Urban Green Space and Physical Activity

Can urban green space advance health by encouraging physical activity?

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Abstract

Nowadays there is a growing amount of empirical evidence stating that urban green areas provide health and wellbeing for people. However, there remain uncertainties concerning the processes through which people gain health from green space. Several processes might explain the health effect of urban green space, one possibility being the encouragement of physical activity. Various studies support the statement that urban green space increases physical activity, but there are also studies which question these results.

Using a representative dataset from 2079 Finnish respondents aged 15 or over, this study aims to research further the controversial relation between urban green space and physical activity of people. With binary logistic regression analyses, this study explores whether urban green space has an effect on total physical activity or on non-recreational physical activity, meaning walking and cycling for transportation purposes. Analyses are controlled with variables measuring population density of a neighborhood, condition of walking and cycling lanes and respondents' age, gender and level of education.

The main result emerging from the analyses of this study is that, contrary to expectations, urban green space seems to increase the likelihood of insufficient physical activity. This trend was particularly visible when non-recreational physical activity was measured. But when controlled with population density, the effect of urban green space on physical activity is reversed, and it seems that urban green space increases the likelihood of particularly sufficient non-recreational physical activity. The findings of this study provide support for the argument that urban green space can encourage especially non-recreational physical activity in the neighborhoods with sufficient population density.

Keywords
health, physical activity, urban green space, neighborhood, urban space

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Tiivistelmä

Laajeneva joukko tutkimuksia osoittaa että kaupunkiviheralueet voivat vaikuttaa positiivisesti ihmisten terveyteen ja hyvinvointiin. Kuitenkin ne prosessit joiden kautta kaupunkiviheralueet tuottavat parempaa terveyttä ovat edelleen epäselviä. Useat tekijät voivat vaikuttaa kaupunkiviheralueiden ja paremman terveyden välisen yhteyden taustalla, joista yksi aiemmin tutkittu on kaupunkiviheralueiden taipumus lisätä ihmisten fyysistä aktiivisuutta. Useat tutkimukset tukevat väitettä että kaupunkiviheralueet lisäävät ihmisten fyysistä aktiivisuutta ja siten parantavat terveyttä, mutta tutkimukset ovat osoittaneet myös vastakkaisia tuloksia. Tämän tutkielman tavoitteena on suomalaisen kvantitatiivisen aineiston avulla tuottaa lisää tutkimustietoa kaupunkiviheralueiden yhteydestä ihmisten fyysiseen aktiivisuuteen.

Käyttämällä logistista regressioanalyysia, tutkielma analysoi kaupunkiviheralueiden vaikutusta ihmisten fyysiseen aktiivisuuteen mitaten sitä kahdella indikaattorilla, liikunnan kokonaismäärällä sekä pelkän hyötyliikunnan määrällä. Hyötyliikunnalla tutkielmassa tarkoitetaan kävelyä tai pyöräilyä työ- tai asiointimatkoilla. Tämän tutkielman käyttämä edustava kyselyaineisto koostuu 2079 suomalaisesta vastaajasta, iältään 15 tai yli. Tutkielman analyyseissa vakioidaan asuinalueen väestöntiheyden, kävely- ja pyöräteiden laadun sekä vastaajan iän, sukupuolen ja koulutusaseman vaikutus.

Tutkielman päätulos on, odotusten vastaisesti, että yleisesti ottaen kaupunkiviheralueet näyttävät lisäävän todennäköisyyttä riittämättömään fyysiseen aktiivisuuteen. Tämä havainto on erityisen näkyvä käytettäessä indikaattorina pelkkää hyötyliikunnan määrää. Kuitenkin, kun analyyseissa vakioidaan väestöntiheyden vaikutus, kaupunkiviheralueiden yhteys fyysiseen aktiivisuuteen näyttää kääntyvän jopa päinvastaiseksi ja kaupunkiviheralueet näyttävät lisäävän ihmisten fyysistä aktiivisuutta, erityisesti hyötyliikunnan määrää. Tutkielman tulokset tarjoavat tukea väitteelle että kaupunkiviheralueet voivat kannustaa etenkin hyötyliikuntaan riittävän tiheästi asutuilla asuinalueilla.

Avainsanat
terveys, fyysinen aktiivisuus, kaupunkiviheralue, asuinalue, kaupunkitila

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1 INTRODUCTION

"First we shape the cities – then they shape us" (Gehl 2010).

The unhealthy consequences of the global trends of rising inactivity of people, such as decreasing physical activity due to cars providing door-to-door transportation and expansion of the amount of sedentary work, have drawn the attention of researchers and policy makers. The harmful health effects of insufficient physical activity are clearly seen from the increased amount of different lifestyle related illnesses and the rising monetary costs of them (e.g. Salasuo 2012, 7).

These lifestyle related health problems have raised a new desire to plan environments that support our health. Built environments are now considered to be one of the factors through which we might accomplish more physical activity and better public health. But urban space is not just an issue of urban planning or geographies. Our living environments shape our cultural practices and ways of behavior, a fact which makes the urban space also a concern of social sciences. Creating healthy environments is a multidisciplinary challenge. The lifestyle related health threat which we face at a rapidly growing pace cannot be countered only by medical science professionals (Jackson 2011). As Jackson states, "health is determined by planning, architecture, transportation, housing, energy, and other disciplines at least as much as it is by medical care" (Ibid., p. xvii). To support the policies made to shape healthier environments, there is a need to learn more about how environment affects behavior, in the moment or in the long term.

Earlier studies (e.g. Scjippering 2010; Maas et al. 2006; Ulrich 2006; Aspinall et al. 2013; Korpela et al. 2008) have found that residents in the urban neighborhoods with more green space, on average, enjoy better health. But why is it so? The processes through which people gain good health from urban green space remain unclear. Several processes may explain the healthy effect of urban green space, one being the influence of urban green areas to encourage physical activity of people.

When it comes to my own experiences, the nearby parks, forests and community gardens provide me and my family a green haven to exercise, play outside, do gardening, explore the wonders of the forests, and to be physically active at the same time. Based on my own perceptions, my expectation was to find clear and evident results that having more urban green space in the neighborhood would have a positive impact on physical activity of people. However, when reviewing earlier studies concerning my topic, to my surprise, the results indicating the effect of urban green space on physical activity of people were contradictory. There are studies which support the assumption that urban green areas might increase physical activity of people (e.g. Kansallinen liikuntatutkimus 2009-2010; Nielsen & Hansen 2007, Oja et al. 1998), but there are also studies which challenge the idea (e.g. Maas et al. 2008; Hillsdon et al. 2006).

The aim of the analyses performed in this study is to further explore this debatable relation between urban green areas and physical activity of people. The controversy and even opposed results of the earlier studies suggest that there still remains a need for more research. Furthermore, to my knowledge, this study is the first attempt to research the relations in the interest of this study with Finnish data. Earlier studies in the field of the topic of this study are mostly international and performed in countries with different environmental conditions than in Finland, such as weather. Especially the Finnish winter weather probably keeps people more indoors than in many other countries. So the results of international studies exploring the relation between urban green space and physical activity might not necessarily apply in Finland.

Using a representative dataset from 2079 Finnish respondents, binary logistic regression analyses were performed to analyze the influence of urban green space on physical activity using two different indicators. Firstly, this study explores how urban green space affects total amount of physical activity of people; and secondly, how urban green space particularly affects non-recreational physical activity of people, meaning walking and cycling for transportation purposes. The data used in this study is part of the Tampere Health and Social Survey 2008 (Luoto et al. 2008), and it is freely available for research purposes from the Finnish Social Science Data Archive. The data

was collected in 2008 in Finland, in the city of Tampere, including people aged 15 and over. In addition to this survey data, a supplementary dataset was created for the use of this study to measure the exact amounts of urban green space and population densities. The statistics concerning these environmental characteristics were provided by city officials of Tampere (Tampere: Kantakaupungin ympäristö- ja maisemaselvitys 2008, 76; Statistical Yearbook of the City of Tampere 2008-2009, 11-13). With these externally measured indicators there was a possibility to explore the effect of these factors with exact quantities, not only with self-reported variables, which are imprecise.

In Chapter 2, this study proceeds to review the literature related to the relations under examination. Chapter 3 will describe the exact research questions, hypotheses, data, method and variables this study uses. At the beginning of Chapter 3, because this study aims to explore research questions which would in an ideal situation need answers concerning the causal relations, there is a description of what kind of requirements there are to reveal a causal relationship. In social sciences, revealing causality is not a simple thing to do, and there will also be evaluation of the possibilities of my study to reveal such a relationship.

At the beginning of Chapter 4, descriptive statistical analyses are performed to test two relations. Firstly, this study looks at how the effect of urban green space on better health, identified in earlier studies, is visible in the sample of this study. Secondly, this study tests if there can be found as clear influence of sufficient physical activity on the health of people in the sample of this study, as has been described by other researchers. Following these simple analyses, using binary logistic regression analyses, this study focuses to analyze its main research questions concerning the effect of urban green space on total physical activity and on non-recreational physical activity of people. Analyses are controlled with the variables measuring environmental characteristics of population density of the neighborhood, the quality of walking and cycling lanes and with variables measuring respondents' age, gender and level of education. The frequencies and the detailed principles of all variable modifications are presented in Appendix 1. The Syntax of the main analyses performed in this study can be found from Appendix 2.

The findings of the analyses performed in Chapter 4 provide evidence for the argument that urban green space can particularly support non-recreational physical activity (walking and cycling for transportation purposes), when certain conditions exist, most importantly sufficient population density of the neighborhood. After reporting the results of binary logistic analyses in Chapter 4, this study continues to discussion and conclusions, where the findings of the analyses are compared with those reported in earlier studies. Chapter 5 draws conclusions of the utility of the findings of this study and gives recommendations for future research. The results of this study give suggestions for indicators to be evaluated in similar future studies, most importantly that the population density seems to have an effect on the relation between urban green areas and physical activity.

2 URBAN GREEN SPACE AND HEALTH

The notion of *health* is widely used in our everyday language and there are numerous definitions for it. The definition which is most widely used and accepted is the definition of health from the 1948 constitution of the World Health Organization, which defines health as *"A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity"* (World Health Organization 2013). This study follows the WHO health definition and so includes many aspects of comfort and well-being as part of health.

The concept of *public health* differs from the concept of health in its political aspect; public health is an integral part of our welfare state model. Public health is evidence-based policies, relying heavily on research and data-collection (Frumkin et al. 2011, 3). The policies of public health aim towards better health at the level of populations. Typically the conversation around public health also includes aspects of public health costs and national economy (Reivinen & Vähäkylä 2012, 9-10).

To research and measure peoples‘ state of health, the concepts of *self-perceived health* and *objective health* are commonly in use in the field of quantitative health research. Self-perceived health is persons’ own opinion about their state of health, and it is most commonly measured by asking individuals to evaluate their own health on various scales (for example in a scale from 0 to 10) or to compare their health with that of their age peers (e.g. Jylhä 2009, 307). Objective measures for health are indicators which can be measured and characterized independently from individuals own perception (e.g. Weden et al. 2008, 1257), such as body weight or blood pressure.

Nowadays there is a growing amount of empirical evidence stating that urban green space will support health and wellbeing of people (e.g. Scjippering 2010; Maas et al. 2006; Ulrich 2006; Aspinall et al. 2013; Korpela et al. 2008). A large scale study of de Vries et al. (2003) from Netherlands explored the relation between green space and self-reported health with a data including over 10 000 people. Health indicators which de Vries et al. used were health problems experienced in the previous 14 days, respondents´ own evaluation of their physical health and respondents´ own evaluation of their mental health. Firstly, the main result of their study was that, generally, urban green space is positively related to all of the three health indicators under examination. Furthermore, their analysis shows that particularly in the subgroups of elderly and housewives there can be found a stronger relation between the urban green space and the number of symptoms mentioned. In the subgroup of people with lower education de Vries et al. found the positive effect of green on health to be stronger with all three of the health indicators. (de Vries et al. 2003.)

Using a representative dataset from 250 782 Dutch respondents, also Maas et al. (2006) researched the relation between green areas and health. Firstly, based on their analyses, Maas et al. concluded that the effect of urban green space on all respondents’ health is considerable. To explore this found relation between urban green space and better health more closely in different subgroups, they performed multilevel logistic regression analyses. In their analyses, Maas et al. used a variable measuring the total percentage of the green areas in the neighborhoods within a one-kilometer and three kilometer radiuses from respondents’ homes using the postal code information and

the variable measuring respondents' self-perceived health (*"In general, would you say that your health is…")*. Their analyses demonstrate that green areas can be a source of health especially to the elderly, the young and people with low socioeconomic status. (Maas et al. 2006.)

Because in addition to already mentioned subgroups, children are also more dependent from the characteristics of their immediate environment, the health effects of urban green space might also be stronger in the subgroup of children. In Finland, for example Kyttä et al. (2009) have researched the urban environmental characteristics which support the physical activity and health of children. However, the aim of this study is to research the effect of urban green space on physical activity of adults. Thus, the question of how the environment affects physical activity of children will not be discussed further here.

2.1 Good health through sufficient physical activity

Physical activity can be defined to be "any bodily movement produced by skeletal muscles that increases energy expenditure above the basal level" (Dannenberg et al. 2011, 389). Besides this bodily definition of physical activity, in this study, the concept of physical activity refers to the total amount of daily physical activity of people which may be obtained from leisure sports or other light exercises, such as walking, cycling or gardening. The concept of *non-recreational physical activity* is also used in this study, which refers to the physical activity obtained through walking and cycling for transportation purposes.

When looking for medical evidence concerning the health advantages from sufficient physical activity, there is a long list. For example, physical activity reduces the risk of being overweight, suffering from cardiovascular diseases such as high blood pressure, heart attacks or stroke, or developing type two diabetes. Being active also reduces the risk of many cancers, osteoporosis, depression and it is also connected with improved sleep. (e.g. Sallis et al. 2011.) As Sallis et al. argue, there might not be any other health

intervention as beneficial as to increase physical activity of people, at least with so few unwanted side effects (Ibid., p. 34). Concerning the public health costs of physical inactivity, it has been estimated that physical passiveness of people has a price of approximately 150-300 euros per person in one year (Vaismaa et al. 2011, 8). If the physical activity of people can be promoted through activity supporting environmental characteristics, there will be also financial advantages.

The study of Lee et al. (2012) provides an extensive analysis about the global health effects of physical inactivity. Using a data from various health studies around the world and the method of population attributable fraction (PAF), Lee et al. estimated of how much disease would be actually averted if physically inactive people would become sufficiently active. Authors explored the influence of physical inactivity on health focusing on the major non-communicable diseases emphasized by UN as threat to global health: namely coronary heart disease; cancer (specifically breast and colon cancers) and type two diabetes. The results of their analyses suggest that 6% of coronary heart diseases, 7% of type two diabetes, 10% of colon cancers and 10% of breast cancers could be eliminated if all physically inactive people would become active. Although the percentages are larger with cancer, in terms of the number of cases, the public health effect concerning coronary heart diseases would be far larger because of its higher frequency. (Lee et al. 2012.)

Lee at al. (2012) also analyzed how the elimination of physical inactivity would affect on global all-cause-mortality and the overall median PAF was 9%. In numbers, according to this result more than 5.3 million deaths worldwide could be averted every year if physical inactivity could be eliminated. (p. 227.) The global influence of this unhealthy behavior of physical inactivity on health is similar to smoking, which is being estimated to cause globally approximately 5 million deaths in a year (Errati 2003, 847).

However, it is not likely that even with the most effective public health interventions, the problem of physical inactivity could be overcome completely. So in addition to 100% elimination of physical inactivity, Lee et al. (2012) estimated the effect of reduced physical inactivity on mortality by assuming 10% or 25% decrease in physical inactivity.

These more realistic analyses resulted that more than 533 000 and 1.3 million deaths could be avoided in a year through sufficient physical activity. (p. 227.) As Lee et al. (2012) conclude, "Physical inactivity has a major health effect worldwide. Decrease in or removal of this unhealthy behaviour could improve health substantially" (p. 219).

Though, however known is that sufficient amount of physical activity is good for our health, only little bit more than ten percent of Finnish aged between 18 and 64, are completely fulfilling the official physical activity recommendations by WHO (Husu et al. 2011a, 36; WHO 2010). According to the global physical activity recommendations of WHO (2010), adults of aged between 18 and 64 should do

- at least 150 minutes of moderate-intensity aerobic physical activity during a week
- or alternatively 75 minutes of vigorous-intensity aerobic activity.
- In addition to that, adults should have muscle-strengthening activities at least two times a week.

Because the survey data used in this study was collected before the new global physical activity recommendations of WHO (2010) were made, its questionnaire is planned according to the Finnish physical activity recommendation of Fogelholm et al. (2007). Thus, the analyses performed in this study follow these old recommendations as well, and this has to be kept in mind when reflecting on the findings of this study. According to Fogelholm et. al. (2007, 3), sufficient amount of physical exercise for health is

- either light exercise, such as walking or cycling, at least 30 minutes per day almost every day of a week,
- or alternatively physical exercise for a minimum of three times a week at least 30 minutes at a time, to a condition where one is at least a bit out of breath and perspiring.

By using these earlier Finnish recommendations, it is estimated by Fogelholm et al. (2007, 3) that as many as from 60 to 65% of Finnish adults accomplish sufficient amount of physical activity. This estimation is clearly more optimistic than by using the new recommendations of WHO, described above, when only little bit more than ten percent of Finnish adults are fulfilling the recommendations (Husu et al. 2011a, 36; WHO 2010).

Particularly the WHO recommendations for sufficient physical activity are quite high and the level of sufficient activity is difficult to accomplish only by doing leisure exercise, such as going to gym or jogging. As Gehl (2010) states, leisure excercise typically requires time, money, determination and willpower. Some demographic groups can handle these challenges, but there are many who cannot. There can also be particular life periods-, during which there is a lack of exercise. (Gehl 2010, 113.) The similar result has been identified in the Finnish research of Paronen et al. (2008), where they found out that parents and especially mothers in families with children, had a higher risk of being physically inactive compared to other adult groups (p. 33).

However, recent sport and health studies (e.g. Katzmarzyk et al. 2009; Patel et al. 2010) show that the health risks of passive lifestyle, especially the effects of sedentary behavior, might also concern those who see themselves doing enough sports (Salasuo 2012,6). In a large scale US study, Patel et al. (2010) explored the effect of leisure time spent sitting and the amount of physical activity on mortality, using survey data from 123 216 respondents. Survey respondents were disease free at the moment of data collection, but 11 307 deaths in men and 7 923 deaths in women were identified during the 14-years follow-up. With this extensive amount of data, Patel et al. (2010)

used Cox proportional hazards modeling to compute respondents' relative risk to mortality. The results were controlled with many other factors affecting mortality, most importantly smoking and body mass index. According to the results of Patel et al., time spent sitting is clearly associated with mortality, regardless of the amount of physical activity. Thus, based on their findings, Patel et al. argue that "Public health messages should include both being physically active and reducing time spent sitting". (Patel et al. 2010.) Generally, people should be encouraged not only to increase their level of physical activity but to reduce the time they spend being sedentary (Katzmarzyk et al. 2009).

To overcome the insufficiency of physical activity, daily physical challenges and lifestyle based physical activity needs to become a more integral part of daily life (Gehl 2010, 113). As, for example, Sallis at al. (2011) has stated, some characteristics of our living environments are associated with increased levels of physical activity. By designing environments that support activity, we can improve the physically active lifestyle and health of people. (Sallis et al. 2011, 33.)

2.2 Urban green space supports activity

"*Designing neighborhoods to support physical activity can now be defined as an international public health issue*" (Sallis et al. 2009, 484).

In this study, the concept of *urban green space* is understood similarly as in the study of Dannenberg et al. (2011), where green space is defined as "undeveloped space designated for parks or natural areas" (p. 384). To limit the observations of this study only to the green space inside cities, this study uses the prefix "urban" with the concept of green space. In addition, this study uses the concept of *urban green areas.* The difference between the concepts of urban green space and urban green areas is that when referring to urban green space, it means the amount of green space in a living area. When referring to urban green areas, it means particular urban green

resource, typically park or forest. So in this study, urban green space consists of urban green areas.

The results of the representative Finnish sport survey with 5 588 respondents (Kansallinen liikuntatutkimus 2009-2010) show that public urban space and particularly urban green areas are important environments of physical activity for people. When the respondents´ most common place to do physical exercise was asked, cumulatively 46% of respondents answered some outdoor environment such as walking and cycling lanes, nature trails or jogging or skiing tracks (p. 14).

According to the Danish study of Nielsen & Hansen (2007), it is essential to the frequency of visits to the urban green areas that they are near the place of our residence. The results of their study indicate that frequency of visits to urban green areas steeply decline when the distance increases, especially over the first 100-300 meters. (Nielsen & Hansen 2007, 842-843.) In the study of Nielsen & Hansen, 2000 randomly selected adults filled a questionnaire about the types of activities they perform in public green areas. The questionnaire also included questions measuring the distance from home to the different types of green and recreational areas, the frequency of visits and the respondents´ health. Based on their data, among other research questions, Nielsen & Hansen analyzed the relation between the distance to urban green areas and the frequency of visits using partial / controlled correlations. Their results clearly demonstrate that there is a highly significant link between the distance of urban green areas and the use of them. Their analysis showed that the mean and the median values for the frequency of visits to urban green areas steeply decline when the distance increases, especially over the first 100-300 meters. (Nielsen & Hansen 2007, 842-843.)

However, Nielsen & Hansen (2007) also performed a logistic regression analysis to study further the association between the access (distance), the frequency of visits to the urban green areas and health (using obesity as an indicator). Their analysis shows that, regardless of the person's level of education, urbanity, gender, age, employment, second home ownership and cycling to work, urban green space lessens the likelihood

of people being overweight and therefore supports health, but the effect of formal visits to urban green areas on health seems to be considerably smaller than the effect of access. Based on their findings, Nielsen & Hansen conclude that instead of formal visits to green areas, "the general character of the neighbourhood could be affected by green infrastructure and thus be more or less conducive to outdoor activities and 'healthy' modes of travel in every day life such as walking and bicycling". (Nielsen & Hansen 2007, 849.)

In the Finnish context, when exploring the possibility to increase the share of cycling or walking for transportation, Oja et al. (1998) explored personal and environmental factors which raise the respondents' willingness to go to work by foot or by bicycle, using Finnish representative data from 2014 respondents aged between 20 and 64. Oja et al. found that in the group of respondents who are active commuters by walking or cycling, the most often reported reasons to walk or to cycle to work are the personal desire for fresh air, exercise and fitness (36-44%), short distance to work (20-27%), inexpensive and convenient way of transport (10-27%), poor connections by public transport (10-25%) and walking or cycling to or from bus stop (10-23%) (p.88). Based on the result of Oja et al. of peoples´ personal desire for fresh air, because in urban green areas the air quality is better than elsewhere in urban space, it could be assumed that the route through green areas might encourage walking or cycling for transportation.

In addition to the studies reported above, which support the positive effect of urban green space on physical activity of people, there are also studies which question the activity supporting character of urban green space. For example, using data from 4899 Dutch respondents, Maas et al. (2008) performed multivariate multilevel analyses and multilevel logistic regression analyses to explore the relation between green areas, physical activity and health. The total percentage of the green space in the neighborhoods was measured within a one-kilometer and three kilometers radiuses from respondents' homes using the postal code information. The amount of physical activity was measured using the SQUASH (Short Questionnaire to Assess Health-Enhancing Physical Activity) questionnaire. Maas et al. (2008) explored particularly the

relation between the percentages of green space and whether or not people fulfill the Dutch public health recommendation for daily physical activity, how much sports respondents do, how much they walk or cycle during their leisure time or for commuting purposes or how much they do gardening. Generally, according to the analyses of Maas et al., when controlling central sosiodemographic and socioeconomic characteristics, there seems to be little effect from green space on respondents´ physical activity. Thus authors conclude that increased physical activity is not likely to be an important mechanism for explaining the health advantages from the local green environment. (Maas et al. 2008.)

When it comes to the results of Maas et al. (2008), where no evidence was found concerning the effect of urban green space on more physical activity, the aim of this study is to set up a similar type of research design in the Finnish context because there are some issues which might have an influence on the results of Maas et al. The authors are wondering whether the walking and cycling facilities in Netherlands are somewhat special and affecting the results. In Netherlands, there are safe cycle tracks and footpaths almost anywhere and there can be difficulties in finding enough differences between living areas concerning their activity supporting characteristics. (Maas et al. 2008, 11). Results from similar analysis might be different if the analysis would be performed using data collected in some less cycling-friendly country – such as Finland.

Similarly, the results of the study of Hillsdon et al. (2006) from UK, gave no evidence of an effect of urban green areas on particularly recreational physical activity of middle-aged adults. Using a survey data from 4950 respondents and geographic information system (GIS), Hillsdon et al. studied the effect of an access to urban green space on level of physical activity. They measured the accessibility of urban green space in terms of three indicators; distance only, distance and size of urban green space and size and quality of urban green space. To measure the quality of urban green space, Hillsdon et al. developed a new tool with a capability of capturing aspects of urban green space related to be more or less physically activating. In the developed tool, there were 69 different potential influencing factors grouped into eight themes; namely accessibility,

maintenance, recreational facilities, amenity provision, signage and lighting, landscape, usage and atmosphere. (p. 1127-1128.) In their analyses Hillsdon et al. (2006) found no evidence to support the argument that urban green space increases the recreational physical activity of people. Furthermore, they found out that respondents in the group with the best access to high-quality large green space reported significantly lower levels of physical activity compared to the groups rated lower considering the accessibility to green space. Drawing conclusions from this finding of greater odds to insufficient physical activity, Hillsdon et al. suggested that "some factors not directly measured here but related to local environments may be determinants of activity". (p. 1130.)

Because the analysis performed in this study also includes the aspect of non-recreational physical activity (walking or cycling to get from one place to another, e.g. to go to work or shopping), it will be interesting to compare the findings of this study with the ones of Hillsdon et al. (2006) where they explored only the effect of urban green space on recreational physical activity. As suggested by Nielsen & Hansen (2007) above, the effect of urban green space on physical activity of people might be related particularly to walking or cycling for transportation. So the analyses of this study will give further information concerning this difference between recreational and non-recreational physical activity related to urban green space.

2.3 Other environmental characteristics supporting physical activity

In addition to the urban green areas, there are definitely more factors which have an influence on the physical activity of people. Sealens et al. (2003) explored the environmental correlates and the physical activity of the residents in two neighborhoods of San Diego, California. Firstly, researchers identified two neighborhoods with different level of walkability, high and low. For a high-walkability neighborhood Sealens et al. selected the neighborhood with more "concentration of nonresidential land uses (restaurants, grocery or convenience stores, and other small retail stores) along with the main corridor of the neighborhood". For a low-walkability

neighborhood, Sealens et al. selected the neighborhood which was “mostly residential and had only a small commercial area on the neighborhood periphery”. (p. 1552.) Generally, as walkable communities can be defined those neighborhoods in which residents can walk to nearby destinations and which encourage walking for transportation purposes (Sallis et al. 2011; Sealens & Handy 2008).

Secondly, to make a comparison between the two neighborhoods with different walkability, Sealens et al. (2003) selected 107 adults and measured their level of physical activity and characteristics of their living areas, using accelerometers (small electric devices worn on the hip of the participant that record movement) and self-report survey. For seven days, the individual accelerometers collected minute-by-minute information about the participant´s physical activity. Same participants answered a survey questionnaire, which was designed to assess the environmental characteristics hypothesized to be related to the physical activity. (p. 1552-1553.)

The results of Sealens et al. (2003) shows that residents living in the high-walkability neighborhood, controlled for age and the level of education, had over 70 minutes more physical activity when compared to the residents of the low-walkability neighborhood. Comparing the environmental characteristics of the two neighborhoods, the residents living in the high-walkability neighborhood – and being clearly more physically active – perceived their living area having a higher residential density, land use mix-access, street connectivity, aesthetics, and pedestrian / automobile safety, than people living in the low-walkability neighborhood. (p. 1552-1553.)

In the detailed definitions of activity supporting environmental characteristics identified by Sealens et al. (2003) (Table 1 below), there are some features that will be the focus of my analysis. Primarily, nature has a central role in the definition of aesthetical environment, aesthetical environment being identified as one environmental factor to support physical activity of people.

Table 1.

Environmental correlates for increased physical activity identified by Sealens et al.

(Sealens et al. 2003, 1554.)

Residential density	How common are detached single-family residences in your immediate neighborhood? How common are apartments or condos 1-3 stories in your immediate neighborhood?
Land use mix-access	I can do most of my shopping at local stores Parking is difficult in local shopping areas.
Street connectivity	The streets in my neighborhood do not have many, or any, cul-de-sacs. The distance between intersections in my neighborhood is usually short.
Aesthetics	There are many attractive natural sights in my neighborhood (such as landscaping, views). There are many attractive buildings / homes in my neighborhood.
Pedestrian / automobile safety	The speed of traffic on most nearby streets is usually slow (30mph or less). There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.

Furthermore, according to the results of Sealens et al. (2003), the residential density of a neighborhood seems to have a clear effect on physical activity of people. So, drawing from the finding of Sealens et al., the results of the analyses performed in this study will be elaborated with the variable measuring the residential density. When Sealens et al. used a self-reported variable to study the effect of residential density, which has its limitations because it is imprecise, this study uses a data created to measure actual quantities of population densities. The influence of the other environmental correlates on increased physical activity identified by Sealens et al. remain as questions for future studies to investigate.

3 STRATEGY FOR ANALYSIS

To support the decision making concerning healthy environments, there is a need for practical information about the effective ways to shape them. For this purpose, there is a need to learn more about causal relations between the environment and health. In social sciences, empirical evidence to support or disprove causality is typically thought to be accumulated particularly through surveys and statistical methods.

In addition to theory based suggestions made by quantitative or qualitative researches, to reveal a causal relationship of which cause (X) might lead to consequence (Y), we need empirical evidence that X really does have an effect on Y. Correlations can tell us that when there is Y there is also X, but they cannot prove which way the influence works, through X or through Y. For that we need causal research. (Töttö 2004, 94-97, 113.)

According to Töttö (2004), in an ideal situation there are four requirements for revealing a causal relation: 1) contingency; 2) temporal order; 3) separating correlation from spurious correlation and 4) mechanism. *Contingency* means that the relation between X and Y cannot be conceptual. X and Y have to happen independently from each others. In practice, when measuring the hypothesized cause and hypothesized consequence using the same questionnaire, there is a danger that the respondent unknowingly or knowingly constructs some relation between the hypothesized factors of causal relation. When this happens, the relation cannot be causal in its nature. (p. 120 -122.)

By *temporal order* Töttö (2004) means that the order in which X and Y happen, has to be so that X happens before Y (p. 120-124). *Spurious correlation* refers to a situation in where a correlation between X and Y exist and the other is not necessarily causing the other, but there can be a mutual reason Z that affects the both. Finding out whether there is a reason Z, requires elaborating the found relation with different factors which might also have an effect on it. (Ibid., p. 129-131.)

The last of the methodological requirements for causality, identified by Töttö (2004), is *mechanism*. In social sciences it is practically impossible to exclude all the other possible factors which might have an effect on the relation under examination. However, if there can be presented a causal mechanism which tells us how X makes Y happen, it can give added proof for revealing the causality of the relation. (p. 131-132.)

In this study, there are difficulties related particularly to the second and the third of the methodological principles for revealing causality: the principle of temporal order and the requirement of separating correlation from spurious correlation. Concerning the relation in the interest of this study (the effect of urban green space on physical activity) and the data this study uses, if there is evidence found that urban green space increases physical activity of people, the causality of the relation is hard to proof. It is not possible to conclude whether the availability of urban green space makes people more physically active or whether the statistical relationship is spurious and derived from a self-selection process, which means that people who are already more active end up living in the neighborhoods giving better facilities to this existing lifestyle.

However, most studies researching how the characteristics of living environments affect physical activity end up being only correlational because they face this same methodological problem of self-selection, which is practically impossible to get over (Sallis et al. 2011, 39). For example, when it comes to the research questions of this study, to get over the problem of self-selection we should study a group of respondents who have moved from a less green neighborhood to a greener neighborhood. If their physical activity would have been measured before they moved and some period of time after they moved, the differences between the amounts of physical activity might give us a chance to evaluate causal relation. This kind of data seems quite impossible to gather, at least in the extent needed for statistical analyses. So in the decisions we make, we need to rely on the best possible research knowledge, though it is correlational in its nature.

3.1 Data: Tampere Health and Social Survey 2008

One of the lessons I remember from my very first university course of statistics-, is that there is not much sense in collecting quantitative data for just one master´s thesis. There are loads of underused data freely available collected by experienced researchers. I wanted to follow this hint and looked for a data for the use of my study from the Finnish Social Science Data Archive and asked it from different research organizations, such as Helsinki Urban Facts and Finnish Youth Research society. The most suitable dataset for the research purposes of this study was found from Finnish Social Science Data Archive and it is the data from the Tampere Health and Social Survey 2008, collected by Riitta Luoto (UKK Institute), Olavi Paronen (UKK Institute) and Mika Vuori (City of Tampere) (Luoto et. al. 2008).

The data of the Tampere Health and Social survey 2008 is a representative dataset with 3500 respondents and 180 variables. It is collected in the city of Tampere in Finland during January and February of 2008, using structured postal and internet questionnaires. The sample of 3500 persons was randomly selected from the population register including people aged 15 and over and excluding those living in institutions. Response rate was 61%. The questionnaire and the codebook of the survey can be found from the website of Finnish Social Science Data Archive, though the questionnaire is available only in Finnish (Finnish Social Science Data Archive 2013). The data of the Tampere Health and Social Survey 2008 is especially suitable for the use of this study because issues concerning peoples´ general health, living habits and neighborhoods were asked in its questionnaire.

To answer the research questions of this study, a part of the original dataset with 2079 respondents is used. From the original data with 3500 respondents, the respondents who lived outside the downtown Tampere were excluded from the sample. The borders of the downtown Tampere are presented in Pictures 4 and 5 in the Appendix 1. The sampled persons who did not respond but were included in the original dataset were excluded. There are no weight variables in the data. The original variable with postal code information identifying the exact city district of the respondent was

removed from the data when archived. However, this postal code information was re-categorized into service unit areas and this study uses this re-categorized variable (See Chapter 3.4 and Appendix 1.)

The following Table 2 presents the basic demographic characteristics of the sample this study uses, defined also by the distribution of the urban green space in four categories.

Table 2.

Sample characteristics of respondents % (N)

		Amount of urban green space			
	Total	**< 30%**	**30-40%**	**40-50%**	**> 50%**
Total	(2079)	43,8 (911)	14,1 (294)	30,6 (637)	11,4 (237)
Gender					
Male	41,4 (861)	39 (355)	37,4 (110)	46,8 (298)	41,4 (98)
Female	58,6 (1218)	61 (556)	62,6 (184)	53,2 (339)	58,6 (139)
Age					
≤ 25	14,8 (308)	12,7 (116)	10,9 (32)	18,5 (118)	17,7 (42)
26-45	30,0 (623)	29,6 (270)	29,6 (87)	28,7 (183)	35,0 (83)
46-60	25,8 (539)	22,6 (206)	31,3 (92)	28,6 (182)	23,6 (56)
≥ 61	29,4 (612)	35,0 (319)	28,2 (83)	24,2 (154)	23,6 (56)
Education	(2077)				
Higher level	26,7 (554)	27,8 (253)	23,5 (69)	25,2 (162)	29,7 (70)
Lower level	73,3 (1523)	72,2 (658)	76,5 (225)	74,5 (474)	70,3 (166)

Concerning the amounts of urban green space, sample distributions ranged from 11,4% (237) to 43,8% (911), the first category of less than 30% of green space having the largest share (43,8%) of the respondents. The largest share of respondents in the category of less than 30% of green space can be explained primarily because the category includes great amount of respondents living in the City Centre. In every category there are more female than male respondents, less young (aged 25 or less) than older respondents and more respondents with lower level of education, but these

characteristics are well balanced between the categories. They occur similarly in every category, regardless of the amount of urban green space.

On the side of the survey data from the Tampere Health and Social Survey 2008, this study uses a supplementary dataset which was created for the use of it to measure the exact amounts of urban green space and population densities. The statistics concerning these environmental characteristics were provided by city officials of Tampere (Tampere: Kantakaupungin ympäristö- ja maisemaselvitys 2008, 76; Statistical Yearbook of the City of Tampere 2008-2009, 11-13). There were some difficulties concerning the distribution and the borders of the service unit areas used as a basis of the re-categorization of postal code variable of the Tampere Health and Social Survey 2008 when used together with the external statistics which follow the borders of specific planning areas. These difficulties are described in detail in Appendix 1.

In the Tampere Health and Social Survey 2008, there were some questions concerning urban green areas which could have been used in this study, such as "Thinking about your local area, how would you rate the following: Parks and recreational areas" or "… Natural environment", but when looking into the frequencies of these variables, there was very limited amount of variation between the living areas. Residents of downtown Tampere seem to appreciate their local urban green areas regardless of their neighborhood. The use of external statistics about the exact amounts of urban green space gave actual differences between the areas. Concerning population densities, the need for the supplementary dataset was even more obvious, because population density was not asked in the questionnaire of the Tampere Health and Social survey 2008. And even if it would have been asked, the use of externally measured indicators on the side of survey data is better option, because it gives a possibility to explore the relations using actual quantities measuring the characteristics of residential areas, not just self-reported variables, which are imprecise in their nature.

As mentioned, the dataset this study uses is collected in the city of Tampere, which is the third largest city in Finland with the population of 215 168 people (Tampereen väestö 2012). As you can see from the map attached (Picture 1), Tampere is located in southern Finland, where there are still relatively mild weather conditions. Weather clearly affects the amount of people´s physical activity, especially when thinking about walking and cycling for transportation purposes.

Picture 1. The location of Tampere

Considering the Finnish weather conditions and the time of the data collection (January and February 2008), the Finnish wintertime is not the best time to collect information about peoples´ physical activity. The winter weather probably keeps people more indoors than in the summertime. Although the variables this study uses for measuring the amount of physical activity are asked in a way "How often, in average…", respondents might report less physical activity in the wintertime that they would during the summertime.

3.2 Research questions and hypotheses

To recap, from the earlier studies which were reviewed in the literature chapter, it is known that there is an effect of urban green space on better health of people. However, the processes through which urban green space benefit health remain unclear. Several mechanisms of behavior may explain this relation, one suggested being the character of urban green space to encourage physical activity of people. The aim of the analyses performed in this study is to further explore the contradictory relation between urban green areas and physical activity. The controversy, and even

opposed results of the earlier studies, suggests that there still remains a need for more research. The primary research questions of this study are:

a) "Does urban green space have an effect on total amount of physical activity of people?"

b) "Does urban green space have an effect on non-recreational physical activity of people?"

c) "How do the findings of the analyses of this study concerning the effect of urban green space on physical activity of people change when elaborating them with population density, the quality of pedestrian and cycling facilities and respondents´ sex, age and the level of education?"

Although the results of the earlier studies concerning the effect of urban green space on physical activity of people are contradictory, the aim of this study is to defend the positive relation between urban green space and increased physical activity of people. As a consequence, it is hypothesized that there is an effect of urban green space on increasing physical activity. So far, to my knowledge, there have been few researches exploring empirically the relation between urban green space and particularly non-recreational physical activity, such as walking and cycling for transportation purposes. But based on the suggestions made in earlier studies (e.g. Nielsen & Hansen 2007; Hillsdon et al. 2006), the hypothesis of this study is that there is even more clear positive effect of urban green space on particularly non-recreational physical activity.

This study is primarily designed to explore the effect of urban green space on peoples´ physical activity, so it cannot give explanations concerning the broader relation of how urban green space affects health of people through the process of increased physical activity. Though, based on earlier health studies, it can be assumed that if urban green

space increases the amount of physical activity it has a clear positive effect on health of people, but this assumption is not empirically explored in this study.

3.3 Method

To explore the relation between urban green space and physical activity of people, two binary logistic regression analyses will be performed. Binary logistic regression analysis is suitable for the analyses of this study, because the primary response variable has only two response categories. The attraction of this approach is that its character allows the estimation of the likeliness of how the respondents distribute into the two non-overlapping categories of response variable, depending from the explanatory variables (see e.g. Nummenmaa 2009, 332). First binary logistic regression analysis is used to test the relation between the amount of urban green space and total physical activity of people. Second binary logistic regression analysis is performed focusing particularly to the effect of urban green space on non-recreational physical activity, such as walking and cycling for transportation purposes. All analyses are conducted using PASW statistics 18.0 for Windows. The Syntax of these analyses can be found from Appendix 2.

3.4 Variables

This study uses eight variables; two response variables, one primary explanatory variable and five variables to elaborate the findings. The variables used have been re-categorized from the original variables of the Tampere Health and Social Survey 2008 (Luoto et al. 2008) and created using external statistics provided by city officials of Tampere measuring the exact amounts of urban green space (Tampere: Kantakaupungin ympäristö- ja maisemaselvitys 2008, 76) and population densities (Statistical Yearbook of the City of Tampere 2008-2009, 11-13).

The purpose of this Chapter is to introduce the variables which this study directly uses to answer its research questions. In Appendix 1 there are more detailed categories, frequencies and distributions of all variables, the variables which are directly used and the variables which have been used as a basis to re-categorized variables. In Appendix 1, there are also more explanations about the choices and calculations that have been made when re-categorizing the variables and creating the supplementary dataset to measure the amounts of urban green space and population densities.

When making comparisons between several variables, the common principle of listwise deletion will be used (see e.g. Vehkalahti 2008, 69) where the single observation is left out, if the respondent has not answered to all the variables in the focus of the comparison. Only complete observations are taken into consideration in the analyses. Because of this principle, depending of the analysis, there was from minimum of 1,9% to maximum of 6,7% of respondents excluded from the analyses.

3.4.1 Response variables

Total physical activity and Non-recreational physical activity

The principles to the categories of sufficient and insufficient total and non-recreational physical activity are borrowed from the Finnish recommendations for healthy amount of physical activity of Fogelholm et al. (2007, 3), which were described in details in Chapter 2.1. Although the more recent global recommendation for the sufficient amount of physical activity given by World Health Organization (WHO 2010) is available, the recommendations of Fogelholm et al. are used because in the questionnaire of the Tampere Health and Social Survey 2008, the amount of respondents´ physical activity was asked following these old recommendations. This has to be kept in mind when reflecting on the findings of this study.

Firstly, to explore the effect of urban green space on physical activity, this study uses the variable [The amount of physical activity] 0 = Sufficient, 1 = Insufficient. The

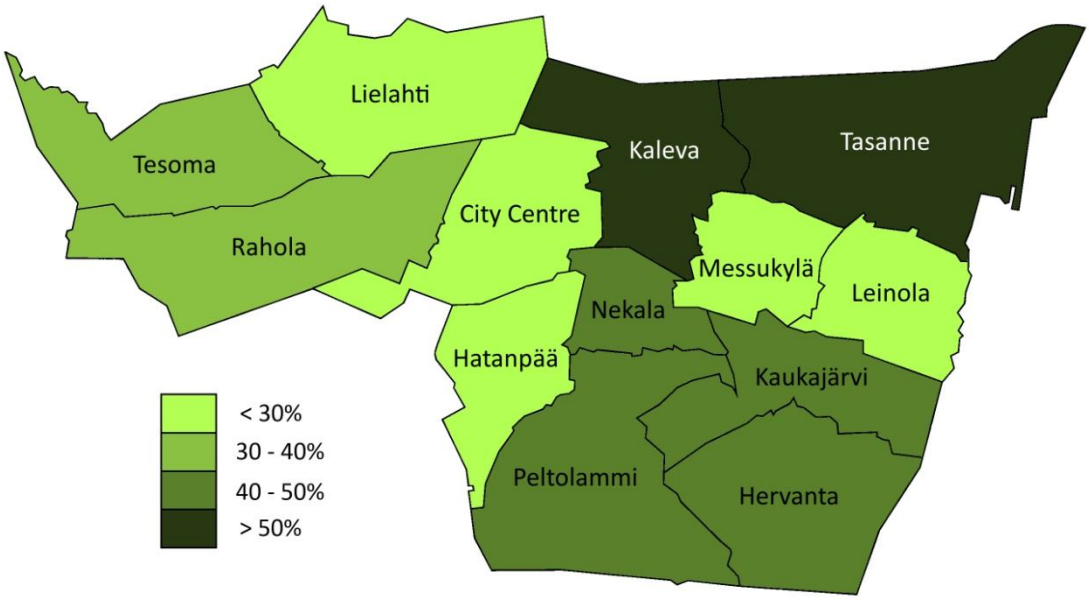
variable was re-categorized from the original variables [q20 In your leisure time, how often do you take physical exercise that lasts at least 30 minutes and makes you breathe more heavily and sweat at least a little?] and [q21 On average, how many minutes a day do you walk or cycle to get from one place to another (e.g. to go to work or shopping)?].

Secondly, to focus the examination particularly to the effect of urban green space on respondent's non-recreational physical activity, this study will use the variable [Non-recreational physical activity (e.g. walking or cycling for transportation purposes)] 0 = Sufficient, 1 = Insufficient. The variable was re-categorized from the original variable [q21 On average, how many minutes a day do you walk or cycle to get from one place to another (e.g. to go to work or shopping)?].

3.4.2 Explanatory variables

Amount of urban green space

To measure the amounts of urban green space in a neighborhood, this study uses the variable [Amount of green space]. The variable was created for the use of this study using external statistics concerning the actual amounts of urban green space of a living area (Tampere: Kantakaupungin ympäristö- ja maisemaselvitys 2008, 76). These statistics of the amounts of urban green space contain only the green areas included in the governmental process of urban planning. Thus some green areas, such as private gardens or green roadside settings, are excluded from this analysis. This exclusion serves the aim of the analyses performed in this study well, because when including only the green areas in the governmental planning process, it can be assumed that those green areas are mostly accessible to all citizens. By using the statistics provided, survey respondents were re-categorized to four categories according to the amount of green space in their residential area. The following Picture 2 presents these four categories and their geographical distribution.

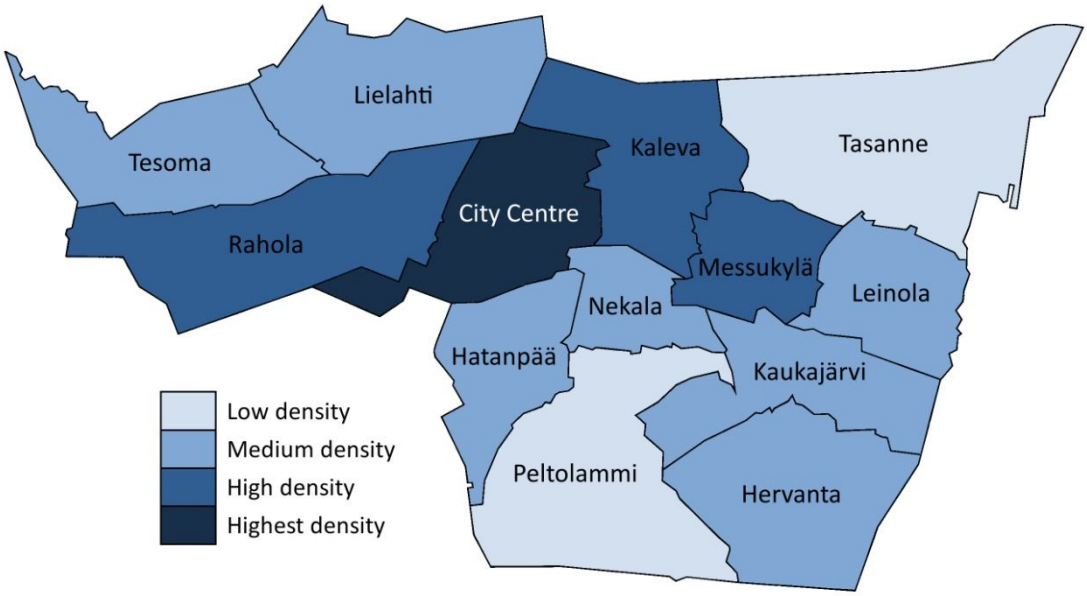


Picture 2. The four categories of urban green space in downtown Tampere; based on the external statistics concerning the amount of urban green space (Tampere: Kantakaupungin ympäristö- ja maisemaselvitys 2008, 76)

Along with urban green space, there are many other factors which affect the choices we make related to our physical activity. In this study, for the purpose of evaluating the reliability of the findings concerning the effect of urban green space on physical activity of people, the following variables are controlled.

Population density

One of the aims of this study is to investigate the influence of population density on the relation between urban green space and physical activity. For that purpose, this study uses the variable [Population density (people per km2)], which is visually presented in the following Picture 3. The variable was created using external statistics measuring the population densities (Statistical Yearbook of the City of Tampere 2008-2009, p. 11-13).



Picture 3. The four categories of population density in downtown Tampere; based on the external statistics concerning the population densities (Statistical Yearbook of the City of Tampere 2008-2009, 11-13)

It has to be kept in mind, that even though this study uses the categories of *high* or *highest* density, the population densities everywhere in Tampere are quite low, especially when compared internationally. So these categories of population densities, which this study uses, are comparable to each other but not to the categories used in many international studies with cities that have much more inhabitants and very high population densities.

Pedestrian and cycle lanes

To elaborate the influence of the quality of walking and cycling lanes on the relation between urban green space and physical activity, this study uses the variable [Pedestrian and cycle lanes]. For this variable, the respondents who report that their living area has very good or fairly good pedestrian and cycle lanes were re-categorized in the category “good”. The respondent who consider the pedestrian and cycle lanes of their living areas as fairly poor or poor, were re-categorized in the category “poor”.

When using this variable it has to be noticed that even after the re-categorizing of the variable there was only seven percent of the respondents who report the walking and cycling lanes of their living area as poor. So it seems that generally in downtown Tampere there are good walking and cycling facilities, regardless of the fact that the data was collected during winter time when the maintenance of light traffic lanes is treated commonly as secondary to the motor vehicle lanes.

Age, Gender and Education

As it was described in Chapter 2, it is known that local environment has greater effect on health of certain groups of population. Because of that fact, the findings of this study will be elaborated with the variables [Age], [Gender] and [Education]. As mentioned before, in Appendix 1 there are presented more detailed categories, frequencies and distributions of all variables.

4 RESULTS

To recap, the interest of this study is to explore whether increased physical activity might be one process through which people gain good health from urban green space. Based on the earlier studies (e.g. Scjippering 2010; Maas et al. 2006; Ulrich 2006; Aspinall et al. 2013; Korpela et al. 2008), it has been assumed in this study that the respondents living in neighborhoods with more urban green space would feel themselves healthier than respondents living in areas with less urban green space. Firstly, a descriptive statistical analysis was performed to see whether this assumed relation between urban green space and health is existent in the sample of this study. The variables used in the analyses are introduced in detail in Chapter 3.4 and in Appendix 1.

From the cross tabulation below (Table 3), there can be seen a reasonably clear tendency of how respondents' self-perceived health increases with the amount of urban green space. When the amount of urban green space increases from less than 30% to more than 50%, the amount of respondents who feel their health good increases from 68,4% to 77,1%. So those who live in an area with more green space are likely to feel themselves healthier. According to X^2-test the result is statistically significant (P<0,05, df 6).

Table 3.

Cross tabulation:

The relation between urban green space and self-perceived health

		Health			
		Good	Fair	Poor	Total
Amount of green space	< 30%	68,4	23,5	8,1	100%
	30-40%	70,1	23,8	6,1	100%
	40-50%	72,8	21,2	6,0	100%
	> 50%	77,1	14,8	8,1	100%
(N=2074)		71%	21,8%	7,2%	100%

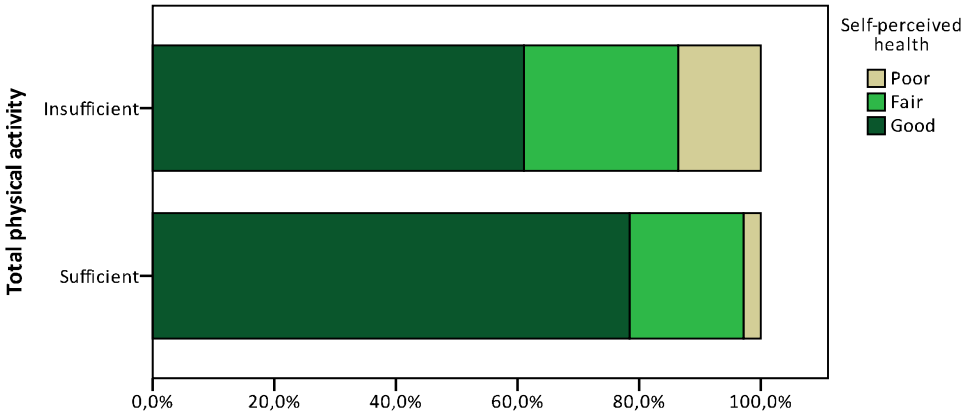
Variables: [Self-perceived health][Amount of urban green space]

Secondly, as seen from earlier health studies (e.g. Sallis et al. 2011; Lee et al. 2012), it is evident that sufficient physical activity increases health. The following Graph 1 illustrates of how the sufficient total physical activity (according to the recommendations by Fogelholm et al. 2007) affects the respondents' self-perceived health in the sample of this study. Graph 2 shows the influence of sufficient non-recreational physical activity on respondents' self-perceived health.

Graph 1.

Total physical activity and self-perceived health

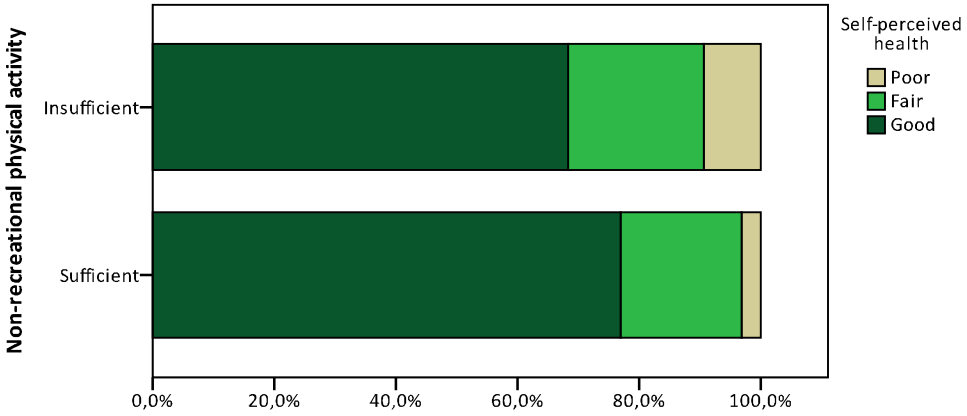
Variables: [Total physical activity] and [Self-perceived health] N=2028



Graph 2.

Non-recreational physical activity and self-perceived health

Variables: [Non-recreational physical activity] and [Self-perceived health] N=2034



The results of these analyses, as shown in the Graph 1 and 2, indicate that sufficient amount of physical activity has clear positive effect on respondents' self-perceived health. As it was expected, respondents who practice sufficient amount of physical activity report a much better health, when compared to the group with insufficient physical activity.

The influence of sufficient physical activity on self-perceived health is particularly visible when using total physical activity as an indicator, but the same trend can also be seen when using the variable measuring particularly non-recreational physical activity. In the group that practices sufficient amount of total physical activity (Graph 1.), there are just a few respondents who announce their heath being only poor, when in the group of respondents who practice insufficient amount of total physical activity there are almost 15% of respondents reporting poor health. So in the group with sufficient total physical activity, there are almost 20% more people announcing their health being good than in the group with insufficient total physical activity.

Similarly, in the group with sufficient non-recreational physical activity (Graph 2.), there are clearly more respondents reporting good health (77%) than in the group with insufficient non-recreational physical activity (68%). In the group with sufficient non-recreational physical activity there are only 3% of respondents stating their health being poor, when in the group with insufficient non-recreational physical activity, there are 9% of respondents who feel their health being only poor.

4.1 Urban green space and total physical activity

The following chapters of this study will focus on their main goal, which is to explore further the relation between urban green space and people's total physical activity and non-recreational physical activity. Using a dataset from 2079 Finnish respondents, this study will explore these relations by performing two binary logistic regression analyses. The first analysis, presented in this Chapter, examines how urban green space affects respondents´ total physical activity. Secondly, in the following Chapter 4.2, the analysis is focused to explore how urban green space affects particularly respondents´ non-recreational physical activity, meaning walking and cycling for transportation purposes. The data, method and the variables are introduced in details in Chapter 3 and in Appendix 1. The Syntax of the analyses can be found from Appendix 2.

Binary logistic regression analyses are used to explore respondents´ likelihood of being more or less physically active when living in a neighborhood with more green space, compared to the respondents living in neighborhoods with less green space. In the later parts of the analyses, to evaluate the reliability of the findings, the influence of population density, quality of walking and cycling facilities and the basic demographic characteristics of age, gender and education will be controlled.

To shortly recap the variables used in the analyses;

- amount of urban green space is measured in four categories, from less than 30% to more than 50%,
- total physical activity and non-recreational physical activity are measured with the dichotomized variable, 0=Sufficient amount and 1=Insufficient amount,
- population density is categorized in four categories, from low to highest density,
- the quality of walking and cycling lanes is categorized in two categories, good and poor
- and education is categorized in two categories, lower level education and higher level education.

Though the earlier researches exploring the relation between urban green space and physical activity have reported contradictory results, in this study it was hypothesized that there is a positive effect of urban green space on total physical activity of people. However, the results of the Model 1 (Table 4) indicate an unexpected opposed trend to the hypothesis of this study. As Model 1 illustrates, when comparing the respondents who live in an area with more urban green space to those with less urban green space, the odds are greater concerning insufficient total physical activity (OR 1,22, 1,13, 1,04). The trend is most visible when comparing the respondents who live in a neighborhood with from 30 to 40% of urban green space to those with less than 30% of urban green space (OR 1,22, P=0,16).

Table 4.

Binary logistic regression analysis:

Model 1

Odds ratio <1, increased likelihood of sufficient total physical activity

Odds ratio >1, increased likelihood of insufficient total physical activity

(N=2033)				95% Confidence level	
		Odds ratio	Significance	Lower level	Upper level
Model 1.	< 30%	1,00			
	30 - 40%	1,22	0,16	0,93	1,60
	40 - 50%	1,13	0,24	0,92	1,40
	> 50%	1,04	0,82	0,77	1,39
Nagelkerke R Square		0,2 %			

* P< 0,05 (α = 5%), ** P< 0,01 (α = 1%), *** P< 0,001 (α =0.1%)

It is important to notice that many of the results have no statistical significance, so there are patterns of behavior to be found from the sample of this study, but these patterns lack the predictability in the formal confidence level of 95%. Also the degree of explanation (Nagelkerke R Square) is low. Thus there is a possibility that the found trend of greater odds for insufficient total physical activity associated with more urban green space is random in the nature. Despite this weakness in the analysis, the found relation will be investigated further by elaborating it with population density, walking and cycling facilities, age, gender and level of education. Firstly, the variable measuring the effect of population density of the neighborhood is added in Model 2 (Table 5). Secondly, the rest of the control variables will be added in Model 3 (Table 6).

Table 5.

Binary logistic regression analysis:

Model 2

Odds ratio <1, increased likelihood of sufficient total physical activity

Odds ratio >1, increased likelihood of insufficient total physical activity

(N=2033)				95% Confidence level	
		Odds ratio	Significance	Lower level	Upper level
Model 2.	< 30%	1,00			
	30 - 40%	1,03	0,83	0,76	1,40
	40 - 50%	0,95	0,71	0,73	1,24
	> 50%	0,87	0,45	0,60	1,25
	Low density	1,00			
	Medium density	0,96	0,81	0,69	1,34
	High density	0,96	0,82	0,66	1,39
	Highest density	**0,67**	**0,06**	0,44	1,02
Nagelkerke R Square		0,6%			

* P< 0,05 (α = 5%), ** P< 0,01 (α = 1%), *** P< 0,001 (α =0.1%)

Model 1 (Table 4) presented earlier displayed a trend that where there was more urban green space, people were more likely to belong into the group with insufficient total physical activity. When controlling the influence of population density in the Model 2 (Table 5), the effect of urban green space on insufficient total physical activity disappears or is reversed and becomes negative. Though the significance levels are not good, there is to be seen a clear effect of population density on the relation between urban green areas and total physical activity of people.

Table 6.

Binary logistic regression analysis:

Model 3

Odds ratio <1, increased likelihood of sufficient total physical activity

Odds ratio >1, increased likelihood of insufficient total physical activity

(N=1940)				95% Confidence level	
		Odds ratio	Significance	Lower level	Upper level
Model 3.	< 30%	1,00			
	30 - 40%	1,00	0,98	0,74	1,37
	40 - 50%	0,99	0,94	0,76	1,29
	> 50%	0,91	0,61	0,62	1,32
	Low density	1,00			
	Medium density	0,97	0,87	0,69	1,36
	High density	0,98	0,90	0,66	1,43
	Highest density	**0,65**	**0,05**	0,42	1,00
	Good	1,00			
	Poor	1,05	0,81	0,73	1,51
	≤ 25	1,00			
	26 - 45	1,22	0,19	0,90	1,66
	45 - 60	1,10	0,53	0,81	1,50
	≥ 61	**1,39**	**0,03**	1,03	1,88
	Female	1,00			
	Male	1,16	0,11	0,97	1,41
	Higher level	1,00			
	Lower level	1,06	0,63	0,85	1,31
Nagelkerke R Square		1,4%			

* P< 0,05 (α = 5%), ** P< 0,01 (α = 1%), *** P< 0,001 (α =0.1%)

When adding more variables in the Model 3 (Table 6), it hardly changes the odds of the Model 2 (Table 5). Though, what Model 3 indicates is that the respondents aged 61 or over seem to have particular risk to belong in the group with insufficient total physical activity. The degree of explanation (Nagelkerke R Square) is as low as 1,4% even after more variables were added to the model.

4.2 Urban green space and non-recreational physical activity

When Chapter 4.1 earlier explored the relation between urban green space and total physical activity, the aim of the analyses of this Chapter is to investigate respondents` likelihood to belong into group with sufficient or insufficient non-recreational physical activity, associated with the amount of urban green space. As a non-recreational physical activity this study refers to the amount of walking and cycling for transportation purposes. Based on the suggestions from the earlier researches (e.g. Nielsen & Hansen 2007), it is hypothesized in this study that there is positive effect of urban green space on non-recreational physical activity of people. The variables this study uses to elaborate its findings are the same as in the analysis performed in Chapter 4.1.

As the results of the following Model 1 (Table 7) indicate, there is a similar style trend concerning the likelihood of insufficient non-recreational physical activity related to more urban green space-, as was found when analyzing the relation between urban green space and total physical activity. However, in this analysis, when taking into consideration only the amount of non-recreational physical activity the effect of urban green space on insufficient physical activity is more obvious. Strong evidence was found especially when comparing the category of from 30 to 40% (OR 1.43, P=0.01) of urban green space to the category of less than 30% of urban green space. This result means that the respondents living in an area which has from 30 to 40% of urban green space-, have clearly increased likelihood of insufficient physical activity when compared to the respondents living in an area with less than 30% of urban green space.

Table 7.

Binary logistic regression analysis:

Model 1

Odds ratio <1, increased likelihood of sufficient non-recreational physical activity

Odds ratio >1, increased likelihood of insufficient non-recreational physical activity

(N=2039)				95% Confidence level	
		Odds ratio	Significance	Lower level	Upper level
Model 1.	< 30%	1,00			
	30 - 40%	**1,43**	0,01	1,08	1,89
	40 - 50%	1,16	0,17	0,94	1,43
	> 50%	1,14	0,38	0,85	1,54
Nagelkerke R Square		0,4%			

* P< 0,05 (α = 5%), ** P< 0,01 (α = 1%), *** P< 0,001 (α =0.1%)

However, when controlling the influence of population density (Model 2, Table 8), the effect of urban green space on insufficient non-recreational physical activity turns more random or is even reversed, to negative odds. This trend is similar with the trend which considered the effect of urban green space on the amount of total physical activity, presented in earlier Chapter 4.1.

Table 8.

Binary logistic regression analysis:

Model 2

Odds ratio <1, increased likelihood of sufficient non-recreational physical activity

Odds ratio >1, increased likelihood of insufficient non-recreational physical activity

(N=2039)				95% Confidence level	
		Odds ratio	Significance	Lower level	Upper level
Model 2.	< 30%	1,00			
	30 - 40%	1,11	0,51	0,81	1,52
	40 - 50%	0,87	0,31	0,67	1,14
	> 50%	0,78	0,18	0,54	1,12
	Low density	1,00			
	Medium density	**0,67**	**0,03**	0,48	0,95
	High density	0,75	0,14	0,51	1,10
	Highest density	**0,43**	**0,00**	0,28	0,65
Nagelkerke R Square		2,3%			

* P< 0,05 (α = 5%), ** P< 0,01 (α = 1%), *** P< 0,001 (α =0.1%)

After controlling the influence of population density in Model 2, when comparing the category with from 30 to 40% of urban green space to the category with less than 30% of urban green space, there is still greater odds for insufficient physical activity to be seen but X^2-test gives no statistical evidence to support this result anymore (P=0,51). When comparing the rest of the categories to the category with less than 30% of urban green space, odds turn to negative. This means that when taking into consideration the positive influence of population density on non-recreational physical activity of people, urban green space seem to increase the likelihood of sufficient non-recreational physical activity. Though, as in the earlier analysis, it is important to notice that although there are trends to be seen, many of the results have no statistical significance in the formal confidence level of 95% and the degree of explanation is low.

In the following Model 3 (Table 9), the relation between urban green space and non-recreational physical activity will be elaborated further by controlling the influence of the quality of pedestrian and cycling lanes, age, gender and the level of education. As it

can be seen from the Model 3 (Table 9), when controlled with more variables, the effect of urban green space on non-recreational physical activity results a bit stronger than in the Model 2, though the results still lack the statistical significance in the formal confidence level of 95%.

Table 9.

Binary logistic regression analysis:

Model 3

Odds ratio <1, increased likelihood of sufficient non-recreational physical activity

Odds ratio >1, increased likelihood of insufficient non-recreational physical activity

(N=1946)				95% Confidence level	
		Odds ratio	Significance	Lower level	Upper level
Model 3.	< 30%	1,00			
	30 - 40%	1,09	0,61	0,79	1,50
	40 - 50%	0,84	0,21	0,64	1,10
	> 50%	0,75	0,15	0,51	1,10
	Low density	1,00			
	Medium density	**0,66**	**0,02**	0,46	0,94
	High density	0,71	0,09	0,48	1,06
	Highest density	**0,39**	0,00	0,25	0,61
	Good	1,00			
	Poor	0,91	0,63	0,63	1,32
	≤ 25	1,00			
	26 - 45	0,91	0,52	0,67	1,23
	45 - 60	**0,67**	**0,01**	0,49	0,91
	≥ 61	0,90	0,50	0,67	1,22
	Female	1,00			
	Male	**1,35**	**0,00**	1,12	1,64
	Higher level	1,00			
	Lower level	**0,73**	**0,01**	0,59	0,91
Nagelkerke R Square		3,3%			

* P< 0,05 (α = 5%), ** P< 0,01 (α = 1%), *** P< 0,001 (α =0.1%)

The findings from the last part of the analysis (Model 3, Table 9) draws attention to the factors with which urban green space seems to support sufficient non-recreational physical activity. Strong evidence still remains concerning particularly the necessity of sufficient population density. So the main result emerging from the analyses of in this study is that urban green space seems to encourage non-recreational physical activity when certain conditions exists, from which the most obvious is sufficient population density. The influence of population density on increased non-recreational physical activity can be seen already when comparing the respondents living in medium density neighborhood to respondents living in low density neighborhood, though the influence is most clearly seen when comparing the respondents living in highest density neighborhood to respondents from low density neighborhood. So according to the findings from the analyses performed in this study, even medium population density seems enough to increase the odds for sufficient non-recreational physical activity associated with more urban green space.

Model 3 (Table 9) also indicates that population groups who have greater odds to belong in the group with sufficient non-recreational physical activity (when controlled with the variables used in this analysis) are people aged from 45 to 60, people with lower level education and women (not presented: OR 0,78, P<0,05). Men seem to have a particular risk of belonging in group with insufficient non-recreational physical activity. The degree of explanation (Nagelkerke R Square) rises from 0.4% to 3.3%, when more variables were added in the Model 3.

When looking at the maps of the downtown Tampere (Picture 2 and Picture 3 in Chapter 3.4.2), presented with the categories of the amounts of urban green space and population densities, it can be seen that there is a neighborhood called Kaleva which has both, relatively high population density and high amount of urban green space. The last analysis of this study (Table 10 below) examines whether there can be found a visible difference concerning the amount of respondents' non-recreational physical activity living in Kaleva, when compared to the respondents from other neighborhoods.

Table 10.

Cross tabulation:

Neighborhood differences concerning respondents´ non-recreational physical activity

		Non-recreational physical activity		
		Sufficient %	Insufficient %	Total
Neighborhood	City Centre	46,7	53,3	100%
	Tesoma	34,9	65,1	100%
	Lielahti	37,4	62,6	100%
	Rahola	29,2	70,8	100%
	Messukylä	29,2	70,8	100%
	Leinola	36	64	100%
	Tasanne	20,3	79,7	100%
	Kaleva	**44,2**	**55,8**	100%
	Hatanpää	39,2	60,8	100%
	Peltolammi	36	64	100%
	Nekala	39,7	60,3	100%
	Hervanta	34	66	100%
	Kaukajärvi	39,3	60,7	100%
(N=2039)		37,8%	62,2%	100%

Variables: [Non-recreational physical activity (e.g. walking or cycling for transportation purposes)], [Neighborhoods of Tampere downtown] N=2039

As can be seen from the Table 10 above, in addition to City Centre (where exists strong effect of population density on non-recreational physical activity), there seems to live more people in the neighborhood of Kaleva with sufficient non-recreational physical activity than in other neighborhoods. In Kaleva 44,2% of respondents report sufficient amount of non-recreational physical activity, when in the other neighborhoods (with the exception of City Centre) there are less than 40% of them. According to X^2-test, the result is statistically significant ($P<0,001$, df 12). This finding further supports the main argument drawn from the analyses of this study, which states that urban green space seems to promote particularly non-recreational physical activity of people when the neighborhood has sufficient population density.

4.3 Discussion

Prior studies (e.g. Scjippering 2010; Maas et al. 2006; Ulrich 2006; Aspinall et al. 2013; Korpela et al. 2008) state that urban green space has positive influence on health of people, but the processes through which people gain health from urban green space remain unclear. Because sufficient physical activity has an evident effect on better health (e.g. Lee et al. 2012; e.g. Sallis et al. 2011), urban green areas might support good health through promoting physical activity of people. However, a contradictory relationship between urban green areas and physical activity has been reported in earlier studies. There are studies which state that physical activity of people might be encouraged through urban green areas (e.g. Nielsen & Hansen 2007), but there are also studies which have arguments opposed to the positive effect of urban green space on increasing physical activity (e.g. Maas et al. 2008; Hillsdon et al. 2006).

The controversy of the earlier studies, exploring the effect of urban green areas on the physical activity of people, suggests a need for further research. This study was designed to explore whether urban green space might affect the total physical activity or the non-recreational physical activity of people (meaning walking or cycling for transportation purposes). It was hypothesized that the respondents living in the neighborhood with more urban green space would have increased likelihood of being physically active when measured by both indicators, total physical activity and non-recreational physical activity.

Firstly, the findings of this study partly run counter to these hypotheses because this study did not demonstrate a strong positive effect of urban green space on total physical activity of people. This result is consistent with those of Maas et al. (2008), who explored the relation between the percentage of green space and physical activity of Dutch people. In the analysis of this study, there is a weak trend to be seen that urban green space might increase the likelihood of insufficient total physical activity, but when controlled with population density, the effect is reversed and urban green space seems to increase the likelihood of sufficient total physical activity. However, there was no statistical significance to support this identified trend.

Secondly, the results of this study concerning the effect of urban green space on particularly non-recreational physical activity are more encouraging. There is evidence found that urban green space increases the amount of respondents´ non-recreational physical activity when certain conditions exist, most importantly sufficient population density of the neighborhood. Before controlling the influence of population density, analyses identified a trend similar to the one found when analyzing the relation between urban green space and total physical activity. There was seen a statistically significant result that urban green space, contrary to expectations, increase the likelihood of insufficient non-recreational physical activity. But when controlling the influence of population density, the described effect of increased likelihood of insufficient physical activity disappears or is reversed. According to this finding, it seems that urban green space might have a notable effect in increasing non-recreational physical activity of people in the neighborhoods with sufficiently dense residential structure.

Hillsdon et al. (2006) have also found a similar effect of less physical activity related to more urban green space. When Hillsdon et al. explored the association between the access to urban green space and the amount of recreational physical activity, they found a result that respondents in the group with the best access to high-quality large green space reported lower levels of physical activity compared to the groups from neighborhoods with less urban green space (OR −0.190 P<0.001). Thus, when reflecting on the results of Hillsdon et al. and the findings of this study concerning the increased likelihood of insufficient total and non-recreational physical activity (before controlling the effect of population density), it seems that there might be a surprising association between urban green areas and less physical activity.

However, more research has to be done before the reasons for this relation between urban green space and increased likelihood of less physical activity can be determined. As is suggested in the research of Sealens et al. (2003), the aesthetics of the neighborhood (i.e. attractive natural sights) is one environmental characteristic which supports physical activity. But other activity-supporting neighborhood characteristics are identified as well, such as greater residential density, better land use mix-access

(i.e. local shopping possibilities) or better street connectivity (i.e. short distances between neighborhood intersections). (Sealens et al. 2003, 1552-1553.) When looking at the map of downtown Tampere (Picture 2, Chapter 3.4.2), the neighborhoods which have the largest share of urban green space are located near the border of the downtown area. Although there is more nature, there are probably fewer other activity-supporting environmental factors identified by Sealens et al. (2003). So it might be that these other factors have a stronger effect on the physical activity of people than nature has. The strong effect of population density on physical activity of people gets support from the analyses of this study.

In the results of this study, there are also findings consistent with earlier research (e.g. de Vries et al. 2003; Maas et al. 2006), concerning the population groups which are more affected by the characteristics of our environment. The control variables included in the analyses indicate that urban green space seems to have a particularly strong effect on non-recreational physical activity of people aged from 45 to 60, people with lower level education and women.

However, because the dataset used in this study was not primarily designed to evaluate the research questions in the interest of this study, it is suggested that the associations identified in this study are investigated further in future studies. These future analyses might also be better to conduct using data collected from some larger city. Generally, in the city of Tampere there might be too much green space and too low population density everywhere to allow for statistically significant differences between neighborhoods. A sample collected from Helsinki might have been more favorable because it would probably have offered more diversity between neighborhoods, Helsinki being the largest city in Finland. However, for the use of this study, there was not freely available such a data. Another weakness of this study might be that the sample of 2079 Finnish adults used in this study is relatively small compared to many studies cited earlier. What would also be needed is exact measurement of the amount of peoples´ physical activity. As Husu et al. (2011b) state, people have a tendency to overestimate the amount of their physical exercise when answering survey questionnaires.

5 CONCLUSIONS

As has become clear from this study, there are some characteristics in our living environments which are associated to encourage the physical activity of people, and physical activity in turn supports good health of people. By building urban environments which encourage physical activity, there might be a possibility to increase the amount of peoples´ daily physical exercises.

Because the desire to explore the topic of this study is based on my own experiences of the importance of urban green areas as a resource for physical activity, I was hoping to find statistical evidence to support this personal perception. Even though the results of this study are partly contrary to this expectation, there are encouraging findings to assess in future research, findings which could lead to improved interventions to build and preserve good urban green resources in the name of public health.

Using quantitative data from 2079 Finnish respondents, binary logistic regression analyses were performed to explore the effect of urban green space on total physical activity and non-recreational physical activity of people. The main result of the analyses is that, contrary to expectations, urban green space seems to increase the likelihood of particularly insufficient non-recreational physical activity. But when controlling the influence of population density, the effect is reversed and urban green space seems to increase the likelihood of sufficient non-recreational physical activity. The results of the analyses performed in this study provide support for the argument that urban green space can promote particularly non-recreational physical activity in the neighborhoods with sufficient population density. So it seems that urban green areas can support physically active lifestyle and health by encouraging people to walk and cycle for transportation purposes.

However, because some of the trends identified in this study lack the statistical significance in the formal confidence level of 95%, it is suggested that the found associations should be investigated further in future studies. If there would have been

a larger sample to use, and a larger scale measuring the amount of urban green space and population density, the analyses might have gotten more statistically significant evidence to support its findings.

The importance of this study is that its findings give suggestions for indicators that should be evaluated in similar future studies, most importantly the effect of population density on the relation between urban green areas and physical activity. As the results of this study show, when controlling the influence of population density, the relation between urban green space and physical activity changes substantially. When the analyses are not controlled with population density, urban green space seems to decrease the amount of physical activity. But when controlled with population density, urban green space seems to have an opposed effect, to increase the amount of physical activity. This result is particularly visible when taking into consideration only non-recreational physical activity.

More research is also needed before the broader association between urban green space, physical activity and health of people is clearly understood. Based on earlier studies and analyses performed in this study, it can be stated that when there is sufficient population density, encouragement of non-recreational physical activity might be one process through which urban green space could support better health of people. But there are definitely other processes working behind this known relation between urban green areas and health, and more research is still needed to determine the processes through which green environment supports better health. The effect of urban green space on health is an important issue for future research because in our time of increasing urbanization there is pressure to build more residences at the cost of urban green areas. If it can be clearly demonstrated that urban green areas support better health, there might be more will to preserve or even build more green areas in our cities.

Nevertheless, even if there is a great and accessible nearby park or excellent cycling lanes connecting home, work and services, many people still make a choice to watch television for their leisure or drive a car to work or services. That is something we just

have to accept and develop different motivational factors for different groups of people. As Schneider (2011) points out, to enhance the personal choices of people towards preferable health outcomes, it requires attention to both: to the environments where the lifestyle choices are made and to the other motivation factors which encourage better choices, including education, regulation, market mechanisms, and social marketing (p. 261). So there remains plenty of work to research the effects of our living environments on our health. Thus, urban space is one of the environments through which we construct our behavioral patterns, and urban green space is one important aspect of it.

Furthermore, as important as sufficient physical activity of people is to their personal health and our public health spending, it is also important when taking ecological issues into consideration. The megatrend of urbanization emphasizes the necessity of good urban planning to support the general well-being of people. (Heikkilä & Kirveennummi 2010, 8.) There will be a great increase in the number of new inhabitants in big cities and their surroundings, a fact which will bring more traffic. And traffic in turn will bring more traffic jams, pollution and accidents. Supporting light traffic instead of cars would improve the well-being of citizens in many ways and reduce the harmful influence of traffic on environment. By supporting walking and cycling as a way of transportation, we support the health of people, but the step towards fewer cars could also be the key element in creating enjoyable cities in the time of increasing urbanization. And as the results of this study indicate, it seems that urban green areas might have potential to encourage people to change from driving cars to walking or cycling.

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APPENDICES

Appendix 1: Frequencies and detailed principles of all variable modifications

RESPONSE VARIABLES

Self-perceived health

When exploring the relation between urban green space and self-perceived health, this study uses the variable [Self-perceived health]

	N	%
1 = Good	1472	70,8
2 = Fair	453	21,8
3 = Poor	149	7,2
	2074	99,8
Missing	5	,2
Total	2079	100,0

which is re-categorized using the original variable, ["In general, would you say that your health is…"].

	N	%
1 = Good	776	37,3
2 = Fairly good	696	33,5
3 = Fair	453	21,8
4 = Fairly poor	119	5,7
5 = Poor	30	1,4
	2074	99,8
Missing	5	,2
Total	2079	100,0

The new variable [Self-perceived health] was needed because there was quite a small amount of respondents in the "Poor"-category of the original variable ["In general, would you say that your health is…"].

Total physical activity

The variable [Total physical activity],

	N	%
0 = Sufficient	1239	59,6
1 = Insufficient	794	38,2
	2033	97,8
Missing	46	2,2
Total	2079	100,0

was re-categorized combining the original variable [q20 In your leisure time, how often do you take physical exercise that lasts at least 30 minutes and makes you breathe more heavily and sweat at least a little?]

	N	%
1 = 6-7 times a week	157	7,6
2 = 3-5 times a week	761	36,6
3 = 1-2 times a week	615	29,6
4 = A few times a month	271	13,0
5 = Less often or not at all	181	8,7
6 = I can´t do physical activities due to illness/disability	85	4,1
	2070	99,6
Missing	9	,4
Total	2079	100,0

and the original variable [q21 On average, how many minutes a day do you walk or cycle to get from one place to another(e.g. to go to work or shopping)?].

	N	%
1 = I don´t cycle or walk daily to get from one place to another	311	15,0
2 = Under 15 minutes a day	287	13,8
3 = 15-29 minutes a day	671	32,3
4 = 30-59 minutes a day	508	24,4
5 = 60 minutes a day or over	262	12,6
	2039	98,1
Missing	40	1,9
Total	2079	100,0

The principles to the categories of sufficient and insufficient physical activities are based for the recommendations for healthy amount of physical activity of Fogelholm et. al. (2007). (See Chapter 2.1.)

Following the recommendations of Fogelholm et al. (2007), the categories one and two (physical exercise three or more times a week) from the variable [[q20 In your leisure time, how often do you take physical exercise that lasts at least 30 minutes and makes you breathe more heavily and sweat at least a little] and categories four and five (walking or cycling at least 30 minutes a day) from the variable [q21 On average, how many minutes a day do you walk or cycle to get from one place to another (e.g. to go to work or shopping)] were re-categorized as sufficient total physical activity. Other categories from both variables were re-categorized as insufficient total physical activity.

Non-recreational physical activity

To explore the relation between the amount of urban green space and respondent's non-recreational physical activity, this study uses use the variable [Non-recreational physical activity (e.g. walking or cycling for transportation purposes)],

	N	%
0 = Sufficient	770	37,0
1 = Insufficient	1269	61,0
	2039	98,1
Missing	40	1,9
Total	2079	100,0

which was re-categorized using the original variable [q21 On average, how many minutes a day do you walk or cycle to get from one place to another (e.g. to go to work or shopping)?].

	N	%
1 = I don´t cycle or walk daily to get from one place to another	311	15,0
2 = Under 15 minutes a day	287	13,8
3 = 15-29 minutes a day	671	32,3
4 = 30-59 minutes a day	508	24,4
5 = 60 minutes a day or over	262	12,6
	2039	98,1
Missing	40	1,9
Total	2079	100,0

Following the recommendations of Fogelholm et al. (2007), the categories four and five (non-recreational physical exercise at least 30 minutes a day) from the variable [q21 On average, how many minutes a day do you walk or cycle to get from one place to another (e.g. to go to work or shopping)?] were re-categorized as sufficient non-recreational physical activity. Other categories were re-categorized as insufficient non-recreational physical activity.

EXPLANATORY VARIABLES

Amount of green space

This study uses the variable [Amount of urban green space] to analyse the effect of urban green space on respondents´ physical activity. The variable was created based on the external statistics concerning the amounts of the urban green space (Tampere: Kantakaupungin ympäristö- ja maisemaselvitys 2008, 76). Using the statistics provided, respondents were re-categorized to four categories

	N	%
1 = < 30%	911	43,8
2 = 30-40%	294	14,1
3 = 40-50%	637	30,6
4 => 50%	237	11,4
Total	2079	100,0

according to the amount of urban green space from the total land area of their neighborhood (presented below).

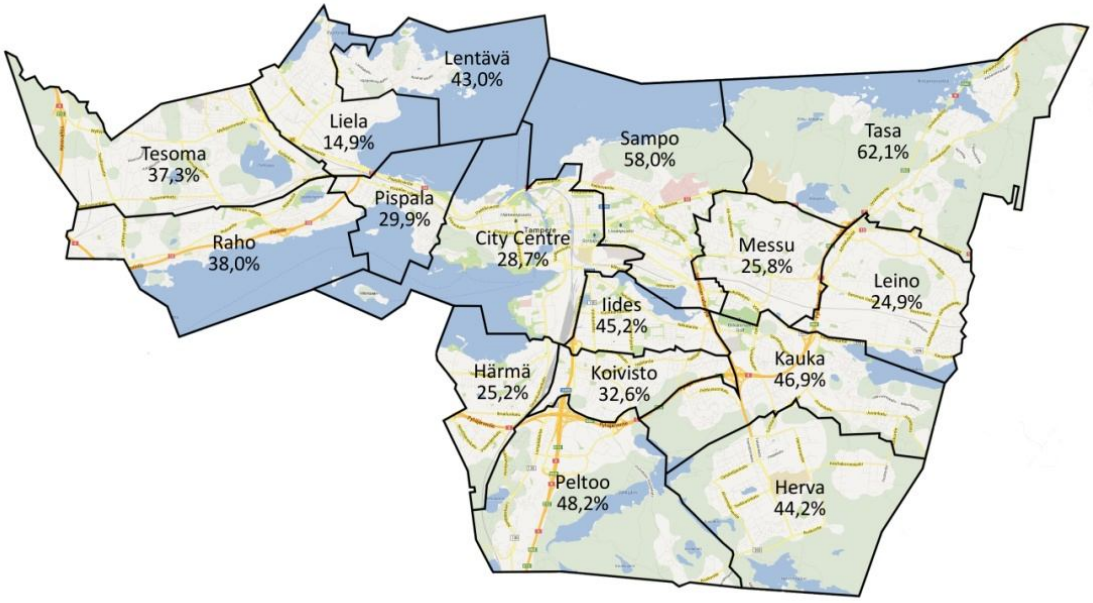
Lielahti 24,2%
Leinola 24,9%
Hatanpää 25,2%
Messukylä 25,8%
City Centre 28,7%
Rahola 36,2%
Tesoma 37,3%
Hervanta 44,2%
Peltolammi 44,3%
Nekala 45,2%
Kaukajärvi 46,0%
Kaleva 58,0%
Tasanne 62,1%

When coding the amounts of urban green space into the dataset this study uses, there were some difficulties. The exact postal codes, asked in the questionnaire of the Tampere Health and Social Survey 2008, had been deleted when the data was archived. Based on the postal codes asked, respondents´ living areas were re-categorized according to specific *service units*, used by Social and health department of the city of Tampere, meanwhile the information concerning the amount of urban green space abide the borderlines of specific *planning areas*, used by City planning department of Tampere. The difficulty was that there are small differences when comparing the borders of these units and areas, used in different branches of city government.

As it can be seen from the Picture 4 and Picture 5 below, borders of the planning areas and service units are mostly the same, but there are some differences. Because of these differences, some green space percentages had to be re-calculated. The following Picture 5 presents the original amounts of green space following the borders of planning areas, which were used in the calculations.

Picture 4. Service units of downtown Tampere

(Adapted from: Tampereen kaupunki 2013)



Picture 5. Amounts of urban green space in downtown Tampere

(Adapted from: Tampere: Kantakaupungin ympäristö- ja maisemaselvitys 2008, 76)

In most cases, the borders of service units and planning areas are completely the same with similar or different name. That is the most common reason to the coding of the amounts of urban green space to the dataset this study uses; service units are the same as planning areas and they take the given amount of urban green space strictly from statistics provided (Tampere: Kantakaupungin ympäristö- ja maisemaselvitys 2008, 76). Secondly, there are service units which include two planning areas, but the borders of the planning areas together are similar with one service unit. In these cases, the amount of urban green space used in my analysis was calculated using the information from both planning areas (Picture 5). Thirdly, there are some service units which are closely the same as one or two planning areas, but their borders have no complete equivalence. However, these differences between the borders of service units and planning areas are so slight, that the amount of urban green space was calculated or used directly as above.

In the case of City Centre, the planning area of City Centre contains two service units, when usually service units contain one or two planning areas. In this case, two service units were combined together to make it comparable with statistics concerning the amount of urban green space of the City Centre. Furthermore, as it can be seen from the maps (Pictures 4 and 5) presented, there are also differences concerning the names of the service units and the planning areas. This study uses the area names used in the original re-classification of the respondents´ living areas from postal code information (Luoto et al. 2008). The changes made concerning the names of the living areas are described in the following Table 11. In addition to maps presented above, in Table 11, there is also information provided which indicates the particular living areas where is some imprecision concerning their borders.

Table 11:

Differences between service units and planning areas

Living area	Service unit	Planning area	Equivalence
City Centre	Pyynikki, Tammela	City Centre	differences
Tesoma	Tesoma	Tesoma	complete equivalence
Lielahti	Lielahti	Liela, Lentävä	complete equivalence
Rahola	Rahola	Raho, Pispala	complete equivalence
Messukylä	Messu	Messu	differences
Leinola	Leino	Leino	complete equivalence
Tasanne	Tasa	Tasa	complete equivalence
Kaleva	Kaleva	Sampo	differences
Hatanpää	Hatanpää	Härmä	differences
Peltolammi	Peltolammi	Peltoo, Koivisto	complete equivalence
Nekala	Nekala	Iides	differences
Hervanta	Hervanta	Herva	complete equivalence
Kaukajärvi	Kaukajärvi	Kauka	complete equivalence

TO ELABORATE

This study elaborates the reliability of its findings using environmental variables [Population density (people per km2)], [Pedestrian and cycle lanes] and the demographic variables [Age], [Gender] and [Education].

Population density

This study investigates the effect of population density using the re-categorized variable [Population density (people per km2)]

	N	%
1 = Low density	212	10,2
2 = Medium density	992	47,7
3 = High density	454	21,8
4 =Highest density	421	20,3
Total	2079	100,0

which was created using the information concerning population densities from Statistical Yearbook of the City of Tampere 2008-2009 (p. 11-13).

Tasanne 415 people per km^2
Peltolammi 699 people per km^2
Tesoma 1 377 people per $km^{/2}$
Hatanpää 1411 people per $km^{/2}$
Lielahti 1 492 people per $km^{/2}$
Nekala 1529 people per $km^{/2}$
Leinola 1547 people per $km^{/2}$
Hervanta 1673 people per $km^{/2}$
Kaukajärvi 1854 people per $km^{/2}$
Rahola 2067 people per $km^{/2}$
Messukylä 2096 people per $km^{/2}$
Kaleva 2286 people per $km^{/2}$
City Centre 4 985 people per $km^{/2}$

The variable [Population density (people per km2)] was re-categorized so that Tasanne and Peltolammi (699 or less people per km2) are in the category “low density”; Tesoma, Hatanpää, Lielahti, Nekala, Leinola, Hervanta ja Kaukajärvi (1377-1854 people per km2) are in the category “medium density; Rahola, Messukylä ja Kaleva (2067-2286 people per km2) are in the category “high density”; and City Centre (4985 people per km2) is in the category “highest density.

When coding the population densities into the dataset that this study uses, there were similar kinds of difficulties as there was when coding the amounts of the urban green space. The information about the population densities was provided abiding the borders of planning areas and there was a need to make similar calculations, as described above, to make it comparable to the respondents’ neighborhood categories, re-categorized according to service units.

Pedestrian and cycle lanes

The variable [Pedestrian and cycle lanes]

	N	%
1 = Good	1840	88,5
2 = Poor	138	6,6
	1978	95,1
Missing	101	4,9
Total	2079	100,0

was re-categorized using the original variable [q46_11 Thinking about your local area, how would you rate the following: Pedestrian and cycle lanes?].

	N	%
1 = Very good	771	37,1
2 = Good	1069	51,4
3 = Can´t say	76	3,7
4 = Fairly poor	118	5,7
5 = Very poor	20	1,0
	2054	98,8
Missing	25	1,2
Total	2079	100,0

The respondents, who report that their living area has very good or fairly good pedestrian and cycle lanes, were re-categorized in the category “good”. The respondent who consider the pedestrian and cycle lanes of their living areas as fairly poor or poor, were re-categorized in the category “poor”. The respondents who have answered “can´t say”, were re-categorized as missing.

Age

The variable [Age],

	N	%
1 = ≤ 25	308	14,8
2 = 26-45	623	30,0
3 = 45-60	536	25,8
4 = ≥ 61-	612	29,4
Total	2079	100,0

was re-categorized using the original variable [q2 Age].

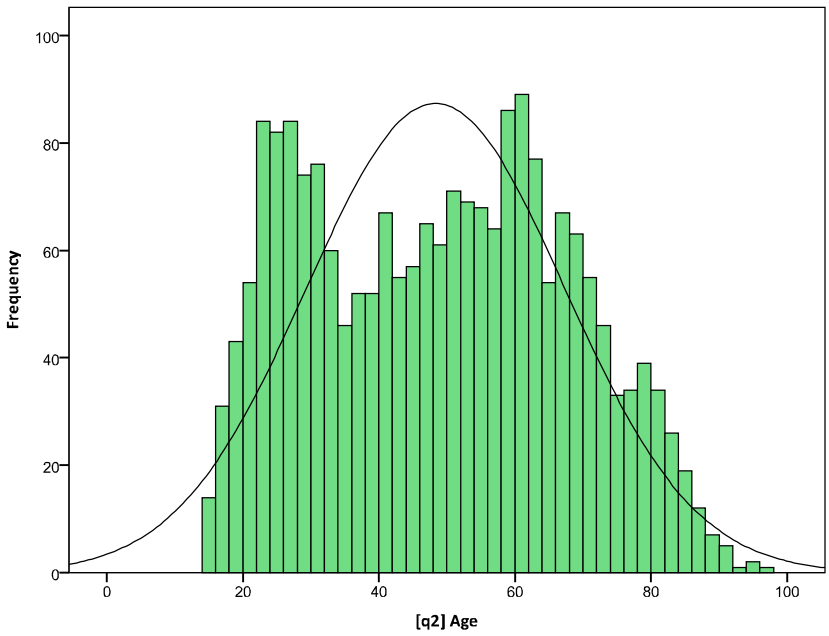
Minimum 15

Maximum 97

Mean 48,33

Median 49,00.

Standard deviation 18.99



Gender

The variable [Gender]

	N	%
1 = Female	1218	58,6
2 = Male	861	41,4
Total	2079	100,0

was re-categorized using the variable [q1 Gender] by turning its scale around. This small change was done with the hypothesis that women have better health than men, so the interpretation of the analysis might be easier without negative values.

Education

The variable [Education] was re-categorized

	N	%
1 = Higher level	554	26,6
2 = Lower level	1523	73,3
	2077	99,9
Missing	2	,1
Total	2079	100,0

from the original variable [q6 The respondent´s education]

	N	%
1 = Primary or lower secondary education	506	24,3
2 = Upper secondary education (general)	200	9,6
3 = Upper secondary education (vocational)	477	22,9
4 = College level vocational education (post-secondary)	340	16,4
5 = Polytechnic or lower academic degree (B.A. or equivalent)	242	11,6
6 = Higher academic degree (M.A. or equivalent or higher)	312	15,0
	2077	99,9
Missing	2	,1
Total	2079	100,0

so that categories five and six of the original variable were re-categorized as higher education level. Categories from one to four of the original variable were re-categorized as lower education level.

Appendix 2: Syntax

```
*Binary logistic to explore the relation between urban green space and physical activity*
DATASET ACTIVATE DataSet1.
LOGISTIC REGRESSION VARIABLES fyysakt_2lk
  /METHOD=ENTER greenspace
  /CONTRAST (greenspace)=Indicator(1)
  /PRINT=CI(95)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).

*Elaborating with the population density*
LOGISTIC REGRESSION VARIABLES fyysakt_2lk
  /METHOD=ENTER greenspace
  /METHOD=ENTER density
  /CONTRAST (greenspace)=Indicator(1)
  /CONTRAST (density)=Indicator(1)
  /PRINT=CI(95)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).

*Adding the rest of the variables*
LOGISTIC REGRESSION VARIABLES fyysakt_2lk
  /METHOD=ENTER greenspace
  /METHOD=ENTER density lanes age gender education
  /CONTRAST (greenspace)=Indicator(1)
  /CONTRAST (density)=Indicator(1)
  /CONTRAST (lanes)=Indicator(1)
  /CONTRAST (age)=Indicator(1)
  /CONTRAST (gender)=Indicator(1)
  /CONTRAST (education)=Indicator(1)
  /PRINT=CI(95)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).

 *Binary logistic to explore the relation between urban green space and non-recreational physical activity*
LOGISTIC REGRESSION VARIABLES nrfyysakt
  /METHOD=ENTER greenspace
  /CONTRAST (greenspace)=Indicator(1)
  /PRINT=CI(95)
```

```
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).

*Elaborating with the population density*
LOGISTIC REGRESSION VARIABLES nrfyysakt
  /METHOD=ENTER greenspace
  /METHOD=ENTER density
  /CONTRAST (greenspace)=Indicator(1)
  /CONTRAST (density)=Indicator(1)
  /PRINT=CI(95)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).

* Adding the rest of the variables*
LOGISTIC REGRESSION VARIABLES nrfyysakt
  /METHOD=ENTER greenspace
  /METHOD=ENTER density lanes age gender education
  /CONTRAST (greenspace)=Indicator(1)
  /CONTRAST (density)=Indicator(1)
  /CONTRAST (lanes)=Indicator(1)
  /CONTRAST (age)=Indicator(1)
  /CONTRAST (gender)=Indicator(1)
  /CONTRAST (education)=Indicator(1)
  /PRINT=CI(95)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).

*Cross tabulation Neighborhood differences of non-recreational physical activity*
CROSSTABS
  /TABLES=neighborhood BY nrfyysakt
  /FORMAT=AVALUE TABLES
  /STATISTICS=CHISQ
  /CELLS=COUNT ROW
  /COUNT ROUND CELL.
```