Relationship between perceived health and accessibility to green space among students in Groningen

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Abstract

Since the COVID-19 pandemic, university students in the Netherlands have experienced an increase in mental and physical health issues. These rising issues are the motivation for research on the effects and possible benefits public green spaces might have on both mental and physical health. There are three relevant concepts, namely public parks, accessibility and service area calculation. Public urban parks larger than one hectare are taken into consideration. Accessibility is calculated as a five-minute distance from public parks, which is travelled using an active mode of transport. The relations between perceived health, accessibility and frequency of visits are studied through the means of a survey asking students in the city of Groningen how they perceive their own mental and physical well-being (N=39). The relationship between age, gender and perceived health is analysed, together with relationships between health and frequency of visits, and accessibility and its effect on visits. Finally, the relationship between perceived health and accessibility to green space, to answer the main question *Is there a relationship between perceived mental and physical health and accessibility to green space among students?* All these relationships are studied through Mann-Whitney U tests and Kruskal-Wallis tests to see if the expectations are met. Through these tests, it can be concluded that mental health is affected by the accessibility to public green spaces. Physical health is only slightly significantly affected by the accessibility, and there is no significant relationship found between frequency of visits and perceived health nor frequency of visits and accessibility.

Contents

1. Introduction

1.1 Background and relevance

Since the COVID-19 pandemic, students have suffered more from mental health issues, especially an increase in stress (Schers, et al., 2021). The perceived health is a concept that has been thoroughly explored and is defined as "a person's general subjective general perception of health" (Smith-Nielsen & Krasnik, 2010). The perceived health can be affected by stress, illness, physical, mental and social well-being, and is often also related to urban green spaces (Government of Canada, 2023; Hartig, et al., 2014). This is why, in particular considering the increasing health issues among students, effects of green space on perceived health needs to keep being explored.

However, the effects green space has on students are mostly studied from an academic performance standpoint, where the academic performance was investigated based on the exposure to green space (Rakowska, et al., 2023). In other instances, the effects green spaces have on health have been researched, but only green space on campus (Xinqin, et al., 2019). Also, the concepts of health and accessibility to green space is an increasingly common subject for studies (Hartig, et al., 2014; Romagosa, 2018), but rarely specifically on the health of students. As a result, the specific relationship between perceived health among students and accessibility to public green spaces needs to be researched to find if there is a positive relationship between the two concepts. Not only that, but the relevance of frequent visits to green space is also often highlighted, since it can have positive effects on one's mental health (Kabisch, et al., 2021). Differences in perceived health can also be found between genders, (Brun Sundblad, et al., 2007), where the health between fifteen year old students was measured, but this relationship gets weaker as students get older (Zhang, et al., 2019). Therefore, this study will gather more data on the relationship between accessibility to green spaces and perceived mental and physical health, to make well-informed policy recommendations.

1.2 Research aim and questions

This study will look into questions regarding the perceived mental and physical health and its relationship with accessibility to green spaces. The main question of this research is: What is the relationship between perceived health and accessibility to public green space in Groningen? The following sub questions will be used to help answering this main question:

Is there a difference in perceived health between genders?

How does accessibility to green space influence the frequency of visits to green space?

Is there a relationship between frequency of visits and perceived health?

Is there a relationship between accessibility and perceived health?

1.3 Structure of the dissertation

To best conduct this research, first the definitions and aspects have to be determined. This will be done in the theoretical framework, where the different concepts and theories are explained and how they are related. Then, the methodology will cover how the case study is structured. The survey will also be explained and what choices have been made to best implement the research aspects into the survey. Next, the statistical analysis will be conducted where the survey results are tested for significance, and the main question and sub questions will be answered. After the statistical analysis, the results will be discussed, the research questions will be answered and improvements to the research and potential future studies will be proposed.

2. Theoretical Framework

2.1 Green Space

First, there are three concepts that need to be explained, the first of which is green space. To know what green space areas are, several previous studies have to be analysed. Green space in itself is an abstract and unclear term, which is why there can be looked at two different criteria: size and recreational value. The size of a green space is important, and one can look at the research as suggested by Annerstedt van den Bosch, et al. (2016), who put the threshold for green space is a public park larger than one hectare before it can be perceived as adding actual value to the surrounding area. This is also motivated by (Ekkel & de Vries, 2017), who studied not only green space, but blue space and countryside as well. An example of research on recreational public spaces can be seen in the research done by Price, et al. (2023), who studied the accessibility to recreational areas in Wales, which includes football and rugby pitches, which again reflects the qualitative value necessary for green spaces.

2.2 Accessibility

The next aspect that needs to be understood is the accessibility. To determine the accessibility, there has to be a set limit to either the distance or time from the public parks, as to create a service area for the green space at a later stage in the research. Several previous researches made use of a time limit, mostly ranging from 10 to 20 minutes of walking (Price, et al., 2023; Poortinga, et al., 2021). However, other researches that have been conducted with similar subjects chose a set distance from the facility (Ekkel & de Vries, 2017; Grahn & Stigsdotter, 2003), who both used a hard limit of 300 metres. The choice between these two options, time and distance, both have good cases for why they should be used. For example, there are instances where “the results confirmed a negative association between residential proximity and depressive symptoms” (Reklaitiene, et al., 2014), showing a relation between the distance of 300 metres and effects on health, with a measurable reduction in the effect after this limit. However, making only use of distance does not take into account wait times, crossings and non-walkable roads, which is why in other instances a short walking distance has been used as a determining factor measured in travel time (Poortinga, et al., 2021).

2.3 Perceived health

Perceived health can be described as “a person’s general subjective general perception of health” (Smith-Nielsen & Krasnik, 2010), and it has been suggested that perceived health uses individual criteria to capture the holistic health perception, including mental and physical health (Idler & Benyamini, 1997). In a Dutch context, perceived health was studied along regarding the effects of health on academic functioning (Boot, et al., 2009), where they found that a better perceived health also saw an increase in a person their well-being and academic functioning.

2.4 Perceived health and gender

The relationship between perceived health and gender among students is a common subject of research (Piko, et al., 1997; Brun Sundblad, et al., 2007), where it was found that female students had a lower perceived mental health compared to male students, which is especially noticeable in frequency of headaches among female students (Brun Sundblad, et al., 2007). In this research by Brun Sundblad, et al. the research was done on school children, aged fifteen years old. However, in a study by Zhang, et al. (2019), there was no relation found between perceived health and gender, who studied college students aged eighteen to twenty. Finally, in a Dutch context, there was also no relation found between gender and perceived health (Boot, et al., 2009).

2.5 Accessibility and frequency of visits

There are several studies that analysed the relationship between accessibility to public parks and frequency of visits (Schnell, et al., 2019; Pham, et al., 2019). Pham, et al. (2019) in particular, who found that travel mode proved to be the most important factor for increasing the frequency of visits, in particular cycling. Additionally, accessibility was significant in explaining both higher frequency as well as duration of visits, meaning that a better accessibility led to higher frequency of visits. Schnell, et al. (2019) found that once people were exposed to nature and social activity in parks, they were more motivated to increase the frequency of visits. This was particularly the case for people that lived within walking distance (400 metre) from public parks.

2.6 Health and frequency of visits

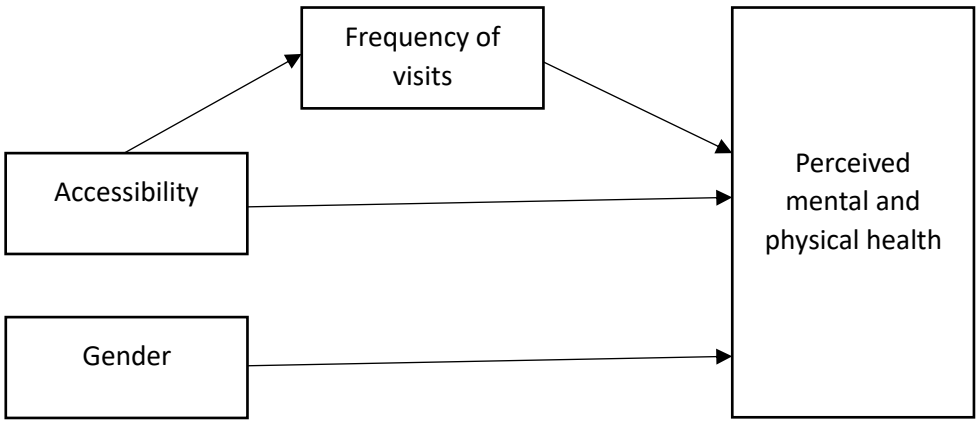
Health and frequency of visits is also an extensively researched subject (Schnell, et al., 2019; Kabisch, et al., 2021). Schnell, et al (2019) found that the frequency of visits is dependent on accessibility, and those who visit more frequently enjoy higher levels of well-being. Kabisch, et al. (2021) also found that there was a better self-perceived health when frequency of visits was higher. This was especially the case in summer heat conditions, as was studied in two parks in Leipzig. This is also reflected in the research by Chiang & Li (2019), who found that increased frequencies of visits had a direct decrease on that person's psychological stress, based on data collected from 964 people across 43 parks in Taipei.

2.7 Health and Accessibility

Regarding perceived health and accessibility to green space, there are also several previous studies that can be referenced (Schnell, et al., 2019; Reklaitiene, et al., 2014). Again Schnell, et al. (2019) who found that a better accessibility increased the perceived health. This is particularly the case for people living within walking distance from public parks, where an increase in individual well-being was found. Similarly, Reklaitiene, et al. (2014) found that there was a negative association between residential proximity to public parks and depressive symptoms.

2.8 Conceptual model

For a better overview of the relations between all factors and variables, one can look at the conceptual model (model 1). In this model, the independent factors (accessibility and gender) are placed on the left and the dependent variable (perceived health) on the right. The moderating variable, frequency of visits, will be tested for on its relationship with accessibility, and the influence it has on the perceived health.



Model 1: Conceptual model of relationships between variables

2.9 Expectations

Regarding the discussed literature and the conceptual model, the hypotheses for the research questions are as follows:

There is no difference between perceived health across genders.

There is no difference between genders their frequencies of visits.

There is a positive relationship between accessibility and frequency of visits.

There is a positive relationship between frequency of visits and perceived health.

There is a positive relationship between accessibility and perceived health.

3. Methodology

3.1 Case study

The quality and the size of the green spaces is of the utmost importance for this research. From these criteria, there are twelve public parks in Groningen selected for the research (figure 1). In the figure it can again be seen that the parks used in the analysis need to have recreational values, and agricultural land outside of the city is not taken into account. To calculate the service areas of the public parks, the area that can be reached within five minutes has to be calculated. Five minutes is chosen, since it was found that a distance that can be covered in this time is still affecting the mental health of people living within the area (Reklaitiene, et al., 2014). This calculation is done through the use of ArcGIS with the service area network analysis tool. First, the public parks had to be mapped (figure 1) to find the size of parks to see if they had the desirable threshold of one hectare (Annerstedt van den Bosch, et al., 2016). However, the tool used in ArcGIS cannot work with a polygon shape which was used to create the public parks layer. Since the polygons are overlaid on the street map, the access points to the parks can easily be found and used as facility point locations for the calculations. The tool measures the distance from the given access points up to the set distance using the road map that is integrated in the analysis. The service area analysis tool that is used in ArcGIS pro uses one selected mode of transport, namely walking, and also takes the time limit into account, which was set to five minutes. This corresponds with a distance of circa three hundred metres from the access points, but also depends on the road network available (ESRI, 2021). Only roads that are useable by pedestrians and cyclists are selected and used in the analysis. This results in the following service area, visible in figure 2. As can be seen, large parts of the north of the city are included in the service area, but there are potential places for improvement in the historic city centre and south of the ring road. The lack of green recreational areas around the city centre and surrounding neighbourhoods can be explained by the fact of the historic value, since there was not as much demand for green areas around the time Groningen was first developing. The south-eastern area of the city also appears to be lacking green space, but the area largely consists of industrial land, ports and furniture retailers, where green space is not as necessary.

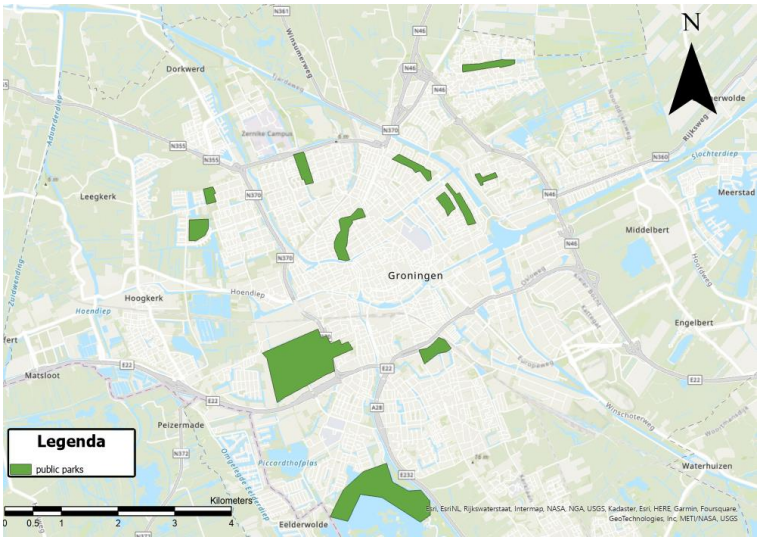


Figure 1: Selected public parks, (Mol, 2023)

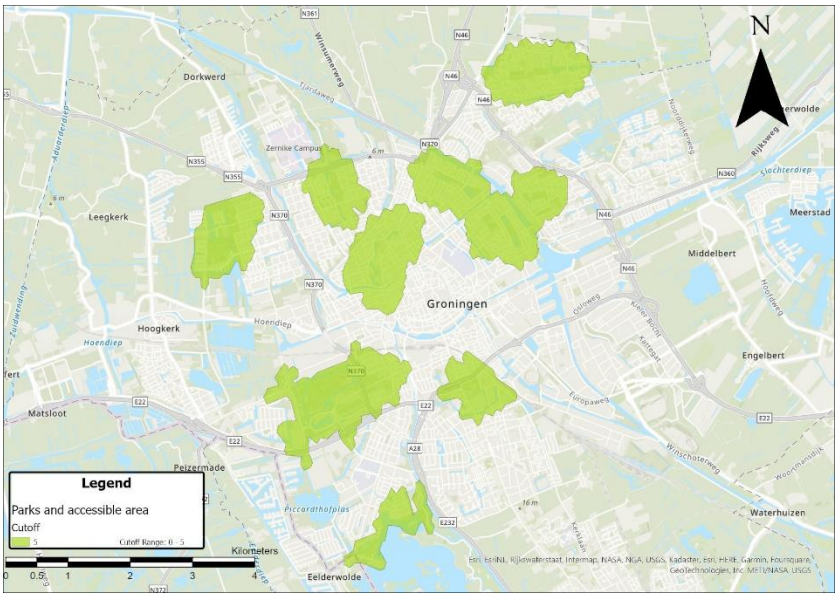


Figure 2: Service areas of public parks in Groningen (Mol, 2023)

3.2 Data collection

3.2.1 Literature review

A literature review was conducted to inform and elaborate on relevant concepts and theories used throughout this research. It helped in answering sub-questions and the research question by giving specific insights in for example perceived health and public green space. Different search engines, for example *Google Scholar, SmartCat* and *Scopus* were used to find relevant articles. The literature used concerns both Dutch, but also international scientific literature in order to obtain a broad understanding of the theories and concepts.

3.2.2 Survey

To gather the data on perceived health, a survey was created and spread out among students in Groningen. For the purposes of the research, three aspects are necessary to know from the respondent. The first of which, is the accessibility, for which figure 2 is used, where the respondent will be asked whether they do or do not live in the highlighted area. The second aspect is the perceived health, both mental as well as physical, which the respondent fills in themselves, on a scale from 1 to 7, as per the research conducted by Korpela, et al. (2010). The final aspect necessary is demographic information, which also highlights whether the respondent is a student, meaning the data can be used for the research. The survey consists of ten questions, the first four to gather data for the demographics of the population. These questions are on the nationality, age, gender and occupation. Age groups are made in ranges, first 18-24, followed by 25-50, then 51-64 and finally 65 and older, which is in correspondence with ResearchGate (2023). The question for gender is to later in the research compare the gender groups to see if there is a difference in responses. The gender options that can be selected are male, female, other and prefer not to say. The question for the occupation is to distinguish whether the respondent is in fact a student, and the answers can be taken up in the research. The remaining six questions are regarding the study itself, with questions on mental and physical health, accessibility, but also frequency of visits, mode of transport used and neighbourhood of residence. The perceived health

is graded by the respondent on a scale from one to seven, with seven being the best and one the worst (Korpela, et al., 2010). The different modes of transport that are asked for are walking, cycling, car and public transport. The full list of survey questions can be found in appendices 1, 2 and 3.

3.2.3 Ethical considerations

Before starting the survey, it was made clear that it is entirely voluntary and no private information will be gathered. This was done by first prompting the respondent with a privacy statement and voluntary participation before being able to continue with the questions. Because of privacy concerns, it was chosen to use the map with the highlighted service area (figure 2), as to not ask people information that can be too sensitive. The researcher could also be contacted through email at any stage in case the respondent had any doubts about their willingness to participate. The survey was spread out to students through the means of social media, making use of the snowball sampling method (Goodman, 1961), where convenience sampling was used, who themselves also spread the survey, preferably randomly. This would in turn result in an ever-growing population of people that satisfy the conditions for the research.

3.2.4 Data analysis

All responses (N=39) were valid, with no missing cases. This means that the full data set can be used for the analysis. Because of the snowball sampling and the selection of respondents by the researcher, it can be guaranteed that all responses were made truthfully by students living in Groningen. There might be a bias towards students in the faculty of spatial sciences, since this group was largely represented in the first selection stage. The gathered data was analysed through the use of non-parametric tests. This is because the questions are asking for ordinal data, which can best be tested for with the Mann-Whitney U test and the Kruskal-Wallis test, depending on the number of groups that need to be compared (Burt, et al., 2009).

4. Results and Discussion

After one month of collecting data by sharing the survey information, a total of 39 valid responses have been recorded. No respondents contacted the researcher about any issues they had with the survey, neither about the difficulty of the questions nor privacy concerns. Almost all respondents used the anonymous link, with only four respondents being recorded using the QR code that was made available. All responses are given by students who currently live in the research area of Groningen. Of the responses, 24 are male and 15 female, with no records selecting a third gender or preferred not to specify, and all respondents are in the age group of 18 to 24 (appendix tables 1 and 2). All of the responses about occupation selected student as dominant occupation (appendix table 3). All modes of transport used to access public parks were through active modes of transport, walking or cycling (appendix table 9). Of the responses, 20 were recorded to live in the service area of the public parks in Groningen, whereas the other 19 respondents did not (appendix table 6). The frequency had a wide range of responses, with most visits being once or twice a month or once a week, six respondents would seldom visit public parks, and one respondent selected almost daily (appendix table 8). There is no dominant neighbourhood that had a significantly higher response, only Selwerd (7), Vinkhuizen (5) and the city centre (5) had slightly more responses, with other neighbourhoods ranging from 1 to 4 responses (appendix table 7). All other descriptive table responses can be found in the appendices. Most of the tests that will be done will be Mann-Whitney U tests, which is a nonparametric test which compares two groups with ordinal data in the test field (Burt, et al., 2009). A nonparametric test is used because that is the best option when working with ordinal values. In other cases, the Kruskal-Wallis test is applied, since in those cases there are more than two groups with more than two responses, in which case a Mann-Whitney U test cannot be used. With the use of these statistical tests, the sub questions, and eventually the main question, will be answered. The results of all tests for significance can be found in the appendices tables 10 to 17.

4.1 Difference in perceived health between demographics

The first sub question that will be discussed is whether there is a difference in perceived health between age groups, genders and occupations, but since all respondents are in the same age group, 18 to 24, and have the same occupation, namely student, only gender differences will be regarded. With the first statistical test, we will look if gender influences perceived health. This is done with the use of the Mann-Whitney U test, which tests the medians of two groups, male or female, and compares if they are similarly distributed. First, the result for physical health is analysed. The null hypothesis is as follows: In the population, the mean ranks for perceived physical health in both men and women is equal. The expectation is that the result will not be significant, and the results will be similar, since the respondents are asked about their own perceived health, rather than comparing themselves with other people. This was also the result in a previous similar study, where it was found that “age, sex, marital status and whether the respondent lived alone did not appear to affect scores significantly” (Hunt, et al., 1980). This can also be seen in the actual results. Looking at the graph (figure 3), it may seem like the results could be skewed, but it is actually a non-significant turn out, with a significance value of 0.943, which is higher than the generally accepted significance level of 0.05 (Burt, et al., 2009), meaning the result is not significant and the null hypothesis is not rejected. In other words, it can be determined that with 95% certainty, that the perceived physical health between men and women is equal. The test results are visible in appendix table 10.

For the second test, the two genders will again be compared, but this time for the perceived mental health. Again, the Mann-Whitney U test will be applied since the variables are ordinal. Similarly, the null hypothesis is: In the population, the mean ranks for perceived mental health in both men and women is equal. Similar to the previous test, the expectation is that the result is not significant, because respondents again had to give their own mental health rather than comparing it with someone else. This expectation is based on the fact that Puriene, et al. could not find a significant difference between men and women and their perceived mental health (Puriene, et al., 2008). Again, the results reflect this expectation. This time, the significance level is 0.223, which is again higher than the threshold of 0.05, meaning the result is not significant and the null hypothesis is not rejected (visible in appendix table 11). This means that with 95% certainty it can be determined that the perceived mental health is equal between men and women. Looking at the graph (figure 4), this may again come as a surprise, since men have made several more responses of lower perceived mental health, but this may be compensated by the larger group that responded with a high level of perceived mental health.

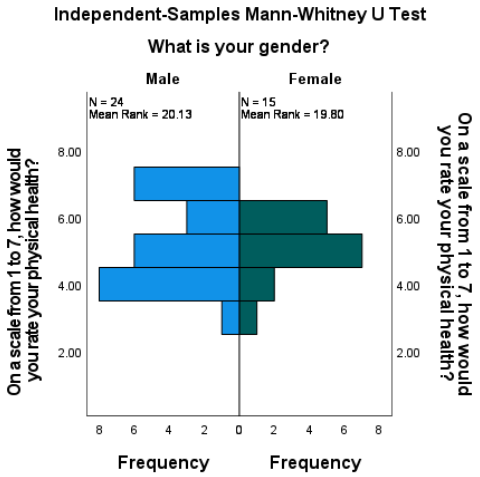


Figure 4: Mann-Whitney U test on perceived physical health between men and women

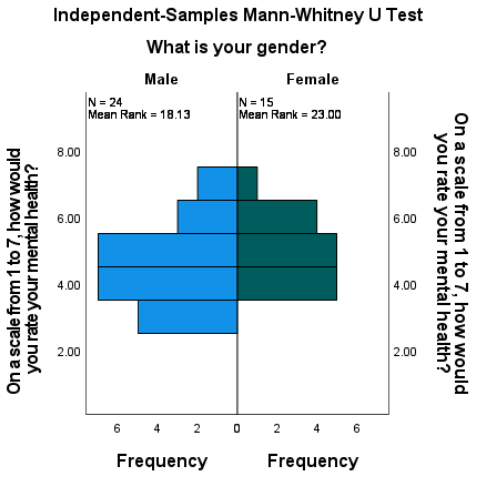


Figure 3: Mann-Whitney U test on perceived mental health between men and women

It was also investigated whether there was a difference in frequency of visits between the two gender groups. This was again done using a Mann-Whitney U test, with the null hypothesis being "In the population, there is no difference in the mean rank of frequency of visits between men and women." The expectation in this case is that there in fact is not a difference between the visits per gender group, this is again based on the previously conducted research by Hunt, et al. (1980), who discussed health in quantitative studies. The expectation is reflected in the data, with a significance level of 0.638, which is higher than 0.05, meaning the null hypothesis will not be rejected, and the frequency of visits between men and women can be considered equal (visible in appendix table 12). The distribution of the frequencies of visits can be seen in the figure below (figure 5), where a peak can be seen around the third and fourth response, which are once or twice a month and once a week, respectively.

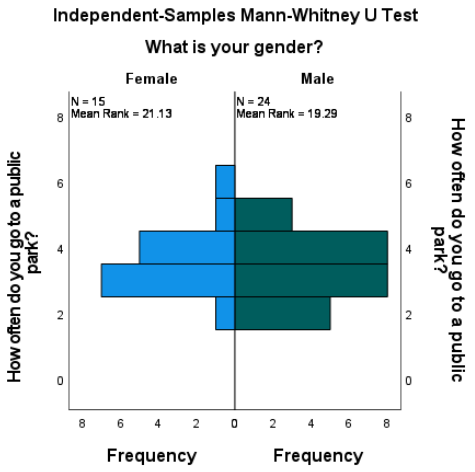


Figure 5: Mann-Whitney U test for gender and frequency of visits

4.2 Influence of accessibility on frequency of visits

Then, to answer the next sub question whether the accessibility influences the frequency of visits. This can again be done with a Mann-Whitney U test. This time, the accessibility is the group value, and the frequency of visits is the test field variable. The null hypothesis that will be tested for is: In the population, the mean ranks for frequency of visits is equal between people living within and outside the service area of public parks. The expectation is that people living within the service area will have a higher frequency of visits, since they have the better opportunity to do so, because they live within a five-minute distance from the facilities. This expectation is based on previous research done by Schnell, et al. (2019), who studied the benefits of discrete visits to public parks. Here they discovered a possible relationship between proximity to parks and the frequency of so-called discrete visits, which are visits made by an individual on their own. With this expectation, one would assume that the significance value is lower than or equal to 0.05, in order to reject the null hypothesis. However, the actual significance value for this test using the Mann-Whitney U test is 0.967, which is higher than the significance threshold of 0.05, meaning the result is not significant and the null hypothesis cannot be rejected (visible in appendix table 13). The distribution of the frequency of visits is visible in the figure below (figure 6), showing two peaks in both accessibility groups. Since the null hypothesis cannot be rejected, it can be determined with 95% that the mean ranks for frequency of visits is equal between people living within and outside the service area. This means that the given expectation is not true, and people that live in the service area have a similar frequency of visits as people that do not live in the service area of public parks.

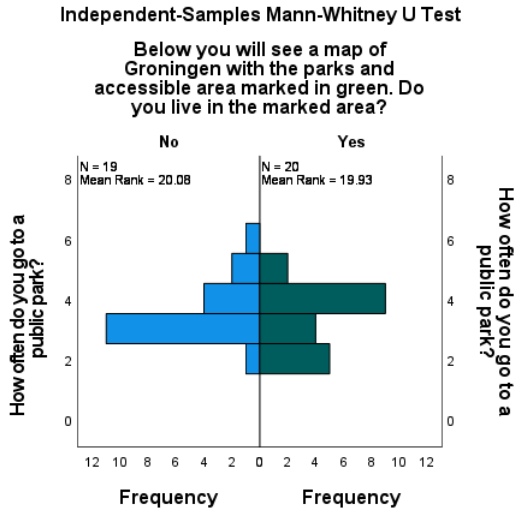


Figure 6: Mann-Whitney U test on accessibility and frequency of visits

4.3 Relationship between frequency of visits and perceived health

To answer the following sub question: Is there a relationship between frequency of visits and perceived health? The Mann-Whitney U test would not suffice, since it can only be used for two groups (Burt, et al., 2009). Preferably, the Chi-square test is used, but this is a test with strict requirements which are difficult to reach, even with an extensive database, for example the minimum of five entries per data field (Burt, et al., 2009). Instead, the Kruskal-Wallis test has to be used, because this test can take multiple groups, and the groups in this case are the frequency of visits, and the test field variable is the perceived physical health. For this test, the null hypothesis is: In the population, the mean rank is equal between all frequencies of visits. The mean rank is defined as "The average of the ranks for all observations within each sample." (Minitab 21 support, 2023). In this case, that means the average of the rank for every respondent per frequency group, which will then be compared to a 0.05 significance value. The expectation in this situation is that there is in fact a better physical health with the increase of number of visits, based on previous studies, which discovered a relationship between physical health among groups who visited public parks more frequently (Hanif, et al., 2020). In this case, the resulting significance value is 0.442, which is higher than the significance value of 0.05, meaning the result is not significant and the null hypothesis cannot be rejected (visible in appendix table 14). This indicates that there is with 95% certainty no difference in perceived health when comparing frequencies of visits. However, this is an over-all result, comparing all mean ranks with all sample groups. When executing a Kruskal-Wallis test, all groups get compared among each other, which again gives different significance results between groups, but in this case, these results do not give a significant result.

To continue with the previous sub question, the influence of frequency of visits will be compared to the perceived mental health. Again, the Kruskal-Wallis test will have to be used, because there are again multiple groups (frequency of visits) with more than two different possible results (perceived mental health on a scale from 1 to 7). The null hypothesis in this case is "In the population, the mean rank of perceived mental health is equal between all frequencies of visits." The expectation is again similar to the previous test, that a relation between frequencies of visits and perceived mental health will be found, which is again based on the research conducted by Hanif, et al. (2020), where they

studied the mental health benefits as a result of frequent visits among adults. The found significance level is 0.526, which is again higher than the threshold of 0.05, meaning the result is not significant and the null hypothesis cannot be rejected (visible in appendix table 15). In this case, that means that there is no difference in perceived mental health when comparing frequencies of visits, with 95% confidence.

4.4 Relationship between perceived health and accessibility

The final test that will be executed will be done to answer the main question in this research, which is "What is the relationship between perceived health and accessibility to public green space?" This will again be done through the means of a Mann-Whitney U test, since the comparison is between health which is measured in ordinal values. The null hypothesis for this test is "In the population, the mean ranks for perceived physical health are equal between the groups living within and outside the service area of public green spaces." The expectation is that there is a relationship between the two, namely that having better access to public green space improves physical health among students. This expectation is reasoned through the work of Reklaitiene, et al (2014), who have previously found a relationship between proximity to public parks and health, but this was measured among the general public, rather than a specific group of people. Another relevant research that found this expectation was in Barcelona, with a focus on relevant activities which resulted in a significant outcome (Romagosa, 2018). The measured significance level is 0.057, which is slightly higher than the set significance level of 0.05, meaning that the result is not significant and the null hypothesis cannot be rejected (visible in appendix table 16). This means that there is no relationship between perceived physical health and accessibility to public green spaces. However, when taking a significance level of 0.1, in accordance with Burt, et al. (2009), it can be considered as a significant result, but only with 90% confidence. This means that it can confidently be determined that physical health is affected by accessibility to green space, with 90% certainty.

Then finally, the test for the relationship between mental health and accessibility to green space. This is again similar to the previous test, where a Mann-Whitney U test, for the comparison between the median values between the people living within and outside the service areas of public parks. The null hypothesis is again "in the population, the mean ranks for perceived mental health are equal between the groups living within and outside the service area of public green spaces." And similarly, the expectation is that there is a relationship between the two variables, and that people living in the service area have a better perceived mental health than people not living in the service area. This expectation is based on works done by Sturm and Cohen (2014), who studied mental health and its relationship to public parks in Los Angeles, and also studies focused on women's mental health and the effect of proximity to public parks (Bojorquez & Ojeda-Revah, 2018). The significance value that should be considered in this case is 0.035, which is lower than the significance level of 0.05, meaning the result is significant, and the null hypothesis can be rejected (visible in appendix table 17). This means that there is a relationship between perceived mental health and accessibility to public green spaces. This is also the expected relationship, since the mean rank for people living within the service area (23.73) is higher than the mean rank of people living outside the service area (16.08).

4.5 Discussion

In conclusion, almost all of the executed statistical tests did not return a significant result. Some of these results were expected, for example between gender and perceived mental and physical health, or gender and frequency of visits, based on findings by (Zhang, et al., 2019). However, some results were more surprising, since a significant result was expected, but did not result in a probability value below 0.05. For example, tests where a significant result was expected turned out as not significant, meaning that there is no relationship between accessibility and frequency of visits, or frequency of visits and perceived mental or physical health. This is unlike the results from previous research, for example Kabisch, et al. (2021) who did find a relationship between perceived health and frequency of visits, or Pham, et al. (2019), who found a relation between frequency of visits and accessibility. There is a possibility that there was no relation found between frequency of visits and accessibility because the selected accessible threshold was focused on the effect distance has on health, rather than frequency of visits. The Significance for the relationship between perceived physical health and accessibility was relatively low, but not low enough to be determined that the null hypothesis could be rejected. It can, however, be said that there was a slightly significant outcome, since the p-value outcome was lower than 0.1, which means there is a weak positive relationship between perceived physical health and accessibility. The final result from this research, regarding the perceived mental health in relation to the accessibility to public green spaces, did show significance, meaning that a positive relationship between perceived mental health and accessibility to green spaces was found. This was also the expectation, based on research by Schnell (2019) and Reklaitiene (2014), who also found a relationship between perceived health and accessibility to green space.

5. Conclusion

The first question that will be looked at is whether there is a difference in perceived health between genders. This can be answered with the results of the first two statistical tests that were executed. First, it is important to remember that only genders were compared, since age groups and occupations were equal throughout the population. With this in mind, it can be concluded that there is no difference in perceived health between genders since the tests turned out to have a nonsignificant probability value. Also, there was no difference found in frequency of visits between the two genders. The next question that will be answered is how does accessibility to green space influence the frequency of visits to green space? The expectation for this question was that there was a higher frequency of visits for people that live in the service area of public parks, as based on previous research (Schnell, et al., 2019), since people with a closer proximity have a better possibility to make use of the amenities. However, the results of the Mann-Whitney U test were not significant, meaning that there is most likely no relationship between the accessibility and the frequency of visits. The next question on whether there is a relationship between frequency of visits and perceived health also gave a surprising outcome. The expectation was that there was a relationship between the two factors, as this was the result in a comparable previous study (Hanif, et al., 2020). This could, however, not be concluded based on the data from this research, which again gave a nonsignificant outcome meaning that there is no relationship between frequency of visits and perceived health. Finally, the main question regarding the relationship between accessibility to public green spaces and perceived mental and physical health. Regarding physical health, the expectation again was that there would be a relationship to accessibility, but there was only a slightly significant result found. At a significance level of 0.057, there is a slightly significant result meaning that there is a positive relationship between perceived physical health and accessibility to green space. The relationship with mental health did give a stronger significant response. This means that the overall conclusion of this research is that there is a relationship between perceived mental and physical health and accessibility to green spaces among students in Groningen. Recommendations students that can be made as a result from this research for cities with high numbers of, is to keep green spaces open to the public, safe, clean and accessible. This is because it has significant benefits to the mental health of students.

When placing this research in a wider context, some similarities can be found in the theories, concepts and results. Most obvious, the different concepts that were applied are based on previous studies, since they are the most befitting to this research. Examples are the definition of green space, as suggested by Annerstedt, et al. (2016), for the size of green space that might affect health, and Price, et al. (2023), who had a focus on actual recreational value of public green spaces. Another important factor that was used was the actual distance for creating the service area of the public parks, as per Grahn & Stigsdotter (2003), for the distance, but also Poortinga, et al. (2021) for recommendations on using time as a determining factor, as this heavily determined the responses given in the survey. Regarding the results of the statistical tests, there were also similarities found that can also be seen in the wider context of health in relation to green space. Examples include similar findings between gender and perceived health, where the expectation was met, as suggested by the research by Hunt, et al (1980) and Puriene, et al. (2008). There was also a similarity found in the research by Sturm & Cohen (2014), who studied the proximity to urban parks and mental health in Los Angeles, who also found a significant result as was also done in this research. There were, however, also dissimilarities with previous studies. The most important being the result of the test for a relationship between perceived physical health and accessibility to green spaces. Where this research concluded no

relationship, other studies have found a link between the two (Reklaitiene, et al., 2014; Romagosa, 2018).

There are improvements that could be made for future research in similar fields of study. The most necessary that should be considered is a wider population of respondents since this could help in the application of statistical tests. For example, the nonparametric Kruskal-Wallis test, used to research the relationship between frequency of visits and perceived mental and physical health, could be replaced by the Chi Square test. This test has stricter requirements but could also offer a better possible representation of the population. Another possibility for future research that is recommended is taking a wider study area, for example multiple cities. This could offer perspective in different applications of public green space in different cities, which can then again be used for a different analysis with a focus on green space usage instead of a focus on accessibility alone. A different approach could be to study the different age groups and make a comparison between different stages of life and the effects public green spaces have on health, which would shift the focus of research to age as the most dominant variable rather than accessibility.

6. References

Annerstedt van den Bosch, M. et al., 2016. Development of an urban green space indicator and the public health rationale. *scandinavian journal of public health,* 44(2), pp. 159-167.

Bojorquez, I. & Ojeda-Revah, L., 2018. Urban public parks and mental health in adult women: mediating and moderating factors. *International journal of social psychiatry,* 64(7), pp. 637-646.

Boot, C. R. L., Rietmeijer, C. B. T., Vonk, P. & Meijman, F. J., 2009. perceived health profiles of dutch university students living with their parents, alone or with peers. *international journal of adolescent medicine and health,* 21(1), pp. 41-49.

British Columbia Healthy communities, 2023. Active transportation. *Plan H.*

Brun Sundblad, G. M., Saartok, T. & Engstrom, L.-M. T., 2007. Prevalence and co-occurrence of self-rated pain and perceived health in school-children: Age and gender differences. *European journal of pain,* 11(2), pp. 171-180.

Burt, J. E., Barber, G. M. & Rigby, D. L., 2009. *Elementary statistics for geographers.* 3rd ed. New York: Guilford press.

Chiang, Y.-C. & Li, D., 2019. Metric or topological proximity? The associations among proximity to parks, the frequency of residents' visits to parks, and perceived stress. *urban forestry & urban greenery,* Volume 38, pp. 205-214.

Ekkel, E. D. & de Vries, S., 2017. nearby green space and human health: evaluating accessibility metrics. *landscape and urban planning,* Volume 157, pp. 214-220.

ESRI, 2021. *Service area analysis.* [Online]
Available at: https://desktop.arcgis.com/en/arcmap/latest/extensions/network-analyst/service-area.htm
[Accessed 3 May 2023].

Gemeente Groningen, 2022. *Snorfiets met benzine motor niet meer welkom op fietspaden.* [Online]
Available at: https://gemeente.groningen.nl/snorfietsen-met-benzinemotor-niet-meer-welkom-op-fietspaden
[Accessed 13 May 2023].

Goodman, L. A., 1961. Snowball sampling. In: *The annals of mathematical statistics.* s.l.:institute of mathematical statistics , pp. 148-170.

Government of Canada, 2023. *Perceived health of a person.* [Online]
Available at: https://www23.statcan.gc.ca/imdb/p3Var.pl?Function=DEC&Id=82428
[Accessed 7 June 2023].

Grahn, P. & Stigsdotter, U. A., 2003. landscape planning and stress. *urban forestry & urban greenery,* 2(1), pp. 1-18.

Hanif, A., Shirazi, S. A. & Majid, A., 2020. role of community for improvement of ecosystem services in urban parks. *Pakistan journal of agricultural sciences,* 57(6), pp. 1591-1596.

Hartig, T., Mitchell , R., De Vries, S. & Frumkin, H., 2014. annual review of public health. *Nature and Health,* Volume 35, pp. 207-228.

Hunt, S. M. et al., 1980. a quantitative approach to perceived health status: a validation study. *journal of epidemiology and community health,* Volume 34, pp. 281-286.

Idler, E. L. & Benyamini, Y., 1997. Self-rated health and mortality: a review of twenty-seven community studies. *J Health Soc Behav,* Volume 38, pp. 21-37.

Kabisch, N. et al., 2021. Impact of summer heat on urban park visitation, perceived health and ecosystem service appreciation. *urban forestry & urban greenery,* Volume 60.

Korpela, K. M., Ylen, M., Tyrväinen, L. & Silvennoinen, H., 2010. Favorite green, waterside and urban environments, restorative experiences and perceived health in Finland. *Health promotion international,* 25(2), pp. 200-209.

Minitab 21 support, 2023. *Interpret all statistics for Kruskal-Wallis test.* [Online]
Available at: https://support.minitab.com/en-us/minitab/21/help-and-how-to/statistics/nonparametrics/how-to/kruskal-wallis-test/interpret-the-results/all-statistics/#:~:text=of%20all%20observations.-,Mean%20rank,for%20the%20Kruskal%2DWallis%20test.
[Accessed 10 May 2023].

Mol, J. P., 2023. *Public parks in Groningen.* Groningen: s.n.

Pham, T.-T.-H., Labbe, D., Lachapelle, U. & Pelletier, E., 2019. Perception of park access and park use amongst youth in Hanoi: How cultural and local context matters. *Landscape and urban planning,* Volume 189, pp. 156-165.

Piko, B., Barabas, K. & Boda, K., 1997. Frequency of common psychosomatic symptoms and its influence on self-perceived health in a Hungarian student population. *European journal of public health,* 7(3), pp. 243-247.

Poortinga, W. et al., 2021. The role of perceived public and private green space in subjective health and wellbeing during and after the first peak of the COVID-19 outbreak. *landscape and urban planning ,* 211(1).

Price, A., Langford, M. & Higgs, G., 2023. Quantifying disparities in access to recreational opportunities by alternative modes of transport. *Case studies on transport policy,* Volume 11.

Puriene, A. et al., 2008. Self-perceived mental health and job satisfaction among Lithuanian dentists. *Industrial health,* Volume 46, pp. 247-252.

Rakowska, S. B., Lutz, K. L., Requia, W. J. & Adams, M. D., 2023. examining the effects of green space accessibility on school performance for 3421 elementary schools. *Landscape and urban planning,* Volume 234.

Reklaitiene, R. et al., 2014. The relationship of green space, depressive symptoms and perceived general health in urban population. *Scandinavian journal of public health,* Volume 42, pp. 669-676.

ResearchGate, 2023. *Age group comparison.* [Online]
Available at: https://www.researchgate.net/figure/Age-group-comparison-between-Young-adult-18-25-age-Adult-26-44-age-Middle-age_tbl1_338842581
[Accessed 8 May 2023].

Romagosa, F., 2018. physical health in green spaces: Visitors' perceptions and activities in protected areas around Barcelona. *journal of outdoor recreation and tourism ,* Volume 23, pp. 26-32.

Schers, H. et al., 2021. the COVID-19 pandemic in Nijmegen, the Netherlands: changes in presented health problems and demand for primary care. *The annals of family medicine ,* 19(1), pp. 44-47.

Schnell, I., Harel, N. & Mishori, D., 2019. The benefits of discrete visits in urban parks. *Urban forestry & urban greening,* Volume 41, pp. 179-184.

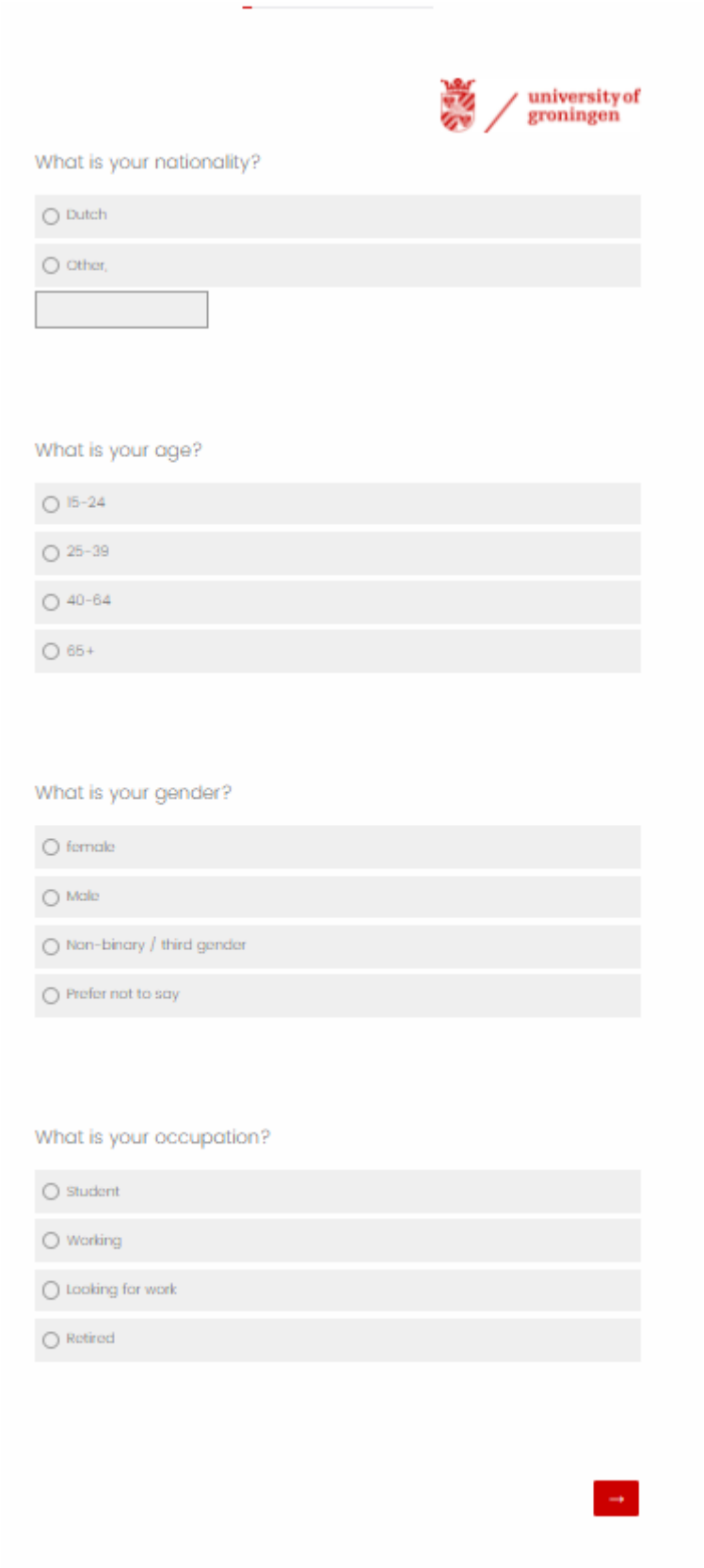
Smith-Nielsen, S. & Krasnik, A., 2010. Pooreself-perceived health among migrants and ethnic minorities versus the majority population in Europe: a systematic review. *International journal of public health,* Volume 55, pp. 357-371.

Sturm, R. & Cohen, D., 2014. proximity to urban parks and mental health. *The journal of mental health policy and economics,* 17(1), pp. 19-24.

Xinqin, L., Guoping, N. & Dewancker, B., 2019. improving the attractiveness and accessibility of campus green space for developing a sustainable university environment. *environmental science and pollution research,* Volume 26, pp. 33399-33415.

Zhang, Z., Chen, B. & Chen, W., 2019. The mediating effect of perceived health on the relationship between physical activity and subjective well-being in Chinese college students. *Journal of american college health,* 69(1), pp. 9-16.

7. Appendices



Appendix 1: Survey demographic questions

university of groningen

On a scale from 1 to 7, how would you rate your physical health?

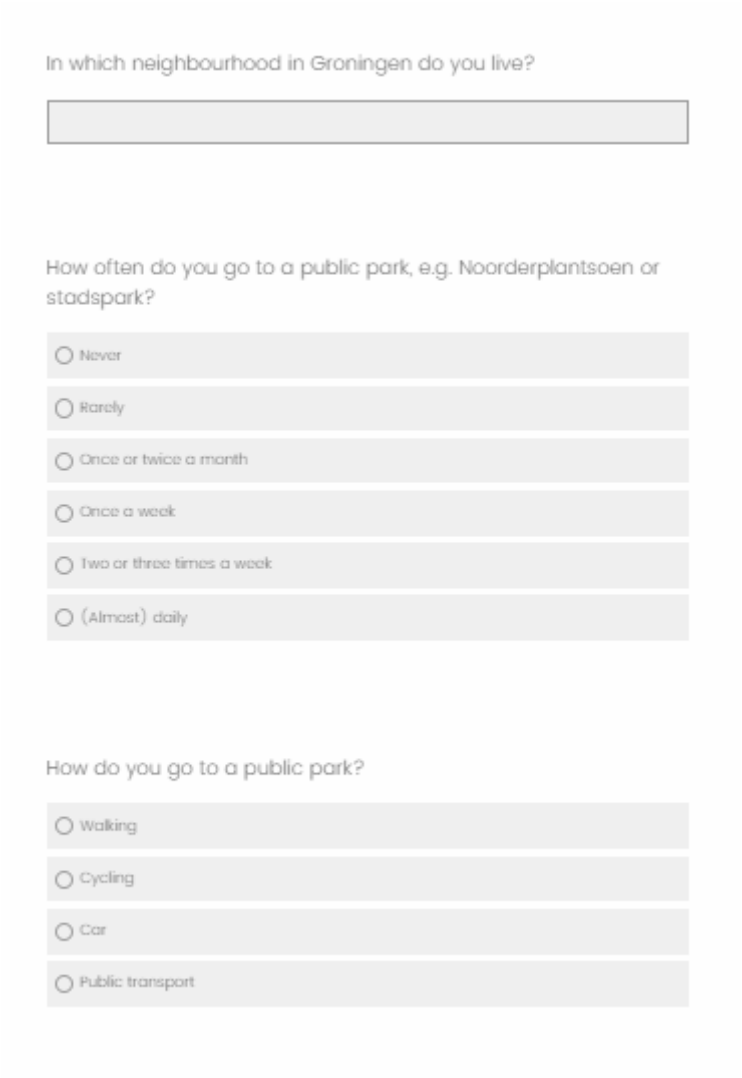
On a scale from 1 to 7, how would you rate your mental health?

Below you will see a map of Groningen with the parks and accessible area marked in green. Do you live in the marked area?

No

Yes

Appendix 2: Survey questions on health and accessibility



Appendix 3: Survey questions on neighbourhood, frequency of visits and mode of transport

What is your age?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15-24	39	100.0	100.0	100.0

Table 1: Age group frequencies

What is your gender?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	24	61.5	61.5	61.5
	Female	15	38.5	38.5	100.0
	Total	39	100.0	100.0	

Table 2: Gender frequencies

What is your occupation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Student	39	100.0	100.0	100.0

Table 3: Occupation frequencies

On a scale from 1 to 7, how would you rate your physical health?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	2	5.1	5.1	5.1
	4.00	10	25.6	25.6	30.8
	5.00	13	33.3	33.3	64.1
	6.00	8	20.5	20.5	84.6
	7.00	6	15.4	15.4	100.0
	Total	39	100.0	100.0	

Table 4: Physical health ratings

On a scale from 1 to 7, how would you rate your mental health?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	4	10.3	10.3	10.3
	4.00	13	33.3	33.3	43.6
	5.00	12	30.8	30.8	74.4
	6.00	7	17.9	17.9	92.3
	7.00	3	7.7	7.7	100.0
	Total	39	100.0	100.0	

Table 5: Mental health ratings

Below you will see a map of Groningen with the parks and accessible area marked in green. Do you live in the marked area?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	19	48.7	48.7	48.7
	Yes	20	51.3	51.3	100.0
	Total	39	100.0	100.0	

Table 6: Accessibility count

In which neighbourhood in Groningen do you live?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Beijum	2	5.1	5.1	5.1
	Binnenstad	5	12.8	12.8	17.9
	Helpman	3	7.7	7.7	25.6
	Korrewegwijk	3	7.7	7.7	33.3
	Oosterparkwijk	1	2.6	2.6	35.9
	Oosterpoortbuurt	4	10.3	10.3	46.2
	Oranjebuurt	2	5.1	5.1	51.3
	Paddepoel	1	2.6	2.6	53.8
	Schildersbuurt	1	2.6	2.6	56.4
	Selwerd	7	17.9	17.9	74.4
	Vinkhuizen	5	12.8	12.8	87.2
	Wijert	2	5.1	5.1	92.3
	Zeeheldenbuurt	3	7.7	7.7	100.0
	Total	39	100.0	100.0	

Table 7: Neighbourhood count

How often do you go to a public park?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	6	15.4	15.4	15.4
	Once or twice a month	15	38.5	38.5	53.8
	Once a week	13	33.3	33.3	87.2
	Two or three times a week	4	10.3	10.3	97.4
	(Almost) Daily	1	2.6	2.6	100.0
	Total	39	100.0	100.0	

Table 8: Frequency of visits count

What mode of transport do you use to go to a public park?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Walking	8	20.5	20.5	20.5
	Cycling	31	79.5	79.5	100.0
	Total	39	100.0	100.0	

Table 9: Mode of transport count

Independent-Samples Mann-Whitney U Test Summary

Total N	39
Mann-Whitney U	177.000
Wilcoxon W	297.000
Test Statistic	177.000
Standard Error	33.484
Standardized Test Statistic	-.090
Asymptotic Sig.(2-sided test)	.929
Exact Sig.(2-sided test)	.943

Table 10: Mann Whitney U test for gender and physical health

Independent-Samples Mann-Whitney U Test Summary

Total N	39
Mann-Whitney U	222.500
Wilcoxon W	342.500
Test Statistic	222.500
Standard Error	33.355
Standardized Test Statistic	1.274
Asymptotic Sig.(2-sided test)	.203
Exact Sig.(2-sided test)	.223

Table 11: Mann Whitney U test for gender and mental health

Independent-Samples Mann-Whitney U Test Summary

Total N	39
Mann-Whitney U	197.000
Wilcoxon W	317.000
Test Statistic	197.000
Standard Error	32.898
Standardized Test Statistic	.517
Asymptotic Sig.(2-sided test)	.605
Exact Sig.(2-sided test)	.638

Table 12: Mann Whitney U test for gender and frequency of visits

Independent-Samples Mann-Whitney U Test Summary

Total N	39
Mann-Whitney U	188.500
Wilcoxon W	398.500
Test Statistic	188.500
Standard Error	33.800
Standardized Test Statistic	-.044
Asymptotic Sig.(2-sided test)	.965
Exact Sig.(2-sided test)	.967

Table 13: Mann Whitney U test for accessibility and frequency of visits

Independent-Samples Kruskal-Wallis Test Summary

Total N	39
Test Statistic	3.745[a]
Degree Of Freedom	4
Asymptotic Sig.(2-sided test)	.442

a. The test statistic is adjusted for ties.

Table 14: Kruskal-Wallis test for frequency of visits and perceived physical health

Independent-Samples Kruskal-Wallis Test Summary

Total N	39
Test Statistic	3.191[a]
Degree Of Freedom	4
Asymptotic Sig.(2-sided test)	.526

a. The test statistic is adjusted for ties.

Table 15: Kruskal-Wallis test for frequency of visits and perceived mental health

Independent-Samples Mann-Whitney U Test Summary

Total N	39
Mann-Whitney U	258.000
Wilcoxon W	468.000
Test Statistic	258.000
Standard Error	34.401
Standardized Test Statistic	1.977
Asymptotic Sig.(2-sided test)	.048
Exact Sig.(2-sided test)	.057

Table 16: Mann Whitney U test for accessibility and perceived physical health

Independent-Samples Mann-Whitney U Test Summary

Total N	39
Mann-Whitney U	264.500
Wilcoxon W	474.500
Test Statistic	264.500
Standard Error	34.269
Standardized Test Statistic	2.174
Asymptotic Sig.(2-sided test)	.030
Exact Sig.(2-sided test)	.035

Table 17: Mann Whitney U test for accessibility and perceived mental health