Improving neighbourhoods, improving health?
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General discussion
In numerous countries severe differences in mortality, morbidity, and health (behaviour) exist (see reviews for overview). Unfortunately, these differences have been found to be increasing over the last decades (e.g.). To be able to turn this trend and diminish these health inequalities, it is crucial to fully understand the causes of these health inequalities and to evaluate the effectiveness of policies and interventions to tackle health inequalities. The ultimate aim of this thesis is to contribute to the evidence base for one possible strategy to tackle health inequalities, namely through area-based interventions in deprived neighbourhoods. The first specific objective was to assess whether inequalities in health between deprived and non-deprived postal code areas can be explained by selective migration. The second specific objective was to identify if changes in specific neighbourhood characteristics influence health outcomes of neighbourhood residents. The third specific objective was to evaluate whether a Dutch large-scale ABI (hereafter called the District Approach) have a significant effect on health outcomes in the 40 most deprived districts of the Netherlands.

This chapter begins with a summary of the main findings of the previous chapters. Subsequently, the most important methodological limitations of the studies in this thesis are discussed. Furthermore, we reflect on our findings and compare our main findings with other relevant studies and present some interpretations of key findings. Next, implications for both policy and research are presented and discussed. Finally, a main conclusion is given.

SUMMARY OF MAIN FINDINGS

Part one: Migration and neighbourhood inequalities in health

Chapter 1 provided insight into the effect of migration on area differences in three measures of health (perceived: general health, longstanding health problems, and disabilities). Firstly, we found smaller area inequalities in health among migrants who moved between deprived and non-deprived postal code areas in the Netherlands compared to the total population. Secondly, the out-migrants are replaced with another group of in-migrants with relatively similar levels of health. Lastly, better health of migrants out of deprived postal code areas and worse health of migrants out of non-deprived postal code areas as compared to the geographically stable, are both attributable to individual socio-demographic characteristics.

From this study we concluded that health is related to migration between deprived and non-deprived postal code areas, mostly through socio-demographic selection instead of a direct effect of health. Despite the relationship with health, migration does not enlarge inequalities in
health between deprived and non-deprived postal code areas in the Netherlands but possibly attenuates the health differences.

Chapter 2 examined potential differences between age groups with regard to the effect of migration on inequalities in general health between deprived and non-deprived postal code areas in the Netherlands. For all ages together and for people aged 25-34 years, we observed smaller area inequalities in health among migrants compared to non-migrants. For most other age groups, we found about equally large differences. Only for the age group 35-44 years, area inequalities in health among migrants were slightly larger than among non-migrants.

In conclusion, for most age groups, the results do not provide empirical support to the expectation that migration would enlarge inequalities in health between deprived and non-deprived postal code areas.

**Part two: The impact of specific neighbourhood characteristics on health outcomes**

In chapter 3 we explored whether and how changes over time in levels of traffic safety were related to physical activity among neighbourhood residents. We found that favourable changes in traffic safety levels between 2006 and 2009 were related to increased odds of being active in 2009, but not to the mean hours of physical activity. These positive relationships with the odds of being active tended to be stronger among women, people aged 35 to 59, and those who were gainfully employed.

From this study we concluded that these change measures provide new and somewhat stronger evidence for a causal relationship between neighbourhood traffic safety and physical activity.

In chapter 4 we assessed whether and how changes over time in levels of environmental factors were related to odds of being active among neighbourhood residents. We observed that, improvements in green spaces, social cohesion, and physical and social disorder were related to higher odds of being active in 2009. These positive associations tended to be stronger among women, but not among older people or among residents who have lived longer in the neighbourhood.
In conclusion, our results of these change measures provide new and somewhat stronger evidence for a causal relationship of green spaces, social cohesion, and physical and social disorder with physical activity.

In chapter 5 we investigated whether and how changes over time in levels of neighbourhood safety (general safety (fear of crime), physical disorder, social disorder, and criminal victimisation) were related to mental health. We found that average improvements in physical disorder in the neighbourhood between the time periods 2004 to 2007 and 2008 to 2011 were positively related to higher odds of having good mental health (cut-off >74). For the results of the lower cut-off point (>60), a similar result was obtained, which was however, statistically significant for women only. For changes in general safety a similar (however not statistically significant) positive relationship was observed with mental health, while such positive relationships were not found for social disorder and criminal victimisation.

In conclusion, our results of these change measures provide additional support for a causal relationship between physical disorder and mental health.

Part three: The impact of a Dutch large-scale area-based initiative on health outcomes

Chapter 6 provided insight into the short-term impact of the District Approach on trends in self-reported leisure-time physical activity (walking, cycling, and sports). We observed a statistically significantly positive pre-post intervention change of trend in walking in the 40 deprived target districts. This change of trend was statistically significantly larger compared to the rest of the Netherlands. For cycling and sports, neither target districts nor control areas showed a statistically significant change of trend. For all leisure-time physical activity outcomes, trend changes were not associated to the intensity of environmental interventions in the target districts.

From this study we concluded that the districts that were subject to the District Approach show improvements in leisure-time walking. These improvements were larger than those in control districts, regardless of the intensity of environmental investments. Investments are not associated with changes in leisure-time cycling and sports.

In chapter 7 we examined the short-term impact of the District Approach on trends in perceived mental health. This was investigated for the total population and for subgroups defined by sex and intensity of ABI efforts. We found that the pre-post intervention change of trend in mental
health among the 40 target districts did not differ from the trend in control areas. However, a strong tendency was found among women towards more positive change of trends in the target districts compared with control areas. This positive effect was not observed among males. In addition, for target districts with more intensive ABI efforts a statistically significant more positive pre-post intervention change of trend was observed compared with the control areas, while no differences were observed for target districts with a less intensive ABI.

In conclusion, the District Approach had no demonstrable positive impact on the development of perceived mental health in all 40 targeted deprived districts, compared with control areas. However, investments did seem to positively affect the development of perceived mental health in the target districts with more intensive ABI efforts.

In chapter 8 we investigated the short-term impact of the Districts Approach on perceived general health. We compared the general health trends of target districts that focused on the improvement of the district environment with target districts that mainly invested in the socio-economic status of its residents. The trend in general health among the 40 districts targeted by the District Approach did not differ from the trend in the control areas. Target districts that invested more in the district environment showed a more positive change in trend in general health than the districts investing in individual inhabitants.

From this study we concluded that the District Approach at large did not seem to incur a positive impact on the development of perceived general health in the 40 targeted deprived districts, compared with control areas. However, investments in the district environment of deprived districts seemed to have generated a positive change in general health (when compared to investments in individual residents).

METHODOLOGICAL CONSIDERATIONS

The methodological considerations directly relevant to the specific studies are addressed in the Discussion sections of the previous chapters. In this section, we discuss some general methodological issues of importance when examining the associations between changes in specific neighbourhood characteristics and health outcomes and assessing the effects of an ABI on health outcomes.

Measurement of neighbourhood characteristics

In part two of this thesis, we used subjective measurements of neighbourhood characteristics
to examine whether changes in specific neighbourhood characteristics are related to physical activity and mental health. Is it likely that our results would be different if we had used objective measures of neighbourhood characteristics instead? Previous research found that both subjective and objective measures of neighbourhood characteristics are related to health\textsuperscript{8-13} and physical activity.\textsuperscript{14} The associations however, seem to be stronger for subjective as compared to objective measures of neighbourhood characteristics.\textsuperscript{13} With regard to subjectively measured neighbourhood characteristics, studies have generally found good internal reliability and test-retest reliability for scales describing neighbourhood characteristics like disorder, safety, neighbourhood participation, and social cohesion.\textsuperscript{15,16} By definition, subjective measures of the neighbourhood environment most closely reflect individuals judgment of neighbourhood characteristics. They may affect health through pathways such as, stress or behavioral choices that are triggered by the hazards and perceptions of safety in one’s environment (e.g.\textsuperscript{15}). Subjective measures may therefore seize aspects of the environment that objective measures do not.

Subjective measures of neighbourhood characteristics should ideally have been proven to be reliable and valid. The measures in this thesis were obtained from national survey data from which we developed composite scales or used single items. Making use of existing data have some disadvantages. One disadvantage is that these survey data or scales have not been validated. Another disadvantage is that we had no influence on the inclusion of items in these surveys or the formulation of the included items. It is possible that at least some of the neighbourhood characteristics measured in this thesis (e.g. green space and/or traffic safety) were composed by too few items. Therefore these measures might not have included all aspects of the construct they were intended to measure. However, most measures of the neighbourhood characteristics studied in this thesis were (partly) based on measures used in previous studies.\textsuperscript{17-22}

Some validated questionnaires of neighbourhood characteristics do exist (e.g. the Neighborhood Environment Walkability Scale (NEWS), the Neighbourhood Quality of Life Study (NQLS); Ross-Mirowsky Perceived Neighbourhood Scale), but these have been developed and validated outside Europe, either in Australia\textsuperscript{23} or the US.\textsuperscript{24-26} Because the built environment in the Netherlands is very different from those in Australia or in the US these questionnaires might not be applicable in a Dutch context. Some Dutch studies have used existing validated international questionnaires (NEWS; NEWS-A) and translated them into Dutch and/or made some adoptions to make it fit better into the Dutch context (e.g.\textsuperscript{27}), but these have, however, not been validated.

To conclude, for some but not all environmental characteristics, we cannot exclude the possibility that our results might have been influenced by the use of available measures and could have
been different if validated measures had been applied. There is need for development of new questionnaires that measure neighbourhood environment in the Dutch context and for Dutch validation research of these new questionnaires and/or the modified versions of existing validated international questionnaires.

**Self-reported versus objective measurement of health outcomes**

Whether health outcomes should be measured by self-report or by objective measures, depend on the health outcomes. Is it likely that our results would be different if we had used objective measures of health outcomes instead? For mental health, self-reported questionnaires have showed similar results to objective measures such as diagnosis given by psychiatrists.\textsuperscript{28-30} Likewise, general health status have been found to be a good predictor of future health care and mortality rates.\textsuperscript{31,32}

Self-reported assessment of physical activity, on the other hand, suffers from substantial reporting bias\textsuperscript{33} due to both social desirability and the cognitive difficulties of accurately reporting physical activity.\textsuperscript{34} In part three of this thesis, we tried to limit this potential bias by comparing the intervention areas with similar other areas. Still, the proportion ethnic minorities differ in the intervention areas and control areas. Some studies found that ethnic minorities tend to answer in a more socially desirable way.\textsuperscript{35,36} The impact of the District Approach on self-reported physical activity may therefore be overestimated, because the residents of the target districts (with a somewhat higher proportion of ethnic minorities than most control districts) may respond to the physical activity questionnaire in a more socially desirable manner than individuals living in control areas. Although, differential social desirability bias cannot be ruled out, it seems unlikely that this have affected the main conclusions in this thesis given that we have made comparisons over the time.

In this thesis, we have only used self-reported measures to assess health outcomes. For general and mental health, we believe that self-reported measures would give about as valid results as objective measurement. We do, however, not know whether a different degree of overestimation of physical activity due to the self-reported nature of this measure would have biased the associations with changes in specific neighbourhood characteristics and/or the associations with the District Approach. Future studies should measure physical activity also objectively.\textsuperscript{37}

**Advantages and disadvantages of our study design**

Nearly all studies examining the association between neighbourhood characteristics and health outcomes have used a cross-sectional design (e.g.\textsuperscript{38-41}). Very few studies to date have examined
whether changes in the environment are related to changes in health outcomes. In part two of this thesis, we applied a more sophisticated design by measuring changes in neighbourhood characteristics with repeated cross-sectional data. This design has the advantage, compared to most other studies, that we eliminated, at least in part, the impact of confounders that are correlated with one-time levels of neighbourhood characteristics.

However, the disadvantage of this design is that the study sample of the different survey years could differ per neighbourhood on socio-demographic characteristics or any other characteristics (such as personality) that are related to our study outcome. Random and non-random changes may have biased observed changes in perceived neighbourhood safety. Random bias in the measurement of change in safety may have resulted in underestimation of the relationship between these changes and MH. We aimed to reduce non-random bias by adjusting the analyses for many socio-demographic factors. However, we could not adjust for other factors potentially related to safety perception, such as personality. Future studies on changes in neighbourhood safety can reduce such bias by using larger interview surveys, longitudinal designs or objective measures of neighbourhood safety.

Furthermore, even though the design used in part two of this thesis was more sophisticated compared to purely cross-sectional studies, residual confounding may still be a possible threat to the validity of these new studies. It might be that unmeasured factors such as physical features of the environment (e.g. connectivity, availability of parking, population density) could still act as a confounder if they are not only related to current levels of environmental deprivation, but also to changes over time in environmental deprivation. Sensitivity analyses for paper 5, which examined the relationship between changes in neighbourhood safety and mental health, revealed that changes in levels of safety between the periods 2004-2007 and 2008-2011 were consistently associated with higher odds of fair or good mental health in 2004-2007. This indicates that some residual confounding might be present. To fully avoid potential bias in the measurement of changes in neighbourhood characteristics and their relationship with health outcomes, a longitudinal design should be applied or changes in neighbourhood characteristics should be measured objectively.

To conclude, though we have limited bias by investigating changes in neighbourhood characteristics, we were not able to adjust for all factors that could have biased our measures and therefore residual confounding cannot be ruled out. Such residual confounding can only be prevented by using an experimental design. Still, we believe we have been able to generate new evidence on the causality of the relationship between neighbourhood characteristics and health.
outcomes.

Observation time needed to demonstrate effects on health outcomes
A certain observation time might be needed in order to demonstrate effects on health outcomes of changes in neighbourhood characteristics. The time needed might depend on both the neighbourhood characteristics and the health outcomes being studied. Also, the observation time needed may depend on the assumed length of the causal pathway between these variables.

With regard to outcome measures, we chose to study mental health and physical activity because we expected the effects of (at least) some neighbourhood characteristics on these outcome measures to be perceivable after a relatively short time period. Blank et al. (2007) suggested that the short-term impact of community-based interventions on health will more likely be seen on mental than on overall self-reported health. Moreover, after six years of observation time, a positive impact of the New Deal for Communities Programme (NDC) on mental health was observed while only a minor positive effect was found for general health. It is possible that no large positive effects on general health were detected because the observation time of six years was too short to generate large effects for this particular health outcome. For similar reasons, we chose not to include indicators like morbidity or mortality rates as an outcome measure in our studies because we expected the available observation time would be too short to generate demonstrable effects.

We chose to study neighbourhood characteristics that we expected to produce perceivable effects on health outcomes after a relatively short time period (i.e. period 2006-2009; e.g. traffic safety, green space, and parking facilities). We expected that some of the other neighbourhood characteristics we investigated (e.g. social cohesion, social disorder, fear of crime, and criminal victimisation) would need some longer time to develop in order to produce perceivable effects on health outcomes. For example, when there is an extra focus on safety, residents might be more aware of safety problems and consequently they may feel more unsafe in their neighbourhood. It is therefore likely that following safety interventions, it will take some time before the residents perceive their neighbourhood as (more) safe and in response may improve mental health and/or physical activity. However, because changes in neighbourhood safety was measured over a relatively long time period (i.e. changes between the periods 2004-2007 and 2008-2011), we are confident that the observation period for the four neighbourhood safety measures was long enough to be able to demonstrate effects on mental health.

We believe that the observation time we had to perceive effects were long enough for some
of the neighbourhood characteristics and health outcomes studied in this thesis. However, for some neighbourhood characteristics and for general health, the observation time we had available might have been too short to generate demonstrable effects. Longer observation time is needed in order to study possible effects of different types of interventions on a broader range of health outcomes.

**Comparability of the control areas**

When assessing the effects of an ABI on health outcomes, the intervention areas should be compared with similar control areas for optimal comparison. However, the intervention areas that were part of the District Approach were not randomly selected among deprived districts. There was a lack of proper control areas since all most severely deprived districts were chosen to be an intervention district. To decrease the possible bias of this methodological problem, we used propensity score matching to select control areas. To the extent possible, these areas were most comparable to the target districts with regard to their livability (living circumstances, physical and social neighbourhood characteristics, and safety) at the moment the implementation of the District Approach started.

Though the propensity score matched control areas were similar to the target districts with regard to many aspects of livability, they might still differ with regard to the circumstances of the individual residents or on other important aspects of the living environment. We compared the trends in the target districts with trends in the most similar control areas possible. Still, it is possible that dissimilarity of our control areas might have biased our results to a small extent.

**Generalisation of the results**

We assume that the majority of the results presented in this thesis can be generalised to the whole population of the Netherlands. This especially applies to the results in chapters 6 to 8. The study samples were large (range \(N=46,240\) to \(66,800\)), derived from a nationwide survey, and geographically representative of the Netherlands, with an inclusion of approximately 89% of all postal code areas in the Netherlands (\(N=3,485\) to \(3,607\)). Furthermore, all deprived target districts (83 postal code areas) that were part of the District Approach were included in these studies. Also, the studies investigating the effect of selective migration on area inequalities in health (chapters 1 and 2) had large sample sizes (\(N=40,213\) and \(61,687\)) and originated from a nationwide survey. In addition, deprived areas were well represented, accounting for 27.9% of the total sample size. However, we expect that the results presented in chapters 3 to 5 to a lesser extent can be generalised to neighbourhood populations in the whole of the Netherlands. To accurately assess changes in environmental characteristics strict inclusion criterias were
used, which resulted in the inclusion of only 320 and 1,043 postal code areas. Though the sample size was relatively large in these studies (range N= 10,007 to 31,783) the samples were not geographically representative of the whole of the Netherlands. The large majority of the respondents living in the included postal code areas lived in (very) strongly urban municipalities. Therefore these results can be generalised to neighbourhood populations in (very) strongly urban municipalities.

It is uncertain whether relationships between improved (specific) neighbourhood characteristics and health outcomes would be similar in neighbourhood populations in other countries in the world. This will depend on whether the underlying mechanisms have similar effects within different national context. This needs further investigation. The same applies to our studies on the effect of migration. As the strength, direction, and the health status of migration flows can differ in both time and between countries, it is possible that the results in this thesis regarding selective migration cannot be generalised to other countries in the world.

**REFLECTIONS ON THE MAIN FINDINGS**

**Did selective migration influence the relationship between the District Approach and health and related behaviour?**

The observed associations between the District Approach and health outcomes as found in part three of this thesis might be influenced by selective-migration between neighbourhoods. If migration of individuals towards the target districts is related to the health outcome being investigated, the association between the District Approach and health outcomes will be stronger. Districts which are part of the District Approach might stimulate in-migration of residents with favourable socio-economic position. It is known that socio-economic characteristics are associated with many health outcomes such as e.g. physical activity and general and mental health.\(^{50,51}\) Thus if people that settle in the target districts have a higher socio-economic status compared to leavers, these respondents may also be more physically active and have better general and mental health. If this is the case then the positive results of the District Approach may stem from selective-migration effects rather than improvements in the environment and the socio-economic position of original residents.

The analyses in this thesis indicate that, in the Netherlands, selective-migration to deprived and non-deprived neighbourhoods hardly contribute to explaining neighbourhood inequalities in health.\(^{52,53}\) This is in accordance with a previous Dutch study.\(^{54}\) In addition, we showed that health is related to migration between deprived and non-deprived areas mostly through socio-
demographic selection. Additionally, a recent Dutch study reported very small differences in income position of settlers and leavers in the target districts for the years 2009 and 2010. To limit the possible influence of selective-migration on our results we adjusted our analyses for many different socio-demographic characteristics.

Thus, the evidence suggests that it is unlikely that selective-migration have influenced the relationship between the District Approach and health outcomes as observed in this thesis to a large extent. Still, it is possible that residents who have benefited from the District Approach have moved out of the target district. This would underestimate the impact of the Districts Approach on health outcomes, particularly the impact of the socio-economic measures.

**Is there evidence for a causal relationship between specific neighbourhood characteristics and health outcomes?**

**Neighbourhood characteristics and physical activity**

The studies in part two of this thesis have shown that favourable changes in levels of traffic safety, green spaces, social cohesion, and physical and social disorder were positively related to higher odds of being active. We found, on the other hand, no relationships of favourable changes in levels of fear of crime or parking with physical activity. These results are in line with some studies in the international literature. Overall however, research on the relationship between these neighbourhood characteristics and physical activity has showed inconsistent results (e.g. 38-41,56). One possible reason for the inconsistent results might be related to the diversity in indicators used to measure these neighbourhood characteristics. Almost all studies measured neighbourhood characteristics at one moment in time. Only two studies measured whether changes in traffic safety or social cohesion were related to changes in physical activity. Humpel et al. (2004) demonstrated that increases in perceived traffic safety were related to an increase in walking in women but not in men. These changes were however measured over a period of only 10 weeks, which is a major limitation of this study. Michael and Carlson (2009) showed, in an experimental intervention study, that changes in social cohesion were not causally related to higher amounts of brisk walking. An important limitation of this study was the small sample size (intervention group N=158; control group N=266). It is possible that changes in social cohesion was unrelated to changes in brisk walking due to lack of sufficient statistical power.

The results of this thesis (with unique measures of changes in neighbourhood environment), together with a large part of the predominately cross-sectional studies which supported our results, allow to conclude that there is support for a causal relationship between some neighbourhood characteristics and physical activity, namely traffic safety, green spaces, social
cohesion, and physical and social disorder.

**Neighbourhood safety and mental health**

In this thesis, it is demonstrated that favourable changes in levels of physical disorder were positively related to higher odds of having a good mental health. For general safety a similar (although less) positive relationship was observed with mental health. These results are supported by almost all cross-sectional studies on these research topics. In addition, one study reported that improvements in general safety following a neighbourhood renewal programme is related to improvements in mental health.\(^{57}\)

Such positive relationships were, however, not observed for social disorder and criminal victimisation. These results are not in line with previous international cross-sectional research, which showed for most studies that neighbourhood (social) order and lower levels of neighbourhood crime are protective of poor mental health.

The results of this thesis, together with results of earlier international studies (with a one-time measure of physical disorder), allow us to conclude that there is support for a causal relationship between physical disorder and mental health.

Overall, the evidence suggests that it is likely that general safety is causally related to better mental health. This primary conclusion is based on the observed positive relationship between changes in general safety and mental health in this thesis (although it could not be demonstrated with statistical significance) together with the highly consistent cross-sectional evidence which supported our findings. Also, a study which found that positive changes in general safety was related with improved mental health supports this conclusion.

Furthermore, with regard to the impact of social disorder and criminal victimisation on mental health, more research is needed because of the inconsistent findings in this thesis with the cross-sectional research on this topic.

**Has the District Approach had a significant effect on health outcomes?**

The studies in part three of this thesis have shown that investments in deprived areas to improve the environment and the socio-economic position of residents, have led to positive developments in some health outcomes of the residents. We found evidence for positive developments in walking, mental health (if more intensive ABI efforts had been implemented), and general health (for districts with ABI efforts focused on the neighbourhood environment
compared with districts with ABI efforts focused on individual residents), while no positive evidence were found for cycling and sports compared to control areas. Our results with regard to mental health are in accordance with the results of the NDC Programme. NDC evaluations found, however, positive developments in mental health for the total population compared to control areas, while we found positive developments for the target districts with more intensive ABI efforts. Our findings on general health were not entirely consistent with results of the NDC Programme. The NDC showed more improvement in general health compared to control areas, although the magnitude of effect was small, while the District Approach did seem to have a positive impact on general health only in the target districts that invested more in the district environment (as compared with target districts that invested more in the individual residents).

The NDC evaluations reported no difference in overall physical activity between NDC areas and control areas. We are, however, not able to compare our findings on walking, cycling, and sports with the results of the NDC, as they only examined overall physical activity and did not distinguish different types of physical activity.

It is striking that we, just a few years after the start of the District Approach, and despite of the fact that the District Approach has achieved limited results on the primary themes, observed some positive developments in some aspects of health outcomes of the residents of the deprived districts. There is evidence, in particular for walking and mental health, to support recommendations for ABI’s as a policy approach to improve the health of people in deprived neighbourhoods.

**IMPLICATIONS FOR POLICY AND RESEARCH**

**Implications for public health policy**

In the Netherlands, living in deprived neighbourhoods is clearly related to poorer health. More specifically, studies in this thesis have showed that the geographically stable population in deprived neighbourhoods have poorer health than migrants moving into, or out of, these neighbourhoods. Consequently, if the aim is to improve the health of people living in deprived neighbourhoods, polices aimed to improve the livability and health situation of deprived neighbourhoods should especially focus on the geographically stable population.

In this thesis it was found that the population health effect of improving the socio-economic situation of individual residents and environmental characteristics was relatively weak. Still, implementing interventions aimed to improve the environment have several advantages, as opposed to interventions aimed at improving the socio-economic position of individual residents.
First, potentially all residents are exposed to the environmental interventions, whereas only a relatively small part of the neighbourhood population is exposed to individual-level interventions because of high costs. Second, many changes in the neighbourhood environment can affect the residents for a much longer period of time than most individual-level interventions. This applies to long-term investments such as more green space (e.g. parks) or improved traffic safety (e.g. narrowed roads, speed humps, zebra crossings, and roundabouts).

Neighbourhood interventions intended to improve the health outcomes of neighbourhood residents should focus on neighbourhood characteristics that have the potential to positively influence health outcomes. The findings of this thesis and a large part of the international literature (although predominately cross-sectional studies), suggest that improving traffic safety, green space, social cohesion and tackling physical and social disorder might lead to an increase in the number of neighbourhood residents who are physically active. Moreover, tackling physical disorder might increase the number of neighbourhood residents with better mental health. Targeting traffic safety, green space, social cohesion, and physical and social disorder might therefore be a good entry point for policy makers.

This thesis has shown that a large-scale ABI was able to improve some aspects of health outcomes of residents in deprived areas. Statistically significant effects on mental health was however only found for target districts that implemented an intense ABI. This emphasises the importance of implementing interventions that reach a large number of residents, that effectuate a large amount of district change, and/or target a high number of policy fields (which have a broad thematic coverage).

Implications for public health research
An extensive amount of cross-sectional studies investigating the relationship between specific neighbourhood characteristics and health outcomes have been conducted. To increase the causal inference, it is now time for studies with a more rigorous methodological design such as a longitudinal and/or (quasi-)experimental studies with longitudinal data.

Numerous European studies have used ad-hoc questionnaires to measure neighbourhood environment or made adaptations to validated questionnaires in terms of language, readability, and removing or adding items. These modified versions have, however, not been validated. Therefore there is large variation in the measurement of subjective neighbourhood characteristics in Europe, making comparisons between studies difficult. This implies that there is need for a greater degree of standardisation of measures of neighbourhood environment, taken into
account the European-specific context. A first step of standardisation was taken by the ALPHA project which have developed an environmental questionnaire for use within the European context. Future research is needed to test the metric properties of this new questionnaire in different languages and in different European countries, inclusive the Netherlands.

Self-reported physical activity is subject to misclassification (due to social desirability and/or cognitive difficulties). As the self-reported nature of physical activity might have biased the associations in this thesis, we advise future studies to also measure physical activity objectively. The use of new technology such as smartphones has made it easy to monitor physical activity by objective monitors. Smartphone apps have potential for affordable utilization in large-scale epidemiological and intervention studies.

Much research has been conducted to assess relationships between neighbourhood characteristics and health outcomes. However, it is important to understand the underlying processes causing these relationships, but such research is very scarce. In the light of this research gap we recommend future research to unravel the mechanisms that link the environment to health outcomes. Such research should hypothesise what characteristics of the social or physical environment might influence health outcomes, and then test these hypotheses by conducting mediation analyses.

It is unclear whether there are truly no large positive effects of ABI’s on general health or that the observation time of the District Approach and other large-scale ABI’s such as the NDC was too short to observe large visible effects for this particular health outcome. Future research studying the impact of ABI’s on health outcomes should have longer observation time in order to detect both large and small effects. Moreover, with a longer observation time it is also possible to detect the ‘true’ magnitude of the impact of ABI’s on health outcomes and to observe whether such effects are sustained over time. With a substantially longer observation time it would even be possible to assess the impact of ABI’s on other important health outcomes such as incidence of diseases or mortality.

When assessing the effects of an ABI on health outcomes, the intervention areas should be compared with similar other areas for optimal comparison. However, the District Approach and most other ABI’s as well tend to target the most deprived areas. While this is unquestionable wise in a policy strategy, it could be a source of bias for research trying to assess the impact of such initiatives. Many studies investigating the health impact of ABI’s have used suboptimal comparison areas (e.g. Batty et al., 2010 45). We aimed to reduce this bias by applying propensity score matching to select control areas that are similar to the intervention areas. Further work is necessary to assess
the extent to which this approach yields optimally comparable areas, and to compare its outcomes with alternative methods such as individual case matching.

**MAIN CONCLUSION**

The ultimate aim of this thesis was to assess the potential of ABI’s to improve the health of disadvantaged populations and thus to decrease area inequalities in health. It is well-known that the characteristics of individual neighbourhood residents (such as their socio-economic status and ethnic origin) explain large parts of area inequalities in health. It has been suggested that selective migration is responsible for large parts of the remaining area inequalities in health. The results of this thesis however have shown that migration does not enlarge inequalities in health between deprived and non-deprived areas in the Netherlands but possibly attenuates the health differences. Thus, it seems plausible that the remaining area inequalities in health are largely attributable to specific social and physical characteristics of the neighbourhood environment. The results of this thesis have provided some additional support for assuming a causal relationship between some of these neighbourhood characteristics and health outcomes.

This suggests that an implementation of ABI’s have the potential to improve the health of disadvantaged populations and to reduce area inequalities in health. A main challenge for research is to assess whether policies and interventions aimed to improve area characteristics are indeed effective in improving the health of residents of deprived areas. In this thesis, we have been able to show positive developments in some aspects of health outcomes of the residents targeted by the Dutch District Approach. The studies in this thesis have yielded evidence for expecting a positive impact of ABI’s that reach a large number of residents and target different policy fields.
REFERENCES


