Yes	No	
<b>Equipped E.g. play equipment (playground or fitness attributes)</b>	Yes	No	
<b>Organized E.g. organised sport events</b>	Yes	No	
<b>Dark E.g. not well lit</b>	Yes	No	

Time	Sex	Age category*	Alone / duo / multiple	Activity type**	Notes

### Observation of people

\*Child: up to 12 years old / Adolescent: 13-20 years old / Adult: 20-64 / Senior: 65+

\*\*Physical activity types divided into:

- Sedentary: individuals lying down, sitting or standing
- Leisure time physical activity: walking, cycling, running, engaging in sports activities (e.g. soccer, basketball), playing
- Transport-related physical activity: walking or cycling with grocery shopping bags

# APPENDIX VII – OBSERVATION OOSTERPARKWIJK

## VII.I. NEIGHBOURHOOD WALK

Screenshot of the route of the neighbourhood walk:



## VII.II. OBSERVATION OOSTERPARK

Location: Oosterpark, Vogelbuurt (1)

Date: 06-04-2020

Time: 9:30 – 10:00 AM

Weather conditions: **sunny** / cloudy / rainy / stormy / other – 13 degrees Celsius

### Area characteristics

			Notes
<b>Short description of the area: green, pathways, water features, disorder etc.</b>			Large pond (oval) surrounded by walking paths, trees, large grass fields, benches and diverse playgrounds. Enclosed by newly built (west) and older houses (north, east, south).
<b>Accessible E.g. not locked or rented to others</b>	<b>Yes</b>	No	Open accessible, no gates. Accessible from all sides of the park
<b>Usable E.g. not wet</b>	<b>Yes</b>	No	
<b>Equipped E.g. play equipment (playground or fitness attributes)</b>	<b>Yes</b>	No	Benches, trashcans and playground attributes
<b>Organized E.g. organised sport events</b>	Yes	<b>No</b>	
<b>Dark E.g. not well lit</b>	<b>Yes</b>	No	No street lights along the walking paths

### Observation of people

\*Sex: Male / Female / Unknown

\*\*Age category: Child: up to 12 years old / Adolescent: 13-20 years old / Adult: 20-64 / Senior: 65+

\*\*\*Physical activity types divided into:

- Sedentary: individuals lying down, sitting or standing
- Leisure time physical activity: walking, cycling, running, engaging in sports activities (e.g. soccer, basketball), playing
- Transport-related physical activity: walking or cycling with grocery shopping bags

Time	Sex	Age category*	Alone / duo / multiple	Activity type**	Notes
9.30	M	Adult	Alone	Dog walking	
9.31	F	Senior	Alone	Dog walking	
9.31	F	Senior	Alone	Walking	
9.32	F	Adult	Alone	Fitness	
9.33	F	Adult	Alone	Running/walking	
9.34	F	Senior	Alone	Walking	
9.35	F	Adult	Alone	Running/walking	
9.36	F	Adolescent	Alone	Fitness	
9.40	M	Adult	Alone	Sitting/phoning	
9.41	M	Adult	Alone	Biking	
9.41	F	Adult	Alone	Dog walking	
9.45	F	Adult	Alone	Walking/Sitting	
9.46	M	Adult	Alone	Dog walking	
9.47	F	Adult	Alone	Biking	
9.52	M	Adult	Alone	Dog walking	
9.53	M M	Adult Adult	Duo	Running	
9.53	F	Senior	Alone	Walking	
9.54	M M	Adult Child	Duo	Dog walking Biking	Man walking with dog, child on bike
9.57	F	Adult	Alone	Running	
9.57	F	Senior	Alone	Sitting/walking	
9.59	F F F M	Adult Child Child Child	Multiple	Walking	

Location: Oosterpark, Vogelbuurt (2)

Date: 08-04-2020

Time: 14:00 – 14:30 PM

Weather conditions: **sunny** / cloudy / rainy / stormy / other – 20 degrees Celsius

#### Area characteristics

			Notes
<b>Short description of the area: green, pathways, water features, disorder etc.</b>			Large pond (oval) surrounded by walking paths, trees, large grass fields, benches and diverse playgrounds. Enclosed by newly built (west) and older houses (north, east, south).
<b>Accessible E.g. not locked or rented to others</b>	<b>Yes</b>	No	Open accessible, no gates. Accessible from all sides of the park
<b>Usable E.g. not wet</b>	<b>Yes</b>	No	
<b>Equipped E.g. play equipment (playground or fitness attributes)</b>	<b>Yes</b>	No	Benches, trashcans and playground attributes
<b>Organized E.g. organised sport events</b>	Yes	<b>No</b>	
<b>Dark E.g. not well lit</b>	<b>Yes</b>	No	No street lights along the walking paths

#### Observation of people

\*Sex: Male / Female / Unknown

\*\*Age category: Child: up to 12 years old / Adolescent: 13-20 years old / Adult: 20-64 / Senior: 65+

\*\*\*Physical activity types divided into:

- Sedentary: individuals lying down, sitting or standing
- Leisure time physical activity: walking, cycling, running, engaging in sports activities (e.g. soccer, basketball), playing
- Transport-related physical activity: walking or cycling with grocery shopping bags

Time	Sex	Age category*	Alone / duo / multiple	Activity type**	Notes
14.00	F M U	Adult Adult Child	Multiple	Walking	Child in pram
14.00	M	Adult	Alone	Sitting	Reading
14.00	F F	Adult	Duo	Sitting	Sunbathing
14.00	F F	Adult	Duo	Sitting	Sunbathing
14.00	F F	Adolescent Adolescent	Duo	Sitting	Sunbathing
14.02	F U	Adult Child	Duo	Dog walking	Child in pram (same as seen in Pioenpark (3))
14.04	M	Adult	Alone	Biking	
14.05	F	Adolescent	Alone	Walking	
14.06	M F	Adult	Duo	Walking	
14.06	F	Senior	Alone	Sitting	
14.07	F	Child	Alone	Biking	Passed by twice
14.08	F F F	Adult Adult Child	Multiple	Sitting + playing	In playground
14.08	F M	Adolescent Adult	Duo	Running	
14.10	M M F	Adolescent Adolescent Adolescent	Multiple	Walking/sitting/football	
14.11	F	Adult	Alone	Dog walking	
14.11	F	Adult	Alone	Walking	
14.11	F	Adult	Alone	Dog walking	
14.13	F	Adult	Alone	Walking	
14.13	F	Adult	Alone	Running	
14.15	M	Child	Alone	Stepping	
14.15	F F	Senior Adult	Duo	Sitting	
14.16	F F	Adult Adult	Duo	Sitting	Sunbathing
14.16	F F	Senior Senior	Duo	Walking	

<b>14.16</b>	M F F M	Adult Child Child Child	Multiple	Sitting + playing	In playground
<b>14.18</b>	F F	Adult Adult	Duo	Walking	
<b>14.19</b>	M M F F	Child Child Adolescent Adolescent	Multiple	Dog walking + football	Seen later in bushes where they hang around on a big fallen tree
<b>14.20</b>	M	Senior	Alone	Dog walking	
<b>14.20</b>	M	Adult	Alone	Running	
<b>14.21</b>	F	Senior	Alone	Dog walking	
<b>14.21</b>	F	Adult	Alone	Dog walking	
<b>14.23</b>	M	Senior	Alone	Biking	
<b>14.24</b>	F	Adult	Alone	Walking	
<b>14.26</b>	M F	Adult	Duo	Walking	
<b>14.27</b>	M	Adult	Alone	Biking	
<b>14.29</b>	F	Adult	Alone	Walking	
<b>14.29</b>	M	Adult	Alone	Biking	
<b>14.30</b>	M	Child	Alone	Biking	

## VII.III. OBSERVATION PIOENPARK

Location: Pioenpark, Florabuurt (1)

Date: 06-04-2020

Time: 10:15 – 10:45 AM

Weather conditions: **sunny** / cloudy / rainy / stormy / other – 13 degrees Celsius

### Area characteristics

			Notes
<b>Short description of the area: green, pathways, water features, disorder etc.</b>			Large pond (rectangular) surrounded by a walking path, trees and benches. Enclosed by newly built (east) and older houses (west).
<b>Accessible E.g. not locked or rented to others</b>	<b>Yes</b>	No	Open accessible, no gates
<b>Usable E.g. not wet</b>	<b>Yes</b>	No	
<b>Equipped E.g. play equipment (playground or fitness attributes)</b>	<b>Yes</b>	No	Benches
<b>Organized E.g. organised sport events</b>	Yes	<b>No</b>	
<b>Dark E.g. not well lit</b>	<b>Yes</b>	<b>No</b>	Bicycle/walking paths cutting from east to west through the park are lit, walking paths along the ponds (north to south) are not.

### Observation of people

\*Sex: Male / Female / Unknown (e.g. a baby)

\*\*Age category: Child: up to 12 years old / Adolescent: 13-20 years old / Adult: 20-64 / Senior: 65+

\*\*\*Physical activity types divided into:

- Sedentary: individuals lying down, sitting or standing
- Leisure time physical activity: walking, cycling, running, engaging in sports activities (e.g. soccer, basketball), playing
- Transport-related physical activity: walking or cycling with grocery shopping bags

Time	Sex	Age category*	Alone / duo / multiple	Activity type**	Notes
10.15	M	Adult	Alone	Running	
10.15	M F	Adult	Duo	Running	
10.17	F	Adult	Alone	Running	
10.17	M	Adult	Alone	Dog cycling	
10.20	F U	Adult Child	Duo	Walking	Child in pram
10.21	M M U	Adult Child Child	Multiple	Walking	Man with child in pram and child on bike
10.23	F	Adult	Alone	Walking	
10.23	M	Adult	Alone	Dog walking	
10.24	M	Adult	Alone	Dog walking	Same man seen in Oosterpark
10.24	F U	Adult Child	Duo	Walking	Child in pram
10.24	F	Adult	Alone	Walking	
10.25	F	Adult	Alone	Running	
10.26	F U	Adult Child	Alone	Walking	Child in pram
10.27	M F	Adult	Duo	Walking	
10.28	M F	Adult	Duo	Dog walking	
10.28	M	Adult	Alone	Dog walking	
10.29	F M	Adult Child	Duo	Dog walking	
10.30	M F	Adult	Duo	Running	
10.31	M	Adult	Alone	Cycling	
10.31	M	Adult	Alone	Walking	
10.32	F	Adult	Alone	Dog walking	
10.33	M	Adult	Alone	Dog walking	
10.33	M	Adult	Alone	Dog walking	
10.35	M	Adult	Alone	Running	
10.36	M	Adolescent	Alone	Running	
10.36	F F	Adolescent	Duo	Dog walking	

<b>10.37</b>	M	Adult	Alone	Dog walking	
<b>10.37</b>	M M	Adolescent	Duo	Scooter riding	
<b>10.39</b>	F	Adolescent	Alone	Running/walking	
<b>10.41</b>	F F	Senior	Duo	Walking	
<b>10.42</b>	F	Adult	Alone	Dog walking	
<b>10.42</b>	F U	Adult Child	Duo	Cycling	With child in front
<b>10.43</b>	M M	Adult Adolescent	Duo	Running/walking	
<b>10.44</b>	F	Adult	Alone	Walking	
<b>10.45</b>	F M	Adult Child	Duo	Walking	Child on bike
<b>10.45</b>	F	Adult	Alone	Dog walking	

Location: Pioenpark, Florabuurt (2)

Date: 08-04-2020

Time: 13:20 – 13:50 PM

Weather conditions: **sunny** / cloudy / rainy / stormy / other – 20 degrees Celsius

#### Area characteristics

			Notes
<b>Short description of the area: green, pathways, water features, disorder etc.</b>			Small designed 'garden' with multiple benches and a pergola. Enclosed by newly built (east) and older houses (west).
<b>Accessible E.g. not locked or rented to others</b>	<b>Yes</b>	No	Open accessible, surrounded by box trees and accessible via 5 entry points
<b>Usable E.g. not wet</b>	<b>Yes</b>	No	
<b>Equipped E.g. play equipment (playground or fitness attributes)</b>	<b>Yes</b>	No	Benches
<b>Organized E.g. organised sport events</b>	Yes	<b>No</b>	
<b>Dark E.g. not well lit</b>	<b>Yes</b>	No	No street lights

#### Observation of people

\*Sex: Male / Female / Unknown (e.g. a baby)

\*\*Age category: Child: up to 12 years old / Adolescent: 13-20 years old / Adult: 20-64 / Senior: 65+

\*\*\*Physical activity types divided into:

- Sedentary: individuals lying down, sitting or standing
- Leisure time physical activity: walking, cycling, running, engaging in sports activities (e.g. soccer, basketball), playing
- Transport-related physical activity: walking or cycling with grocery shopping bags

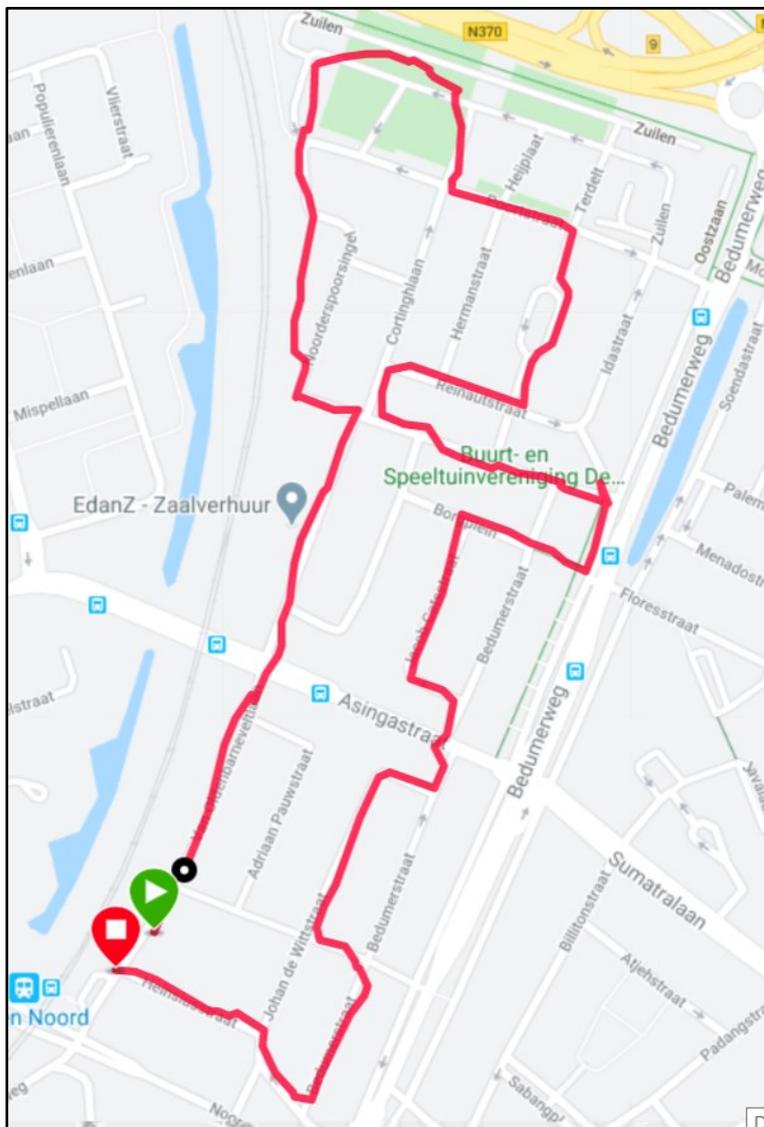
Time	Sex	Age category*	Alone / duo / multiple	Activity type**	Notes
13.20	M	Senior	Alone	Sitting	
13.20	M	Adult	Alone	Sitting	
13.20	M	Adult	Alone	Sitting/walking/Football	
13.21	M	Adult	Alone	Walking	
13.21	F F	Adult	Duo	Walking	
13.22	F	Adult	Alone	Walking	
13.23	M	Adolescent	Alone	Biking	
13.23	F	Adolescent	Alone	Biking	
13.24	F	Adult	Alone	Walking	
13.24	F	Adult	Alone	Biking	
13.24	F U	Adult Child	Duo	Walking	Child in pram
13.25	M	Adult	Alone	Biking	
13.25	M M	Adult Child	Duo	Waling	
13.29	F	Adult	Alone	Dog walking	
13.31	F M	Adult	Duo	Dog waling	
13.32	F	Adult	Alone	Walking	
13.33	F U	Adult Child	Duo	Dog walking	Child in pram
13.33	F	Adult	Alone	Dog walking	
13.34	M	Adult	Alone	Walking	
13.34	F	Adult	Alone	Biking	
13.36	M	Adult	Alone	Running	
13.37	F	Adult	Alone	Biking	
13.37	F	Senior	Alone	Biking	
13.37	F	Adult	Alone	Biking	
13.38	M	Adult	Alone	Biking	
13.38	M	Adult	Alone	Running	
13.38	M F	Adult Adult	Duo	Running	
13.39	M M F	Adult Child Adolescent	Multiple	Biking	
13.40	M F	Adolescent Adolescent	Duo	Biking	

<b>13.40</b>	M	Adolescent	Duo	Biking/sitting	
	M	Adolescent			
<b>13.41</b>	M	Adult	Alone	Biking	
<b>13.41</b>	F	Adolescent	Alone	Walking/sitting	
<b>13.42</b>	M	Adult	Alone	Walking	
<b>13.42</b>	M	Adult	Alone	Biking	
<b>13.42</b>	M	Adult	Alone	Walking	
<b>13.43</b>	F	Senior	Alone	Walking	
<b>13.44</b>	F	Adult	Alone	Walking	
<b>13.45</b>	M	Senior	Alone	Walking	
<b>13.46</b>	M	Adult	Alone	Walking	
<b>13.48</b>	M	Adult	Alone	Walking	
<b>13.50</b>	M	Adult	Alone	Walking	
<b>13.50</b>	M	Adult	Duo	Sitting	
	F	Adult			
<b>13.50</b>	F	Senior	Alone	Sitting	

## APPENDIX VIII – OBSERVATION DE HOOGTE

### VIII.I. NEIGHBOURHOOD WALK

Screenshot of the route of the neighbourhood walk:



### VIII.II. OBSERVATION

*Note:* For this neighbourhood, no observation as in Oosterparkwijk could be conducted, because of the lack of suitable areas. The observant therefore walked across the main playground several times during the walk through the neighbourhood.

Location: Playground De Hoogte

Date: 06-04-2020

Time: 14:00 PM

Weather conditions: **sunny** / cloudy / rainy / stormy / other – 22 degrees Celsius

### Area characteristics

			Notes
<b>Short description of the area: green, pathways, water features, disorder etc.</b>			Playground with a diversity of play equipment, benches and a basketball/soccer field (Krajicek Foundation). Surrounded by box trees with entry points on both the north and south side of the playground. The building of the neighbourhood and playground association is also located on this terrain.
<b>Accessible E.g. not locked or rented to others</b>	<b>Yes</b>	No	Open accessible, no gates. Accessible from the north and south side.
<b>Usable E.g. not wet</b>	<b>Yes</b>	No	
<b>Equipped E.g. play equipment (playground or fitness attributes)</b>	<b>Yes</b>	No	Benches, trashcans, playground and sports attributes
<b>Organized E.g. organised sport events</b>	Yes	<b>No</b>	
<b>Dark E.g. not well lit</b>	<b>Yes</b>	No	A couple of street lights

### Observation of people

\*Sex: Male / Female / Unknown

\*\*Age category: Child: up to 12 years old / Adolescent: 13-20 years old / Adult: 20-64 / Senior: 65+

\*\*\*Physical activity types divided into:

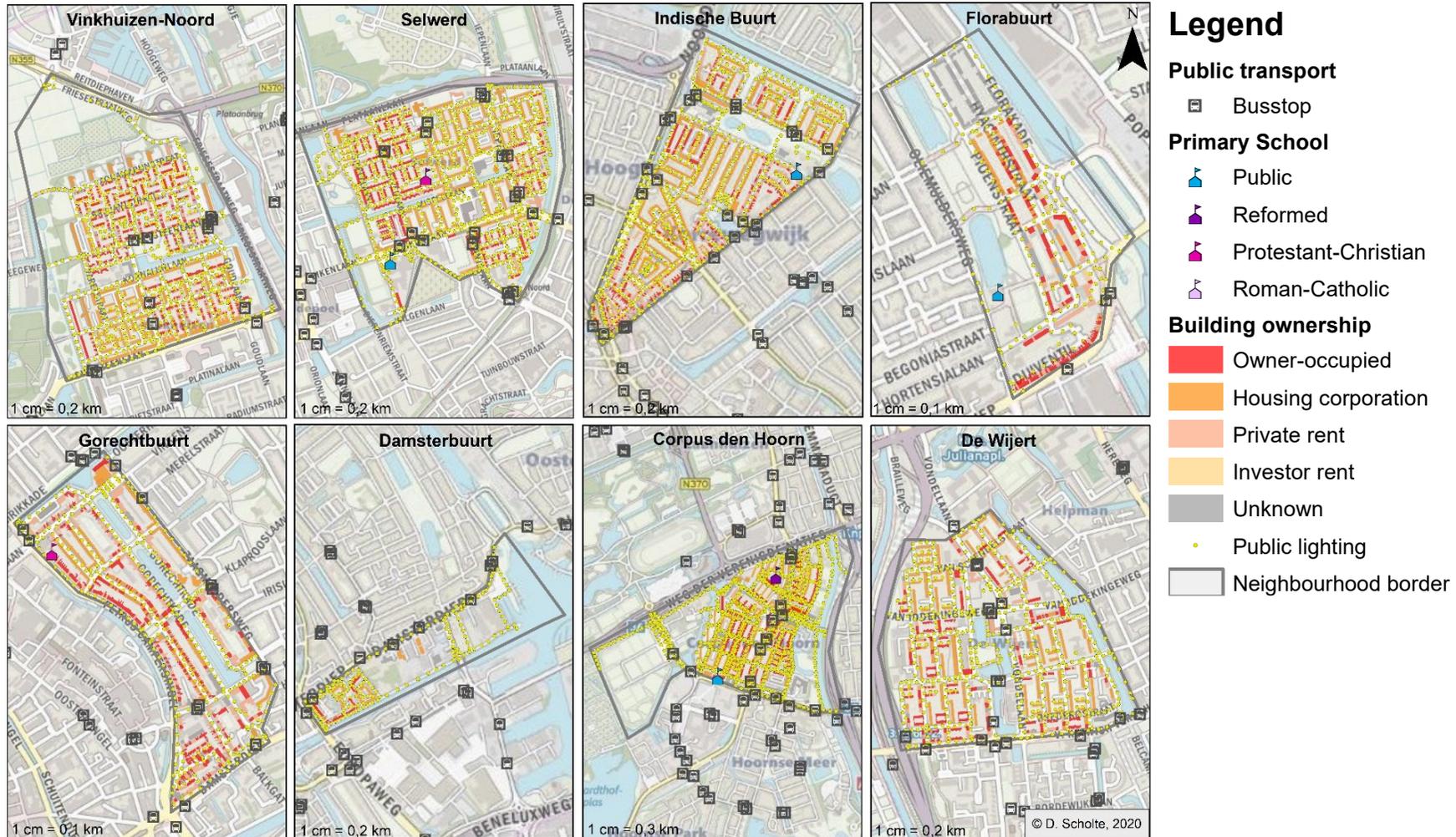
- Sedentary: individuals lying down, sitting or standing
- Leisure time physical activity: walking, cycling, running, engaging in sports activities (e.g. soccer, basketball), playing
- Transport-related physical activity: walking or cycling with grocery shopping bags

Time	Sex	Age category*	Alone / duo / multiple	Activity type**	Notes
14.00		Adult	Multiple	Sitting	5 parents sitting and chatting on a bench
14.00		Child	Multiple	Playing	12 children playing in the playground
14.00		Adult/Adolescent	Multiple	Playing basketball	3 females and 2 males playing basketball
14.00		Adult + child	Duo	Walking	
14.00		Adult	Duo	Walking	Sunbathing

## APPENDIX IX – EXTRA MAPS

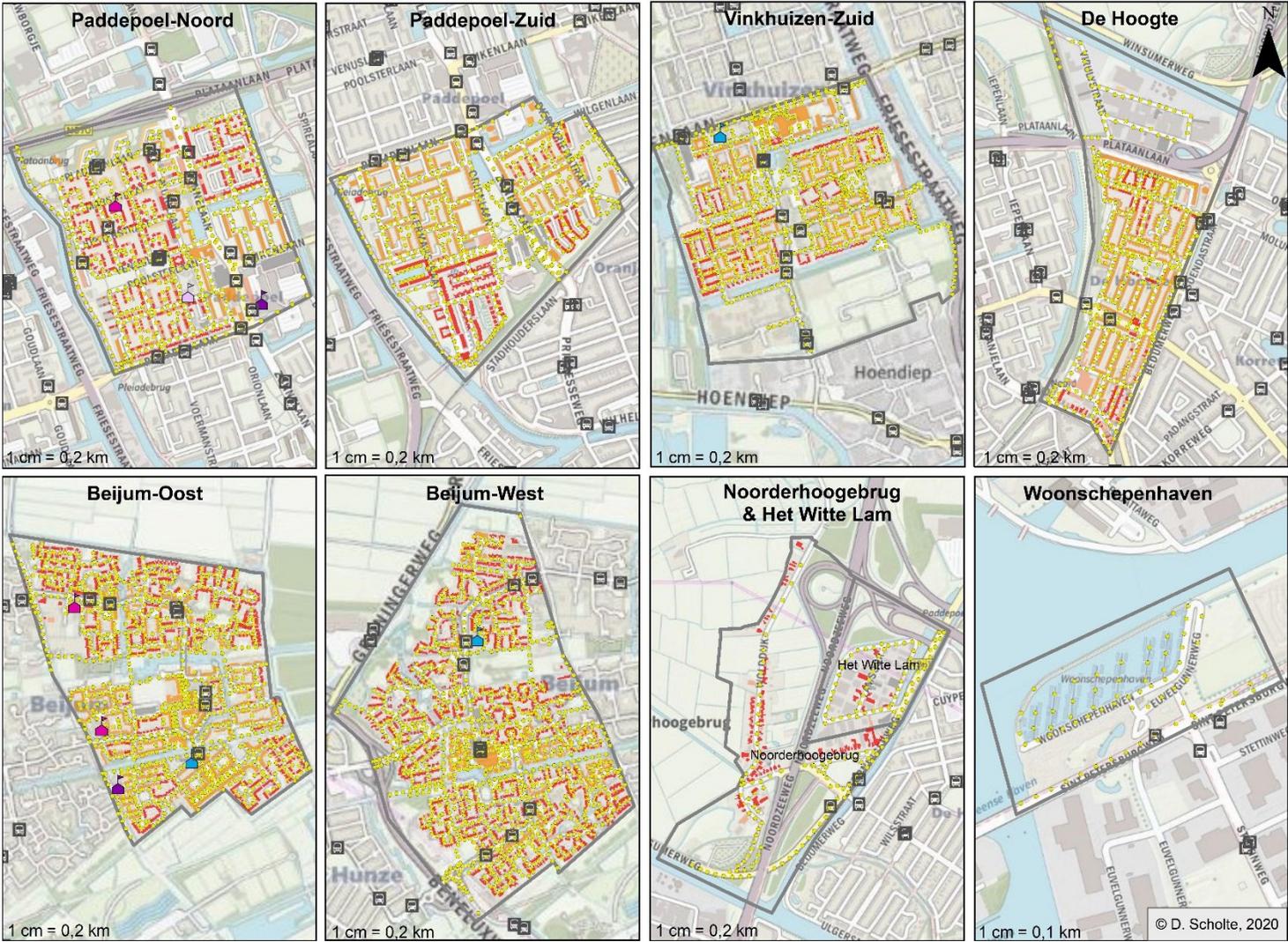
Street design with public lighting in low-SES neighbourhoods with an above-average PA score.

### Street design in low-SES neighbourhoods with an above-average PA score



Street design with public lighting in low-SES neighbourhoods with a below-average PA score (part 1).

Street design in low-SES neighbourhoods with a below-average PA score (1)



Street design with public lighting in low-SES neighbourhoods with a below-average PA score (part 2).

## Street design in low-SES neighbourhoods with a below-average PA score (2)



### Legend

**Public transport**

☐ Busstop

**Primary School**

🏫 Public

🏫 Reformed

🏫 Protestant-Christian

🏫 Roman-Catholic

**Building ownership**

🔴 Owner-occupied

🟠 Housing corporation

🟡 Private rent

🟠 Investor rent

🟡 Unknown

• Public lighting

▭ Neighbourhood border

Green areas without trees in low-SES neighbourhoods with an above-average PA score.

Green areas in low-SES neighbourhoods with an above-average PA score



- Legend**
- Park
  - Forest
  - Grass
  - Pond
  - Watercourse
  - Neighbourhood border

Green areas without trees in low-SES neighbourhoods with a below-average PA score (part 1).

Green areas in low-SES neighbourhoods with a below-average PA score (1)



Green areas without trees in low-SES neighbourhoods with a below-average PA score (part 2).

**Green areas in low-SES neighbourhoods with a below-average PA score (2)**



- Legend**
- Park
  - Forest
  - Grass
  - Pond
  - Watercourse
  - Neighbourhood border