Spatial Data Analysis and Simulation Modelling

Shortpaper

Active Transport in the City

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Abstract

This short study reviewed three papers that investigate to what extent a better walkable environment (i.e., walkability) affects the active transport (i.e., physical activity) in a city. Although the results and methodology of these studies differ slightly, this study still finds that on average an increased walkable environment - examined with walkability indices - is significantly positive associated with the active transport in a city. Moreover, confounding for social economic status (SES) neighborhoods found that better SES neighborhoods were associated with lower active transport in the city. Presumably, caused by easier access to capital by residents to buy motorized vehicles. Overall, the findings of this study and future research can help policy makers and project managers to improve the walkable environment and subsequently active transport in the city. Hence, establishing improved health of residents and decreased climate change risks.

Keywords - built environment, walkability indices, active transport

Introduction

Active transport is the transport of people or goods based around human physical activity e.g., walking and cycling [Larouche, 2018]. Compared with motorized transport, active transport improves health both through reduced air pollution emissions and physical activity [Carlos D, 2011]. Walkability is one of the aspects within physical activity. According to Saelens et al. (2003), important elements of walkability are high population density, a good mixture of land use and high connectivity [Saelens et al., 2003].

Which factors improve active transport and the methodology of the research vary across different studies. For example Van Dyck et al. (2010) state, "However, findings are at this stage ambiguous, with some studies finding that high-SES neighborhood inhabitants are more physically active [Kavanagh et al., 2005], [McNeill et al., 2006] and other studies finding the opposite [van Lenthe et al., 2005], [Ross, 2000]. SES (Social Economic Status) is determined by the annual household income. We hypothesize that these different outcomes is partially a result of the different methodology that is being used [Van Dyck et al., 2010].

Further research is therefore needed to clarify these associations. "Policy makers have less accurate and valid walkability index at their disposal to arrange the structure of neighborhoods (i.e., 'built environment', 'connectivity') to improve the quality of life of residents and the built environment in general [Frank et al., 2005]. Since there is already quite some research on this topic, this study aims to compare their methodology and corresponding results. This will not be done by collecting our own data, but by comparing different studies on the topic.

Methods

To assess the current knowledge of active transport and walkability, three academic papers have been selected from the suggested literature list, see table 1 below.

Table 1: Selected papers regarding walkability of active transport in a city.

Author	Year	Index	Data source	Country
Frank et al.	2005	Walkability index	Interview / GIS / Accelerometers	United States
Van Dyck D et al.	2010	Neighborhood-level walkability index	Interview / GIS	Belgium
Koohsari MJ et al.	2016	Full walkability & SSW	Survey / GIS	Australia

The selection criteria is that the studies should be from different years,different countries and use some sort of walkability index based on the built environment. These were then retrieved from the academic database PubMed. To assess the different studies, the methodology and the results will be reviewed for each paper.

A summary of the papers will be written in the Results section. In the Discussion the differences and similarities between the papers will be described.

Results

This study reviewed three papers regarding the effect between walkability indices and active transport in a city. The primary need for this review was to identify if there is a positive relationship between walkability and physical activity and what are the outcomes of these reviewed papers.

In the first paper of Van Dyck et al. (2010) was a neighborhood-level walkability index used, based on objectively assessed land use variables, calculated by using GIS. Geographical data were obtained through the Service for Environmental Planning in Ghent. Three-environmental attributes were found to be related to physical activity: residential density, intersection density, and land use mix. Cadastral data (residential land use, street centerline data, zoning data) and census data were integrated in a GIS database to create a walkability index for each statistical sector. It describes that living in a high-walkable neighborhood was associated with significantly more walking for transport ($p<0.001$), more cycling for transport ($p<0.001$), less motorized transport ($p<0.05$), more recreational walking ($p<0.001$). Living in a high-SES neighborhood was associated with significantly less walking for transport ($p<0.05$) and more motorized transport ($p<0.001$). For the moderating effects of neighborhood SES on the relationship between walkability and the physical activity behaviors, no significant results were found [Van Dyck et al., 2010].

The second paper of Frank et al. (2005), used a walkability index to determine the relationship between the measures of the index and the number of minutes of moderate physical activity per day. The walkability is calculated by formula (1):

$$\begin{aligned} Walkability\,index = {} & (6 * Z - score\,of\,land\,use\,mix) + \\ & (Z - score\,of\,net\,residential\,density) + \\ & (Z - score\,of\,intersection\,density) \end{aligned} \tag{1}$$

A combined walkability index of these urban form factors was significant ($p=0.002$) and explained additional variation in the number of minutes of moderate activity per day over sociodemographic covariates. 37 percent of individuals in the highest walkability index quartile met the ≥ 30 minutes of physical activity recommended, compared to only 18% of individuals in the lowest walkability quartile. Individuals in the highest walkability quartile were 2.4 times more likely (confidence interval = 1.18-4.88) than individuals in the lowest walkability quartile to meet the recommended ≥ 30 minutes of moderate physical activity per day [Frank et al., 2005].

The last paper of Koohsari et al. (2016), used the walking for transport (WT) frequency of WT was used as the outcome. Which means that participants reported their frequency of WT (days) in the past week, using the following question: "During the last 7 days, on how many days did you walk for at least 10 min at a time to go from place to place?" They used two different walkability indexes, formulas (2) and (3):

$$\begin{aligned} Full\,walkability = z[&z(net\,residential\,density)+ \\ &2(z(intersection\,density)+ \\ &z(retail\,floor\,area\,ratio) + z(land\,use\,mix)] \end{aligned} \tag{2}$$

$$SSW = z[z(gross\,population\,study) + 2 * z(integration)] \tag{3}$$

Appendix A table 2 shows the results of the associations of net residential density, gross population density, intersection density, integration, full walkability and SSW with the frequency of WT. The associations of all density and street network measures with WT frequency were positive, with regression coefficients ranging from 1.09 to 1.12. For full walkability and SSW, an increment of 1 SD unit in these indices was associated with respectively, 12% and 14% higher frequency in WT, ceteris paribus. The best fitting model (smallest AIC and BIC values) was observed for SSW. However, the differences in model fit were very small. [Koohsari et al., 2016].

Discussion

Although the results of Frank et al. (2005), Van Dyck et al. (2010) and Koohsari et al. (2016) that were examined in this study show a similar pattern (i.e., all three authors find a positive relationship between a better built environment (walkability indices) and physical activity), the order of magnitude of the coefficients and applied methods/models are different. The three authors all used a slightly different index and ways to obtain the data to determine the built environment of a city. In addition, the research was carried out in dissimilar countries respectively, the United States, Belgium and Australia. Different countries with different infrastructure, other legislation for municipalities could potentially lead to different outcomes of the variables of interest. And finally, the control variables between the three papers use different ranges or categorical outcomes, which could also lead to different outcomes for the built environment coefficient (e.g., range of age varies between the studies, hence have a different moderating effect). Interesting is that the paper by Van Dyck et al. (2010) examined the confounding effect of SES on physical activity, where they found that higher SES neighborhoods are associated with less physical activity. Presumably, because higher SES neighborhood households have access to more capital for motorized vehicles, while potentially still preserving a healthy lifestyle (e.g., use of a gym or other sports).

Although the outcomes of this study show a significant positive association between walkability and active transport, the validity of walkability indices is highly susceptible to the environment, (socio)demographic characteristics, and structure of a country or a city and their residents. Therefore, it is hard to say which walkability index is more valid and reliable. Additionally, other scholars could extend their scope and examine potential cross-country (or city) differences within their walkability index, use different models or use additional well chosen control variables to enhance the internal validity.

Nevertheless, the findings of these papers all aim to help policy makers and project developers to understand the importance of improving the use of land, street connectivity and residential density. The aforementioned papers statistically prove that the better these characteristics, the higher the physical activity and therefore improving the overall health (e.g., decrease of cardiovascular disease mortality or obesity) of residents. Not only will this be beneficial for the individual itself, but it will also reduce the pressure on and costs for healthcare. Especially now with the COVID-19 pandemic, it is important to reduce this negative societal impact and act accordingly. Furthermore, it will also decrease the emission of CO2 because residents are more prone to walk or cycle instead of using their car or motor. Subsequently, this will reduce climate change risks and improve air quality in the neighborhood, which is also beneficial for the health of residents.

References

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Appendix A

Table 2: Associations of density, street layout and walkability measures with WT frequency [Koohsari et al., 2016].

Model	Exposure	IRR (95%CI)	AIC	BIC
1	Net residential density	1.09 (1.05, 1.13)*	4.614239	−17967.44
2	Gross population density	1.12 (1.08, 1.16)*	4.610708	−17976.57
3	Intersection density	1.09 (1.05, 1.14)*	4.613614	−17969.06
4	Integration	1.12 (1.08, 1.16)*	4.609942	−17978.55
5	Full walkability	1.12 (1.08, 1.17)*	4.609867	−17978.75
6	SSW	1.14 (1.10, 1.19)*	4.607357	−17985.24

All models accounted for clustering at the CCD level and adjusted for age, gender, education, marital status, children in household, income, employment status, and neighborhood SES.
All exposure measures were standardized
IRR incidence rate ratio
AIC Akaike information criterion
BIC Bayesian information criterion
* $p<0.01$