Seniors accessibility to primary health care centers using the public transport system in Uppsala

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ABSTRACT

Since many seniors are non-car holders, they are often dependent of the public transport system in reaching vital services, such as primary health care centers. Having spatial accessibility to primary health care centers can be of importance not only for preventing fatal outcomes of chronic diseases, but also for the utilization of these services. The aim of this study is to analyze how accessible primary health care centers are for people from the age of 65 and older in Uppsala by analyzing the public transport system. Statistical data on populations was collected, such as positions of bus stops and primary health care centers. GIS was used as a tool in order to analyze and visualize the data with maps. Accessibility was implemented through the cumulative opportunities measure with distance as impedance to get the total number of primary health care centers reached within each residential area. The measure of centrality was based on the assumption of Uppsala being a monocentric city where the central point was set at the most central clinic in the city. A regression analysis was conducted in order to see if closeness to a public health care facility, wealth, disposable income and centrality had an impact on accessibility and if there were any differences between the seniors and the general population in accessibility. The results showed that seniors were having better access to primary health care centers than the total population. The seniors who were living within a walking distance to a primary health care center had better accessibility, but fewer primary health care centers to choose from. Furthermore, both rich and poor individuals had an increase in accessibility suggesting that poor seniors do not have lower accessibility. Residential areas with a higher and lower disposable income had slightly lower accessibility. At last, the centrality measure showed a similar result, where central and peripheral areas had lower accessibility but areas in between had higher accessibility, which stands in contrast with the conducted maps, indicating that Uppsala might be a polycentric and not a monocentric city.

Keywords: Accessibility, public transport, primary health care, seniors, GIS

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1. INTRODUCTION

With a population increasingly growing older, the incentive to create cities that enhances public transport systems in order to reach important services becomes essential. Public transportation is an inevitably important part of a city’s structure. It connects people with places and enables us to visit and spend time at places far away from our homes that might be out of reach just by walking to them. It is thus also an important part of our daily lives since it can expand the possibilities regarding which places we can visit during one day. But for a city just to provide a public transport system isn’t enough. It also has to enable the reach of opportunities in the city that are vital for the inhabitant’s lives. This means that the public transportation system has to provide transport to important destinations such as shopping, supermarkets, pharmacists and health care facilities among others (Fatima and Moridpour, 2019; Lange & Norman, 2018).

When the ability, or the willingness, to drive a car or walk longer distances diminishes with age (Lange & Norman, 2018; Ricciardi et al, 2015), the public transport system can serve as an important component in reaching vital services (Lange & Norman, 2018). Primary health care services are especially important to have access to since the prevalence of certain chronic diseases is higher for seniors (Levasseur et al, 2015). Critical outcomes of these can be prevented with interventions in the urban environment, where transportation can play a vital role. Spatial accessibility to primary health care centers can also keep patients going on regular visits to the facilities (Arcury et al, 2005) and for seniors this might be of more importance than others. Some areas can be said to have a higher spatial accessibility than others, based on the notion that they are central (Crucitti et al, 2006), hence becoming a factor to take into notice when studying accessibility to primary health care centers. Although the need for health care might not differ based on the level of disposable income, the access to health care facilities isn’t always equally distributed regarded to income levels. Low-income families and individuals often have a harder time accessing health care facilities that are within a reasonable distance and amount of time travelled (Hernandez & Rossel, 2015; Hawthorne & Kwan, 2013). Since seniors are relatively poorer than the rest of the population in Sweden with a lower disposable income (Pensionsmyndigheten, 2018), their accessibility to public health care facilities might be compromised.

The questions that arises are if the primary health care centers are accessible for the seniors and if they can reach the primary health care centers by using the public transport system. The public transport system can only be seen as a good means of transportation if it is accessible to reach and if it facilitates seniors’ needs of reaching opportunities. If they don’t, the seniors will have less use for it. Studying the accessibility of primary health care centers regarding the geographical distribution of disposable income and centrality becomes of importance since it can have an impact on the accessibility of health care facilities.

1.1 Purpose

The aim of this research is to examine how accessible primary health care centers are for seniors in Uppsala by analyzing the public transport system.
1.2 Research questions
- How does seniors’ accessibility to primary health care centers compare to the rest of the population?
- How does centrality, walking distance to primary health care centers, wealth and disposable income affect the accessibility to primary health care centers?

1.3 Limitations
The study takes into account primary health care centers, bus stops, bus routes and households with individuals from the age of 65 and older that are within Uppsala. The city busses are the only ones included in the study. Additional bus routes, such as those operating on a regional level which might be passing the same bus stops, are not included. Furthermore, the focus of the study will be on public transport that departs from the bus stops according to the set timetable and therefore does not take into account additional transport services that can be ordered by the seniors on their own. In addition, the study only takes into account bus traffic in public transport and does not count on other collective means of transport that possibly operate on the same routes. The concept of accessibility will only include spatial accessibility and will not regard other aspects such as quality of the public transport system or primary health care facilities. The main focus regarding accessibility will also just include the distance as the impedance and number of facilities reached and does not include cost or time of travel to the facilities. Since seniors often have less ability to walk, the shortest distance of 400 meters will be used in this study as an indicator of accessibility from the bus stops. Further than that, and the station will be seen as inaccessible. With regard to transfers in public transport, this study only looks to how many primary health care centers that can be reached without switching bus routes. When measuring the accessibility to primary health care centers it is hard to get an exact measure. These facilities might be situated within a bigger building and some might have more than one entrance. Within this study, these facilities are only measured based on one spatial point which can affect the accessibility and the closeness to the roads that surrounds it.

2. BACKGROUND

The following chapter presents the background to the ageing population in Sweden and Uppsala, together with information about the available means of transport and primary health care centers in Uppsala. Both the historical and the contemporary aspect will be presented.

2.1 An ageing population
The population of western societies are getting older and the Swedish population is no exception. In 1900, the share of the population aged 65 years or older was 8,4 percent. In comparison, the same cohort in 2018 accounted for almost 20 percent of the total Swedish population (Statistiska centralbyrån, 2018a). This trend does not seem to be changing in the near future, but rather be amplified. Today, the share of people from 80 years of age and older in Sweden are increasing the most, and by the time of 2028 this cohort is expected to increase with 255 000 individuals (Statistiska centralbyrån, 2018b). This is an increase of 50 percent compared to the measured amount in 2018 (Statistiska centralbyrån, 2018b). The pattern of population growth in Uppsala is similar to the national level where the share of individuals above 65 years of age will be steadily increasing up until 2040 while other cohorts will be
diminishing or have a stable growth (Region Uppsala, 2017). With an ageing population in Uppsala, the planning practices have to be adapted in order to deal with this demographical change. Provided public services, such as the public transportation system, has to be designed accordingly to the needs of the citizens. In addition to seniors making up a larger proportion of the total population, they are also relatively poorer than the rest of the population in Sweden with a lower disposable income (Pensionsmyndigheten, 2018). According to Pensionsmyndigheten (2018) the share of seniors with a low economic standard in Sweden is about 12 percent, but many seniors are centered on the limit value of 12,100 SEK a month.

2.2 Busses in Uppsala
Within the central parts of Uppsala, the bus system was modified in 2017. This was done in order to further increase the attractiveness of travelling by bus and meet the needs of a growing population (Länstrafiken i Uppsala, 2019d). The bus system now consists of twelve regular routes where route number 1 is a circle line that goes around the city in both directions. These routes are stretching from Gamla Uppsala in the north to Graneberg in the south, Kvarnbo in the west and reaching to the outskirts of Fyrislund in the east. An additional three lines number 30, 31 and 32 are included in “Mjuka linjen”, the soft line, which are operating a bit differently than the other lines. These are stretching further into the residential areas where the bus stops are lying closer to services such as shopping centers, hospitals and primary health care centers.

The soft line busses are said to be specially adapted for seniors and the disabled, but can also come in handy for families with younger children (Länstrafiken i Uppsala, 2019). In January 2019, the prices of public transportation were increased. A one-way journey with any bus in central Uppsala can differ in cost depending on how the ticket has been bought. With travelling funds (UL-card or cellphone app) the ticket for an adult costs 25 SEK, if the ticket is bought in advance in a ticket vending machine it costs 32 SEK, and if it is bought on board of the bus with a bank card it costs 37 SEK (Länstrafiken i Uppsala, 2019c). The price for seniors regarding one-way tickets are the same as for adults, which might be a problem since the majority of seniors lack a similar disposable income. Discounts are only had if annual tickets or 30- or 60-day tickets are bought. But there are other rules when going to a health care facility and the public transport system can then even be a preferable means of transport. If an individual has a booked appointment at a health care facility, they can travel for free that same day to and from the facility with a 24-hour ticket (Länstrafiken i Uppsala, 2019a). This can make the seniors save a lot of money if they are in need of health care on a regular basis.

2.2.1 Transportation service
Transportation service, or “Färdtjänst”, can be an alternative for seniors when travelling from place to place. This is a special means of transport, which can be seen as a complement to the public transport system, that some might have the right to use in order to get to a destination more convenient. If a senior wants to have the right to use transportation service, they must in advance sign up for it and wait for a decision from the municipality (Uppsala kommun, 2018a). Transportation service can only be used by people who have difficulties that hinders them from travelling by public transport or have a permanent disability that will remain for life or which they have had for at least three months (Uppsala kommun, 2018a). While travelling with transportation services there are two alternatives; to travel alone or car-pooling with other seniors. Car-pooling is the cheapest alternative, but still more expensive than using the public
transport system. Within Uppsala, one journey cost 40 SEK. If a senior orders a car for travelling alone, 80 SEK (Uppsala kommun, 2018a). These prices are within Uppsala and is even more expensive if one lives in another part of the municipality. Car-pooling is also likely to be more time-consuming since detours are made in order to pick up and leave the others on the bus on their destinations. What also differs from the usual public transport system is that the trip often has to be booked 30 minutes in advance (Uppsala kommun, 2018a). This further makes it a less convenient means of transport on many levels. First, spontaneous trips are being vastly limited. Instead of having many departure times to choose from like at a regular bus station, one will have to plan the day more carefully. If changes are made and one might want to stay longer at a place after the trip has been booked, it might be hard to cancel and rebook. Second, many seniors who might not have a mobile phone will have problems with ordering transportation service while they’re away from their homes. Stationary phones might be found at some malls or shops, but it might be time consuming to get to a place where a phone is. In addition, the transportation service might not always be able to get to the exact place where one wants to be picked up, and the seniors still might have to walk for a while in order to reach it. Therefore, the ordinary public transport system serves as a vital means of transport for elders.

2.3 Primary health care centers in Uppsala
In Sweden, there is a possibility for individuals to receive primary health care from both public and private primary health care centers. In 2010, the bill on a new health care reform, “Vårdvalsreformen”, was passed in Sweden. The health care reform meant that it would be mandatory for county councils to have a specific system in primary health care where the patient was free to choose to list themselves at any primary health care center they wanted (Vårdanalys, 2014). After the introduction of this law, individuals are not automatically listed on the facility spatially closest to their registered address but instead have the ability to choose more freely between different facilities if they’re not satisfied with the one they have been assigned to. This means that individuals now have more than one possible facility to be listed on. One of the reasons of the reform was to increase spatial accessibility, regarding time and distance, to the facilities (Vårdanalys, 2014). This has proven to be realized only to some extent in Sweden where there are big differences between urban and rural areas and both in and between counties since most private primary health care centers have been located within or near urban areas (Vårdanalys, 2014) leaving the people within these areas with a higher accessibility. Between 2010 and 2013, Uppsala municipality had an increase with nine new primary health care centers. Since then, an additional two facilities have been added, reaching a total of 51 facilities. Every primary health care center that opened after the reform was placed in central Uppsala (Region Uppsala, 2015). Since individuals are now free to choose any primary health care center they want to be listed on, there is a wider range of facilities available. This can therefore be interesting to study in order to see how seniors’ accessibility to primary health care centers differs from the rest of the population.

3. THEORETICAL FRAMEWORK AND PREVIOUS STUDIES

The following chapter introduces the concept of accessibility. Furthermore, it presents previous research related to seniors, health care, public transport, centrality and income.
3.1 Accessibility
Accessibility is a concept that can be defined in different ways, depending on the scientific field of study. Within the field of geography, studies on transportation have used the concept frequently (Mavoa et al, 2012) and it is therefore of importance to define the concept within this study. The concept is also widely common in the field of health geography (Apparicio et al, 2017) and is of relevance when it comes to analyzing the accessibility to primary health care centers in Uppsala. A high accessibility can be seen as one of the main reasons why people choose to live in urban areas. The wide range of choices within both the social and economic field, where interaction with other people in one’s spare time, and the employment possibilities are greater, keeps people living in cities even when other less attractive factors of cities are prevailing (Handy & Niemeier, 1997). Accessibility is determined by several factors: the ease of reaching a destination, spatial distribution of destinations as well as the quality and magnitude of the opportunities that can be found (Handy & Niemeier, 1997, p. 1175). There are many different components affecting accessibility. First, accessibility is determined by spatial factors where the distribution and character of the activities found at a certain destination, indicates that it is a geographical measure. Furthermore, other factors like the impedance, referred to the time taken, distance travelled, or money spent to get to the destination (Handy & Niemeier, 1997) is also affecting accessibility. The ease of reaching a destination is also stated to be a factor of accessibility, which can differ greatly between individuals. These factors can be more or less important to different individuals, since we all have variations in our preference, whereby accessibility must be measured in accordance with how the people define accessibility (Handy & Niemeier, 1997). There are three types of ways in measuring accessibility; (1) the cumulative opportunities measure, (2) the gravity-based measure and (3) the utility based measure. The first is the simplest of measures, since it weighs all opportunities the same and doesn’t consider the size or the quality of the opportunities. It rather displays the number of choices available. This measure can show the variety of primary health care centers available which is an important part of accessibility. The second measure weighs all opportunities against each other with regard to impedance in order to see which opportunity has the most attraction. The bigger the opportunity and the closer the opportunity is, the better the accessibility. The third measure is based on the economic random utility theory which basically derives from “How much does one person has to be compensated in order to make another choice?” Within every accessibility measure, decisions regarding the level of disaggregation, type of impedance and the definition of origins and destinations also has to be taken in account (Handy & Niemeier, 1997).

There are no right or wrong accessibility measures to use, but the choices made can be important factors in minimizing accessibility measurement errors (Apparicio et al, 2017; Handy & Niemeier, 1997). Furthermore, the chosen opportunities for a study of accessibility should also be opportunities that are accessible to the chosen people within study in reality. If the chosen dataset of seniors to be analyzed doesn’t consider what opportunities they have in real life to actually reach the destination of choice, it might end up presenting a level of accessibility that doesn’t represent the individuals. The socio-economic level, where opportunities that are unaffordable for some groups, must be regarded in the analysis of the dataset (Handy & Niemeier, 1997).
3.1.1 Health care accessibility measure
Accessibility is a concept that can include other, non-spatial aspects. Spatial factors, like closeness between two points in space, can show access at one level, but according to Penchansky & Thomas (1981) it isn’t always enough to claim that one person has high access just by living close to a primary health care center. Several components, such as opening times, cost of care and number of available doctors can be included in order to evaluate how accessible an opportunity, like a primary health care center, is. Yang & Liang (2018;118) define spatial accessibility to primary health care centers as follows: “Accessibility to healthcare refers to the ease with which people of a given area can reach medical services and facilities”. Like Handy & Niemeier (1997), Yang & Liang (2018) are in line with the fact that the ease of reaching a certain destination is important. Furthermore, there are three important factors to be included when measuring the accessibility to health care facilities; (1) geographical distribution of people in need of health care services, (2) geographical distribution of health care and (3) the spatial barriers between these via transportation (Yang & Liang, 2018, 118; Khan, 1992). By using these measures, the understanding of the distribution of health care centers can be made and further give a clue of which populations might need extended access to these facilities (Yang & Liang, 2018). Buzza et al (2011) also stress that the distance to health care facilities has proven to be an important barrier when measuring accessibility. Both the absolute distance and the relative distance can be taken in to account since people can experience the same absolute distance to destinations in different ways. This study only takes the spatial accessibility and the absolute distance in to account since the aim is to provide a general view of the accessibility seniors have and does not take on the matter of senior’s perceived accessibility.

3.2 Income and accessibility
Seniors and low-income families often have lower accessibility than high income families and the general population. Farber et al (2014) conducted a study on transit-based accessibility to supermarkets in Cincinnati, USA and compared the accessibility between different socioeconomic groups. They showed that the accessibility to supermarkets during the day can differ between socioeconomic groups where low-income households generally had a lower accessibility. Even if lower-income groups had a higher level of transit-based access, they still had a lower accessibility to supermarkets since they couldn’t reach the facilities within a 10-minute walk or within 10 minutes by public transport like other cohorts could. Farber et al (2014) also showed that besides low-income households having lower accessibility, seniors tended to have a lower level of access to supermarkets than the general population. Hawthorne and Kwan (2013) showed that health care facilities accessibility was unequally distributed in a low-income area in Ohio, USA. That measure of accessibility included waiting times, overcrowded facilities and the lack of finding a good doctor at a decent distance. In a similar study, Hernandez and Rossel (2015) showed that low-income households have a harder time to overcome costs in space-time, such as having to wait long times at the facility and time reaching a social services facility. This was first and foremost because of middle- and upper- income families have access to a car, which in turn made them more mobile and enabled them to travel longer distances in a shorter amount of time.
3.3 Centrality, monocentric and polycentric cities

Centrality is a concept based on the notion that some nodes in a network in a city are more important than others (Crucitti et al, 2006). By investigating centrality, the structure of a city can be evaluated, showing where bigger and denser clusters of relations between people, transportation and businesses are situated in the city. This can indicate where accessibility might be higher or lower in a city. Bertaud (2001) have identified two types of cities with different centrality; monocentric and polycentric. In monocentric cities, the majority of meeting places, such as residences and business opportunities lie within one central area. The opportunities available in these cities are highly concentrated in one area and the density of the city is thus very high in this point, leaving outer parts less dense. Even though there are less opportunities within the outer parts of the city, there are often roads that easily enable travels from the periphery of the city to the center and thus enable a unified labor market (Bertaud, 2001). Polycentric cities are quite the opposite, there can be more than high-density area and several different residential and business districts (Bertaud, 2001). There can therefore be several different areas that operate in the same way, providing likewise opportunities. Within these cities, transports also operate differently where each of the sub-centers attract trips from all of the other centers, leaving the city structure with more of a web-like pattern (Bertaud, 2001). However, monocentric and polycentric cities have a common nominator: they attract inhabitants from the entire city, and not just people who are living close to one center. Bertaud (2001) further explains that monocentric cities, when becoming big enough, often develop into a polycentric city structure. Cities are however often hybrids of both of these structures, where some are dominantly monocentric, other cities are dominantly polycentric, and others are somewhere in between these structures (Bertaud, 2001).

3.4 Ageing and health care accessibility

Seniors in general tend to be less mobile than the average person. This might in turn affect their ability to access vital services such as primary health care centers (Paez et al, 2010). The spatial barriers between patient and health care facilities have proven to be of utmost importance. A patient that experiences a health care facility to be out of reach will be less likely to make a visit to it. If a facility is out of reach, this spatial barrier contributes to lower health care utilization, which in turn can have a negative effect on population’s health (Neutens, 2015; Hiscock et al., 2008; Nemet & Bailey, 2000). Paez et al (2010) compared accessibility to health care centers for seniors and non-seniors using the cumulative opportunity measure with an impedance of average trip length. They showed that areas within Montreal Island, where most seniors lived, both in absolute and relative terms were the ones that had a lower accessibility to health care facilities. Seniors living in central urban areas or the ones having a car were experiencing a slightly higher accessibility to health care facilities than seniors who didn’t, but even so they were having lower accessibility than other reference groups (Paez et al, 2010). This indicates that seniors, no matter the chosen type of transport, often experience substandard levels of accessibility to health care facilities relative to other cohorts.

3.5 Ageing and transport

The public transport system serves as a vital means of transport for non-car holders (Mavoa et al, 2012) including many seniors (Martin et al, 2008). The seniors are to be seen as a public transport-reliant cohort and without access to public transport, their opportunities to visit a
range of destinations such as health care facilities might be compromised (Martin et al, 2008). Martin et al (2008) further found that people who have health problems often has a lower level of access to private vehicles compares to the total population. Furthermore, both Ricciardi et al (2015) and Delbosc & Currie (2011) have identified seniors as one group of society that experiences transport disadvantages. The concept of transport disadvantage means that these cohorts often experience an overall limited access to public transport and that the distribution of public transportation are less equally distributed when compared to the entire population in a city (Ricciardi et al (2015). Ricciardi et al (2015) conducted research on several transport disadvantaged groups in Perth, Australia, by using a method based on gini coefficient, showing a cumulative inequality measure based on the supply of transport to ferries, busses and trains. A total 90 percent of the seniors could reach 58 percent of the transport system. This further indicates that they have less potential to reach different opportunities in a city compared to other groups, which eventually can exclude them from participation in society on equal terms and also affect their well-being (Ricciardi et al, 2015: Delbosc & Currie, 2011).

3.5.1 Walking and transfers
Using public transport includes walking to and from the station and transferring between different vehicles (Wardman, 2004). These two factors are important to keep in mind when designing transports for the elderly since they can be a greater part of their willingness to use public transports. Transfers between lines and vehicles can be an undesirable feature of public transportation (Wardman, 2004) hence, reaching vital services by just using one bus route is preferable for most individuals. For seniors, it might even be preferable to have a shorter walking distance and a longer time on the bus (Farber et al, 2014). When walking to a bus station, Lange & Norman (2018) mentions that between 400 and 800 meters are the longest distances an individual can be estimated to walk to reach a public transport station from their residence. These distances are commonly used in studies regarding urban planning and transportation (Lange & Norman, 2018; Currie, 2010) and are therefore used as measure in this study.

4. METHODS
In order to answer the research questions, this study have used a quantitative methodological approach. By using statistical data on populations, income levels and positions of bus stops and primary health care centers, a generalized measure on accessibility can be analyzed (Bryman, 2018). This is preferable for this study since it can give a broader understanding of seniors’ accessibility situation in Uppsala and can be applied to this study’s chosen type of accessibility measure. The following chapter describes the methods and data used to answer the research questions. Initially, the methods and the tools used to process the data in the study are presented, followed by a presentation of the study area and the datasets used.

4.1 Regression analysis
SPSS is a statistical tool, often used in social sciences, where statistical analyses and regression models can be made (IBM, 2019a; Bryman, 2018). A linear regression analysis was made using SPSS in order to see how disposable income, wealth, seniors, population and closeness to primary health care centers correlated with accessibility. Since accessibility was to be analyzed in this study, it was set as the dependent variable to which all the other independent variables
were tested. Disposable income (DispInc), disposable income squared (DispIncSQ), centrality (Centrality), centrality squared (Centrality SQ), number of seniors (65+), total population in the study area (Pop), primary health care centers reached within 400 meters (PrimaryHCC400m), counts of rich people (Rich) and counts of poor people (Poor) were set as independent variables. The B-coefficient in the linear regression explains how much a movement in an independent variable can be explained by a movement in the dependent variable (IBM, 2019b). A negative value shows a negative correlation between the dependent and the independent variable and a positive value shows a positive correlation between the variables. Since the non-squared variables weren’t normally distributed, they were squared in order to make a better estimation. The total population was included in order to see how accessibility differs between the seniors and the general population. The regression analysis was divided into two models, where the first one only included disposable income, disposable income squared, centrality and centrality squared since these were seen to be drivers of accessibility and central aspects of the regression model. The second model included the ones from the first model together with the remaining independent variables. In social sciences, the significance level is usually accepted at p<0.05 (Bryman, 2018) and this level were therefore also used in this study.

4.2 Geographical information system (GIS)
Spatial accessibility is based on geographical measures which make GIS a suitable tool for visualizing and measuring the accessibility to primary health care centers (Esri, 2019b; McLafferty, 2003). The accessibility can, by using GIS, be visualized in order to bring about more understanding about a specific issue and is well suited when it comes to measuring accessibility via public transport. All maps in this study have been created using ESRI ArcMap 10.4.1. All the incorporated datasets have been projected to the SWEREF99 coordinate system in order to get the correct spatial positions of the residential areas, income areas, bus stops and the primary health care centers.

4.2.1 Network analysis
Within ArcMap 10.4.1, a network analysis was made with the “Network analyst” tool. A network is a system of several interconnected elements, such as lines, connected with junctions, points, in order to find possible routes from one point to another (Esri, 2019a). With a network analysis several questions regarding distance, time or cost can be answered. Regarding distance, this can answer “Which primary health care facilities can be reached within a distance of X meters?”. This analysis tool can measure the network distance via the walk- and car roads and was therefore a suitable analysis tool used in the study. In order to measure accessibility by network distance, a network buffer of 400 meters was set up around the bus stops using the “New Service Area”-function. If two or more bus stops intersect within 400 meters, they were merged by the break value. This buffer was set up in order to see which seniors, in what residential areas, that had access to these bus stops. If a residential area wasn’t included within the set up buffer of the bus stops, the seniors living there were seen as having inadequate access to a primary health care center since they weren’t able to reach any bus stop. If a primary health care center was intersected by the buffer of 400 meters, it was seen as accessible from the bus stop. A network buffer of 400 meters was also separately set up around each of the primary health care centers in order to see which residential areas that had primary health care centers within a walking distance.
4.2.2 Centrality measure
In this study, Uppsala was seen as a monocentric city on which the centrality measure is based on. The centrality measure was used in order to see what parts of Uppsala that were central, and which parts were peripheral based on distance from a central point. Since Uppsala was seen as a monocentric city, the primary health care center “Centrumkliniken” was used as the rough location of the central point of the city. This clinic is based close to Uppsala central station where many people commute on a daily basis and lies right next to the shopping districts where a significant amount of people spend time during the day. The distance to Centrumkliniken was measured between each populated residential area, showing the network distance to the closest residences and the ones further from the central part.

4.3 Cumulative opportunities measure and network distance
This study looks the matter of accessibility when it comes to the amount of primary health care centers reached within each residential area, which Handy & Niemeier (1997) refers to as the cumulative opportunities measure. By using this measure regarding seniors’ accessibility to primary health care centers, it can give a clue on how many centers they can reach via the public transport system based on their residential area. The more services reached, the better the accessibility. Since seniors are walking from their residence to the bus station, taking the bus and then walk to the primary health care, the impedance was seen as the network distance in meters. The time of travelling is often seen as a measure of impedance most related to people’s own experiences (Mavoa et al, 2012), but since this study relates of walking to and from the bus stops, the time taken is harder to evaluate since it can differ from senior to senior. Measuring accessibility primarily by distance to bus stops and primary health care centers thus was implemented in this study.

4.4 Study area
The area of interest in this study is Uppsala (Figure 1). Some of the bus stations were situated outside of the official boundary of the densely built-up area. A buffer of 800 meters based on the bus stations was set up in order to avoid border effects (Figure 2) since this is often seen to be the maximum distance an individual is willing to walk to a bus station (Lange & Norman, 2015).
4.5 Data collection

Lantmäteriet, Region Uppsala, Uppsala länstrafik (UL), Uppsala municipality and the Department of Social and Economic Geography at Uppsala University are the main sources where data have been collected from.

4.5.1 Roads

The network of roads in Uppsala was provided from Lantmäteriet via the GET (Geodata extraction tool). These were used in the network analysis. Both data on walkways and data on roadways were included in order to have the complete network of roads where the seniors can walk. Since there are no restrictions on what roads to use for walking, seniors can be seen to both use the walk ways and road ways to get to the bus stops and primary health care facilities. In addition to the presented dataset, the administration area, water and land cover was added from Lantmäteriet to make the area of study easier to comprehend.

4.5.2 Primary health care centers

Coordinates on the location of all primary health care centers in Uppsala municipality 2019 were obtained from Region Uppsala. The facilities laying within the study area have been picked out from the dataset by using the geoprocessing tool “Intersect”. Both public and private primary health care centers were included in the dataset and were used in the study. Coordinates within SWEREF99 reference system on two of the facilities; “Familjeläkarna Luthagen” and “Capio vårdcentral Sävja”, were missing. These coordinates were obtained from hitta.se. “Flogsta vårdcentral” was currently under renovation and the listed patients have been assigned to Samariterhemmets vårdcentral, Stenhagens vårdcentral and Kungsgårdets vårdcentral (Region Uppsala, n.d). Because of this, Flogsta vårdcentral had the same coordinates as
“Samariterhemmets vårdcentral” in the provided dataset from Region Uppsala and was therefore removed from this study’s dataset. The “Spatial join”-tool was used in order to get a number of facilities that intersected with the set up network buffer that was based on the bus stops.

4.5.3 Public transport
Data on public transport in central Uppsala was collected from Uppsala länstrafik, UL, which is in charge of the public transport system in the entire Uppsala county. All bus stops and routes in the dataset were operating in 2019. Each separate bus route from number one to twelve, the three “soft line” routes and the bus stops for each line were included in the data. The data was provided in the WGS1984 coordinate system and was therefore converted into SWEREF99 by using an internet based coordinate converter (https://rl.se/rt90). All public transport routes have been mapped out between the bus stops using the “point to line” feature in ArcMap 10.4.1. These routes are merely included within the study to visualize where the route operates and in between which bus stops. Since the routes will not be analyzed regarding the distance travelled, the point to line feature used will not compromise the result of the study.

4.5.4 Population data
Data on seniors from the age of 65 and older in central Uppsala were obtained from Uppsala municipality and includes data from the year of 2019. This data is based on the population data from Statistiska centralbyrån, SCB. The data of the seniors were provided in aggregated smaller zones on a level of 100 x 100 meters squares in order to minimize measurement errors (Apparicio et al, 2017; Handy & Niemeier, 1997). The population of seniors in the squares are based on their area of residence since the residence as the base to measure accessibility from has been made in several studies (Handy & Niemeier, 1997). The original aggregated squares of geographical areas obtained from Uppsala municipality that contain more than three seniors show the exact amount of seniors in that area, while squares containing three seniors or less do not show the amount of seniors in that area. This is due to the fact that that no single individual should be able to be identified and the material should regard confidentiality. The squares that contain three or less seniors have not been modified in order to still get numerical information in these squares. Since there was no number of the total population included in the material from Uppsala municipality, this was obtained from the Department of Social and Economic Geography at Uppsala University. For this study, the number of the total population within each residential area is assumed to be the same as it would have been in 2019.

4.5.5 Income and wealth
Since Uppsala municipality wasn’t able to provide income data from 2019 on an aggregated level of 100 x 100 meters, the data on disposable income and on rich and poor were instead provided from the Department of Social and Economic Geography at Uppsala University. This data on disposable income and on levels of rich and poor within every residential area, is from 2014 which differs from the rest of the provided population data on seniors that is from 2019. For this study, data on income level and wealth from 2014 is stated to be the same as in 2019 in order to still get a hint of the differences they can make for accessibility. Disposable income was the median amount of money per year an individual could distribute after all payments had been done. The variables “rich” and “poor” referred to individuals being in the top 20 percent or lowest 20 percent of total wealth set at an EU level.
5. RESULTS

The following chapter presents the results of the study. The first section presents the spatial distribution of bus stops and bus routes. The second section presents the accessibility to primary health care centers. The last section presents centrality, wealth and disposable income and its effect on accessibility to primary health care centers.

5.1 Spatial distribution of bus stops and bus routes

A total fifteen bus routes and 423 bus stops were localized within the dataset and are being presented with a map in figure 3. Several of the routes were overlapping each other and several bus stops were integrated in more than one route. The network buffer of 400 meters based on the bus stops is visualized with a map in figure 4. This shows that the bus stops and routes covered a big part of Uppsala with the 400 meter network buffer but not the entire study area. Furthermore, the total number of bus routes available within each residential area that could be reached within 400 meters were different depending what residential area one was living in (Figure 5). Several routes passed the same bus stops, resulting in summarized counts of possible routes reached in the residential areas. The blue and purple areas of the city shows the residential areas that had the highest amount of bus routes to choose from and the yellow and orange parts shows the residential areas that had the fewest bus routes to choose from. The central parts of Uppsala had the highest amount of bus routes in reach to choose from and the outer parts had fewer bus routes to choose from, showing that the central areas had a higher access to busses. There were no residential areas that had access to every single rout. However, in Gottsunda in the south, a high amount of busses could be reached in several residential areas, which was alike some areas situated closer to the central parts.
Figure 3. Bus stops and bus routes within Uppsala. Source: Lantmäteriet, UL. Cartography: Emma Öberg
Figure 4. Network buffer of 400 meters based on the bus stops. Source: Lantmäteriet, UL. Cartography: Emma Öberg
Figure 5. Number of bus routes reached within each residential area. Source: Lantmäteriet, SCB, UL. Cartography: Emma Öberg.
5.2 Accessing primary health care centers
The total population within each residential area in Uppsala are visualized in Figure 6. A high density of the population can be seen in residential areas in Gottsunda in the south, Sala Backe in the north and in Gränby in the east. In the south, Sunnersta had a lower density. The central parts of the city had some areas with a higher density of the population.

The population of seniors in each residential area in Uppsala looks slightly different compared to the population (Figure 7). The central parts of Uppsala had the most residential areas with the highest density of seniors, but some residential areas in the south and in the east of the central parts were also populated with many seniors. The residential areas in the outskirts of the study area were populated with the fewest seniors. Within the study area, a total of 30508 seniors were residing. 28822 of these were residing within the network buffer, resulting in 95 percent of all seniors having access to at least one bus stop. Each of the total 21 primary health care centers within the study area were located within the network buffer and could therefore be accessed by bus by 28822 seniors.

A larger amount of primary health care centers accessed by bus could be seen in the city’s central areas and fewer facilities could be reached by bus in the southern part of Uppsala (see Figure 8). More precisely, the map in figure 8 shows the total amount of options available in each residential area, which includes counts of every primary health care center from every route. Several bus routes passed the same primary health care centers as others, leaving the map with a summarized count of all facilities reached by all the bus routes from one residential area. This means that each of the 21 primary health care centers could be counted more than once since several facilities were integrated in more than one route, resulting in a high number of 63 options in the center of Uppsala even though there were only 21 primary health care facilities in total to have access to. The central parts of Uppsala had the highest number of options to choose from and the outer parts had fewer primary health care facility options. Within the areas of the city with the most options to primary health care centers, 43-63, 5 percent of the seniors were residing (see Table 1). One area summed up of several residential areas in Gottsunda in the south of Uppsala had a higher number of options of primary health care centers than the closely surrounding areas. Gottsunda was therefore alike some parts centered around the central parts of the city. 67,64 percent of the seniors had between 3-16 options to primary health care centers, showing that the majority of seniors were living outside of the areas where most primary health care centers could be reached by bus.

Table 3 on page 28 shows the linear regression analysis, where the difference in accessibility between seniors and the total population can be seen. Seniors were seen to have better accessibility than the population. The B-correlation column shows that for every unit increase in seniors in one residential area, an increase of 0,149 in accessibility were seen. For the total population and accessibility, there was a negative correlation. For every unit increase of the total population in a residential area there was a decrease of 0,0024 units accessibility, indicating that more populated areas have lower accessibility.
Figure 6. Primary health care centers and residential areas with total population within the network buffer. Source: Lantmäteriet, Region Uppsala, SCB, UL. Cartography: Emma Öberg.
Figure 7. Primary health care centers and residential areas with seniors within the network buffer. Source: Lantmäteriet, Region Uppsala, SCB, UL. Cartography: Emma Öberg
Figure 8. Counts of primary health care center options by public transport within each residential area. Source: Lantmäteriet, UL. Cartography: Emma Öberg
<table>
<thead>
<tr>
<th>Primary health care center options</th>
<th>Total seniors</th>
<th>Percent seniors</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-63</td>
<td>891</td>
<td>2,92%</td>
</tr>
<tr>
<td>43-53</td>
<td>636</td>
<td>2,08%</td>
</tr>
<tr>
<td>35-42</td>
<td>1059</td>
<td>3,47%</td>
</tr>
<tr>
<td>28-34</td>
<td>556</td>
<td>1,82%</td>
</tr>
<tr>
<td>22-27</td>
<td>1896</td>
<td>6,21%</td>
</tr>
<tr>
<td>17-21</td>
<td>3039</td>
<td>9,96%</td>
</tr>
<tr>
<td>13-16</td>
<td>5315</td>
<td>17,42%</td>
</tr>
<tr>
<td>8-12</td>
<td>7820</td>
<td>25,63%</td>
</tr>
<tr>
<td>3-7</td>
<td>7502</td>
<td>24,59%</td>
</tr>
<tr>
<td>1-2</td>
<td>61</td>
<td>0,20%</td>
</tr>
<tr>
<td>0</td>
<td>1733</td>
<td>5,68%</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>30508</strong></td>
<td><strong>100,00%</strong></td>
</tr>
</tbody>
</table>

Table 1. Number of options to primary health care centers and amount of seniors. Source: Region Uppsala, SCB. By: Emma Öberg.
5.2.1 Primary health care centers within 400 meters from residence

The map in figure 9 shows the number of health care centers that could be reached within 400 meters from the residential areas without using the bus. The central areas had a higher general access to primary health care centers since there were more primary health care centers situated in these areas. Seniors who lived in the very central parts therefore had more accessibility to primary health care centers within a walking distance than those living in the periphery since they could reach more facilities. Areas outside of the center which had primary health care centers within reach of 400 meters was Sävja, Stenhagen, Gottsunda and Gränby. However, even if the accessibility was greater in the central parts, a majority of seniors, 66 percent, didn’t have any access to primary health care centers within a walking distance of 400 meters (Table 2). Within the residential areas in the center of Uppsala that had the most access to three primary health care centers within 400 meters, not one senior was residing. 770 seniors could reach two primary health care centers and 9560 seniors could reach one primary health care center within 400 meters. A total 10330 seniors, 33.8 percent, could reach between one and three primary health care centers 400 meters from their residential area.

Table 3 on page 28 shows the regression model with accessibility as the dependent variable. Having a primary health care center within 400 meters from the residential area had the biggest correlation with accessibility. For every unit increase in accessibility, there was an increase in 10,549 primary health care centers within 400 meters from the residential area.

<table>
<thead>
<tr>
<th>Primary health care centers</th>
<th>Total seniors</th>
<th>Percent seniors</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0,000%</td>
</tr>
<tr>
<td>2</td>
<td>770</td>
<td>2,524%</td>
</tr>
<tr>
<td>1</td>
<td>9560</td>
<td>31,336%</td>
</tr>
<tr>
<td>0</td>
<td>20178</td>
<td>66,140%</td>
</tr>
<tr>
<td>Total:</td>
<td>30508</td>
<td>100,000%</td>
</tr>
</tbody>
</table>

Table 2. Counts of primary health care centers available for seniors within a walking distance of 400 meters. Source: Region Uppsala, SCB. By: Emma Öberg.
Figure 9. Counts of primary health care centers within 400 meters from residential area. Source: Region Uppsala, SCB. Cartography: Emma Öberg.
5.3 Disposable income, wealth and centrality

Regarding the centrality measure, the network distance from Centrumkliniken to the residential areas show that there are differences within Uppsala regarding the level of centrality. The blue areas show that the residential areas are closest to Centrumkliniken and the red residential areas in the outskirts are the ones furthest away (Figure 10). The spatial distribution of disposable income in Uppsala in each residential area is made up of an irregular pattern (see Figure 11). One area made up of five residential areas in the center of the city had a higher level of disposable income. Besides those, the surrounding residential areas in the central parts had similar levels of disposable income as other residential areas that are not based in the central parts of the city. The highest median disposable incomes can be seen in the outskirts of the city, where two residential areas in the south and two residential areas in the east have shown the highest levels of median disposable income. Apart from this, there is an irregularity in where people with different disposable income levels are living.

The regression analysis shows that all independent variables are significant to accessibility since they have a sig.-value of .000 (Table 3), but they are correlated with accessibility in different ways. Model 1 in the linear regression model indicates that both centrality (CentralitySQ) and disposable income (DispIncSQ) were significant variables that had an effect on accessibility (see Table 3). Squared values are different from non-squared values. These takes the form of a hill when the value is negative and of a valley when the value is positive. The squared values in the B-coefficient column are negative which means that these adopt the shape of a hill. This means that in residential areas where income and centrality is lower and in areas where income and centrality in higher, accessibility is low. Even if the B-coefficient value for the centrality is small, a high centrality measure can be seen in between the central and the peripheral areas in the study area, challenging the monocentric centrality measure. The second model included model 1 plus seniors, population count, primary health care centers within 400 meters, rich and poor in order to see how these variables were correlating with accessibility. Model 2 showed that centrality and disposable income were significant but of even smaller importance regarding accessibility when the other variables were included in the linear regression since they had a smaller B-coefficient value. Being rich or poor had a higher positive correlation with accessibility than disposable income since the B-coefficient value was greater. For every increase of one unit rich in each residential area, accessibility was increased by 0,116 units. For every unit increase in poor in one residential area, accessibility was increased by 0,060 units.

The estimation of how strong the relationship between the models in the linear regression and the dependent variable, accessibility, can be seen in the model summary in Table 4. The R value of 0,591 indicates that there is a 59,1 percent correlation between the independent variables in model no. 2 and the dependent variable, accessibility. Since the R-value is large, closer to 1, it indicates that it is a relatively strong relationship between accessibility and the independent variables presented in the model.

The R² indicates that model 2 is more fitted to the regression line than model 1, since the number is closer to 1, indicating that 35 percent of the variance in the independent variables is explained by the accessibility.
<table>
<thead>
<tr>
<th>Model</th>
<th>B-coefficient</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intercept</td>
<td>3,739</td>
<td>0,125</td>
</tr>
<tr>
<td></td>
<td>DispInc</td>
<td>0,001</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td>DispIncSQ</td>
<td>-1,898E-08</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td>Centrality</td>
<td>0,002</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td>CentralitySQ</td>
<td>-1,706E-07</td>
<td>0,000</td>
</tr>
<tr>
<td>2</td>
<td>Intercept</td>
<td>2,582</td>
<td>0,107</td>
</tr>
<tr>
<td></td>
<td>DispInc</td>
<td>0,001</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td>DispIncSQ</td>
<td>-8,621E-09</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td>Centrality</td>
<td>0,001</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td>CentralitySQ</td>
<td>-3,669E-08</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td>65+</td>
<td>0,149</td>
<td>0,009</td>
</tr>
<tr>
<td></td>
<td>Pop</td>
<td>-0,024</td>
<td>0,003</td>
</tr>
<tr>
<td></td>
<td>Rich</td>
<td>0,116</td>
<td>0,010</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>0,06</td>
<td>0,008</td>
</tr>
<tr>
<td></td>
<td>PrimaryHCC 400m</td>
<td>10,549</td>
<td>0,228</td>
</tr>
</tbody>
</table>

Table 3. Regression analysis. Unstandardized b-coefficients. Dependent variable: Accessibility. Source: SCB, UL.

<table>
<thead>
<tr>
<th>Model</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0,282</td>
<td>0,800</td>
<td>0,079</td>
</tr>
<tr>
<td>2</td>
<td>0,591</td>
<td>0,350</td>
<td>0,349</td>
</tr>
</tbody>
</table>

Table 4. Model summary. Measures of how close the data is to the regression models 1 and 2.
Figure 10. Network distance from Centrumkliniken. Source: Region Uppsala, SCB. Cartography: Emma Öberg.
Figure 11. Median income in each residential area. Source: Lantmäteriet, SCB. Cartography: Emma Öberg.
6. DISCUSSION

The following chapter discusses the results of this study and relates it to previous studies.

6.1 Seniors’ accessibility to public health care versus population

The public transport system in Uppsala covers a great extent of the city. Within the central areas the ability to reach public transportation were greater. This means that more routes are passing by the central areas of the city, leaving seniors within these areas having a variety of bus routes to choose from to go to the primary health care centers. Even though a minority of the residential areas where seniors were living weren’t covered, a total 95 percent of all seniors covered by the bus network must be seen as a high proportion of this cohort having access to the bus stops compared to the 58 percent access to public transport seniors had in Perth (Ricciardi et al, 2015). The access seniors are having to public transport in Uppsala stands in contrast with the studies conducted by Ricciardi et al (2015) of seniors having transport disadvantages. Uppsala shows a different result where seniors doesn’t seem to have a transport disadvantage when looking at the public transport system regarding bus stops accessible within 400 meters. But there are differences regarding the methods used within this study and in the study conducted by Ricciardi et al (2015). This study was using a network analysis and the cumulative opportunities measure to count the routes available within the residential areas. Ricciardi et al (2015) conducted their study based on the gini coefficient, showing cumulative distribution of transport between cohorts based on the supply of transport. This difference seen in seniors’ access to public transport can then have been affected by the chosen type of method. However, even if the same method might have been used, other differences could have had an importance regarding the results such as size of the study area and number of transport stop stations.

When combining public transport and primary health care centers, seniors in Uppsala were having better accessibility to public health care centers than the total population, which stands in contrast with the previous studies made by Paez et al (2010) on seniors’ accessibility to health care centers. In Uppsala, a greater amount of seniors can be seen in some of the central areas of the city compared to the total population, where there are more options of primary health care centers since there are also more bus routes to choose from within this area. Within the central areas, the total options of primary health care centers could be as much as 63 facilities. This number was based on the ability to reach primary health care centers via public transport, and isn’t a surprise since the map of total routes reached also has the highest density within the central parts of the city. Surprisingly, even if a majority of seniors could reach between 3 to 16 primary health care centers, and very few had the most options to choose from, they still had a higher correlation of accessibility than the total population. This might be due to the fact that there are in general fewer people residing within the most central areas where the accessibility is the highest. The most populated areas were in the peripheral parts of the city, explaining the results of accessibility being lower where there are more people.

By including the variable of walking distance to public primary health care centers, the number of seniors having the same distance to a primary health care center as a bus stop could be analyzed. If not using the bus, seniors who are content with walking 400 meters to and from a primary health care center can reach between 1-2 primary facilities. But within these areas only a third of all seniors are residing, leaving two thirds without accessible primary health care. Furthermore, when adding public transport within these areas, it provides more
options which increases accessibility. If a senior then isn’t content with the facility they are listed on, they have more variety of choosing primary health care centers to be listed on if using the bus. Since accessibility in this study was measured according to the most primary health care centers reached, the results from the linear regression showing that seniors who are in a walking distance of a primary health care facility has the most accessibility doesn’t necessarily have to be true. But, since accessibility according to Handy & Niemeier (1997) and Yang & Liang (2018) includes the ease of reaching an opportunity, it might be true for some seniors that accessibility is better within a walking distance. Some who prefer to have a walking distance directly to the primary health care center instead of walking to the bus, might find this accurate as an indicator of accessibility. Even though seniors who reside within a walking distance to primary health care centers have a higher accessibility, analyzing the distance to primary health care centers one by one instead of grouping them together, can show different levels of accessibility of specific primary health care centers, showing spatial zones where improvement might be needed. Furthermore, the higher accessibility for seniors within Uppsala could be the result of the population data of seniors being from 2019 and the other data from 2014. Within the last five years, if the predictions on increasing levels of seniors are right, there might have been changes in the amount of seniors in Uppsala. With an increase of seniors between 2014 and 2019 living within the same residential areas, there is a possibility that the accessibility in this study might have been affected.

6.2 Disposable income and wealth
The results are indicating that it’s not just disposable income that has an effect of accessibility, but being rich or poor as well. Individuals with a lower disposable income such as those with a higher disposable income had, if not a discrete, lower accessibility than those with a disposable income in between these measures. This can be the result of irregular patterns of the spatial distribution of disposable income levels. Since many individuals with a higher disposable income resided in the outer parts of the city where fewer bus routes were operating, they showed a lower accessibility to primary health care centers. This was also the fact for the lower disposable income residential areas, indicating that these are also in residential areas where the accessibility is slightly lower. The difference though between high and low disposable income areas is that the higher disposable income areas might have the ability to afford a car, which enables them to visit public health care centers easier than the ones with a low disposable income. Seniors in Uppsala who are living in lower disposable income residential areas might therefore have a lower accessibility than the ones living in high disposable income areas. But, this doesn’t remove the fact that seniors in general often doesn’t have access to a car and, as Martin et al (2008) stated, since individuals who are experiencing health problems often has a lower accessibility to private transport, seniors in high disposable income areas still then might not be better off than seniors in low disposable income areas. What has an even bigger effect on accessibility is being rich or being poor, suggesting that both rich and poor seniors are residing within areas with high accessibility. Being wealthy can increase accessibility more than being poor, but both groups can be seen to correlate with higher accessibility. Poor seniors therefore do not have a lower accessibility to health care facilities than rich seniors. Even though other studies have proven otherwise, that low-income households are worse off in terms of accessibility, what has to be stated is that these levels of accessibility seen by Hawthorne and Kwan (2013) and Hernandez and Rossel (2015) have been measured in Ohio, USA and in
Montevideo, Uruguay in bigger areas than what is analyzed in this study. These studies were also conducted with other types of methods which can have affected the differences in the results. Ohio, USA and Montevideo, Uruguay might also have another distribution of public health care facilities and public transport that differs from Sweden and Uppsala which provides them with another level of accessibility. The study by Farber et al (2014) was not only conducted in Cincinnati, USA, which can have affected the differing results, but was furthermore conducted on seniors’ accessibility to supermarkets, which can have another spatial distribution and be prioritized differently from public health care centers in a city.

6.3 Centrality
Based on the notion of Uppsala being a monocentric city, the results indicate that this might be otherwise. Centrality is significant and correlates with accessibility to primary health care centers, even if to a small extent. The result of centrality shows a slightly higher accessibility in between the central and the peripheral parts of Uppsala. This might indicate that there are other central areas in Uppsala, other than the one chosen for the study, with a similar density having high accessibility. This further challenge the use of this study’s centrality measure and of Uppsala being an entirely monocentric city. Based on the maps of amount of bus routes and primary health care centers, a higher accessibility could be seen in two separate areas; The central area used in the measure and in Gottsunda, which differs from the measure of centrality that was used. The accessibility within Gottsunda are alike areas outside of the central parts which can have affected the measure of centrality, indicating that living in the central areas isn’t necessarily increasing accessibility to primary health care centers. The results indicate that Uppsala thus might have more than one central area which could have been included in the centrality measure as a polycentric city structure. If a polycentric structure then might have been used, it could have shown other correlations between centrality and accessibility.
7. CONCLUSION

Compared to the total population in Uppsala, seniors were seen to have better accessibility to primary health care centers. Seniors who were living within a walking distance to primary health care centers were having the best correlation with accessibility since they were living close. Even so, most of the seniors having a primary health care center within a walking distance do not have a variety of facilities to choose from which can compromise their level of accessibility. Disposable income had a small impact on accessibility where individuals with a low disposable income and individuals with a high disposable income were having a lower accessibility to primary health care centers. Residential areas with a high proportion of rich individuals had an increase in accessibility, which also goes for residential areas with poor people, suggesting that poor seniors do not have lower accessibility than rich seniors. Centrality had a small, but nevertheless an impact, on accessibility, showing that residences placed in between the central and the peripheral areas had higher accessibility. This suggests that the monocentric centrality measure instead could have been replaced with a polycentric measure since Gottsunda showed levels of accessibility similar to the proposed center.
8. REFERENCES


Levasseur, M., Généreux, M., Bruneau, J., Vanasse, A., Chabot, É., Beaulac, C. and Bédard, M. 2015. Importance of proximity to resources, social support, transportation and neighborhood security for mobility and social participation in older adults: results from a scoping study. BMC Public Health, vol 15


**Electronic sources:**


