Built environment, lifestyle, and diabetes

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Summary

Type 2 diabetes (T2D) is one of the most prevalent chronic diseases worldwide. Key modifiable risk factors include unhealthy diet and lack of physical activity (PA). Lifestyle behaviour change is an effective strategy to delay or prevent T2D, as illustrated in controlled diabetes prevention trials. However, lifestyle modification interventions in real life are often ineffective or not sustainable in the long term. Therefore, in the past decades, attention has shifted to more upstream determinants of lifestyle behaviour and chronic disease, such as the built environment, that may enable or support such lifestyle modification. The aim of this thesis was to investigate 1) the association between food environment, diet quality and T2D outcomes and 2) the association between PA environment, PA behaviours and T2D outcomes.

Chapter 2 provides an overview of the available evidence on built environment and T2D in a systematic review and meta-analysis. A total of 109 studies were included and 40 studies were meta-analysed, divided in built environmental characteristics related to 1) urban-rural differences, 2) diet and 3) PA. The results indicated that urban residence was associated with higher T2D risk and prevalence (odds ratio (OR): 1.4, 95% confidence interval (CI): 1.2 – 1.61), mainly in middle income countries. For PA environment, higher neighbourhood walkability was associated with lower T2D risk (OR: 0.79, 95%CI: 0.72 – 0.87), and more green space was be associated with lower T2D risk (OR: 0.91, 95%-CI: 0.88 – 0.95). No convincing evidence was found for an association between the food environment and T2D, and results were very heterogeneous. Studies using subjective food environment measures were more likely to be associated with T2D, whereas studies using objective measures showed mixed results and were too heterogeneous in design to be meta-analysed.

In chapter 3 and 4 we investigated the association between food environment, diet and T2D. In chapter 3 we showed that highest tertile of adherence to the Dutch dietary guidelines was associated with lower T2D incidence (Prevalence Ratio (PR)_{T3}\text{vs}T_1: 0.70, 95%CI: 0.53 – 0.92) and pointed toward a lower incidence of pre-diabetes (PR_{T3}\text{vs}T_1: 0.87, 95%CI: 0.74 – 1.03), in the harmonized Hoorn Study cohorts. In chapter 4 we investigated the association between accessibility of food retailers and T2D incidence.
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in four Dutch prospective cohorts. This study contributed to the evidence base by using homogeneous objective exposure measures of the food environment in four cohorts covering a vast geographical area of the Netherlands. Also, to gain insight in the distal pathway between food environment and T2D incidence, we investigated the mediating role of diet quality, through adherence to the Dutch dietary guidelines. Overall, there was no pooled association between accessibility to supermarkets, fast-food outlets or green grocers and T2D incidence. The mediation analyses revealed subtle associations, indicating that residents living at further distance to supermarkets had poorer diet quality ($\beta_{\text{per100m}}$: -0.1, 95%CI:-0.2 – 0.0), and those at further distance to fast-food outlets had better diet quality ($\beta_{\text{per100m}}$: 0.1, 95%CI:0.0 – 0.2). However, diet quality was not significantly associated with T2D incidence in this study.

In chapter 5 and 6 we focussed on combined elements of the built environment potentially related to passive transport, coined as ‘drivability’, and the association with car use in the general population. Car use has been associated with sedentary behaviour and higher risk of chronic diseases, such as T2D. As people usually cross larger distances by car driving than walking and travel beyond the neighbourhood boundaries, it is of special interest to take into account more than the residential environment. In chapter 5 we investigated the relative contribution of individual-level characteristics and residential neighbourhood built environment characteristics to car use in adults across five European countries. At the individual level a higher age, male sex, being employed and living in a ≥3 person household were associated with higher weekly minutes of car driving. At the neighbourhood level higher residential density and higher land-use mix were associated with fewer minutes of car driving. Both the individual- and neighbourhood-level variables contributed equally to the explained variance in minutes of weekly car driving. In chapter 6 we developed and validated a novel drivability index, inspired by the walkability index, and investigated its association with transport mode choice for all trips and for short and long trips. The drivability index consisted of three factors: urban sprawl, pedestrian facilities and parking availability. There were statistically significant higher levels of car use in highly drivable neighbourhoods compared to low drivable neighbourhoods (rate ratio (RR): 1.80, 95%CI: 1.77 – 1.88), and stronger associations were observed for short trips (RR: 2.72, 95%CI: 2.48 – 2.92). This indicated that a car-facilitating residential environment...
could increase car use for short or discretionary trips – which are relatively easy to be substituted by active transport modes. Moreover, as car driving is likely to cross residential neighbourhood borders, we applied our drivability index to the workplace, and found a stronger association when both residential drivability and workplace drivability were high, than when either or both were low (RR for car use in high/high vs. low/low residential/workplace drivability: 2.18, 95%CI: 2.08 – 2.29). This indicates that characteristics of both the residential and destination built environment are important for car use. Even though the results for built environment and car use were promising, these studies had a cross-sectional design, so the possibility of reverse causation should be taken into account when interpreting these results.

In chapter 7 we investigated the association between neighbourhood walkability, PA, and change in glycaemic markers in a population with T2D. This subpopulation is understudied when it comes to objective PA environment, while this population may be more dependent on their neighbourhood environment, as they are usually an older and potentially more vulnerable group. Overall, we found no meaningful association between neighbourhood walkability and change in HbA1c or fasting plasma glucose (FPG) over 1 year (HbA1c: $\beta$: -0.15 mmol/mol (95%CI: -0.59; 0.28), FPG: $\beta$: -0.03 mmol/L (95%CI: -0.13; 0.07)). We investigated mediation by accelerometer-based hours of total PA per week, but found an inverse association such that higher walkability was associated with less time spend in PA per week ($\beta$: -0.95 h/week, 95%CI: -1.51; -0.38). Moreover, the association between PA and change in glycaemic markers was zero (HbA1c: $\beta$: 0.00 mmol/mol, 95%CI: -0.05; 0.05), indicating no mediation by PA was possible. These findings on walkability and PA levels were in contrast to earlier studies. An important difference was that those earlier studies mainly investigated perceived walkability as well as self-reported PA. Moreover, in our study and others, self-selection bias may have been an issue. Even though we adjusted for residential self-selection based on PA preferences, there may have been selection on health status, with the most healthy and active people living in the least walkable areas. This may have contributed to counterintuitive associations with PA.

Overall, this thesis supported associations between PA environment and favourable behavioural and T2D outcomes in healthy populations. Especially composite measures
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seem to be a good reflection of the PA environment and support multicomponent interventions. Even though the literature on food environment was heterogeneous, in this thesis we observed subtle associations between the food environment, diet quality and T2D incidence. However, we were not able to fully explain heterogeneity, and thus more research is needed. In future studies causality, complex systems and combination of PA and food environments should be explored.