The effects of the built environment on physical activity and health

SUMMARY

The city of Maastricht used to be crossed by a highway, which formed a physical and social barrier between the neighborhoods east and west of it. In 2016, a 2.3-km long double-layered tunnel was constructed to replace the highway and facilitate the passing traffic. On top of this tunnel, two one-way streets were created to accommodate the remaining local traffic. The two one-way streets are separated by a middle part, which is prioritized for pedestrians, cyclists and recreation. The middle part is separated from the adjacent streets by grass and trees, creating the so-called 'Green Carpet'. The aim of the research presented in this dissertation was to evaluate the effects of the Green Carpet in Maastricht on physical activity, sedentary behavior and health-related quality of life. In addition, we aimed to explore differences in the relationship between the environment and behavior for more or less advantaged individuals in society. Lastly, we evaluated the effect of contextual factors on the design, execution and evaluation of the Green Carpet project.

Chapter 2 describes the results of the systematic review. The aim of the systematic review was to examine the effect of built environment infrastructural changes (BEIC) on physical activity, active transport and sedentary behavior. A literature search in two electronic databases resulted in nineteen eligible articles. BEICs were separated in two categories: on- and off-road bicycling and/or walking trails, and more extensive BEICs involving changes in the larger (infrastructural) system. The results showed that on- and off-road bicycling and/or walking trails resulted in inconsistent effects on overall PA and walking, and in predominantly positive effects on bicycling. The more extensive BEICs led to mixed results, with mainly non-significant effects. However, positive effects on bicycling were found for people living closer to the BEICs. Remarkably, none of the studies assessed the effect on sedentary behavior. The risk of outcome measurement bias and bias in the selection of reported results was higher in the studies that evaluated smaller on- and off-road walking and/or bicycling trails in comparison to the more extensive infrastructural interventions. So, studies with a higher risk of bias were more likely to report significant changes in outcomes than studies with a lower risk of bias. To improve the understanding of the potential of BEICs to increase physical activity levels and decrease sedentary behavior at population-level, more high-quality research is needed. Future research should consider the use of context-specific measurements, provision of detailed description of the context in which an intervention takes place, and the inclusion of multiple groups based on the proximity to the intervention.

Chapter 3 describes how the context of mid- and long-term urban reconstructions such as the Green Carpet influences design and implementation conditions that prove crucial to project achievement. The socioeconomic and geographical context were especially

of importance during the agenda setting phase. The geographical context influenced the planning procedure due to the physical location of the city, which is bordered by protected natural areas. The poor socioeconomic position of neighborhood bordering the Green Carpet stressed the need for change in this area. The project had to follow existing legal frameworks, which makes that this context shaped the initial project. The political context evoked most of the changes during the planning and implementation phases, due to the political agency of specific stakeholders, national policies, and obligatory and voluntary consultations of the inhabitants and stakeholders. The changes in the context influenced the design and implementation conditions that prove crucial to project achievement. Due to the constant interactions between context and the project, impacts can hardly be ascribed to the initial project. Traditional evaluation designs often ignore these process dynamics in order to maintain 'study design fidelity'. To improve the internal validity, interpretation and implications of future evaluations, we recommend adopting a complex systems approach and mixed methods design that enable investigating the interactions between the project and its context.

In **chapter 4 and 5,** the relationships between the perceived neighborhood walkability and (context-specific) physical activity levels are presented. The results of the baseline measurements of the effect evaluation showed that more physical activity-supportive environments such as the presence of places to go within walking distance and the presence of attractive buildings are associated with less sedentary behavior and an increase in moderate-to-vigorous physical activity, but might not affect light physical activity (**chapter 4**). However, the potential of the built environment to affect physical activity levels differed for more and less advantaged individuals in society (i.e. lower educated individuals and higher educated individuals). For less advantaged individuals, the absence of (physical) barriers (i.e. highways, railways, traffic) might lead to more physical activity and less sedentary behavior. For more advantaged individuals, the presence of physical activity supporting elements (i.e. aesthetics, presence of destinations) was found to be associated with more physical activity. Further, context-specific analyses of the data showed that associations between perceived neighborhood walkability and neighborhood-based physical activity depends on the time that is spent in the home neighborhood (**chapter 5**). Perceived neighborhood walkability only affected neighborhood-based physical activity levels for those who spent relatively more time in their home neighborhoods. Physical activity facilitating features in the home neighborhood were only associated with more neighborhood-based physical activity for more advantaged individuals. These findings imply that the same physical environment might have different effects on more and less vulnerable individuals.

The effects of the Green Carpet on physical activity, active transport and sedentary behavior at the first follow-up are presented in **chapter 6**. At this relative short term, no increases in total or transport-based physical activity levels were found for the minimal and maximal exposure groups in Maastricht. However, a decrease in transport-based MVPA and increase in transport-based SB was observed in the no exposure group. This might be an indication that the Green Carpet prevents the increase in transport-based SB over time. Subgroup analyses showed that the area-based differences might reflect the differences between users and non-users, but this should be interpret with caution, due to potential selective mobility bias.

Spatial analyses in **Chapter 7** show that the changes in the environment changed the physical activity patterns of the residents that lived in the adjacent neighborhood. This might indicate a rerouting of pre-existing travel, or an actual shift in physical activity behavior that will eventually lead to increases in the volume of total daily physical activity, as a result of prolonged favorable physical activities such as active transport. These results show that following an integrative approach by targeting multiple aspects in the environment, such as improved traffic safety, green space, and connectivity, can lead to changes in the use of public spaces on the short term. Also, both lower and higher educated individuals tended to use the new infrastructure at the first follow-up. So, such major infrastructural projects can influence the behavior of different subgroups in society. It highlights the fact that changes in the built environment can lead to changes in physical activity patterns of individuals, but this does not necessarily lead to changes on population-level physical activity levels. This advocates for more diverse forms of data collection and analysis methods if we are to better understand how the physical environment affects behavior and health, particularly to improve our insights in creating impact for vulnerable populations.

Chapter 8 discusses the results of the longer-term follow-up measurements of the effect evaluation. The aim of this evaluation was to assess the longer-term effects of the Green Carpet on physical activity, sedentary behavior, active transport and health-related quality of life at 29-39 months after the official opening of the Green Carpet. The results show significant intervention effects on transport-based sedentary behavior and transport-based light intensity physical activity for both exposure groups, compared to the no exposure group. In comparison to the shorter-term evaluation and despite the COVID-19 physical isolation policies, the effect sizes increase over time. These results emphasize the potential of the built environment in changing and sustaining healthy behavior over a longer period of time. Social participation and meaningfulness increased in the maximal exposure group while it decreased in the minimal and no exposure groups, but changes

were not statistically significant. As the intervention area is still under construction, even longer follow-up terms might be needed to explore its full potential.

Finally, **chapter 9** summarizes the main findings, discusses the theoretical and methodological considerations, and presents implications and recommendations for future research and practice. We conclude that the built environment has an impact on the physical activity behaviors of individuals who live in this environment, especially on physical activity and sedentary behavior during transport.