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promoting physical activity

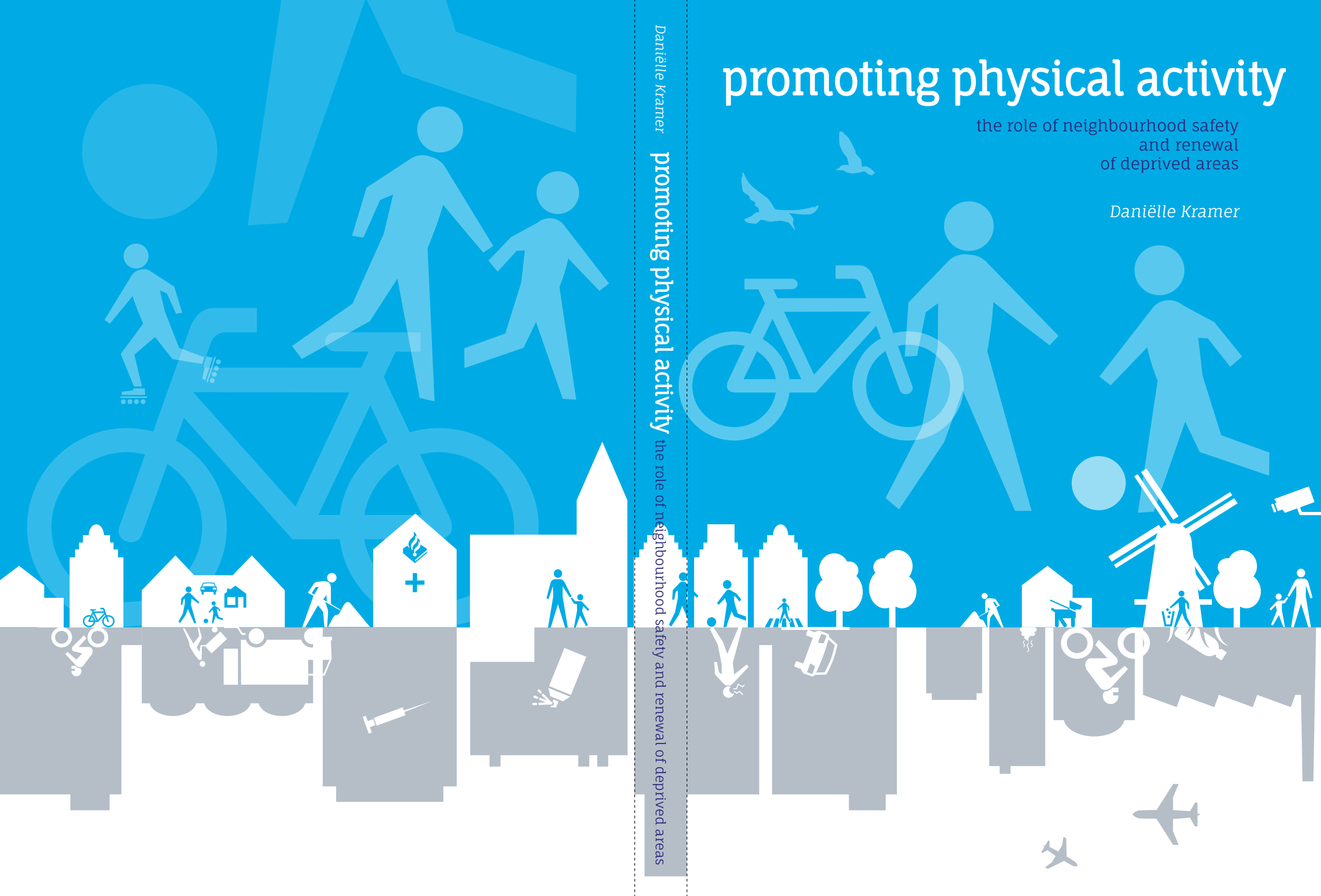
the role of neighbourhood safety
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PROMOTING PHYSICAL ACTIVITY

The role of neighbourhood safety
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Daniëlle Kramer

Colofon

Promoting physical activity: the role of neighbourhood safety and renewal of deprived areas.
PhD thesis, Academic Medical Centre – University of Amsterdam, the Netherlands

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PROMOTING PHYSICAL ACTIVITY

The role of neighbourhood safety
and renewal of deprived areas

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. D.C. van den Boom
ten overstaan van een door het college voor promoties ingestelde
commissie, in het openbaar te verdedigen in de Agnietenkapel
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Faculteit der Geneeskunde

Voor mijn ouders

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CHAPTER

1

General introduction

GENERAL INTRODUCTION

Physical inactivity is an important risk factor for many major chronic diseases such as cardiovascular disease, diabetes, and various types of cancer [1]. Worldwide, lack of physical activity (PA) has been estimated to cause 6-10% of the major chronic diseases and 9% of premature mortality [1]. To promote and maintain good health, current guidelines advise adults to engage in moderate-intensity PA for at least 30 minutes at five days of the week, or in vigorous-intensity PA for at least 20 minutes at three days of the week [2]. Worldwide, 31% of the adults do not meet these recommendations [3]. Physical inactivity is even more present in upper-middle and high income countries, where more than 40% of the adults are not physically active enough [3]. In these countries, technological advancements have reduced the amount of physical labour needed to accomplish many tasks in daily life. Transport has become more motorized, and manual labour has been replaced by machines. Therefore, in these countries, leisure-time physical activity (LTPA) has become increasingly more important to meet recommended levels of PA. However, only 39% of the adult European population engage in some or a lot of LTPA [4].

CORRELATES OF LEISURE-TIME PHYSICAL ACTIVITY

Understanding why some adults do and others do not engage in LTPA is essential for the development of effective public health interventions. Traditionally, research on determinants of health behaviours like LTPA has primarily focused on individual-level factors [5]. The most prominent individual-level theories come from the field of social psychology and include theories such as the Theory of Reasoned Action and its extended version Theory of Planned Behaviour [6], and the Health Belief Model [7]. These theories state that human behaviours like LTPA are influenced by a variety of psychosocial factors such as attitude, perceived social norm, perceived behavioural control, self-efficacy, perceived benefits and barriers, and perceived threat. However, LTPA promotion interventions that have employed such individual approaches have generally produced only small, short-term changes in LTPA [8].

In the past two decades, LTPA research has shown an increased interest in social-ecological models[8-12]. “Ecological” refers to peoples’ transactions with their physical and social environments. These models posit that health behaviours like LTPA are not only shaped by individual-level determinants, but also by various environmental-level determinants. Influences on LTPA may interact across these levels. Therefore, interventions that target both individuals and their environment are suggested to be most effective in producing long-term, population-wide LTPA

changes. The neighbourhood environment may be of particular interest, because this is the most frequently used setting for LTPA [13,14].

Since the introduction of the social-ecological model, a large number of studies have explored possible neighbourhood environmental correlates of LTPA. Several reviews have shown that it is important to study purpose-specific PA behaviours, as environmental correlates of LTPA are different from those of PA for transport reasons [15-19]. Most of the reviews have focused on leisure-time walking. These reviews have documented positive associations of leisure-time walking with neighbourhood aesthetics and with the presence, proximity, and quality of sidewalks and LTPA facilities [15,17,19]. Another review has found consistent associations of leisure-time sports with the availability of PA equipment and the amount of social support, and some evidence for associations with convenience of recreational facilities [16]. The majority of studies in these reviews originated from America or Australia. A recent review of European studies found evidence of associations of a composite recreational walking and cycling measure with traffic safety, and of total LTPA with quality of the neighbourhood environment [18]. In contrast with non-European reviews, there was no support for associations with neighbourhood aesthetics or recreational facilities.

NEIGHBOURHOOD SAFETY AND LEISURE-TIME PHYSICAL ACTIVITY

There is inconsistent empirical support for the role of neighbourhood safety in LTPA [15,16,17,19-21]. Poor neighbourhood safety may be perceived by residents as threatening and hence cause stress or fear [20-24]. To try and alleviate this fear, adults may minimize their exposure to potentially dangerous places by avoiding them. Hence, LTPA levels may decrease. Inconsistencies in the evidence on the role of neighbourhood safety in LTPA may be due to the complexity of the relation.

First, adults may not only engage in PA for different purposes (leisure or transport), but they may also engage in different types of LTPA. One might expect that the neighbourhood environment is most likely to affect LTPA that is performed in public spaces. This suggests that adults are less likely to be affected by neighbourhood safety when working out at the gym or when gardening, than when walking in the park, cycling on a trail, or jogging in the streets. Use of generic LTPA measures may obscure such differences. Research provides some support for the use of specific PA measures. Two reviews found more convincing evidence for an association between the neighbourhood environment and PA when looking at specific types of PA (e.g. sports, walking) rather than general PA [16,25].

Second, poor neighbourhood safety may have many causes. To be able to develop effective interventions, it is important to identify which issues are at the core of the problem. Studies on environmental determinants of LTPA usually distinguish between personal safety (also referred to as fear of crime) and traffic safety [15-17,19]. While traffic safety has one clear underlying cause (i.e. traffic), personal safety may have many underlying causes. Traditionally, research has focused on criminal victimization as the main underlying cause. However, personal safety concerns are far more widespread than crime, suggesting alternative causes [26-28]. The incivilities thesis posits that personal safety concerns are partly caused by physical (e.g. litter, graffiti) and social disorder (e.g. public drinking, drug use, youth gangs) [29]. Residents may interpret disorder as a sign that fellow residents and officials are unable or unwilling to preserve order, causing them to feel personally at risk of more serious crime. There is strong evidence for an association between disorder and personal safety concerns [30,31], but there is limited evidence on its relation with LTPA.

Studies on personal safety and PA have usually applied generic safety measures that make no explicit reference to the underlying cause, or composite safety measures that combine various causes into one overall measure [20,21]. These measures lack specificity and may obscure possible associations of LTPA with specific safety problems. Studies that have explored associations of specific safety problems with LTPA have most often focused on only one or two problems. Comparability of the results of these studies is limited due to differences in settings and in measurement of PA and safety. Only few studies have simultaneously explored associations of various specific safety problems on LTPA. For example, in Australia, traffic problems and social disorder were found to be significantly associated with lower levels of leisure-time walking, while there was no evidence for the role of crime and mixed evidence for the role of physical disorder [32]. In America, crime, physical disorder, social disorder, and traffic safety were all found to be significantly associated with lower levels of leisure-time walking [33]. More research is needed in countries other than America and Australia [16,21].

Third, neighbourhood safety may be more strongly related to LTPA behaviour in some socio-demographic groups than in others. Women, elderly, ethnic minorities, and individuals with lower socio-economic status more often report poor neighbourhood safety than their counterparts [20,21,23,34]. These groups are suggested to be more concerned about safety because of higher physical and social vulnerability, which causes them to feel more at risk of crime [21,23]. As a result, they may be more inclined than other groups to avoid potentially dangerous places and hence reduce their levels of LTPA. There is some evidence that poor neighbourhood safety may constrain PA, particularly among women and older adults, but more research is needed to corroborate these findings [20,21,34].

RESIDENTIAL SELF-SELECTION

Most of the evidence on the relation between neighbourhood safety and LTPA has been derived from cross-sectional studies [21,34]. This type of study is vulnerable to bias due to residential self-selection [35,36]. Self-selection entails that people who are active or who like to be active go live in neighbourhoods that facilitate PA. Thus, high levels of LTPA in safe neighbourhoods may not be the result of adults getting active because of good neighbourhood safety, but of active adults choosing to live in safe neighbourhoods. Cross-sectional studies that do not account for this self-selection bias may overestimate associations of neighbourhood safety with LTPA [35,36].

There is limited understanding of the role of residential self-selection in the relation between neighbourhood safety and LTPA. A handful of studies on neighbourhood safety and general PA have taken self-selection into account by looking at changes in neighbourhood safety over time in relation to PA. This study design minimizes the chance of self-selection bias by controlling for factors that remain stable over time, including residential preferences [37]. An Australian study by Humpel et al. [38] provided evidence for an association of traffic safety with PA beyond residential self-selection. They found that men who perceived traffic safety to have become less of a problem over a 10-week period of time, were less likely to have increased their walking, while women were more likely to have increased their walking in this time period. Two Dutch studies by Jongeneel-Grimen et al. [39,40] also provided evidence for an association of neighbourhood safety with PA beyond residential self-selection. They found that adults were more likely to participate in PA when living in neighbourhoods that showed more favourable changes in self-reported traffic safety, fear of crime, physical order, and social order over the past years. Additional research along the lines of Jongeneel-Grimen et al. [39,40] is needed with purpose-specific PA measures.

AREA-BASED INEQUALITIES IN LEISURE-TIME PHYSICAL ACTIVITY

Adults that live in deprived neighbourhoods report lower levels of LTPA than adults living in non-deprived neighbourhoods [41-43]. In Perth, Australia, 60.7% of the adults in deprived neighbourhoods participated in leisure-time walking and 40.7% participated in sports, compared to 76.8% and 53.6%, respectively, of adults in non-deprived neighbourhoods [41]. In Melbourne, Australia, 13.2% of the adults in the most deprived neighbourhoods cycled at least once a month for recreational purposes, compared to 18.7% in the least deprived neighbourhoods [43]. In Eindhoven, the Netherlands, 82.6% of the adults in the most deprived

neighbourhoods were found to walk, cycle, or garden in leisure time and 37.1% participated in sports, compared to 87.4% and 54.6%, respectively, of the adults living in the least deprived neighbourhoods [42].

These findings raise questions about the mechanisms responsible for area-based inequalities in LTPA. Inequalities cannot entirely be explained by individual-level factors, as associations between neighbourhood deprivation and LTPA have been found to persist even after taking differences in demographic and socio-economic characteristics into account [42,43]. It has been suggested that LTPA inequalities may partly be the result of differences in environmental conditions, such as neighbourhood safety [41-43]. Adults living in deprived neighbourhoods have reported more safety concerns, and more crime and disorder, as well as lower levels of neighbourhood attractiveness, less public recreational facilities, less social support, and lower levels of trust and social cohesion than adults living in non-deprived neighbourhoods [41,44-46]. There is some evidence to suggest that area-based LTPA inequalities can be explained by differences in environmental conditions. In the Netherlands, area-based inequalities in leisure-time walking, cycling, and gardening were found to be partly mediated by differences in general physical neighbourhood design, and inequalities in sports participation were partly mediated by differences in required police attention [42]. In Australia, area-based inequalities in leisure-time cycling were partly mediated by objectively measured neighbourhood aesthetics, but not by objectively measured neighbourhood design, safety, or destinations [43].

In the past two decades, numerous area-based initiatives (ABIs) have been implemented in deprived areas across Western-Europe, with the aim to improve the physical and social conditions in these areas as well as the socio-economic position of its residents [47-49]. ABIs take a vastly different approach than the urban renewal programmes that were popular in the 1960's, 70's, and 80's [47,48]. These urban renewal programmes primarily aimed to improve the physical appearance of deprived areas, without paying much attention to its residents and the social neighbourhood conditions. From the 1990's onwards, urban policies took on a more area-based and integral approach. Public-private partnerships were developed, residents were more involved in the approach, and areas were given the autonomy to develop a set of interventions tailored to their local situation.

Though they do not explicitly aim to improve LTPA, ABIs have the potential to stimulate LTPA in deprived areas by improving neighbourhood safety and other neighbourhood conditions known to be associated with LTPA, such as neighbourhood aesthetics, infrastructure, PA facilities, and social networks. ABIs may improve neighbourhood safety by tackling underlying safety problems such as crime and disorder [21,30,31]. Moreover, they may improve neighbourhood safety by improving physical and social neighbourhood conditions [21,30,31]. Improving the physical

design of the neighbourhood may improve opportunities for surveillance from fellow residents, which may cause people to feel less at risk of crime and disorder, and hence reduces fear and safety concerns. Alternatively, strengthening the social networks in the neighbourhood may safeguard against the fear resulting from poor physical neighbourhood conditions by making people feel less vulnerable to crime.

THE IMPACT OF AREA-BASED INITIATIVES

ABIs can be regarded as “natural experiments” and may be useful to generate more evidence for the impact of area-level policies on LTPA and neighbourhood conditions such as area safety in deprived areas [50,51]. Though many researchers have expressed the need for natural experimental studies, only very few ABIs have been scientifically evaluated for their impact on neighbourhood safety [52] or health, let alone LTPA [50,51,53]. Studies that have done so have generally evaluated smaller scale interventions, such as park upgrades, new cycling infrastructure, new greenway trail, or extra street lighting to enhance PA [36], and home security improvements, extra street lighting, or installation of closed-circuit television systems to improve neighbourhood safety [52]. Moreover, these interventions have generally not been specifically aimed at deprived areas.

Only two ABIs were identified that have been scientifically evaluated for their impact on PA and neighbourhood safety: the Single Regeneration Budget (SRB) and the New Deal for Communities (NDC). Both have been launched by the English government. In 1994, the SRB was launched with the aim to improve the economic, physical, and social conditions in local areas across England [54,55]. Between 1995 and 2001 a total of 1028 schemes were funded. Of the total SRB expenditure, 80% went to the 99 most deprived districts of England [54]. Because of the large amount of schemes, a case-study-based approach was adopted to evaluate the impact of the SRB. Cases were selected from the roughly 300 schemes that were funded in 1995 and 1996. In each case study area, change in outcome variables was traced using household surveys. A baseline was established in 1996. Cross-sectional follow-up measurements were performed in 1999 and 2001. Changes in the SRB areas were compared with those in England as a whole. At 5-year follow-up, SRB areas saw larger reductions in the number of residents feeling very unsafe than the rest of England [55]. However, differences were not tested for statistical significance. There were no effects on crime, vandalism, problems with dogs, and litter.

In 1998, the NDC was launched with the aim to reduce the gap between the 39 most deprived urban areas in England and the rest of the country with respect to health, education, unemployment, crime, community, and housing and the physical

environment [56,57]. Compared to the SRB, the NDC had a more area-based focus by targeting only the most deprived areas of the country. The impact of the NDC was measured using household surveys [56,57]. A common baseline was established in 2002. Cross-sectional follow-up measurements were taken in 2004, 2006, and 2008. Changes in outcome variables in NDC areas were compared with those in non-adjacent, similarly deprived areas. At 4-year and 6-year follow-up, PA levels did not improve in NDC areas, neither when looking at absolute change, nor when looking at the change relatively to that in comparator areas [56,57]. At 6-year follow-up, NDC areas saw significantly larger reductions in the number of residents reporting victimization, and lawlessness and dereliction than similarly deprived areas [58]. There were no effects on fear of crime or feeling unsafe after dark in general. However, positive effects on fear of crime were found in areas with greater safety problems at the start of the programme and with larger safety interventions [59,60]. These findings reinforce the earlier expressed need to take variations in programme delivery and contextual factors into account when evaluating ABIs [53].

More quasi-experimental research is needed to strengthen the evidence base on the impact of ABIs on LTPA and neighbourhood safety. Existing evidence has exclusively been derived from England. It is important to extend the research to other countries, as the impact of ABIs may depend on the context in which it is implemented. Moreover, to strengthen the causal inferences that can be drawn from natural experimental studies, the Medical Research Council guidance has advised researchers to include multiple pre and post measurements of the outcome (as in an interrupted time series design), multiple intervention and control groups, and potential confounders [51]. So far, none of the SRB and NDC evaluation studies have incorporated all advises.

UNDERLYING PATHWAYS

To be able to improve future ABIs, it is important to not only know whether an intervention was successful, but to also understand how it worked, why it was successful or not, and for whom. Several studies have expressed the need to know more about the pathways by which ABIs produce change [36,53]. The realist approach has been opted as a useful approach to uncover the inner workings of complex programmes like ABIs [61,62]. The key aim of this explanatory and theory driven evaluation approach is to uncover how a programme works, for whom, and in what conditions. The realist approach has already been applied in a wide range of fields, including sociology, psychology, and economics, but only few studies in the field of public health have adopted this approach [62].

Three concepts are central to the realist approach: mechanisms, contexts, and outcomes [61,62]. *Mechanisms* refer to the choices and capacities that are offered to a person by the programme. They answer the question of how a programme produces change. Mechanisms are only active when the programme is active. They are often hidden and should not be confused with programme components. Whether and how these mechanisms are acted upon by the person and what *outcomes* they produce, depends on the *context* in which they are implemented. The context will always exist, even if the programme is not active. The context consists of many layers, from the individual level to the interpersonal, institutional, and infra-structural systems surrounding the individual. They answer the question of for whom and in what conditions a programme produces change.

Realist approach posits that programmes are always based on underlying assumptions about how an intervention is assumed to work, in what conditions, and with what outcomes [61,62]. This is called the programme theory. A realist study starts by identifying the underlying programme theory. The programme theory can be identified using discussions with experts, or by searching the literature. Then, empirical evidence is gathered to test and refine this theory. This process differs between the two types of realist studies: realist review and realist evaluation. A realist review aims to explore the inner workings of a particular programme that may be implemented in a wide range of contexts, e.g. an ABI. Evidence to test and refine the programme theory is collected by means of a review of the peer-reviewed literature. In contrast with traditional systematic reviews, this type of review is interested in mechanisms rather than effect sizes and is purposive and iterative. A realist evaluation aims to explore the inner workings of a particular programme that has been implemented in a particular context, e.g. a specific intervention that has been implemented in a specific area. Evidence to test and refine the programme theory is gathered from interviews with practitioners, observations, reports, policy documents, etc.

THE NETHERLANDS

The Netherlands may be a particularly interesting country to assess associations of neighbourhood safety with LTPA, and the impact of ABIs on both aspects. Prevalence of LTPA in the Netherlands is among the highest in Europe, with 58% of all adults engaging in some or a lot of LTPA [4]. Moreover, the number of cyclists in the Netherlands is the largest around the world, offering the chance to explore this much less studied component of LTPA [63,64]. Though levels of LTPA are generally high in the Netherlands, prevalence rates differ between areas. In the most disadvantaged neighbourhoods of the city Eindhoven, 82.6% of the adults have been found to walk,

cycle, or garden in leisure-time and 37.1% engage in sports, compared to 87.4% and 54.6%, respectively, in the most advantaged neighbourhoods [42]. In the forty most deprived districts of the Netherlands, 64.7% of adults have been found to engage in moderate-intensity PA, compared to 68.9% in other districts within the same cities [65].

In 2007, the Dutch government launched an ABI called the District Approach [66]. The District Approach aimed to reduce problems related to employment, education, housing and the physical environment, safety, and social cohesion in the forty most deprived districts of the Netherlands. The forty districts are spread across 18 cities, of which most have a strong urban character. Districts were selected based on their accumulation of economic, physical, and social problems, judged on statistics and survey data. Each district was given the autonomy to develop a set of locally tailored interventions, as long as they addressed the five core problems mentioned above. As a result, there were large between-district variations in the interventions that were implemented [67]. Examples of interventions that aimed to improve the physical and social neighbourhood environment include housing renovations, demolition and building of housing estates, extra trees, upgrading of parks and playgrounds, upgrading of the walking and cycling infrastructure, more police surveillance, extra maintenance of public space, extra waste facilities, and extra leisure and sports activities and facilities [see Droomers et al. [67] for more detailed information on the content and scale of implemented interventions]. The District Approach provides the opportunity to extend the research on the impact of ABIs on neighbourhood safety and LTPA to countries other than England.

AIMS AND RESEARCH QUESTIONS OF THIS THESIS

The overall aim of this thesis is to assess the interplay of LTPA, self-reported neighbourhood safety, and ABIs in deprived areas. More specifically, this thesis aims to assess relations of neighbourhood safety with LTPA among Dutch adults, and the impact of ABIs like the Dutch District Approach on neighbourhood safety and LTPA among adults in deprived areas. Three specific research questions are addressed:

1. To what extent are general neighbourhood safety and specific safety problems associated with leisure-time walking, cycling, and sports in Dutch adults?
2. To what extent and how is the Dutch District Approach associated with changes in general neighbourhood safety and specific safety problems as reported by adult residents of deprived target districts?
3. To what extent and how is the Dutch District Approach associated with changes in leisure-time walking, cycling, and sports among adult residents of deprived target districts?

OUTLINE OF THIS THESIS

This thesis consists of three parts (figure 1). **Part I** consists of **chapters 2 to 4** and focuses on the first research question “To what extent are general neighbourhood safety and specific safety problems associated with leisure-time walking, cycling, and sports in Dutch adults?” **Chapter 2** reports on associations of self-reported general safety, physical order, social order, crime safety, and traffic safety with leisure-time walking and cycling. In addition, differences in association by age, gender, and educational level are described. **Chapter 3** reports on the associations of self-reported neighbourhood social safety with leisure-time sports at various locations. **Chapter 4** describes associations of levels of self-reported neighbourhood safety at one point in time as well as *changes* in self-reported neighbourhood safety over time with leisure-time walking, cycling, and sports.

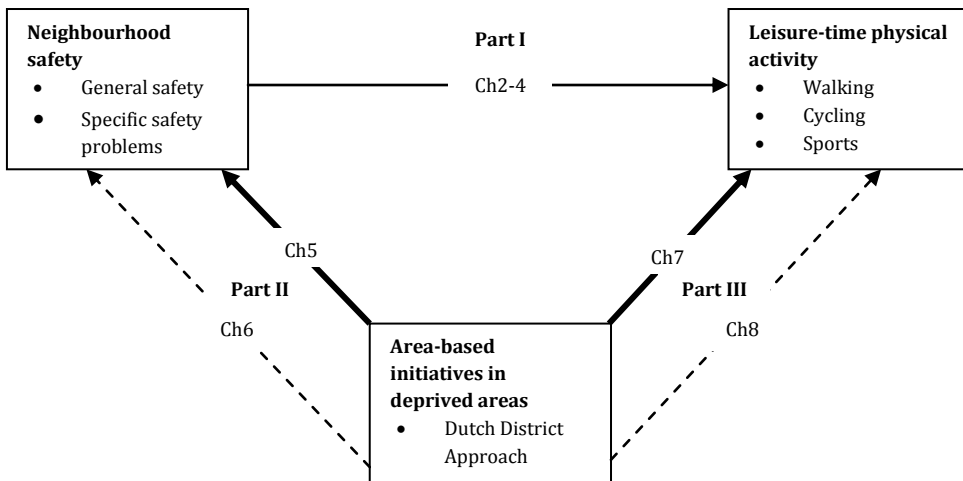


FIGURE 1. Framework of the research outlined in this thesis. → cross-sectional study design. → quasi-experimental design. - → realist design.

Part II consists of **chapters 5 and 6** and focuses on the second research question “To what extent and how is the Dutch District Approach associated with changes in general neighbourhood safety and specific safety problems as reported by adult residents of deprived target districts?” **Chapter 5** describes the results of a quasi-experimental study in which we explored to what extent the District Approach was associated with changes in trends of self-reported general safety, physical order, social order, and criminal non-victimization in deprived target districts. **Chapter 6** presents the results of a realist evaluation in which we explored how a specific

neighbour nuisance intervention had an impact on neighbourhood safety as reported by adults residents of four deprived districts in Arnhem.

Part III consists of **chapters 7 and 8** and focuses on the third research question “To what extent and how is the Dutch District Approach associated with changes in leisure-time walking, cycling, and sports among adult residents of deprived target districts?” **Chapter 7** describes the results of a quasi-experimental study in which we assessed to what extent the District Approach was associated with changes in leisure-time walking, cycling, and sports in deprived target districts. **Chapter 8** presents the results of a realist review in which we explored how the environmental interventions of ABIs may stimulate leisure-time walking in deprived areas.

Finally, in **chapter 9**, the main findings of part I to III are summarized and discussed in light of various methodological considerations and previous research. Furthermore, implications and recommendations for practice and research are described.

REFERENCES

1. Lee I, Shiroma EJ, Lobelo F, Puska P, Blair SB, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* 2012;380:219-29.
2. Haskell WL, Lee I, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health. Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation* 2007;116:1081-1093.
3. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet* 2012;380:247-257.
4. van Tuyckom. Macro-environmental factors associated with leisure-time physical activity: a cross-national analysis of EU countries. *Scand J Public Health* 2011;39:419.
5. Glanz K, Rimer BK, Viswanath K. *Health behavior and health education*. San Fransisco: Jossey-Bass, 2008.
6. Ajzen I. The theory of planned behaviour. *Organizational Behavior and Human Decision Processes* 1991;50:179-211.
7. Janz NK, Becker MH. The health belief model: a decade later. *Health Educ Quart* 1984;11:1-47.
8. Spence JC, Lee RE. Toward a comprehensive model of physical activity. *Psychol Sport Exerc* 2003;4:7-24.
9. Stokols D. Establishing and maintaining healthy environments. Toward a social ecology of health promotion. *Am Psychol* 1992;47:6-22.
10. Sallis JF, Bauman A, Pratt M. Environmental and policy interventions to promote physical activity. *Am J Prev Med* 1998;15:379-397.
11. Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. *Annu Rev Public Health* 2006;27:297-322.

12. Sallis JF, Owen N, Fisher EB. Ecological models of health behaviour. In: Glanz K, Rimer BK, Viswanath K (eds). *Health behavior and health education*. San Fransisco: Jossey-Bass, 2008.
13. Giles-Corti B, Knuiaman M, Timperio A, van Niel K, Pikora TJ, Bull FCL, et al. Evaluation of the implementation of a state government community design policy aimed at increasing local walking: design issues and baseline results from RESIDE, Perth Western Australia. *Prev Med* 2008;46:46-54.
14. Sugiyama T, Leslie E, Giles-Corti B, Owen N. Physical activity for recreation or exercise on neighbourhood streets: associations with perceived environmental attributes. *Health Place* 2009;15:1058-1063.
15. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking. Review and research agenda. *Am J Prev Med* 2004;27:67-76.
16. Wendel-Vos W, Droomers M, Kremers S, Brug J, van Lenthe F. Potential environmental determinants of physical activity in adults: a systematic review. *Obes Rev* 2007;8:425-40.
17. Saelens BE, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc* 2008;40:550-566.
18. van Holle V, Deforche B, van Cauwenberg J, Goubert L, Maes L, van de Weghe N, et al. Relationship between the physical environment and different domains of physical activity in European adults: a systematic review. *BMC Public Health*, 2012;12:807.
19. Sugiyama T, Neuhaus M, Cole R, Giles-Corti B, Owen N. Destination and route attributes associated with adults' walking: a review. *Med Sci Sports Exerc* 2012;44:1275-1286.
20. Loukaitou-Sideris A. Is it safe to walk? Neighborhood safety and security considerations and their effects on walking. *J Plan Lit* 2006;20:219-232.
21. Foster S, Giles-Corti B. The built environment, neighborhood crime and constrained physical activity: an exploration of inconsistent findings. *Prev Med* 2008;47:241-251.
22. Farafalo J. The fear of crime: causes and consequences. *J Crim Law Crim* 1973;72:839-857.
23. Skogan WG, Maxfield MG. *Coping with crime. Individual and neighbourhood reactions*. London: Sage Publications, 1981.
24. Evans GW, Cohen S. Environmental stress. In: Stokols D, Altman I (eds). *Handbook of environmental psychology*. New York: John Wiley & Sons, 1987.
25. Durand CP, Andalib M, Dunton GF, Wolch J, Pentz MA. A systematic review of built environment factors related to physical activity and obesity risk: implications for smart growth urban planning. *Obes Rev* 2011;12:173-182.
26. Taylor RB, Hale M. Testing alternative models of fear of crime. *J Crim Law Crim* 1986;77:151-189.
27. Covington J, Taylor RB. Fear of crime in urban residential neighborhoods: implications of between- and within-neighbourhood sources for current models. *Sociol Quart* 1991;32:231-249.
28. Ferraro KF. *Fear of crime: interpreting victimization risk*. Albany: State University of New York Press, 1995.
29. Taylor RB. The incivilities thesis: theory, measurement, and policy. In Reno J, Fisher RC, Robinson L, Brennan N, Travis J, Brann JE (Eds). *Measuring what matters*. Washington: U.S. Department of Justice, 1999.
30. Lorenc T, Clayton S, Neary D, Whitehead M, Petticrew M, Thomson H, et al. Crime, fear of crime, environment, and mental health and wellbeing: mapping review of theories and causal pathways. *Health Place* 2012;18:757-765.

31. Lorenc T, Petticrew M, Whitehead M, Neary D, Clayton S, Wright K, et al. Fear of crime and the environment: systematic review of UK qualitative evidence. *BMC Public Health* 2013;13:496.
32. Foster S, Giles-Corti B, Knuiaman M. Does fear of crime discourage walkers? A social-ecological exploration of fear as a deterrent to walking. *Environ Behav* 2012 [Epub ahead of print].
33. McGinn AP, Evenson KR, Herrin AH, Huston SL, Rodriguez DA. The association of perceived and objectively measured crime with physical activity: a cross-sectional analysis. *J Phys Act Health* 2008;5:117-131.
34. Loukaitou-Sideris A, Eck JE. Crime prevention and active living. *Am J Health Promot* 2007;21:380-389.
35. Cao X, Mokhtarian PL, Handy SL. Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. *Transport Rev* 2009;29:359-395.
36. McGormack GR, Shiell A. In search of causality: a systematic review of the relationship between the built environment and physical activity among adults. *I J Behav Nutr Phys Act* 2011;8.
37. Mokhtarian PL, Cao X. Examining the impacts of residential self-selection on travel behaviour: a focus on methodologies. *Transport Rev* 2008;42:204-228.
38. Humpel N, Marshall AL, Leslie E, Bauman A, Owen N. Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Ann Behav Med* 2004;27:60-67.
39. Jongeneel-Grimen, B, Busschers W, Droomers M, van Oers HAM, Stronks K, Kunst AE. Change in neighborhood traffic safety: does it matter in terms of physical activity? *Plos One* 2013;8:e62525
40. Jongeneel-Grimen B, Droomers M, van Oers HAM, Stronks K, Kunst AE. The relationship between physical activity and het living environment: a multi-level analyses focusing on changes over time in environmental factors. *Health Place* 2014;26:149-160.
41. Giles-Corti B, Donovan RJ. Socioeconomic differences in recreational physical activity levels and real and perceived access to a supportive physical environment. *Prev Med* 2002;35:601-11.
42. van Lenthe FJ, Brug J, Mackenbach JP. Neighbourhood inequalities in physical inactivity: the role of neighbourhood attractiveness, proximity to local facilities and safety in the Netherlands. *Soc Sci Med* 2005;60:763-75.
43. Kamphuis CBM, Giskes K, Kavanagh AM, Thornton LE, Thomas LR, van Lenthe FJ, et al. Area variation in recreational cycling in Melbourne: a compositional or contextual effect? *J Epidemiol Community Health* 2008;62:890-898.
44. Chandola T. The fear of crime and area differences in health. *Health & Place* 2001;7:105-116.
45. Wilson DK, Kirtland KA, Ainsworth BE, Addy CL. Socioeconomic status and perceptions of access and safety for physical activity. *Ann Behav Med* 2004;28:20-8.
46. Baum FE, Ziersch AM, Zhang G, Osborne K. Do perceived neighbourhood cohesion and safety contribute to neighbourhood differences in health? *Health Place* 2009, 15:925-934.
47. Andersen HT, van Kempen R. New trends in urban policies in Europe: evidence from the Netherlands and Denmark. *Cities* 2003;20:77-86.
48. Atkinson, R. European urban policies and the neighbourhood: an overview. *Urban Des Plann* 2008;161:115-122.

49. van Gent WPC, Musterd S, Ostendorf W. Disentangling neighbourhood problems: area-based interventions in Western European cities. *Urban Res Pract* 2009;2:53-67.
50. Petticrew M, Cummins S, Ferrell C, Findlay A, Higgins C, Hoy C, et al. Natural experiments: an underused tool for public health. *Public Health* 2005;119:751-757.
51. Craig P, Cooper C, Gunnell D, Haw S, Lawson K, Macintyre S, et al. Using natural experiments to evaluate population health interventions: new Medical Research Council guidance. *J Epidemiol Community Health* 2012, 66;1182-1186.
52. Lorenc T, Petticrew M, Whitehead M, Neary D, Clayton S, Wright K, et al. Environmental interventions to reduce fear of crime: systematic review of effectiveness. *Syst Rev* 2013;2:30.
53. Thomson H, Atkinson R, Petticrew M, Kearns A. Do urban regeneration programmes improve public health and reduce health inequalities? A synthesis of the evidence from UK policy and practice (1980 – 2004). *J Epidemiol Community Health* 2006;60:108-115.
54. Rhodes J, Tyler P, Brennan A. New developments in area-based initiatives in England: the experience of the Single Regeneration Budget. *Urban Stud* 2003;40:1399-1426.
55. Rhodes J, Tyler P, Brennan A. Assessing the effect of area based initiatives on local area outcomes: some thoughts based on the national evaluation of the Single Regeneration Budget in England. *Urban Stud* 2005;42:1919-1946.
56. Batty E, Beatty C, Foden M, Lawless P, Pearson S, Wilson I. *The New Deal for Communities Experience: a final assessment. Communities and local governments*. West Yorkshire: Department of Communities and Local Government, 2010.
57. Lawless P, Foden M, Wilson I, Beatty C. Understanding area-based regeneration: the New Deal for Communities Programme in England. *Urban Stud* 2010;47:257-275.
58. Lawless P. Understanding the scale and nature of outcome change in area-regeneration programmes: evidence from the New Deal for Communities programme in England. *Environ Plann C* 2011;29:520-532.
59. Foden M, Grimsley M, Lawless P, Wilson I. Linking interventions to outcomes in area regeneration. *TPR* 2010;81:151-172.
60. Lawless P, Beatty C. Exploring change in local regeneration areas: evidence from the New Deal for Communities programme in England. *Urban Stud* 2012;1-17.
61. Pawson R, Tilley N. *Realistic evaluation*. London: SAGE Publications Ltd, 1997.
62. Pawson R, Greenhalgh T, Harvey G, Walshe K. Realist review – a new method of systematic review designed for complex policy interventions. *J Health Serv Res Policy* 2005;10:21-34.
63. Bassett DR, Pucher J, Buehler R, Thompson DL, Crouter SE. Walking, cycling, and obesity rates in Europe, North America, and Australia. *J Phys Act Health* 2008;5:795-814.
64. Pucher J, Buehler R. Making cycling irresistible: lessons from the Netherlands, Denmark and Germany. *Transport Rev* 2008;28:495-528.
65. Ruijsbroek A, Droomers M, Kunst AE, van den Brink. Gezondheid en leefstijl in de krachtwijken: een verkenning. *Tijdschr Soc Geneesk* 2011;89:214-221.
66. Vogelaar E. *Actieplan krachtwijken; van aandachtswijk naar krachtwijk*. Den Haag: Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 2007.
67. Droomers M, Harting J, Jongeneel-Grimen B, Rutten L, van Kats J, Stronks K. Area-based interventions to ameliorate deprived Dutch neighborhoods in practice: does the Dutch District Approach address the social determinants of health to such an extent that future health impacts may be expected? *Prev Med* 2014;61:122-127.

PART

I

**Neighbourhood safety
and physical activity**

CHAPTER 2

Neighbourhood safety and leisure-time physical activity among Dutch adults: a multilevel perspective

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ABSTRACT

Background Several neighbourhood elements have been found to be related to leisure-time walking and cycling. However, the association with neighbourhood safety remains unclear. This study aimed to assess the association of neighbourhood-level safety with leisure-time walking and cycling among Dutch adults.

Methods Data were derived from the national health survey (POLS) 2006-2009, with valid data on 20046 respondents residing in 2127 neighbourhoods. Multilevel logistic regression models were used to examine the association between neighbourhood-level safety (general safety and specific safety components: physical disorder, social disorder, crime-related fear, traffic safety) and residents' engagement in outdoor leisure-time walking and cycling for at least 30 minutes per week.

Results An increase in neighbourhood safety (both general safety and each of the safety components) was significantly associated with an increase in leisure-time cycling participation. Associations were strongest for general safety and among older women. In the general population, neighbourhood safety was not significantly associated with leisure-time walking. However, among younger and older adult men and lower educated individuals, an increase in general safety was associated with a decrease in leisure-time walking participation.

Conclusions In the Netherlands, neighbourhood safety appears to be related to leisure-time cycling but not to walking. Leisure-time cycling may best be encouraged by improving different safety components at once, rather than focusing on one safety aspect such as traffic safety. Special attention is needed for older women.

Keywords physical activity, walking, cycling, safety, crime, environment

BACKGROUND

Leisure-time walking and cycling may be appropriate types of physical activity (PA) to achieve current PA recommendations, since they are easy to implement in daily life with low cost and little risk of injury. The most effective ways to encourage these types of PA in adults are yet uncertain. Traditionally, focus has been on individual-level determinants of PA. Recently, a complementary ecological approach has been taken on which postulates that PA is also influenced by the individuals' living environment [1].

To create neighbourhood environments that encourage leisure-time walking and cycling, it is important to understand which neighbourhood elements are most strongly related to these types of PA. According to a recent review, no firm conclusions can be drawn on environmental determinants of cycling due to lack of studies on this topic [2]. Leisure-time walking has been studied more extensively. Pedestrian infrastructure and neighbourhood aesthetics have consistently been found to be associated with leisure-time walking [3]. There is less consistent empirical support for other neighbourhood elements.

One of these elements is neighbourhood safety. Some studies have found a positive association between general neighbourhood safety and walking in leisure time [4,5], but most studies did not find an association [6-13]. Many of the studies on neighbourhood safety have used a composite measure, in which various safety components (e.g. traffic, crime, disorder) are combined into one comprehensive safety variable [4,6,7,9-12]. The use of such combined safety indicators might obscure the effects of the specific safety components.

Studies on specific safety components have most often explored the role of traffic safety. Inoue et al. [14] found that people who perceived good traffic safety were 1.5 times more likely to walk in leisure-time than those who perceived poor traffic safety. However, much other research has found inconsistent [5,15,16] or no associations [6,7,17-20] between traffic safety and walking. With regard to crime safety, again, results are inconsistent. Shigematsu et al. [18] found respondents' perceptions to be associated with leisure-time walking, but only in some age groups. Other studies have found no association at all [6,14,17,20,21]. Only few studies have explored the role of neighbourhood disorder. Cleland et al. [16] found limited evidence of a positive association with leisure-time walking. Absence of physical neighbourhood disorder was positively associated with maintaining high levels of leisure-time walking between baseline and follow-up, but not with three other leisure-time walking outcomes. Other studies did not find any significant association of leisure-time

walking with indicators of neighbourhood disorder such as garbage, graffiti or public drunkenness [6,7].

Comparability of these results is limited, due to differences in settings, PA measures, and safety measures. Therefore, it is hard to determine the relative impact of each specific safety component on leisure-time walking behaviour. Studies are needed that simultaneously explore the association of various safety components with leisure-time walking. To our knowledge, there is only one American study that has explored multiple safety components [6]. The authors found no association between leisure-time walking and objective measures of criminal offenses, traffic-related offenses, physical disorder and social disorder.

As the latter study [6], most studies on safety and leisure-time walking have been performed in America and Australia [2,22]. European studies on this topic are rare. Yet, results may be different in Europe because PA patterns as well as the safety situation of neighbourhoods may differ [23,24]. For example, the association of leisure-time PA with crime and traffic safety may be less strong, because of safer traffic and lower crime rates in deprived neighbourhoods in Europe compared to America [23]. Within Europe, the Netherlands may be a particularly interesting country to explore the associations between neighbourhood safety and leisure-time PA. Due to high prevalence rates of walking and cycling [25], it offers the opportunity to explore the association of neighbourhood safety with both walking and the much less studied PA component cycling. The current evidence on the environmental correlates of cycling mainly comes from the transportation literature and has focused on cycling for transport rather than cycling in leisure time [17,20,26,27]. The one study on leisure-time cycling found no significant association with general safety [28].

The aim of the current study is to explore the association of neighbourhood-level safety with leisure-time walking and cycling in a large sample of Dutch adults. First, the association of general safety with leisure-time walking and cycling will be explored. Next, we will explore whether these associations are different for specific safety components. Following McGinn et al. [6], the safety components will include physical disorder, social disorder, crime-related fear and traffic safety. In a last step, we will explore whether associations differ by subpopulation. A review of Foster et al. [22] has postulated that associations may differ according to age, gender, education, and residential density of the neighbourhood. Women, elderly and lower educated tend to feel more vulnerable which may manifest itself in a stronger association of safety with leisure-time walking and cycling. Further, we postulate that in the Netherlands, densely populated areas may provide increased natural surveillance from both houses and pedestrians, which may make people feel less vulnerable to unsafe situations. If so, this would result in a weaker effect of safety on leisure-time

walking and cycling in densely populated areas. Little research has focused on these differences.

METHODS

Study population

Cross-sectional data on individual characteristics and leisure-time walking and cycling behaviour were obtained from the Dutch national health survey of 2006 to 2009, which is part of the yearly administered Dutch Integrated Survey on Household Living Conditions (POLS). A random nationwide sample of in total 57,281 non-institutionalized persons was drawn from the national population registry. Selected individuals were approached by an interviewer and asked to participate in an interview and, if 12 years and older, to fill in an additional paper-and-pencil survey on specific health topics, including PA. There was a non-response of 36% for the interview, with an additional 16% non-response for the survey. Due to the age restriction, 16% of the sample was not eligible to complete the paper-and-pencil survey. A total of 25,206 persons of 12 years and older completed the survey.

Cross-sectional data on residents' perceptions of neighbourhood safety were obtained using the three-yearly conducted Dutch Housing Questionnaire (WoON) of 2006. A random nationwide sample of 113,837 non-institutionalized adults (18 years and older) was approached by phone and asked to complete an interview either by phone, face to face, or on paper. There was a non-response of 42%. A total of 64,005 adults from 3,495 neighbourhoods completed the survey. To assess the safety situation in each neighbourhood at large, we constructed neighbourhood-level safety scores by averaging the scores of all WoON respondents living in the same neighbourhood. Neighbourhood-level safety data from the WoON survey were linked to individual-level data from the Dutch national health survey using the 4-digit zipcode.

From the POLS data, we excluded respondents younger than 18 (N= 2,237), respondents whose neighbourhood-level safety scores have been based on less than five observations in the WoON survey (N=2,369) and respondents with unrealistic and missing PA scores (N=554 for walking, N=566 for cycling). PA scores were classified as unrealistic if the score exceeded 3360 minutes per week, which equals 8 hours each day of the week. A total remained of 20,046 POLS respondents with valid walking scores and 20,034 respondents with valid cycling scores, living in 2,127 neighbourhoods.

Measures

Leisure-time walking and cycling

Self-reported PA was measured in POLS using the Dutch Short QUestionnaire to ASsess Health-enhancing PA (SQUASH). This instrument has shown to be fairly reliable and valid, especially for large samples [29,30]. Respondents were asked to report the frequency (number of days) and duration (hours and minutes per day) of leisure-time walking and cycling and other PA activities in a typical week. Total minutes per week spent on walking and cycling in leisure time were calculated.

The distribution of leisure-time walking and cycling was highly skewed with 37% reporting zero minutes of leisure-time walking per week and 45% of respondents reporting zero minutes of cycling. Therefore, instead of using a continuous outcome measure, dummy variables were created for leisure-time walking and cycling by classifying respondents as 'inactive' (less than 30 minutes per week) versus 'active' (at least 30 minutes per week) levels. In other PA studies, respondents have often been classified on the basis of the WHO recommendation of 150 minutes per week. However, this 150 minutes cut-off point applies to overall levels of PA. In this study, we used a lower cut-off point because we focused on two specific components of PA (walking and cycling). Sensitivity analyses showed that the results of the present study are robust against alternative cut off points for leisure-time walking or cycling (0 or 60 minutes per week).

Neighbourhood safety

We measured four specific safety components, based on the distinctions made by McGinn et al. [6]: physical disorder, social disorder, crime-related fear and traffic safety.

Physical disorder

Physical disorder was assessed using the five items 'graffiti on walls and buildings', 'devastation of phone booths and bus-/tram booths', 'rubbish on the street', 'dog faeces on the street' and 'smell, dust and/or dirt'. All items used a three-point Likert scale ranging from 1 (often) to 3 (never). The physical disorder scale was computed by taking the average score of these five items. Alpha reliability analyses have been performed to determine the internal consistency of this scale. Cronbach's alpha was 0.73, indicating good reliability.

Social disorder

Social disorder was assessed using the three items 'nuisance from direct neighbours', 'nuisance from other neighbourhood residents' and 'nuisance from youth'. All items

used a three-point Likert scale ranging from 1 (often) to 3 (never). A social disorder scale was computed by taking the average score of these three items. Cronbach's alpha was 0.76, indicating good reliability.

Crime-related fear

Crime-related fear was assessed using the one item 'I am afraid to be troubled or robbed in this neighbourhood'. Answers were on a three-point Likert scale ranging from 1 (often) to 3 (never).

Traffic safety

Traffic safety was assessed using the one item 'I think the traffic situation in this neighbourhood is safe'. This item used a five-point Likert scale ranging from 1 (totally agree) to 5 (totally disagree). The two upper and lower scores have been combined, resulting in a three point Likert scale ranging from 1 (agree) to 3 (disagree).

All four safety variables were coded such that a higher score indicated higher perceived safety. The general safety scale has been composed by computing the average score on the four safety components. Cronbach's alpha was 0.68, indicating fair reliability.

The measures above were constructed for the individual respondents of the WoON survey. Neighbourhood-level safety variables were constructed for each of the five safety measures by computing the average of the safety scores of all respondents living within the same 4-digit zipcode. All five neighbourhood-level safety variables were measured as continuous variables ranging from 1 (not safe) to 5 (very safe).

Potential confounders

Potential individual-level confounders that have been measured are age (continuous), gender, household composition (five categories), ethnicity (four categories) and socioeconomic status (SES). Three indicators of SES were included: education (five ordinal groups), disposable household income (five quintiles of net income in Euros) and disposable household wealth (five quintiles of the assembly of assets and debts in Euros). Age, gender, household composition and education have been assessed using the POLS questionnaire. Ethnicity was derived from the national population registry. Information on household income and wealth was obtained from the national tax registration. A potential neighbourhood-level confounder that has been included is population density (five ordinal groups). Population density has been estimated for each neighbourhood using data on the address density of the wider municipality. Data on address density has been derived from Statistics Netherlands.

Statistical methods

To take the sampling design of the POLS survey into account, prevalence of leisure-time walking and cycling were weighted for age, gender, marital status, household size, urbanization, province, and month of survey. The associations of (specific components of) neighbourhood safety with leisure-time walking and cycling were assessed by means of odds ratios derived from multilevel logistic regression analysis. Level 1 represented individuals, level 2 represented the neighbourhoods. A three-stage modelling approach was used to make a stepwise adjustment for age, gender, household composition, ethnicity (model 1), education, household income, household wealth (model 2) and population density (model 3). Each potential confounder was included as a set of dummy variables. Subpopulation analyses were performed using model 3. Potential effect-modification by age-gender, education and neighbourhood population density was investigated by entering interaction terms in the model. Intraclass Correlation Coefficient (ICC) was estimated using Rho to display the proportion of total variance in leisure-time walking and cycling that is attributable to the neighbourhood level. Associations were weighted using a complex survey sample design with sample weights. Results were almost identical to those presented below. For all analyses, statistical significance was set at 0.05. Analyses were carried out using the STATA 11.0 software.

This study was based on secondary analyses of anonymized data by Statistics Netherlands (the "CBS"), with approval of the CBS authority for privacy protection. This authority has the responsibility to guarantee that all activities of the CBS are in strict agreement the Dutch laws for the protection of privacy of residents and subjects.

RESULTS

TABLE 1. Weighted prevalence of leisure-time walking and cycling among the valid study population and various subgroups

| Population | N with valid PA scores | Leisure-time walking | | Leisure-time cycling | |
|-----------------|---------------------------|---------------------------|--------------|---------------------------|-----------------------|
| | | % N \geq 30 min/week | Mean (SD) | % N \geq 30 min/week | Mean min/week (SD) |
| Total | 20046 | 61.9 | 158 (265) | 52.5 | 131 (267) |
| Men | | | | | |
| 18-30 years old | 1492 | 42.8 | 97 (276) | 42.8 | 97 (267) |
| 31-45 years old | 2542 | 58.5 | 121 (232) | 48.8 | 90 (214) |
| 46-65 years old | 3557 | 64.6 | 169 (254) | 54.1 | 140 (288) |
| > 65 years old | 1870 | 59.8 | 185 (266) | 56.8 | 204 (331) |
| Women | | | | | |
| 18-30 years old | 1703 | 58.5 | 130 (268) | 49.0 | 97 (227) |
| 31-45 years old | 2913 | 68.3 | 167 (272) | 57.7 | 126 (266) |
| 46-65 years old | 3718 | 70.4 | 196 (289) | 60.8 | 160 (276) |
| > 65 years old | 2251 | 58.7 | 172 (241) | 40.8 | 128 (238) |

TABLE 2. Association of individual and neighbourhood characteristics with leisure-time walking and cycling.

| | % N | Odds Ratio (95% CI) Model 3 ^a | |
|--------------------------------------|---------|--|----------------------|
| | | Leisure-time walking | Leisure-time cycling |
| Individual characteristics | | | |
| Age (years) | 49 ± 17 | 1.01 (1.01 - 1.01)* | 1.00 (1.00 - 1.00) |
| Gender | | | |
| Men | 47.2% | 1.00 | 1.00 |
| Women | 52.8% | 1.46 (1.38 - 1.55)* | 1.18 (1.12 - 1.25)* |
| Ethnicity | | | |
| Native (Dutch) | 87.1% | 1.00 | 1.00 |
| Non-native, Western | 6.4% | 1.19 (1.06 - 1.35)* | 0.84 (0.75 - 0.95)* |
| Non-native, non-Western | 3.5% | 1.16 (0.99 - 1.37) | 0.54 (0.45 - 0.63)* |
| Non-native, origin unknown | 2.9% | 0.90 (0.76 - 1.06) | 0.68 (0.58 - 0.81)* |
| Household composition | | | |
| Married/partner, no children | 37.8% | 1.00 | 1.00 |
| Married/partner with child(ren) | 39.9% | 0.93 (0.87 - 1.01) | 0.94 (0.87 - 1.01) |
| Single, no children | 17.2% | 0.74 (0.68 - 0.81)* | 0.77 (0.71 - 0.84)* |
| Single with child(ren) | 4.4% | 0.70 (0.60 - 0.81)* | 0.75 (0.65 - 0.87)* |
| Unknown | 0.8% | 0.59 (0.43 - 0.80)* | 0.77 (0.56 - 1.06) |
| Education | | | |
| Tertiary education | 26.3% | 1.00 | 1.00 |
| Secondary education: upper level | 35.5% | 0.73 (0.67 - 0.79)* | 0.79 (0.74 - 0.86)* |
| Secondary education: mid level | 8.5% | 0.65 (0.58 - 0.73)* | 0.73 (0.65 - 0.82)* |
| Secondary education: lower level | 14.8% | 0.58 (0.52 - 0.64)* | 0.73 (0.66 - 0.81)* |
| Primary education | 14.6% | 0.42 (0.38 - 0.47)* | 0.48 (0.43 - 0.53)* |
| Unknown | 0.3% | 1.08 (0.61 - 1.91) | 0.63 (0.38 - 1.06) |
| Household income (€) | | | |
| >29.900 | 20.9% | 1.00 | 1.00 |
| 23.600 - 29.900 | 20.5% | 1.02 (0.93 - 1.12) | 1.04 (0.95 - 1.14) |
| 19.200 - 23.600 | 20.1% | 1.00 (0.91 - 1.10) | 1.15 (1.04 - 1.26)* |
| 15.200 - 19.200 | 19.8% | 1.03 (0.93 - 1.13) | 1.21 (1.09 - 1.33)* |
| <15.200 | 17.8% | 0.95 (0.85 - 1.05) | 1.11 (0.99 - 1.23) |
| Unknown | 1.1% | 0.93 (0.70 - 1.25) | 1.06 (0.79 - 1.41) |
| Household wealth (€) | | | |
| >293.469 | 15.1% | 1.00 | 1.00 |
| 148.000 - 293.469 | 15.0% | 0.97 (0.87 - 1.09) | 0.97 (0.87 - 1.08) |
| 39.047 - 148.000 | 14.5% | 1.02 (0.92 - 1.14) | 0.87 (0.78 - 0.97)* |
| 3.362 - 39.047 | 13.6% | 0.89 (0.80 - 1.00) | 0.71 (0.63 - 0.79)* |
| <3.362 | 12.2% | 1.00 (0.89 - 1.13) | 0.70 (0.62 - 0.79)* |
| Unknown | 29.6% | 1.02 (0.92 - 1.13) | 0.83 (0.75 - 0.91)* |
| Neighbourhood characteristics | | | |
| Population density | | | |
| Very dense | 16.5% | 1.00 | 1.00 |
| Dense | 27.6% | 0.92 (0.84 - 1.01) | 0.99 (0.90 - 1.09) |
| Moderately dense | 21.8% | 0.97 (0.88 - 1.08) | 1.03 (0.93 - 1.14) |
| Slightly dense | 23.2% | 0.99 (0.89 - 1.10) | 1.04 (0.94 - 1.16) |
| Not dense | 10.9% | 1.03 (0.91 - 1.17) | 0.97 (0.85 - 1.10) |

^aAdjusted for age, gender, ethnicity, household composition, education, household income, household wealth, population density.

*p≤0,05

Among the total adult population, the weighted prevalence of leisure-time walking was higher than of cycling (table 1). More women than men engaged in leisure-time walking and cycling. Weighted prevalence of leisure-time walking and cycling among both groups increased with age up to 46-65 years old.

These age and gender differences in PA were found to be significant in multilevel logistic regression analyses (table 2). Moreover, non-natives, married people, and higher educated people were significantly more likely to walk and cycle in leisure-time compared to their counterparts. Leisure-time cycling was positively associated with household wealth, but negatively associated with household income.

TABLE 3. Mean neighbourhood-level safety scores and the correlation between safety variables.

| Safety variables | Mean (SD) | Range | Pearson correlation coefficient | | | |
|--------------------|-------------|-------------|---------------------------------|-------------------|-----------------|--------------------|
| | | | General safety | Physical disorder | Social disorder | Crime-related fear |
| General safety | 4.35 (0.28) | 2.81 – 4.97 | | | | |
| Physical disorder | 4.24 (0.35) | 2.83 – 4.95 | 0.80 | | | |
| Social disorder | 4.49 (0.30) | 3.15 – 4.96 | 0.76 | 0.68 | | |
| Crime-related fear | 4.65 (0.37) | 2.08 – 4.96 | 0.73 | 0.56 | 0.53 | |
| Traffic-safety | 4.01 (0.50) | 1.67 – 4.89 | 0.66 | 0.28 | 0.24 | 0.17 |

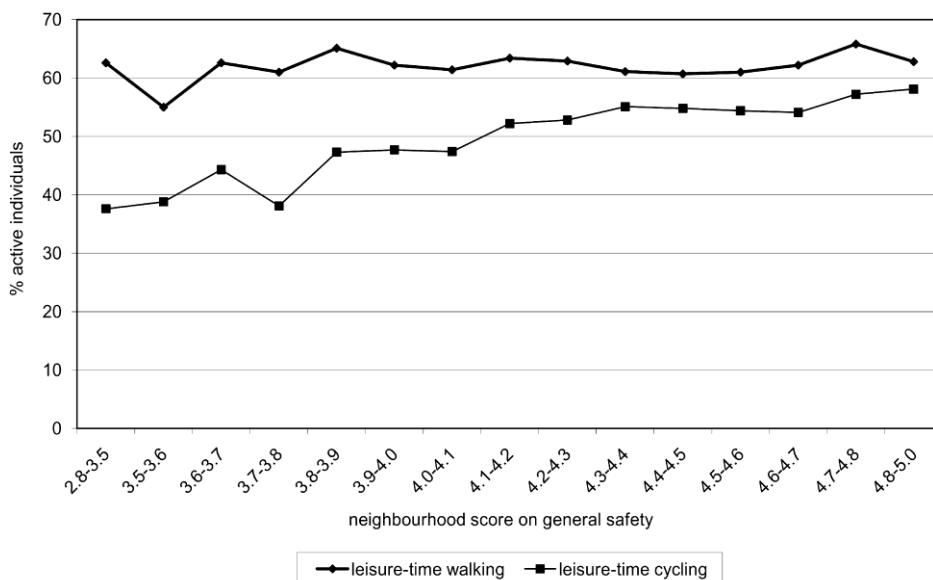


FIGURE 1. Weighted percentage of individuals engaging in leisure-time walking or cycling for at least 30 minutes per week, by level of general neighbourhood safety.

Table 3 shows that neighbourhood variations in levels of safety were most pronounced for traffic safety. The four specific safety components were highly to moderately correlated with each other, except for traffic safety.

Figure 1 shows to what amount the prevalence of leisure-time PA varied according to the level of general neighbourhood safety. The prevalence of leisure-time walking remained the same (60%) across the range of general safety, while prevalence of leisure-time cycling increased from 40% in the most unsafe to 60% in the safest neighbourhoods.

TABLE 4. Association of general safety and specific safety components with leisure-time walking and -cycling

| | Odds Ratio (95% CI) | | |
|---|---|--|-------------------------------------|
| | Model 1 (age, gender, ethnicity, household comp.) | Model 2 (+education, income, wealth) | Model 3 (+population density) |
| Leisure-time walking | | | |
| General safety | 0.96 (0.86 - 1.08) | 0.95 (0.85 - 1.06) | 0.92 (0.81 - 1.05) |
| Physical disorder | 0.94 (0.86 - 1.03) | 0.94 (0.86 - 1.03) | 0.90 (0.81 - 1.01) |
| Social disorder | 0.94 (0.84 - 1.04) | 0.95 (0.85 - 1.05) | 0.92 (0.82 - 1.04) |
| Crime-related fear | 0.98 (0.90 - 1.06) | 0.98 (0.90 - 1.06) | 0.97 (0.88 - 1.06) |
| Traffic safety | 1.02 (0.95 - 1.09) | 1.00 (0.94 - 1.07) | 1.00 (0.93 - 1.06) |
| Leisure-time cycling | | | |
| General safety | 1.50 (1.34 - 1.68)* | 1.42 (1.27 - 1.59)* | 1.40 (1.23 - 1.60)* |
| Physical disorder | 1.34 (1.22 - 1.47)* | 1.28 (1.17 - 1.41)* | 1.27 (1.14 - 1.42)* |
| Social disorder | 1.31 (1.18 - 1.46)* | 1.27 (1.14 - 1.41)* | 1.22 (1.08 - 1.37)* |
| Crime-related fear | 1.29 (1.19 - 1.40)* | 1.26 (1.16 - 1.37)* | 1.23 (1.12 - 1.35)* |
| Traffic safety | 1.13 (1.05 - 1.20)* | 1.10 (1.04 - 1.18)* | 1.09 (1.02 - 1.17)* |
| Intraclass Correlation Coefficient | | | |
| Leisure-time walking | 0.00 (0.00 - 0.04) | 0.00 (0.00 - 0.62) | 0.00 (0.00 - 0.99) |
| Leisure-time cycling | 0.01 (0.01 - 0.02)* | 0.01 (0.00 - 0.02)* | 0.01 (0.00 - 0.02)* |

* $p \leq 0.05$.

Logistic regression analyses also show no strong association between neighbourhood safety and leisure-time walking (table 4). The association was not statistically significant for general safety and the four specific safety components. In contrast, for leisure-time cycling, a positive and statistically significant association was found with both general neighbourhood safety and each of the four specific safety components. A 1-unit increase in general neighbourhood safety was associated with a 40% increase in odds of leisure-time cycling. Associations with the specific safety components were somewhat weaker, and weakest for traffic safety. With a 1-unit increase in neighbourhood traffic safety, odds of leisure-time cycling increased by only 9%. For all safety indicators, odds ratios of leisure-time walking and cycling changed to only a small extent after potential confounders were added to the model. Thus, measurable confounders appeared to have only a limited impact on the observed associations. The

ICC shows that nearly one percent of the variance in leisure-time cycling is attributable to the neighbourhood-level, while there is no statistical support for between-neighbourhood differences in walking (table 4).

TABLE 5. Association of general safety with leisure-time walking and cycling in different subgroups.

| | Leisure-time walking | | Leisure-time cycling | |
|--------------------------------------|------------------------|---------------------------|------------------------|---------------------------|
| | Odds Ratio (95% CI) | p-value of interaction | Odds Ratio (95% CI) | p-value of interaction |
| Age-gender category | | | | |
| Men 18-30 years | 0.42 (0.27 – 0.65)* | Reference | 1.25 (0.80 – 1.94) | Reference |
| Men 31-45 years | 0.90 (0.67 – 1.21) | <0.01* | 1.25 (0.93 – 1.69) | 0.99 |
| Men 46-65 years | 1.15 (0.87 – 1.51) | <0.01* | 1.37 (1.04 – 1.80)* | 0.72 |
| Men > 65 years | 0.65 (0.45 – 0.93)* | 0.14 | 1.53 (1.06 – 2.19)* | 0.48 |
| Women 18-30 years | 1.12 (0.76 – 1.64) | <0.01* | 1.01 (0.69 – 1.48) | 0.47 |
| Women 31-45 years | 1.20 (0.90 – 1.60) | <0.01* | 1.39 (1.05 – 1.84)* | 0.68 |
| Women 46-65 years | 1.06 (0.80 – 1.42) | <0.01* | 1.74 (1.32 – 2.30)* | 0.20 |
| Women > 65 years | 1.02 (0.73 – 1.43) | <0.01* | 2.23 (1.57 – 3.16)* | 0.04* |
| Educational level^a | | | | |
| Higher educated | 1.04 (0.88 – 1.22) | Reference | 1.37 (1.17 – 1.61)* | Reference |
| Lower educated | 0.79 (0.66 – 0.95)* | 0.02* | 1.48 (1.22 – 1.78)* | 0.51 |
| Population density | | | | |
| Very dense | 0.98 (0.75 – 1.27) | Reference | 1.70 (1.30 – 2.23)* | Reference |
| Dense | 0.96 (0.76 – 1.21) | 0.91 | 1.33 (1.05 – 1.68)* | 0.17 |
| Moderately dense | 0.89 (0.67 – 1.19) | 0.64 | 1.41 (1.06 – 1.88)* | 0.34 |
| Slightly dense | 0.84 (0.60 – 1.18) | 0.50 | 1.24 (0.88 – 1.74) | 0.15 |
| Not dense | 0.86 (0.55 – 1.34) | 0.62 | 1.23 (0.79 – 1.92) | 0.22 |

* p≤0,05
^aHigher educated: tertiary education, upper level secondary education
Lower educated: mid and lower level secondary education, primary education

Subpopulation differences in associations between general safety and leisure-time walking and cycling are presented in table 5. For leisure-time walking, a significant inverse association with general safety was found for the youngest and oldest men and for the lower educated individuals. In these groups, an increase in general neighbourhood safety was related to a decrease in odds of leisure-time walking. For leisure-time cycling, the association with general neighbourhood safety was found to strengthen with increasing age. The association was also stronger for women compared to men of the same age. Cycling behaviour is most strongly related to safety for older women. The association between general safety and cycling appeared to be strongest with very dense populations, although interaction with population density was not statistically significant.

DISCUSSION

In the present study, an increase in general neighbourhood safety and all specific safety components was found to be associated with an increase in leisure-time cycling participation. Associations were strongest for general safety and among older women. Overall, none of the neighbourhood safety outcomes was significantly associated with leisure-time walking. However, an increase in general neighbourhood safety was found to be associated with a decrease in leisure-time walking participation for the youngest and oldest adult men and for the lower educated people.

Limitations

The data available to this study had some potential limitations. First, while many potential confounders at the individual level have been accounted for, not all neighbourhood-level factors have taken into account that may have confounded the association between safety and PA. For example, an area with mixed land use and nearby shopping and recreational facilities may stimulate leisure-time walking, while such an area might at the same time be relatively unsafe. In the present study, confounding by such factors may have concealed an association between safety and leisure-time walking. In order to address this potential source of bias, we have adjusted our analyses for population density, as this variable may correlate with land use mix and the proximity of facilities. We found that control for population density had negligible effects on the associations between safety and walking or cycling. Future research should aim to control for neighbourhood-level confounders in more detail.

There was a non-response of 36% for the POLS interview and another 16% for the additional paper-and-pencil survey. Non-respondents may have differed in important aspects from the study population. However, this would only have biased the results of this study if non-response varied according to the level of individual PA, as well as the degree of neighbourhood safety, after accounting for confounders. We think this is not very likely, but we can not entirely exclude the possibility of some bias.

Another limitation has to do with the self-reported nature of PA. People may have difficulty estimating their time spent on PA and may be inclined to give socially desirable answers, which might have caused them to overestimate their levels of PA [31]. However, this only becomes a problem if the amount of overestimation differs between safe and unsafe neighbourhoods after controlling for individual-level confounders. Again, we think this is not very likely.

Neighbourhood safety was also self-reported. We chose to use subjective measures of neighbourhood safety, because there is evidence that objective and subjective ratings are poorly correlated [16,32] and that subjective ratings may be more important in determining PA behaviour [32,33]. Those in favour of objective measures have argued that objective measures are needed to avoid bias associated with self-reports, such as the 'single source bias' [34]. This source of bias may occur if self-reported data on both determinants and outcomes are collected using the same survey. To avoid this source of bias, we have used two different sets of respondents for measuring neighbourhood safety (the WoON survey) and leisure-time walking and cycling (the POLS survey).

Interpretation of key results

Associations between safety and leisure-time cycling have been found to be strongest for general safety. This suggests that a combination of safety problems may have more impact on people's engagement in cycling than isolated safety problems. The weakest association with cycling has been found for traffic safety. This supports an earlier study that found traffic safety to have less influence on leisure-time PA than other safety components [6]. The weak association for traffic safety is remarkable as neighbourhood variations in levels of safety were most profound for traffic safety (table 2). Results of the present study suggest that people are more influenced by social aspects of safety such as crime and social disorder, than by traffic safety.

Subgroup analyses suggested that elderly women were most influenced by general neighbourhood safety in their cycling behaviour. This supports earlier research [22,35]. Foster et al. [22] suggest that women and elderly may be more sensitive to safety as they feel more physically vulnerable than men and young adults.

The positive association between neighbourhood safety and cycling may in part reflect a safety component that has not been included: fear of bicycle theft or damage. This seems to be a plausible mechanism since bicycle theft rates among bicycle owners in the Netherlands are the highest in the world [24].

Leisure-time walking was not significantly associated with general neighbourhood safety or any of its safety components. An American study that used various objectively measures safety components, yielded the same results [6]. Many other studies, too, did not find an association between safety and leisure-time walking [6-13,17,20,21]. Some evidence of an association was found in other studies, but results were mostly inconsistent [4,5,14-16,18,19].

Lack of a positive association in the present study might have been due to focus on fairly large neighbourhoods. 4-digit zip code areas have an average of 4.088 inhabitants [36]. Environmental influences of safety on walking may have been more

apparent on a smaller scale, since walking is primarily performed in the immediate area around the home. Future research should assess if a focus on smaller areas reveals a more significant association.

Subgroup analyses have shown an inverse relationship between safety and leisure-time walking for young men and for lower educated. Earlier studies support this finding [18,37,38]. Ross et al. [38] suggest that unsafe neighbourhoods have a culture of being outside on the streets, which may be especially attractive to these groups.

CONCLUSIONS

The current study indicates that, in the Netherlands, a safe neighbourhood may increase adults' participation in leisure-time cycling but not necessarily in walking. Leisure-time cycling may best be encouraged by improving different safety components at once, rather than focusing on one aspect such as traffic safety. Special attention needs to be paid to residents that are particularly sensitive to the safety situation in the neighbourhood, such as older women.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

DK and AK developed the study design. MW and DK prepared the data. DK performed the analyses and, with help of AK, drafted the manuscript. JM, and MW revised intermediate results and manuscript versions and made substantial contributions to subsequent versions. All authors have read and approved the final version of the manuscript.

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REFERENCES

1. Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. *Annu Rev Public Health* 2006;27:297–322.
2. Wendel-Vos W, Droomers M, Kremers S, Brug J, van Lenthe F. Potential environmental determinants of physical activity in adults: a systematic review. *Obes Rev* 2007;8:425–440.
3. Saelens B, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc* 2008;40:550–566.
4. Giles-Corti B, Donovan RJ. Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment. *Prev Med* 2002;35:601–611.
5. Cao X, Handy SL, Mokhtarian PL. The influences of the built environment and residential self-selection on pedestrian behavior: evidence from Austin, TX. *Transportation* 2006;33:1–20.
6. McGinn AP, Evenson KR, Herrin AH, Huston SL, Rodriguez DA. The association of perceived and objectively measured crime with physical activity: a cross-sectional analysis. *J Phys Act Health* 2008;5:117–131.
7. Hallal PC, Reis RS, Parra DC, Hoehner C, Brownson RC, Simoes EJ. Association between perceived environmental attributes and physical activity among adults in Recife, Brazil. *J Phys Act Health* 2010;7:213–222.
8. Kamphuis CBN, van Lenthe FJ, Giskes K, Huisman M, Brug J, Mackenbach JP. Socioeconomic differences in lack of recreational walking among older adults: the role of neighbourhood and individual factors. *I J Behav Nutr Phys Act* 2009;6.
9. Mendes de Leon CF, Cagney KA, Bienias JL, Barnes LL, Skarupski KA, Scherr PA, et al. Neighbourhood social cohesion and disorder in relation to walking in community-dwelling older adults: a multilevel analysis. *J Aging Health* 2009;21:155–171.
10. Gauvin L, Riva M, Barnett T, Richard L, Craig CL, Spivock M, et al. Association between neighbourhood active living potential and walking. *Am J Epidemiol* 2007;167:944–953.
11. Ball K, Timperio A, Salmon J, Giles-Corti B, Roberts R, Crawford D. Personal, social and environmental determinants of educational inequalities in walking: a multilevel study. *J Epidemiol Community Health* 2007;61:108–114.
12. Pikora T, Giles-Corti B, Knuiam MW, Bull FC, Jamrozik K, Donovan RJ. Neighbourhood environmental factors correlated with walking near home: using SPACES. *Med Sci Sports Exerc* 2006;38:708–714.
13. van Lenthe FJ, Brug J, Mackenbach JP. Neighbourhood inequalities in physical inactivity: the role of neighbourhood attractiveness, proximity to local facilities and safety in the Netherlands. *Soc Sci Med* 2005;60:763–775.
14. Inoue S, Ohya Y, Odagiri Y, Takamiya T, Ishii K, Kitabayashi M, et al. Association between perceived neighbourhood environment and walking among adults in 4 cities in Japan. *J Epidemiol* 2010;20:277–286.
15. Nagel CL, Carlson NE, Bosworth M, Michael YL. The relation between neighbourhood built environment and walking activity among older adults. *Am J Epidemiol* 2008;168:461–468.
16. Cleland VJ, Timperio A, Crawford D. Are perceptions of the physical and social environment associated with mothers' walking for leisure and for transport? A longitudinal study. *Prev Med* 2008;47:188–193.

17. van Dyck D, Cardon G, Deforche B, Giles-Corti B, Sallis JF, Owen N, et al. Environmental and psychosocial correlates of accelerometer-assessed and self-reported physical activity in Belgian Adults. *Int J Behav Med* 2010;18:235-245.
18. Shigematsu R, Sallis JF, Conway TL, Saelens BE, Frank LD, Cain KL, et al. Age differences in the relation of perceived neighborhood environment and walking. *Med Sci Sports Exerc* 2009;41:314-321.
19. McGinn AP, Evenson KR, Herrin AH, Huston SL, Rodriguez DA. Exploring associations between physical activity and perceived and objective measures of the built environment. *J Urban Health* 2007;84:162-184.
20. Bourdeaudhuij de I, Teixeira PJ, Cardon G, Deforche B. Environmental and psychosocial correlated of physical activity in Portugese and Belgian adults. *Public Health Nutr* 2005;8:886-895.
21. Foster C, Hillsdon M, Jones A, Grundy C, Wilkinson P, White M, et al. Objective measures of the environment and physical activity – results of the environment and physical activity study in English adults. *J Phys Act Health* 2009;6:70-80.
22. Foster S, Giles-Corti B. The built environment, neighbourhood crime and constrained physical activity: an exploration of inconsistent findings. *Prev Med* 2008;47:241-251.
23. Bassett DR, Pucher J, Buehler R, Thompson DL, Crouter SE. Walking, cycling, and obesity rates in Europe, North America, and Australia. *J Phys Act Health* 2008;5:795-814.
24. van Dijk J, van Kestern J, Smit P. *Criminal victimization in international perspective: key findings from the 2004-2005 ICVS and EU ICS*. Meppel: Boom Juridische uitgevers, 2007.
25. Pucher J, Buehler R. Making cycling irresistible: lessons from the Netherlands, Denmark and Germany. *Transp Rev* 2008;28:495-528.
26. Titze S, Stronegger WJ, Janschitz S, Oja P. Association of built -environment, social-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers. *Prev Med* 2008;147:252-259.
27. Geus de B, Bourdeaudhuij de I, Jannes C, Meeusen R. Psychosocial and environmental factors associated with cycling for transport among a working population. *Health Educ Res* 2008;23:697-708.
28. Kamphuis CBM, Giskes K, Kavanagh AM, Thornton LE, Thomas LR, van Lenthe FJ, et al. Area variation in recreational cycling in Melbourne: a compositional or contextual effect? *J Epidemiol Community Health* 2008;62:890-898.
29. Wagenmakers R, van den Akker-Scheek I, Groothoff JW, Zijlstra W, Bulstra SK, Kootstra JWJ, et al. Reliability and validity of the short questionnaire to assess health-enhancing physical activity (SQUASH) in patients after total hip arthroplasty. *BMC Musculoskel Dis* 2008;9:141.
30. Wendel-Vos GCW, Schuit AJ, Saris WHM, Kromhout D. Reproducibility and relative validity of the Short Questionnaire to Assess Health-enhancing physical activity. *J Clin Epidemiol* 2003;56:1163-1169.
31. Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *Br J Sports Med* 2003;37:197-206.
32. Gebel K, Bauman A, Owen N. Correlates of non-concordance between perceived and objective measures of walkability. *Annals of Behav Med* 2009;37:228-238.
33. Ball K, Cleland, VJ, Timperio AF, Salmon J, Giles-Corti B, Crawford DA. Love thy neighbour? Associations of social capital and crime with physical activity amongst women. *Soc Sci Med* 2010;71:807-814.

34. King WC, Belle SH, Brach JS, Simkin-Silverman LR, Soska T, Kriska AM. Objective measures of neighborhood environment and physical activity in older women. *Am J Prev Med* 2005;28:461-469.
35. Shenessa ED, Liebhaber A, Ezeamama A. Perceived safety of area of residence and exercise: a pan-European study. *Am J Epidemiol* 2006;163:1012-1017.
36. Bevolking en huishoudens: viercijferige postcode [homepage on the internet]. Den Haag: Centraal Bureau voor de Statistiek; c2008. [updated 2008 November 21; cited 2012 February 3]. Available from <https://statline.cbs.nl/StatWeb/>
37. Humpel N, Owen N, Iverson D, Leslie E, Bauman A. Perceived environment attributes, residential location, and walking for particular purposes. *Am J Prev Med* 2004;26:119-125.
38. Ross CE. Walking, exercising, and smoking: does neighbourhood matter? *Soc Sci Med* 2000;51:265-274.

CHAPTER

3

Social neighborhood environment and sports participation among Dutch adults: does sports location matter?

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ABSTRACT

Studies on the relation between the social neighbourhood environment and sports participation have produced inconsistent results. Use of generic sports outcomes may have obscured associations only apparent for sports at certain locations. This study aims to assess the association between the social neighbourhood environment and three location-specific sports outcomes. Repeated cross-sectional data on sports participation (any type of sports, sports at indoor sports clubs, sports at outdoor sports clubs, sports on streets) were obtained from 20,600 adults using the Dutch national health survey (POLS) 2006-2009. Data on neighbourhood social safety and social capital were obtained using the Dutch Housing Research (WoON) 2006. Over 40% of Dutch adults participated in any type of sports. Indoor sports clubs were most popular. Multilevel logistic regression analyses revealed that neighbourhood social safety was positively associated with sports at indoor sports clubs (OR=1.25, 95%CI=1.06-1.48), but not with the other sports outcomes. Contrary, neighbourhood social capital was positively associated with sports on streets only (OR=1.69, 95%CI=1.17-2.44). The results suggest that a positive social neighbourhood environment enhances sports participation, but that this impact depends on the location of the sports activity. This study highlights the importance of using location-specific sports outcomes when assessing environmental determinants.

INTRODUCTION

There is ample evidence of the association between a person's immediate social environment and sports participation. Adults with much social support from friends, family or spouses have consistently been found to have higher odds of participating in sports than their counterparts [1-3]. According to the ecological approach, the broader social neighbourhood environment may also be an important determinant of sports participation [4]. However, few studies have explored the association between the social neighbourhood environment and sports participation [5]. Neighbourhood social safety and social capital are the two most commonly explored social environmental determinants of sports participation [5]. So far, the evidence is inconsistent.

Social capital has been defined as those 'features of social life – networks, norms, and trust – that enable participants to act together more effectively to pursue shared objectives' [6]. According to McNeill et al. [7], communities with much social capital may be better able to reinforce positive social norms for health behaviours like physical activity. Social capital may also increase the likelihood that people observe and copy the behaviour of fellow (active) neighbours, called the contagion effect [8]. A study in the Dutch city Eindhoven found adults to be more likely to participate in sports in case they had an extensive social network in their neighbourhood, experienced much social cohesion among neighbours, and felt at home in their neighbourhood [9]. However, other studies found no significant association between social capital and sports participation [3,10].

A safe neighbourhood may alleviate residents' fear of being out on the streets, which may stimulate sports participation [11]. In Eindhoven, residents of neighbourhoods with little social nuisance and crime have been found to be more likely to participate in sports activities than those residing in a less safe neighbourhood [9,12]. However, studies from other countries found no support for an association between neighbourhood social safety and sports participation [10,13].

Inconsistencies in the evidence on social environmental determinants of sports participation may have been due to the use of generic sports outcomes. Some have advocated the use of location-specific activity outcomes, as individuals may only be influenced by the social neighbourhood environment when they are actually exposed to it during exercise [13-16]. So far, location-specific sports outcomes have been applied in research only once [12]. In Eindhoven, Beenackers et al. [12] found neighbourhood safety to be more strongly associated with neighbourhood oriented sports than with organized sports.

This study aims to re-assess the association between the social neighbourhood environment and sports participation among Dutch adults by using three location-specific sports outcomes. We will extend the work of Beenackers et al. [12] by analysing data on adults across the Netherlands, instead of one single city. Furthermore, we explore the association with neighbourhood social safety, as well as neighbourhood social capital. We assess their association both with overall sports participation and three location-specific sports outcomes: sports at indoor sports clubs, sports at outdoor sports clubs, and sports on streets. Given the results of Beenackers et al. [12], we hypothesize the association between the social neighbourhood environment and sports participation to only exist for sports on streets, and not for overall sports and sports at sports clubs.

METHODS

Study population

Repeated cross-sectional data on individual characteristics and sports participation were obtained using the Dutch national health survey of 2006 to 2009. This survey is part of the yearly administered national Integrated Survey on Living Conditions (POLS). Each year, a random nationwide sample of about 14,000 individuals was drawn from the national population registry, resulting in a pooled sample of 57,281 individuals. Selected individuals were interviewed and, if 12 years and older, asked to complete an additional paper and pencil survey on specific health topics, including sports participation. Due to the age restriction, 16% of the pooled sample was not eligible to fill in the survey. Non-response was 36% for the interview and 16% for the paper and pencil survey. In the pooled dataset, a total remained of 25,206 persons over 12 years old.

Cross-sectional data on individual perceptions of neighbourhood social safety and social capital were obtained using the three-yearly conducted Dutch Housing Research (WoON) of 2006. A total of 64,005 adults from 3,495 neighbourhoods completed the survey. To assess the social situation in the neighbourhood at large, we constructed neighbourhood-level scores of social safety and social capital by averaging all individual-level scores within each 4-digit zipcode. These neighbourhood-level scores from the WoON survey were then linked to individual POLS data using the 4-digit zipcode.

We excluded respondents younger than 18 (N=2,242) and residents of neighbourhoods with five or less valid individual-level social safety/social capital scores in WoON (N=2,364). Sensitivity analyses have found our results to be robust

against a further exclusion of neighbourhoods with ten or less valid scores in WoON. A total of 20,600 adults residing in 2,129 neighbourhoods were analyzed.

Measures

Sports participation

Self-reported sports participation was measured using the Dutch Short QUESTIONNAIRE to ASSESS Health-enhancing physical activity (SQUASH). This instrument has shown to be fairly reliable and valid, especially for large samples [17,18]. The questionnaire assessed the extent to which respondents participated in sports and physical activity in other domains (transportation, work, household, recreational walking/cycling/gardening). For sports participation, respondents were asked to report up to four sports they had performed in an average week over the past few months. For each sports, they had to provide the frequency (days per week) and duration (hours and minutes per day).

Water-related sports (diving, surfing, ice skating) were excluded because of the geographical restriction of these sports. Sports for medical purposes (e.g. physiotherapy), in-home sports, activities in domains other than sport (transportation, work, household, recreational walking and cycling), and low-intensity sports were also excluded. Classification of the intensity of the sports was based on a classification system developed by prior Dutch research [19]. Accordingly, low-intensity agility sport (e.g. bowling, darts, golf) and mental sport (e.g. chess) were classified as low intensity sports and excluded from our analysis.

Overall sports participation was calculated as minutes per week spent on any of the remaining sports. The distribution of overall sports participation was highly skewed with 57.5% not engaging in any sports at all. Therefore, the sports measure was dichotomised into 'active' (more than 0 minutes per week) versus 'inactive' (0 minutes per week).

The sports were divided into three location-specific sports measures: sports performed at indoor sports clubs (e.g. fitness, basketball), sports performed at outdoor sports clubs (e.g. hockey, tennis), and sports performed on streets (e.g. jogging, speed cycling). The location-specific sports measures were dichotomised into 'active' (more than 0 minutes per week at the location of interest) versus 'inactive' (0 minutes per week at any location). Respondents who were 'inactive' in sports at the location of interest were excluded if they were 'active' in sports at another location. This resulted in 18,351 14,144 and 13,633 respondents for the analyses of sports at indoor facilities, sports at outdoor facilities, and sports on streets, respectively.

Neighbourhood social environment

Individual perceptions of neighbourhood social safety were assessed using three items on social disorder and one item on crime-related fear (table 1). For crime-related fear, the two upper and the two lower scores were combined, so all items were rated on a scale from 1(unsafe) to 3(safe). All four items proved to be intercorrelated ($\alpha = 0.80$). To prevent overrepresentation of social disorder in the overall social safety score, we created a mean social disorder score by averaging the scores on the social disorder items. An overall neighbourhood social safety score was created by averaging the mean score on social disorder and the score on crime-related fear.

TABLE 1. Items and response categories for the constructs of neighbourhood social safety and social capital

| Item | Response category |
|--|---|
| Neighbourhood social safety | |
| Social disorder | |
| Nuisance from direct neighbours | 1(often) to 3(never) |
| Nuisance from other neighbourhood residents | 1(often) to 3(never) |
| Nuisance from youth | 1(often) to 3(never) |
| Crime-related fear | |
| I am afraid to be troubled or robbed in this neighbourhood | 1(totally agree) to 5(totally disagree) |
| Neighbourhood social capital | |
| It is unpleasant to live in this neighbourhood | 1(totally agree) to 5(totally disagree) |
| I feel attached to this neighbourhood | 1(totally agree) to 5(totally disagree) |
| I feel at home in this neighbourhood | 1(totally agree) to 5(totally disagree) |
| I am in touch a lot with my direct neighbours | 1(totally agree) to 5(totally disagree) |
| I am in touch a lot with other neighbours | 1(totally agree) to 5(totally disagree) |
| People treat each other nicely in this neighbourhood | 1(totally agree) to 5(totally disagree) |
| I live in a social neighbourhood with high levels of solidarity | 1(totally agree) to 5(totally disagree) |
| People in this neighbourhood hardly know each other | 1(totally agree) to 5(totally disagree) |
| I am satisfied with the population composition of this neighbourhood | 1(totally agree) to 5(totally disagree) |

Individual perceptions of neighbourhood social capital were assessed using nine items that correspond to Putnam's definition of social capital (table 1) [6]. Some items were rearranged so that all items were rated on a scale from 1(low social capital) to 5(high social capital). The nine items proved to be intercorrelated ($\alpha = 0.83$). An overall neighbourhood social capital score was created by averaging the scores on all nine items.

Neighbourhood-level overall social safety and social capital scores were calculated by averaging the scores of all respondents living within the same 4-digit zipcode. This resulted in neighbourhood-level averages between 1 and 3 for social safety, and between 1 and 5 for social capital. The averages for social safety scores were

transformed to make them comparable to those for social capital, so that both scores ranged from 1(low) to 5(high).

Potential confounders

We controlled for various potential confounders that have been found to be related to sports participation and whose prevalence may strongly differ between neighbourhoods [20]. At the individual level, we controlled for age (continuous), gender (female; male), household composition (married/partner with children; married/partner without children; single without children; single with children), ethnicity (Dutch origin; non-Dutch, western origin; non-Dutch, non-western origin; non-Dutch, origin unknown), and socio-economic status (SES). Three SES indicators were included: educational level (primary; lower secondary; mid secondary; upper secondary; tertiary), disposable household income (five quintiles based on net income in Euros), and disposable household wealth (five quintiles based on the sum of assets and debts in Euros). Age, gender, household composition, and education have been assessed using POLS. Data on ethnicity were derived from the national population registry. Information on household income and wealth was obtained from the national tax registration.

At the municipal level, we controlled for population density as a composite indicator of various potential environmental confounders such as land use mix or proximity of facilities. Population density has been determined at the municipal level using data on address density, i.e. the number of addresses per square kilometer (km²) within a municipality. Municipalities were categorized as either very dense (2500 addresses or more per km²), dense (1500-2500 addresses per km²), moderately dense (1000-1500 addresses per km²), slightly dense (500-1000 addresses per km²), and not densely populated (<500 addresses per km²). Information was available from Statistics Netherlands.

Statistical analysis

To take the sampling design of the POLS survey into account, prevalence of the four sports outcomes were weighted for age, gender, marital status, household size, urbanization, province, and month of survey. The associations of neighbourhood social safety and social capital with each of the sports outcomes were assessed by means of odds ratios derived from multilevel logistic regression analysis. Multilevel modelling (level 1: individuals; level 2: neighbourhoods) was used to account for clustering of individuals in neighbourhoods. A four-stage modelling approach was used with stepwise adjustment for socio-demographic factors (stage 1: age, gender, household composition, ethnicity), SES indicators (stage 2: education, household income, household wealth), municipal factors (stage 3: population density), and

neighbourhood factors (stage 4: neighbourhood social safety/ social capital). Each potential confounder was included as a set of dummy variables. For all analyses, statistical significance was set at 0.05. Analyses were carried out using the STATA 11.0 software (StataCorp, College Station, Texas, USA).

This study was based on secondary analyses of anonymized survey data by Statistics Netherlands (the "CBS"). The Medical Ethics Committee has confirmed that the Medical Research Involving Human Subjects Act (WMO) does not apply to this study and therefore, no official approval was required.

RESULTS

Of the respondents, 42.5% participated in any sports. Sports at indoor sports clubs (31.1%) was more popular than sports at outdoor sports clubs (10.1%) and on streets (8.1%). Respondents participating in sports, spent most time on sports at outdoor sports clubs (209 minutes per week), and less on sports at indoor sports clubs (169 minutes per week) and sports on streets (155 minutes per week).

Overall, young adults, non-Dutch adults of Western origin, adults with high levels of education, income, and wealth, and adults living in very densely populated areas were more likely to participate in sports than their counterparts (table 2). Between-sport differences were observed. Females and childless people were more likely to participate in sports at indoor sports clubs, while males and married people with children were more likely to participate in sports at outdoor sports clubs and on streets.

With an increase in neighbourhood social safety and social capital, there was a slight increase in weighted prevalence of overall sports and sports at outdoor sports clubs (figure 1). Results of the multilevel logistic regression analyses mainly confirmed these patterns (table 3). After initial adjustment (model 1), neighbourhood social safety was significantly positively associated with all sports outcomes except sports on streets. Additional adjustment for individual-level SES had limited effect (model 2). Additional adjustment for population density slightly strengthened the associations (model 3). Additional adjustment for neighbourhood social capital weakened the association with sports at outdoor sports clubs to the point that the association was no longer significant. In the final model, one unit increase in social safety was associated with 16% higher odds of overall sports and 25% higher odds of sports at indoor sports clubs (model 4). There were no significant associations with sports at outdoor sports clubs and sports on streets. After initial adjustment (model 1), neighbourhood social capital was significantly positively associated with overall

sports and sports at outdoor sports clubs, but not with the other types of sports. For all sports except sports on streets, additional adjustment for SES (model 2) and social safety (model 4) weakened the associations, while additional adjustment for population density (model 3) strengthened the associations. Contrary, for sports on streets, the association with social capital strengthened with each additional adjustment. In the final model, one unit increase in social capital was significantly associated with 69% higher odds of sports on streets. There were no significant associations with the other sports outcomes.

TABLE 2. The association of individual-level covariates with sports participation

| | % N ¹ | Odds Ratio (95% CI) model 4 ² | | | |
|------------------------------|------------------|--|-------------------------------|--------------------------------|-------------------|
| | | Overall sports | Sports at indoor sports clubs | Sports at outdoor sports clubs | Sports on streets |
| Age (years) | 48.4 | 0.97 (0.97–0.97)* | 0.97 (0.97–0.97)* | 0.96 (0.95–0.96)* | 0.95 (0.94–0.95)* |
| Gender | | | | | |
| Female | 52.2 | Ref | Ref | Ref | Ref |
| Male | 47.8 | 0.89 (0.84–0.95)* | 0.69 (0.64–0.74)* | 2.04 (1.84–2.27)* | 1.87 (1.66–2.10)* |
| Household composition | | | | | |
| Married/partner, child | 39.2 | Ref | Ref | Ref | Ref |
| Married/partner, no child | 35.8 | 1.08 (1.00–1.17)* | 1.19 (1.10–1.29)* | 0.94 (0.83–1.07) | 0.72 (0.62–0.83)* |
| Single, no child | 19.5 | 1.19 (1.08–1.31)* | 1.34 (1.21–1.48)* | 0.90 (0.76–1.07) | 0.99 (0.83–1.19) |
| Single, child | 4.6 | 0.80 (0.69–0.93)* | 0.83 (0.70–0.97)* | 0.76 (0.58–0.99) | 0.69 (0.51–0.93)* |
| Origin | | | | | |
| Dutch | 86.3 | Ref | Ref | Ref | Ref |
| Non-Dutch, western | 6.6 | 1.21 (1.07–1.37)* | 1.29 (1.13–1.47)* | 1.33 (1.08–1.64)* | 1.05 (0.82–1.35) |
| Non-Dutch, non-western | 4.1 | 0.84 (0.71–0.99)* | 0.99 (0.83–1.18) | 0.63 (0.45–0.88)* | 0.41 (0.26–0.62)* |
| Non-Dutch, unknown | 3.1 | 0.99 (0.83–1.19) | 0.98 (0.81–1.19) | 1.00 (0.74–1.37) | 0.98 (0.70–1.37) |
| Educational level | | | | | |
| Primary | 14.5 | Ref | Ref | Ref | Ref |
| Lower secondary | 14.3 | 1.33 (1.18–1.50)* | 1.33 (1.17–1.52)* | 1.51 (1.14–1.98)* | 1.44 (1.00–2.07)* |
| Mid secondary | 8.3 | 1.73 (1.51–1.99)* | 1.60 (1.38–1.86)* | 2.87 (2.17–3.81)* | 1.98 (1.34–2.92)* |
| Upper secondary | 35.6 | 1.84 (1.65–2.05)* | 1.76 (1.57–1.98)* | 2.55 (2.01–3.25)* | 3.19 (2.33–4.36)* |
| Tertiary | 27.0 | 2.91 (2.59–3.26)* | 2.65 (2.34–2.99)* | 4.34 (3.40–5.54)* | 6.72 (4.90–9.21)* |
| Household income (€) | | | | | |
| <15 200 | 18.3 | Ref | Ref | Ref | Ref |
| 15 200 – 19 200 | 19.4 | 1.19 (1.07–1.32)* | 1.21 (1.09–1.36)* | 1.09 (0.89–1.33) | 1.05 (0.84–1.30) |
| 19 200 – 23 600 | 19.9 | 1.37 (1.24–1.52)* | 1.41 (1.26–1.57)* | 1.41 (1.17–1.71)* | 1.10 (0.89–1.36) |
| 23 600 – 29 900 | 20.3 | 1.54 (1.39–1.71)* | 1.56 (1.39–1.74)* | 1.75 (1.45–2.10)* | 1.35 (1.10–1.66)* |
| >29 900 | 20.8 | 1.79 (1.60–1.99)* | 1.74 (1.55–1.96)* | 2.31 (1.91–2.80)* | 2.05 (1.67–2.53)* |
| Household wealth (€) | | | | | |
| <3 362 | 12.9 | Ref | Ref | Ref | Ref |
| 3 362 – 39 047 | 14.0 | 1.10 (0.98–1.25) | 1.12 (0.98–1.27) | 0.94 (0.75–1.17) | 1.16 (0.92–1.47) |
| 39 047 – 148 000 | 14.6 | 1.23 (1.09–1.38)* | 1.22 (1.07–1.38)* | 1.15 (0.93–1.42) | 1.26 (1.00–1.58)* |
| 148 000 – 293 469 | 14.5 | 1.42 (1.26–1.61)* | 1.42 (1.24–1.62)* | 1.34 (1.09–1.66)* | 1.39 (1.10–1.76)* |
| >293 469 | 14.3 | 1.40 (1.24–1.59)* | 1.32 (1.15–1.51)* | 1.64 (1.32–2.03)* | 1.26 (0.99–1.61) |
| Unknown | 29.6 | 1.27 (1.14–1.41)* | 1.24 (1.10–1.39)* | 1.30 (1.08–1.57)* | 1.15 (0.93–1.41) |
| Population density | | | | | |
| Very dense | 18.8 | Ref | Ref | Ref | Ref |
| Dense | 27.8 | 0.97 (0.88–1.07) | 0.99 (0.89–1.10) | 0.99 (0.83–1.19) | 0.97 (0.81–1.16) |
| Moderately dense | 21.5 | 0.95 (0.85–1.06) | 0.98 (0.88–1.10) | 1.02 (0.84–1.24) | 0.89 (0.73–1.10) |
| Slightly dense | 21.9 | 0.89 (0.79–0.99)* | 0.90 (0.79–1.01) | 0.95 (0.78–1.17) | 0.88 (0.71–1.10) |
| Not dense | 10.0 | 0.86 (0.75–0.98)* | 0.87 (0.75–1.01) | 0.88 (0.69–1.12) | 0.86 (0.66–1.11) |

*p≤0,05

¹Percentages may not add up to 100%, due to the category 'missings' which has not been shown here.²Odds of sports participation adjusted for age, gender, ethnicity, household composition, education, income, wealth, population density, neighbourhood social safety/ social capital.

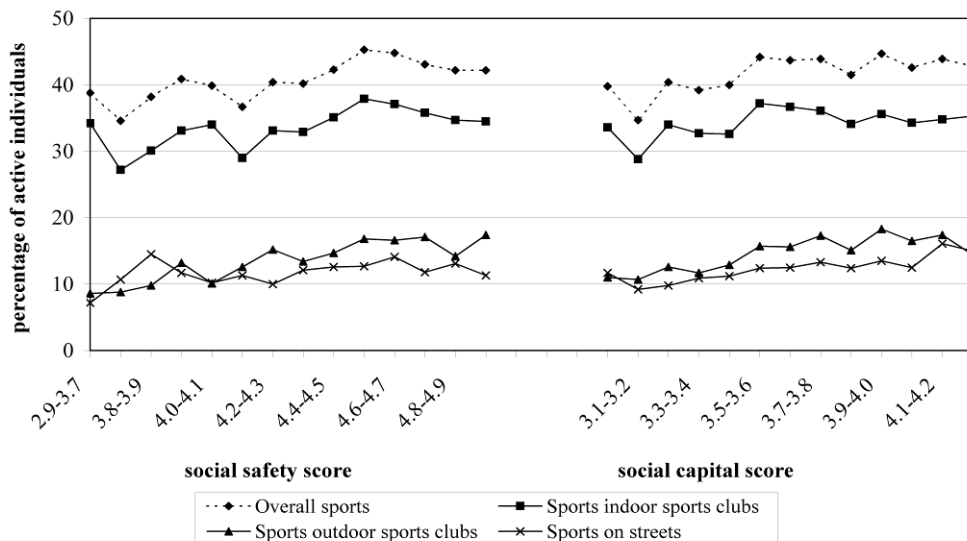


FIGURE 1. Weighted prevalence of sports participation by neighbourhood-level social safety and social capital. Neighbourhood-level social safety scores range from 1 (not safe) to 5 (very safe). Neighbourhood-level social capital scores range from 1 (low social capital) to 5 (high social capital)

TABLE 3. The association of neighbourhood-level social safety and social capital with sports participation, in four logistic regression models

| | Odds Ratio (95% CI) ¹ | | | |
|-------------------------------------|--|---|--------------------------------------|--|
| | Model 1 (age, gender, household comp., ethnicity) | Model 2 (+ education, income, wealth) | Model 3 (+ population density) | Model 4 (+ social capital / social safety) |
| Neighbourhood social safety | | | | |
| Overall sports | 1.15 (1.03 – 1.29)* | 1.12 (1.00 – 1.26)* | 1.20 (1.05 – 1.37)* | 1.16 (0.99 – 1.35) |
| Sports at indoor sports clubs | 1.16 (1.03 – 1.31)* | 1.14 (1.01 – 1.28)* | 1.23 (1.07 – 1.42)* | 1.25 (1.06 – 1.48)* |
| Sports at outdoor sports clubs | 1.38 (1.13 – 1.69)* | 1.32 (1.07 – 1.62)* | 1.35 (1.06 – 1.71)* | 1.19 (0.90 – 1.58) |
| Sports on streets | 0.96 (0.77 – 1.18) | 1.01 (0.81 – 1.25) | 1.05 (0.82 – 1.35) | 0.84 (0.63 – 1.13) |
| Neighbourhood social capital | | | | |
| Overall sports | 1.16 (1.01 – 1.34)* | 1.11 (0.97 – 1.28) | 1.21 (1.02 – 1.43)* | 1.09 (0.90 – 1.33) |
| Sports at indoor sports clubs | 1.08 (0.93 – 1.26) | 1.04 (0.90 – 1.21) | 1.13 (0.95 – 1.35) | 0.97 (0.78 – 1.19) |
| Sports at outdoor sports clubs | 1.51 (1.18 – 1.93)* | 1.42 (1.10 – 1.83)* | 1.49 (1.11 – 2.00)* | 1.33 (0.94 – 1.87) |
| Sports on streets | 1.20 (0.92 – 1.56) | 1.31 (0.99 – 1.71) | 1.51 (1.10 – 2.06)* | 1.69 (1.17 – 2.44)* |

*p≤0,05

¹ Odds of sports participation = 1 (yes).

DISCUSSION

We expected the social neighbourhood environment to be associated with sports on streets, but not with sports in general or at other locations. This hypothesis was supported by the results for neighbourhood social capital. Unexpectedly, neighbourhood social safety was significantly positively associated with sports at indoor sports clubs only.

Evaluation of data limitations

Data available to this study had some potential limitations. First, information on the location of the sports activity was not available from the survey. Therefore, some sports activities may have been misclassified, such as basketball. We classified basketball as an indoor sports as we assumed basketball to have taken place at an indoor court. However, it may have also taken place at an outdoor court in the neighbourhood. Classification of these types of sports activities were based on the most common location in the Netherlands.

The cross-sectional nature of our study does not allow us to establish the causality of the observed associations. On one hand, a safe neighbourhood with much social capital may stimulate sports participation. On the other hand, a safe neighbourhood with much social capital might attract people who like to exercise. This is called self-selection [21].

Sports participation was measured in years 2006 to 2009, while the social neighbourhood environment was measured only in 2006. We added the years 2007 to 2009 to increase statistical power and to take into account possible lag times of effect. This may have biased our results if differences between neighbourhoods in environmental conditions have changed between 2006 and 2009. Prior research on traffic safety and physical activity suggests that such differences may indeed have changed [22]. Traffic safety appeared to have improved between 2006 and 2009 in some neighbourhoods but not in others. An improvement in traffic safety was related to increased odds of being physically active. Similar studies are needed on the impact of trends in social neighbourhood environment on sports participation.

The social neighbourhood environment was measured using relatively small areas of only 3.4 km² wide. Since our sports measure was not neighbourhood-specific, some of the sports activities listed by the respondents may have (partly) taken place outside the neighbourhood limits. As a consequence, we are only able to anticipate the impact of the environment in which people live, rather than where they exercise.

We used subjective measures of the social neighbourhood environment because there is evidence that objective ratings do not always coincide with residents' perceptions [23,24] and that perceptions may be more important in determining physical activity behaviour than objective ratings [23,25]. The use of subjective neighbourhood measures may result in the so called 'single source bias' if self-reported data on both determinants and outcomes are collected from the same respondent [26]. To eliminate this source of bias, we used neighbourhood-level measures of the perceived social neighbourhood environment. These measures are based on perceptions of other residents living in the same neighbourhood as the respondent, rather than on perceptions of the respondent himself.

Interpretation of key results

So far, studies on the association of neighbourhood social safety and social capital with sports participation have produced inconsistent results. Some studies found no significant association [3,10,13]. Studies that did find both aspects to be positively associated with overall sports participation have all been conducted in the Netherlands [9,12]. Therefore, associations may be restricted to the Dutch context. Like the other Dutch studies, we found both neighbourhood social safety and social capital to be associated with sports participation. However, the associations were found to differ according to the location of the sports activity.

As expected, neighbourhood social capital was positively associated with sports on streets, but not with sports at sports clubs. These results support the use location-specific sports outcomes, as suggested in prior research [13-16]. The underlying mechanisms remain unclear. It might be that residents of neighbourhoods with much social capital are more likely to adopt the (active) behaviour of their fellow residents. This is termed the contagion effect [8]. Ross [8] points out that for this contagion effect to occur, behaviours have to be visible in the streets, as is the case with sports on streets rather than at sports clubs.

Unexpectedly, we found neighbourhood social safety to be associated with sports at indoor sports clubs, but not with sports on streets. Prior research has suggested that neighbourhood social safety might not only be important during the exercise itself, but also when travelling to sports facilities [12]. Sports at sports clubs often take place at a fixed location and at set times (most often in the evenings), require membership fees, and are multiplayer. As a result, residents of unsafe neighbourhoods are less able to avoid unsafe places and hours when going to the sports club. Sports on streets on the other hand, can be practiced everywhere, anytime, without cost, and are solo. As a result, street exercisers living in unsafe areas, have the ability to go out at safer hours and into safer areas, limiting the impact of neighbourhood social safety.

There is a possibility that the positive associations between the social neighbourhood environment and sports participation have been caused by an underlying (neighbourhood) factor. While we have extensively accounted for individual-level confounders, we have not been able to control for all possible neighbourhood-level confounders, such as availability of sports clubs or outdoor facilities. Vigorous activity at sports clubs has been found to be associated with a higher density of paid facilities [27]. These facilities tend to be more present in suburban and rural areas [28,29], which generally face less safety problems compared to urban areas. Recreational activity or exercise on neighbourhood streets has been found to be associated with access to outdoor recreational facilities (park, sports facility, beach, river) [13], which in turn have been found to stimulate the development of social ties between neighbours [30]. We have adjusted our analysis for population density as an indicator of these various potential environmental determinants. Future research should aim to control for neighbourhood-level confounders in more detail.

PERSPECTIVE

The results of this study suggest that sports participation might be enhanced by means of a positive social neighbourhood environment. However, the impact of the social neighbourhood environment was found to depend on the location of the sports activity. A neighbourhood with much social safety might enhance participation in sports at indoor sports clubs, while neighbourhoods with much social capital might enhance participation in sports on streets. Even though many researchers have advocated the use of location-specific physical activity outcomes [13-16], we are one of the first to apply this to sports research. Our results highlight the need to use location-specific sports measures in research on environmental determinants of sports participation. More research is needed to explore the mechanisms underlying these associations and to take the possibility of neighbourhood-level confounding into account.

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REFERENCES

1. Sallis JF, Hovell MF, Hofstetter R, Barrington E. Explanation of vigorous physical activity during two years using social learning variables. *Soc Sci Med* 1992;34:25-32.
2. Grzywacz JG, Marks NF. Social inequalities and exercise during adulthood: toward an ecological perspective. *J Health Soc Behav* 2001;42:202-220.
3. van Dyck D, Cardon G, Deforche B, Giles-Corti B, Sallis JF, Owen N, et al. Environmental and psychosocial correlates of accelerometer-assessed and self-reported physical activity in Belgian adults. *Int J Behav Med* 2011;18:235-245.
4. Sallis JF, Certero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. *Ann Rev Public Health* 2006;27:297-322.
5. Wendel-Vos W, Droomers M, Kremers S, Brug J, van Lenthe F. Potential environmental determinants of physical activity in adults: a systematic review. *Obes Rev* 2007;8:425 – 440.
6. Putnam RD. Tuning in, tuning out: the strange disappearance of social capital in America. *PS* 1995;28:664-683.
7. McNeill LH, Kreuter MW, Subramanian SV. Social environment and physical activity: a review of concepts and evidence. *Soc Sci Med* 2006;63:1011-1022.
8. Ross CE. Walking, exercising, and smoking: does neighbourhood matter? *Soc Sci Med* 2000;51:265-274.
9. Kamphuis CBM, van Lenthe FJ, Giskes K, Huisman M, Brug J, Mackenbach JP. Socioeconomic status, environmental and individual factors, and sports participation. *Med Sci Sports Exerc* 2008;40:71-81.
10. Poortinga W. Perceptions of the environment, physical activity, and obesity. *Soc Sci Med* 2006;63:2835-2846.
11. Foster S, Giles-Corti B. The built environment, neighbourhood crime and constrained physical activity: an exploration of inconsistent findings. *Prev Med* 2008;47:241-251.
12. Beenackers MA, Kamphuis CBM, Burdorf A, Mackenbach JP, van Lenthe FJ. Sports participation, perceived neighbourhood safety, and individual cognitions: how do they interact? *I J Behav Nutr Phys Act* 2011;8:76.
13. Sugiyama T, Leslie E, Giles-Corti B, Owen N. Physical activity for recreation or exercise on neighbourhood streets: associations with perceived environmental attributes. *Health Place* 2009;15:1058-1063.
14. Humpel N, Owen N, Iverson D, Leslie E, Bauman A. Perceived environment attributes, residential location, and walking for particular purposes. *Am J Prev Med* 2004;26:119-125.
15. Giles-Corti B, Timperio A, Bull F, Pikora T. Understanding physical activity environmental correlates: increased specificity for ecological models. *Exerc Sport Sci Rev* 2005;33:175-181.
16. Mohnen SM, Völker B, Flap H, Groenewegen PP. Health-related behavior as a mechanism behind the relationship between neighborhood social capital and individual health – a multilevel analysis. *BMC Public Health* 2012;12:116.
17. Wendel-Vos GCW, Schuit AJ, Saris WHM, Kromhout D. Reproducibility and relative validity of the Short Questionnaire to Assess Health-enhancing physical activity. *J Clin Epidemiol* 2003;56:1163 – 1169.
18. Wagenmakers R, van den Akker-Scheek I, Groothoff JW, Zijlstra W, Bulstra SK, Kootstra JWJ, et al. Reliability and validity of the short questionnaire to assess health-enhancing

- physical activity (SQUASH) in patients after total hip arthroplasty. *BMC Musculoskel Dis* 2008;9:141.
19. van den Dool R, Elling A, Hoekman R. *Sportersmonitor*. 's Hertogenbosch: Mulier Instituut, 2009.
 20. Hovemann G, Wicker P. Determinants of sport participation in the European Union. *Eur J Sport Soc* 2009;6:51-59.
 21. Handy S, Cao X, Mokhtarian PL. Self-selection in the relationship between the built environment and walking: empirical evidence from Northern California. *J Am Plann Ass* 2007;72:55-74.
 22. Jongeneel-Grimen B, Busschers, W, Droomers M, van Oers HAM, Stronks K, Kunst AE. Change in neighborhood traffic safety: does it matter in terms of physical activity? *Plos One* 2013;8.
 23. McGinn AP, Evenson KR, Herring AH, Huston SL, Rodriguez DA. Exploring associations between physical activity and perceived and objective measures of the built environment. *J Urban Health* 2007;84:162-184.
 24. Gebel K, Bauman A, Owen N. Correlates of non-concordance between perceived and objective measures of walkability. *Ann Behav Med* 2009;37:228-238.
 25. Ball K, Cleland VJ, Timperio AF, Salmon J, Giles-Corti B, Crawford DA. Love thy neighbour? Associations of social capital and crime with physical activity amongst women. *Soc Sci Med* 2010;71:807-814.
 26. King WC, Belle SH, Brach JS, Simkin-Silverman LR, Soska T, Kriska AM. Objective measures of neighborhood environment and physical activity in older women. *Am J Prev Med* 2005;28:461-469.
 27. Sallis JF, Hovell MF, Hofstetter R, Elder JP, Hackley M, Caspersen CJ, et al. Distance between homes and exercise facilities related to frequency of exercise among San Diego Residents. *Public Health Rep* 1990;105:179-185.
 28. Breedveld K, Tiessen-Raaphorst A. *Rapportage sport 2006*. Den Haag : Sociaal en Cultureel Planbureau, 2006.
 29. Steenbeckers A, Simon C, Veldheer V. *Thuis op het platteland: de leefsituatie van platteland en stad vergeleken*. Den Haag: Sociaal en Cultureel Planbureau, 2006.
 30. Völker B, Flap H, Lindenberg S. When are neighbourhoods communities? Community in Dutch neighbourhoods. *Eur Soc Rev* 2006;23:99-114.

CHAPTER

4

Associations of changes in neighbourhood safety with leisure-time physical activity: evidence for the role of residential self-selection

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ABSTRACT

Purpose Evidence on the relation between neighbourhood safety and physical activity has primarily been derived from cross-sectional studies, which are vulnerable to residential self-selection bias. This study aimed to assess the role of residential self-selection in the relation between neighbourhood safety and leisure-time physical activity (LTPA) among Dutch adults.

Methods Data on LTPA were obtained from the Dutch Health Interview Survey 2009-2011. Data on self-reported neighbourhood safety were obtained from the National Safety Monitor 2005-2008 (P1) and the Integrated Safety Monitor 2008-2011 (P2). Multilevel logistic regression analyses (N=15 608 adults) were used to assess associations of LTPA with levels of neighbourhood safety in P1 and with changes in neighbourhood safety between P1 and P2. Results of both analyses were compared to assess the role of residential self-selection.

Results Leisure-time walking was negatively associated with levels of social order and non-victimization, but not associated with levels of general safety and physical order. Associations were about equally strong for changes in neighbourhood safety. Leisure-time cycling was positively associated with levels of all four safety indicators and with changes therein, though these latter associations were weaker. Leisure-time sports was positively associated with levels of all four safety indicators, but only with changes in social order and non-victimization.

Conclusions Leisure-time cycling and sports were less strongly associated with changes in neighbourhood safety than with levels of neighbourhood safety. This suggests that residential self-selection explains a substantial part of the relation between neighbourhood safety and leisure-time cycling and sports.

Keywords physical activity, leisure time, neighbourhood, safety, crime, disorder, self-selection

INTRODUCTION

There is ample evidence that physical inactivity is detrimental for health [1]. Despite this evidence, 31% of adults worldwide do not meet current guidelines for physical activity (PA) [2]. To achieve population-level improvements in PA, social-ecological models suggest implementing multilevel interventions that do not only address PA determinants at the individual level, but also at the environmental level [3-5]. Various reviews have found PA to be consistently associated with several neighbourhood characteristics, including aesthetics, pedestrian infrastructure, and recreational facilities [6-11].

There is less consistent evidence for the role of neighbourhood safety in PA [12]. Some studies found no evidence of an association, while others found evidence of a positive association [12]. A positive association may indicate that living in a safe neighbourhood stimulates PA and that living in an unsafe neighbourhood hinders PA. Safety concerns may cause stress and fear, which adults may try to alleviate by avoiding potentially dangerous places, thereby decreasing their levels of PA [13-15]. Residential self-selection has been raised as an alternative reason for the positive association between neighbourhood safety and PA. Self-selection entails that adults who are active or willing to be active go live in safe neighbourhoods that facilitate PA [16,17]. Hence, high levels of PA in safe neighbourhoods may not be the result of adults getting more active because of better safety, but of active adults moving into safe neighbourhoods. So far, the majority of studies on neighbourhood safety and PA have been cross-sectional [12,18]. These studies are vulnerable to residential self-selection bias and may therefore overestimate the causal effect of neighbourhood safety on PA [16,17,19].

There is only limited understanding of the role of residential self-selection in the relation between neighbourhood safety and PA. A few studies have taken self-selection into account by assessing associations of PA with *changes* in neighbourhood safety over time. This study design minimizes the chance of self-selection bias by controlling for factors that remain stable over time, including residential preferences [19]. In Australia, Humpel et al. [20] explored to what extent individuals' perceptions of changes in traffic safety were associated with changes in walking during a 10-week period. Men who reported positive changes in traffic safety were less likely to have increased their walking, while women were more likely to have increased their walking. In the Netherlands, Jongeneel-Grimen et al. [21,22] explored to what extent neighbourhood-wide perceptions of changes in various neighbourhood safety indicators were associated with PA afterwards. More favourable changes in traffic safety, crime safety, physical order, and social order over time were associated with

higher odds of PA. These studies provide evidence to suggest that neighbourhood safety may be associated with PA beyond residential self-selection.

Additional research along the lines of Jongeneel-Grimen et al. [21,22] is needed with more specific PA measures, because neighbourhood environmental correlates of PA have been found to differ according to the purpose (i.e. leisure or transport) and type (e.g. walking, cycling) of PA [6,8,9,11]. The current study aimed to assess to what extent associations between neighbourhood safety and specific types of leisure-time physical activity (LTPA) in Dutch adults could be explained by residential self-selection. We explored associations of leisure-time walking, cycling, and sports with levels of neighbourhood safety at one point in time and with changes in neighbourhood safety over time. Four indicators of neighbourhood safety were included: general safety, physical order, social order, and non-victimization. Results for safety levels were compared with those for safety changes to assess the role of residential self-selection. Based on the assumption that part of the safety-LTPA relation is due to residential self-selection, we expected LTPA to be less strongly associated with safety changes than with safety levels.

Previous studies have suggested that neighbourhood safety may be more strongly associated with PA in women, elderly people, and people with a lower socio-economic status [12,18]. Therefore, in case we found neighbourhood safety to be related with LTPA beyond residential self-selection, we also explored whether the relation differed by age, gender, and educational level. We expected LTPA to be more strongly associated with safety changes among women, older adults, and lower educated adults.

METHODS

This study was based on secondary analyses of anonymized survey data provided by Statistics Netherlands (the "CBS"). The Medical Ethics Committee of the Academic Medical Centre in Amsterdam, the Netherlands, has confirmed that the Dutch Medical Research Involving Human Subjects Act (WMO) does not apply to this study (reference number W14_150 # 14.17.0187). Therefore, no official ethics approval was required.

Data

Repeated cross-sectional data on LTPA and potential confounders were obtained from the Dutch Health Interview Survey (*Gezondheidsenquête*) 2009-2011. Each year, a random nationwide sample of non-institutionalized individuals of all ages was drawn

from the national population registry. Selected individuals were interviewed at home (2009) or asked to fill in an online survey (2010, 2011). In 2010 and 2011, non-respondents were approached by telephone or interviewer. In addition to the basic survey, individuals of 12 years and older were asked to complete a supplementary survey about specific health topics, including LTPA. Respondents were able to fill in the supplementary survey on paper (2009-2011) or online (2010,2011). Between 2009 and 2011, a total of about 45 000 individuals were approached with the basic survey. Non-response was 35-40%. Of the remaining individuals of 12 years and older, non-response to the supplementary survey was 20% (2009) and 45% (2010,2011). Respondents were excluded when they were under 18 years old or had no zip code information. A total remained of 18 255 adults.

Repeated cross-sectional data on neighbourhood safety were obtained from the National Safety Monitor (*Veiligheidsmonitor Rijk*) (NSM) 2005-2008 and its successor the Integrated Safety Monitor (*Integrale Veiligheidsmonitor*) (ISM) 2008-2011. For both surveys, data were collected at a national level. For the ISM, additional data were collected at the local level every two years. We only included data collected at the national level to increase comparability of the data over the years. For the national data collection of both surveys, monthly random nationwide samples of non-institutionalized individuals of 15 years and older were drawn from the national population registry using a two-step design, with sub-municipalities in step one and individuals in step two. For the NSM, individuals were approached by telephone or interviewer between January and March. For the ISM, individuals were sent a letter between mid-September and December in which they were asked to fill in an online survey or paper-and-pencil survey. Non-respondents were approached by telephone or interviewer. Between 2005 and 2011, a total of 226 165 individuals were approached. Non-response was 38%. Respondents were excluded when they were under 18 years old, had no personal identification number, or had no zip code information. A total remained of 133 522 adults.

Measures

LTPA

LTPA was measured using the Dutch Short QQuestionnaire to ASsess Health-enhancing physical activity (SQUASH). This instrument has shown to be fairly reliable and valid for measuring PA [23,24]. Respondents were asked to report the duration (hours and minutes per day) and frequency (days per week) of leisure-time walking, cycling, and up to four different sports. Water-related sports (e.g. skiing, surfing, diving), agility sports (e.g. bowling, darts, golf) and mental sports (e.g. chess) were excluded. Total minutes per week spent on leisure-time walking, cycling, and total amount of sports were calculated by multiplying duration and frequency. Individuals were excluded

when total score exceeded 3 360 minutes per week. As the distribution of the three LTPA outcomes was highly skewed, LTPA was dichotomised into 'inactive' (no minutes per week) versus 'active' (any minutes per week). Sensitivity analyses were performed to assess whether results were different using higher cut-off points for LTPA (i.e. 30 and 60 minutes per week).

Neighbourhood safety

Neighbourhood safety was measured using four indicators:

- *Perceived general safety.* Respondents were asked whether they sometimes felt unsafe in their own neighbourhood. They were able to answer 'yes' (0) or 'no' (1).
- *Perceived physical order:* Respondents were asked whether they judged graffiti, litter, dog waste, and demolition of phone booths/bus-cubicles/tram-cubicles to occur often (1), sometimes (2), or (almost) never (3) in their neighbourhood. We calculated the average score on all four items (range 1-3). Cronbach's alpha of the four items was 0.61, indicating fair reliability.
- *Perceived social order.* Respondents were asked whether they judged youth nuisance, drugs nuisance, neighbour nuisance, drunk people on the street, and harassment of people on the street to occur often (1), sometimes (2), or (almost) never (3) in their neighbourhood. We calculated the average score on all five items (range 1-3). Cronbach's alpha of the five items was 0.68, indicating fair reliability.
- *Criminal non-victimization.* Respondents were asked whether they had been a victim in the past five years of attempted burglary, burglary, bicycle theft, car theft, theft from their car, car damaging, pick pocketing, violent robbery, other thefts, other damaging, sexual abuse, threat of physical abuse, physical abuse, other crimes. If respondents were victimized, they were asked if that happened before or after January 1st of last year (NSM), or this year, last year, or earlier (ISM). If respondents were victimized after January 1st of last year (NSM) or this year (ISM) they were asked whether the last time occurred in their own neighbourhood, somewhere else in the municipality, somewhere else in the Netherlands, or in a foreign country. For each of the fourteen crimes, respondents were given a score of 1 if they had been victimized in their own neighbourhood after January 1st of last year (NSM) or this year (ISM). All other respondents were given a score of 0. An overall non-victimization variable was computed by summing the scores of all fourteen crimes (range 0-14).

First, for each safety indicator, *levels* of neighbourhood safety were calculated by aggregating all individual scores within period 1 (P1: 2005-2008, NSM) and those in period 2 (P2: 2008-2011, ISM) at the neighbourhood level. For general safety and non-victimization, neighbourhood-level scores were obtained by calculating the percentage of residents within the neighbourhood that felt safe or were not

victimized, respectively, in P1 and P2 (range 0-100). For physical and social order, neighbourhood-level scores were obtained by averaging all individual scores within the neighbourhood in P1 and P2 (range 1-3). A neighbourhood was defined as the area within one 4-digit zip code. Neighbourhood-level variables were standardized using z-scores to increase comparability across safety indicators. To accurately assess neighbourhood-level perceptions, neighbourhoods were excluded when neighbourhood-level scores were based on less than 10 valid scores or less than 2 years per period. Sensitivity analyses were performed to assess whether results were different using higher cut-off points for neighbourhood-level safety (i.e. 20 valid scores or less than 2 years per period).

Second, for each safety indicator, *changes* in neighbourhood safety over time were calculated by subtracting neighbourhood-level scores in P1 from those in P2. A negative score indicated a worsening of neighbourhood safety between periods, a score of 0 indicated no change, and a positive score indicated an improvement of neighbourhood safety between periods. Neighbourhoods were excluded when one of the period averages was missing.

Finally, safety levels and safety changes were linked to the Dutch Health Interview Survey data using data on the 4-digit zip code. Individuals were excluded from the Dutch Health Interview Survey when no data on safety change were available. A total remained of between 15 392 and 15 608 adult respondents residing in 1931 to 1938 neighbourhoods (depending on the safety measure and LTPA outcome).

Covariates

Data on age (continuous), gender (men, women), household composition (four combinations of partner or single and children or no children), and educational level (primary, lower secondary, higher secondary, tertiary) were obtained from the Dutch Health Interview Survey. Data on ethnicity (ethnic Dutch, and three non-ethnic Dutch groups: Western, non-Western, origin unknown) were derived from the national population registry. Data on equivalent disposable household income (quintiles) were obtained from the national tax registry.

Statistical analyses

Logistic regression analyses were applied to assess to what extent the odds of doing any leisure-time walking, cycling, or sports in 2009-2011 (P2) were associated with levels of neighbourhood safety in P1 and with changes in neighbourhood safety between P1 and P2. Safety levels and safety changes were included in the model simultaneously. Separate analyses were performed for each safety indicator and LTPA outcome. Analyses were adjusted for age, gender, ethnicity, household composition,

educational level, and household income. Multilevel regression analyses were applied to take clustering of respondents in neighbourhoods into account. Level 1 represented individuals and level 2 represented neighbourhoods.

First, we estimated associations for the total adult population. Then, we estimated associations for subgroups of gender (men; women), age (under 55 years old; 55 years and older), and educational level (primary and lower secondary level; higher secondary and tertiary level). These estimates were derived by simultaneously adding interaction terms of neighbourhood safety levels with the subgroup of interest and of neighbourhood safety changes with the subgroup of interest. All analyses were carried out using STATA 11.0 software. Statistical significance was set at 0.05. Results that were marginally statistically significant (i.e. with a p-value between 0.05 and 0.10) were also presented.

RESULTS

Neighbourhood-wide perceptions of general safety, physical order, and social order deteriorated between P1 and P2 (Table 1). On the contrary, between P1 and P2 there was an increase in the number of adults who had never been victimized. The degree to which neighbourhood safety changed between P1 and P2 varied between neighbourhoods. For example, the degree of change in non-victimization varied from a decrease of about 3% in neighbourhoods at the 25th percentile, to an increase of about 9% in neighbourhoods at the 75th percentile.

TABLE 1. Characteristics of neighbourhood safety levels in the periods 2005-2008 (P1) and 2008-2011 (P2), and of changes in neighbourhood safety between the periods 2005-2008 and 2008-2011 (Δ P1-P2) (unstandardized)

| | General safety ¹ | Physical order ² | Social order ² | Non-victimization ¹ |
|----------------------------------|-----------------------------|-----------------------------|---------------------------|--------------------------------|
| P1 | | | | |
| Mean | 92.07 | 2.35 | 2.75 | 81.66 |
| Standard deviation | 7.31 | 0.19 | 0.12 | 9.48 |
| 25 th percentile | 88.24 | 2.23 | 2.70 | 76.47 |
| 75 th percentile | 97.37 | 2.48 | 2.83 | 88.24 |
| P2 | | | | |
| Mean | 84.40 | 2.27 | 2.65 | 84.60 |
| Standard deviation | 10.17 | 0.18 | 0.16 | 8.65 |
| 25 th percentile | 78.72 | 2.14 | 2.57 | 80.00 |
| 75 th percentile | 91.84 | 2.40 | 2.75 | 90.91 |
| Δ P1-P2 | | | | |
| Mean | -7.67 | -0.08 | -0.11 | 2.95 |
| Standard deviation | 8.82 | 0.13 | 0.11 | 10.08 |
| 25 th percentile | -12.63 | -0.16 | -0.16 | -3.33 |
| 75 th percentile | -1.68 | 0.00 | -0.04 | 9.09 |

¹Percentage of respondents feeling safe/not victimized

²Mean score between 1 (never order) and 3 ((almost) always order)

TABLE 2. Associations of LTPA in P2 with individual characteristics, with neighbourhood safety levels in the period 2005-2008 (P1), and with changes in neighbourhood safety between the periods 2005-2008 and 2008-2011 (Δ P1-P2) (z-scores)

| | % N ¹ | Odds Ratio's for being active in leisure time in P2 (95% CI) ² | | |
|---|------------------|---|----------------------|----------------------|
| | | Walking | Cycling | Sports |
| Individual characteristics | | | | |
| Age (years, mean) | 50.8 | 1.01 (1.00 – 1.01)** | 1.00 (0.99 – 1.00) | 0.97 (0.97 – 0.98)** |
| Gender | | | | |
| Women | 47.6 | Ref | Ref | Ref |
| Men | 52.4 | 1.59 (1.48 – 1.70)** | 1.24 (1.16 – 1.33)** | 1.13 (1.05 – 1.20)** |
| Household composition | | | | |
| Partner/married with child(ren) | 35.3 | Ref | Ref | Ref |
| Partner/married no child(ren) | 41.0 | 1.07 (0.98 – 1.17) | 0.98 (0.90 – 1.07) | 1.07 (0.98 – 1.16) |
| Single no child(ren) | 18.4 | 0.88 (0.80 – 0.98)** | 0.75 (0.67 – 0.83)** | 1.13 (1.01 – 1.25)** |
| Single with child(ren) | 4.0 | 0.70 (0.59 – 0.84)** | 0.83 (0.70 – 0.99)** | 0.94 (0.79 – 1.12) |
| Ethnicity | | | | |
| Ethnic Dutch | 87.4 | Ref | Ref | Ref |
| Non-ethnic Dutch, western | 6.0 | 0.90 (0.78 – 1.03) | 0.75 (0.65 – 0.86)** | 1.16 (1.01 – 1.34)** |
| Non-ethnic Dutch, non-western | 1.9 | 0.89 (0.69 – 1.14) | 0.52 (0.40 – 0.66)** | 0.73 (0.56 – 0.94)** |
| Non-ethnic Dutch, origin unknown | 3.4 | 0.89 (0.74 – 1.07) | 0.57 (0.47 – 0.68)** | 0.96 (0.80 – 1.16) |
| Educational level | | | | |
| Primary | 12.7 | Ref | Ref | Ref |
| Secondary: lower level | 22.7 | 1.47 (1.31 – 1.65)** | 1.54 (1.37 – 1.73)** | 1.60 (1.40 – 1.82)** |
| Secondary: higher level | 30.6 | 1.84 (1.64 – 2.07)** | 1.81 (1.61 – 2.04)** | 2.13 (1.87 – 2.42)** |
| Tertiary | 29.4 | 2.48 (2.19 – 2.81)** | 2.46 (2.17 – 2.78)** | 2.96 (2.59 – 3.39)** |
| Household income (€) | | | | |
| 1 st quintile (<17 197) | 19.7 | Ref | Ref | Ref |
| 2 nd quintile (17 197 – 21 517) | 19.9 | 1.16 (1.04 – 1.29)** | 1.04 (0.94 – 1.16) | 1.30 (1.16 – 1.46)** |
| 3 rd quintile (21 518 – 26 213) | 20.0 | 1.22 (1.09 – 1.36)** | 1.04 (0.94 – 1.16) | 1.54 (1.37 – 1.72)** |
| 4 th quintile (26 214 – 33 098) | 20.1 | 1.09 (0.97 – 1.21) | 0.96 (0.86 – 1.07) | 1.76 (1.57 – 1.98)** |
| 5 th quintile (>33 098) | 20.0 | 1.14 (1.02 – 1.29)** | 0.99 (0.86 – 1.11) | 2.21 (1.97 – 2.49)** |
| Neighbourhood safety P1 | | | | |
| General safety | 92.07 | 0.97 (0.93 – 1.01) | 1.12 (1.08 – 1.16)** | 1.07 (1.03 – 1.11)** |
| Physical order | 2.35 | 0.97 (0.94 – 1.01) | 1.10 (1.05 – 1.14)** | 1.07 (1.03 – 1.11)** |
| Social order | 2.75 | 0.96 (0.93 – 0.99)** | 1.07 (1.03 – 1.11)** | 1.06 (1.02 – 1.10)** |
| Non-victimization | 81.66 | 0.94 (0.90 – 0.99)** | 1.06 (1.01 – 1.11)** | 1.06 (1.02 – 1.11)** |
| Neighbourhood safety Δ P1-P2 | | | | |
| Δ General safety | -7.67 | 0.99 (0.96 – 1.03) | 1.07 (1.03 – 1.11)** | 1.02 (0.98 – 1.05) |
| Δ Physical order | -0.08 | 1.01 (0.97 – 1.05) | 1.06 (1.02 – 1.10)** | 1.01 (0.97 – 1.05) |
| Δ Social order | -0.11 | 0.97 (0.94 – 1.01)* | 1.03 (0.99 – 1.07)* | 1.03 (0.99 – 1.07)* |
| Δ Non-victimization | 2.95 | 0.95 (0.91 – 0.99)** | 1.04 (0.99 – 1.09)* | 1.05 (1.00 – 1.09)** |

¹Percentages may not add up to 100% due to the category 'missings' which has not been reported. Characteristics represent average values over the years 2005-2011.

²Individual characteristics, neighbourhood safety P1, and neighbourhood safety Δ P1-P2 were all included in the model. Separate models were used for each safety indicator and LTPA outcome.

** $p \leq 0.05$; * $0.05 < p \leq 0.10$

The upper part of table 2 displays associations of LTPA in P2 with individual-level factors. Odds of LTPA were generally higher among men, couples, adults of Dutch origin, higher educated adults, and adults with higher income levels. Increasing age was associated with increased odds of walking, but decreased odds of sports participation. The middle part of table 2 displays associations of LTPA in P2 with levels of neighbourhood safety in P1. For leisure-time walking, higher levels of social order and non-victimization were associated with lower odds of being active. There were no associations with levels of general safety and physical order. For both leisure-time cycling and sports, higher levels of all four safety indicators were associated with higher odds of being active.

The bottom part of table 2 displays associations of LTPA in P2 with changes in neighbourhood safety between P1 and P2. For leisure-time walking, greater improvements in social order and non-victimization over time were associated with lower odds of being active. There were no associations with changes in general safety and physical order. For leisure-time cycling, greater improvements in all four safety indicators over time were associated with higher odds of being active. For leisure-time sports, greater improvements in social order and non-victimization over time were associated with higher odds of being active. There were no associations with changes in general safety and physical order. A comparison of results displayed in the middle and bottom part of table 2 reveals that leisure-time cycling and sports were less strongly associated with changes in neighbourhood safety between P1 and P2 than with levels of neighbourhood safety in P1. For leisure-time walking, no such differences were apparent. Differences were apparent for all safety indicators, but least for non-victimization.

Table 3 displays associations of LTPA in P2 with changes in neighbourhood safety between P1 and P2, stratified by subgroup. Several (marginally) significant interactions were found. Leisure-time walking was more positively associated with changes in physical order among women, and more negatively associated with changes in general safety among older adults. Leisure-time cycling was more positively associated with changes in physical order among women, with changes in non-victimization among men, with changes in general safety and non-victimization among older adults, and with changes in non-victimization among lower educated adults. Leisure-time sports was more positively associated with changes in physical order among women, with changes in social order among older adults, and with changes in all safety indicators except physical order among lower educated adults. Thus, when interactions were observed, associations were generally stronger among women, older adults, and lower educated adults.

TABLE 3. Associations of LTPA in P2 with changes in neighbourhood safety between the periods 2005-2008 and 2008-2011 ($\Delta P1-P2$) (z-scores), stratified by subgroup

| | Odds Ratio's for being active in leisure time in P2 (95% CI) ¹ | | |
|--------------------------------------|---|-----------------------|-----------------------|
| | Walking | Cycling | Sports |
| Gender | | | |
| Men (ref) | | | |
| Δ General safety | 0.97 (0.93 - 1.02) | 1.05 (1.00 - 1.10)* | 0.99 (0.94 - 1.04) |
| Δ Physical order | 0.96 (0.91 - 1.01) | 1.01 (0.96 - 1.07) | 0.96 (0.91 - 1.01) |
| Δ Social order | 0.98 (0.93 - 1.03) | 1.01 (0.96 - 1.07) | 1.03 (0.98 - 1.08) |
| Δ Non-victimization | 0.97 (0.91 - 1.03) | 1.09 (1.02 - 1.16)** | 1.04 (0.97 - 1.10) |
| Women | | | |
| Δ General safety | 1.01 (0.96 - 1.06) | 1.08 (1.03 - 1.14)** | 1.04 (0.99 - 1.09)* |
| Δ Physical order | 1.06 (1.01 - 1.12)**† | 1.11 (1.05 - 1.17)**† | 1.06 (1.00 - 1.11)**† |
| Δ Social order | 0.96 (0.92 - 1.01) | 1.05 (1.00 - 1.10)** | 1.03 (0.98 - 1.08) |
| Δ Non-victimization | 0.93 (0.88 - 0.99)** | 1.00 (0.94 - 1.07)‡ | 1.06 (1.00 - 1.13)* |
| Age² | | | |
| Younger (ref) | | | |
| Δ General safety | 1.03 (0.98 - 1.07) | 1.04 (0.99 - 1.09) | 1.01 (0.96 - 1.05) |
| Δ Physical order | 1.02 (0.97 - 1.07) | 1.05 (1.00 - 1.10)* | 1.00 (0.96 - 1.05) |
| Δ Social order | 0.97 (0.92 - 1.01) | 1.02 (0.98 - 1.07) | 1.01 (0.97 - 1.05) |
| Δ Non-victimization | 0.95 (0.90 - 1.01)* | 0.98 (0.93 - 1.04) | 1.02 (0.97 - 1.08) |
| Older | | | |
| Δ General safety | 0.94 (0.89 - 0.99)**† | 1.10 (1.05 - 1.17)**‡ | 1.03 (0.98 - 1.09) |
| Δ Physical order | 1.00 (0.94 - 1.05) | 1.07 (1.01 - 1.13)** | 1.02 (0.96 - 1.08) |
| Δ Social order | 0.97 (0.92 - 1.03) | 1.05 (0.99 - 1.11)* | 1.07 (1.01 - 1.13)**‡ |
| Δ Non-victimization | 0.94 (0.88 - 1.00)* | 1.14 (1.07 - 1.22)**† | 1.09 (1.02 - 1.17)** |
| Educational level³ | | | |
| Higher level (ref) | | | |
| Δ General safety | 0.98 (0.94 - 1.03) | 1.05 (1.00 - 1.10)** | 0.99 (0.94 - 1.03) |
| Δ Physical order | 1.02 (0.97 - 1.07) | 1.04 (0.99 - 1.10)* | 0.99 (0.94 - 1.04) |
| Δ Social order | 0.96 (0.92 - 1.01) | 1.02 (0.98 - 1.07) | 1.01 (0.97 - 1.06) |
| Δ Non-victimization | 0.95 (0.90 - 1.01) | 0.98 (0.93 - 1.04) | 1.03 (0.97 - 1.08) |
| Lower level | | | |
| Δ General safety | 0.99 (0.93 - 1.05) | 1.10 (1.04 - 1.17)** | 1.11 (1.05 - 1.19)**† |
| Δ Physical order | 0.98 (0.92 - 1.04) | 1.08 (1.02 - 1.15)** | 1.05 (0.99 - 1.13) |
| Δ Social order | 0.97 (0.92 - 1.03) | 1.06 (1.00 - 1.12)** | 1.10 (1.03 - 1.17)**† |
| Δ Non-victimization | 0.93 (0.86 - 1.00)** | 1.17 (1.09 - 1.27)**† | 1.15 (1.06 - 1.24)**† |

¹Adjusted for age, gender, household composition, ethnicity, educational level, household income, and an interaction term of neighbourhood safety P1 with the subgroup of interest. Separate models were used for each safety indicator and LTPA outcome.

²Younger = under 55 years old; older = 55 years and older.

³Higher = higher secondary and tertiary level; lower = primary and lower secondary level.

**p \leq 0.05; *0.05<p \leq 0.10

†interaction p \leq 0.05; ‡interaction 0.05<p \leq 0.10

Table 4 displays associations of LTPA in P2 with changes in neighbourhood safety between P1 and P2, using different cut-off points for LTPA and neighbourhood safety. The top part of table 4 displays results for different cut-off points for LTPA. Results for the 30 and 60 minutes per week cut-off point were similar to those for the initial 0 minutes per week cut-off point. The only exception being that leisure-time cycling was

less strongly associated with changes in general safety and physical order when using the higher cut-off points. However, associations remained statistically significant.

The bottom part of table 4 displays results for different cut-off points for neighbourhood-level safety. For leisure-time cycling, results for the cut-off point of 20 valid safety scores per period were similar to those for the initial cut-off point of 10 valid safety scores per period. Leisure-time walking was no longer marginally significantly associated with changes in social order using the higher cut-off point, while it turned out to be marginally significantly associated with changes in physical order. Leisure-time sports was no longer associated with changes in any of the safety indicators when using the higher cut-off point.

TABLE 4. Associations of LTPA in P2 with changes in neighbourhood safety between the periods 2005-2008 and 2008-2011 ($\Delta P1-P2$) (z-scores), sensitivity analyses

| Neighbourhood safety $\Delta P1-P2$ | Odds Ratio's for being active in leisure time in P2 (95% CI) ² | | |
|--|---|----------------------|----------------------|
| | Walking | Cycling | Sports |
| Alternative cut-off points for LTPA | | | |
| 0 minutes per week | | | |
| Δ General safety | 0.99 (0.96 – 1.03) | 1.07 (1.03 – 1.11)** | 1.02 (0.98 – 1.05) |
| Δ Physical order | 1.01 (0.97 – 1.05) | 1.06 (1.02 – 1.10)** | 1.01 (0.97 – 1.05) |
| Δ Social order | 0.97 (0.94 – 1.01)* | 1.03 (1.00 – 1.07)* | 1.03 (0.99 – 1.07)* |
| Δ Non-victimization | 0.95 (0.91 – 0.99)** | 1.04 (1.00 – 1.09)* | 1.05 (1.00 – 1.09)** |
| 30 minutes per week | | | |
| Δ General safety | 0.98 (0.95 – 1.02) | 1.05 (1.01 – 1.09)** | 1.02 (0.98 – 1.05) |
| Δ Physical order | 1.01 (0.97 – 1.05) | 1.06 (1.02 – 1.10)** | 1.01 (0.98 – 1.05) |
| Δ Social order | 0.97 (0.94 – 1.01)* | 1.03 (1.00 – 1.07)* | 1.03 (1.00 – 1.07)* |
| Δ Non-victimization | 0.95 (0.91 – 0.99)** | 1.04 (0.99 – 1.08) | 1.05 (1.00 – 1.09)** |
| 60 minutes per week | | | |
| Δ General safety | 0.99 (0.95 – 1.02) | 1.04 (1.00 – 1.08)** | 1.02 (0.98 – 1.05) |
| Δ Physical order | 1.00 (0.97 – 1.04) | 1.04 (1.00 – 1.08)** | 1.01 (0.98 – 1.05) |
| Δ Social order | 0.97 (0.93 – 1.00)* | 1.03 (0.99 – 1.06) | 1.04 (1.00 – 1.08)** |
| Δ Non-victimization | 0.95 (0.91 – 1.00)** | 1.03 (0.99 – 1.08) | 1.04 (1.00 – 1.09)* |
| Alternative cut-off points for neighbourhood safety $\Delta P1-P2$ | | | |
| 10 valid safety scores per period | | | |
| Δ General safety | 0.99 (0.96 – 1.03) | 1.07 (1.03 – 1.11)** | 1.02 (0.98 – 1.05) |
| Δ Physical order | 1.01 (0.97 – 1.05) | 1.06 (1.02 – 1.10)** | 1.01 (0.97 – 1.05) |
| Δ Social order | 0.97 (0.94 – 1.01)* | 1.03 (0.99 – 1.07)* | 1.03 (0.99 – 1.07)* |
| Δ Non-victimization | 0.95 (0.91 – 0.99)** | 1.04 (0.99 – 1.09)* | 1.05 (1.00 – 1.09)** |
| 20 valid safety scores per period | | | |
| Δ General safety | 1.00 (0.96 – 1.05) | 1.07 (1.02 – 1.11)** | 1.01 (0.97 – 1.05) |
| Δ Physical order | 1.04 (1.00 – 1.09)* | 1.07 (1.02 – 1.11)** | 0.99 (0.94 – 1.03) |
| Δ Social order | 1.01 (0.97 – 1.05) | 1.05 (1.01 – 1.10)** | 1.03 (0.99 – 1.07) |
| Δ Non-victimization | 0.95 (0.90 – 1.01)* | 1.03 (0.98 – 1.09) | 1.02 (0.97 – 1.07) |

¹Adjusted for age, gender, household composition, ethnicity, educational level, household income, and neighbourhood safety P1. Separate models are used for each safety indicator and LTPA outcome.

** $p \leq 0.05$; * $0.05 < p \leq 0.10$

DISCUSSION

The overall aim of this study was to explore to what extent associations of self-reported neighbourhood safety with LTPA in Dutch adults could be explained by residential self-selection. We explored the role of self-selection by assessing associations between LTPA and levels of neighbourhood safety at one point in time, and by comparing them with associations between LTPA and changes in neighbourhood safety over time. Leisure-time walking was negatively associated with both levels of and changes in social order and non-victimization, but not with levels of or changes in general safety or physical order. Leisure-time cycling was positively associated with levels of all four safety indicators, as well as with changes therein, though these latter associations were substantially weaker than the first. Leisure-time sports was positively associated with levels of all four safety indicators, but only with changes in social order and non-victimization.

Limitations

Several methodological considerations need to be taken into account when interpreting the results of this study. In 2008, some alterations were made to the survey that was used to measure perceptions of neighbourhood safety. The phrasing of the questions that were relevant for this study remained unchanged, but their order slightly changed and the main survey mode changed from telephone to internet. This may have caused us to misestimate absolute changes in neighbourhood safety over time. However, this would have only biased our results if the error systematically differed by levels of LTPA or neighbourhood safety, which we do not consider to be very likely.

While we included a wide variety of potential individual-level confounders, we were unable to account for residual neighbourhood-level confounding. Our results may have been biased if neighbourhoods changed in ways related to both neighbourhood safety and LTPA. The mechanisms underlying changes in neighbourhood safety are complex and hard to quantify. Therefore, we were unable to include all relevant neighbourhood-level confounders. To address this problem, future studies are advised to adopt a quasi-experimental design, thereby exploring changes in LTPA in neighbourhoods where safety levels changed because of specific programmes or policies.

We only had individual-level data on LTPA in P2, and not on LTPA in P1 and P2. Longitudinal data would have allowed us to look at changes in individual-level LTPA over time in relation to changes in neighbourhood safety over time. By doing so, we would have been better able to account for baseline levels of LTPA.

LTPA has been assessed using survey data, which has been associated with issues like social desirability and recall errors [25]. As a result, levels of PA are generally over-reported in surveys [26]. However, this will have only affected our results if the degree of over-reporting systematically differed by levels of or changes in neighbourhood safety, which is unlikely. Another issue is that the survey did not provide information about the location where adults were active. By including LTPA activities that were performed within as well as outside the neighbourhood of residence, we may have underestimated some of the associations between safety changes and LTPA.

Most of the neighbourhood safety indicators that we used represented adults' perceptions of safety. Research has shown that people's perception of their neighbourhood is generally poorly correlated with objectively measured neighbourhood features [27-29]. We chose to use perceptions of neighbourhood safety in this study. While safety problems may objectively be resolved over time, adults will remain fearful and constrain their behaviour as long as they do not perceive that these problems have been resolved. Research has found evidence to suggest that neighbourhood perceptions may indeed be more strongly associated with PA than the objective neighbourhood environment [29]. People who perceived their objectively measured high walkable neighbourhood as low walkable, were found to decrease their transport walking significantly more than those with matched perceptions [29].

Interpretation of key findings

Leisure-time cycling and sports were substantially less strongly associated with changes in neighbourhood safety over time than with levels of neighbourhood safety at one point in time. Our findings are in line with earlier research by Jongeneel-Grimen et al. [22], who found that general PA was less strongly associated with changes in various neighbourhood safety indicators over time than with levels of these safety indicators. This indicates that a substantial part of the safety-LTPA association is due to residential self-selection. It confirms earlier suggestions that cross-sectional studies are likely to overestimate associations of the neighbourhood environment with PA if they do not account for residential self-selection [16,17,19,].

LTPA was less strongly associated with changes in neighbourhood safety than with levels of neighbourhood safety for self-reported general safety, physical order, and social, but less so for non-victimization. This implies that self-selection is particularly evident in associations with safety perceptions, but that this may be less evident in associations with more objective safety indicators. This seems plausible as residential preferences are primarily based on people's perception of the neighbourhood.

Changes in neighbourhood safety were positively associated with both leisure-time cycling and sports, though these latter associations were only evident for some safety indicators. These results are in line with earlier research on other types of PA. Changes in neighbourhood safety have been associated with general PA [21,22] and neighbourhood walking [20]. Our results indicate that neighbourhood safety may be associated with leisure-time cycling beyond residential self-selection. The same may be true for leisure-time sports, though the evidence is somewhat weaker.

Contrary to the results for leisure-time cycling and sports, we found that changes in neighbourhood safety were negatively associated with leisure-time walking. In neighbourhoods that got safer over time, perhaps adults have substituted walking for cycling and sports, hence leading to lower levels of walking but higher levels of cycling and sports [30]. However, it remains unclear why adults would choose to substitute walking for cycling or sports.

Overall, LTPA was more consistently associated with changes in social order and non-victimization than with changes in general safety and physical order. This implies that the social neighbourhood environment may be a more important cause of fear than the physical environment. A recent review of qualitative evidence on fear of crime and the environment provides evidence to support this hypothesis [31]. Qualitative studies have identified social nuisance and crime as key sources of fear that keep adults from walking in their neighbourhood [32,33]. While physical disorder was also found to keep adults from walking, this was mainly because of aesthetical reasons, which may have a less powerful impact on PA than fear [32,33].

Changes in neighbourhood safety were generally more strongly associated with LTPA among women, older adults, and lower educated adults. These results are somewhat in line with previous research. Jongeneel-Grimen et al. [21,22] found that changes in various neighbourhood safety indicators tended to be more strongly associated with PA among women. Associations did not clearly differ by age. Humpel et al. [20] found that traffic safety changes were only positively associated with walking among women. Subgroup differences have been suggested to be the result of differences in physical and social vulnerability [12,14]. Women and elderly may be less able to defend themselves during an attack than their counterparts. Adults with a lower socio-economic status may be more exposed to unsafe situations and may have fewer resources to deal with the medical and economic consequences of victimization than their counterparts. As a result, these groups may be more inclined to restrict their LTPA when feeling unsafe.

CONCLUSIONS

So far, evidence on the association between neighbourhood safety and LTPA has primarily been derived from cross-sectional studies that do not account for residential self-selection. Our results indicate that these studies are likely to overestimate associations of neighbourhood safety with leisure-time cycling and sports, because a substantial part of these associations may be attributable to residential self-selection, particularly when using subjective safety indicators. Longitudinal and quasi-experimental studies are needed to assess the extent to which observed associations reflect a causal effect of neighbourhood safety on LTPA.

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

REFERENCES

1. Lee I, Shiroma EJ, Lobelo F, Puska P, Blair SB, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* 2012;380:219-29.
2. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekuland U, et al. Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet* 2012;380:247-257.
3. Stokols D. Establishing and maintaining healthy environments. Toward a social ecology of health promotion. *Am Psychol* 1992;47:6-22.
4. Spence JC, Lee RE. Toward a comprehensive model of physical activity. *Psychol Sport Exerc* 2003;4:7-24.
5. Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J, et al. An ecological approach to creating active living communities. *Annu Rev Publ Health* 2006;27:297-322.
6. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking. Review and research agenda. *Am J Prev Med* 2004;27:67-76.

7. Duncan MJ, Spence JC, Mummery WK. Perceived environment and physical activity: a meta-analysis of selected environmental characteristics. *I J Behav Nutr Phys Act* 2005;2:11.
8. Wendel-Vos W, Droomers M, Kremers S, Brug J, van Lenthe F. Potential environmental determinants of physical activity in adults: a systematic review. *Obes Rev* 2007;8:425-40.
9. Saelens BE, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc* 2008;40:550-566.
10. van Holle V, Deforche B, van Cauwenberg J, Goubert L, Maes L, van de Weghe N, et al. Relationship between the physical environment and different domains of physical activity in European adults: a systematic review. *BMC Public Health*, 2012;12:807.
11. Sugiyama T, Neuhaus M, Cole R, Giles-Corti B, Owen N. Destination and route attributes associated with adults' walking: a review. *Med Sci Sports Exerc* 2012;44:1275-1286.
12. Foster S, Giles-Corti B. The built environment, neighborhood crime and constrained physical activity: an exploration of inconsistent findings. *Prev Med* 2008;47:241-251.
13. Farafalo J. The fear of crime: causes and consequences. *J Crim Law Crim* 1973;72:839-857.
14. Skogan WG, Maxfield MG. *Coping with crime. Individual and neighbourhood reactions*. London: Sage Publications, 1981.
15. Evans GW, Cohen S. Environmental stress. In: Stokols D, Altman I (eds). *Handbook of environmental psychology*. New York: John Wiley & Sons, 1987.
16. Cao X, Mokhtarian PL, Handy SL. Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. *Transport Rev* 2009;29:359-395.
17. McGormack GR, Shiell A. In search of causality: a systematic review of the relationship between the built environment and physical activity among adults. *I J Behav Nutr Phys Act* 2011;8.
18. Loukaitou-Sideris A, Eck JE. Crime prevention and active living. *Am J Health Promot* 2007;21:380-389.
19. Mokhtarian PL, Cao X. Examining the impacts of residential self-selection on travel behaviour: a focus on methodologies. *Transport Rev* 2008;42:204-228.
20. Humpel N, Marshall AL, Leslie E, Bauman A, Owen N. Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Ann Behav Med* 2004;27:60-67.
21. Jongeneel-Grimen, B, Busschers W, Droomers M, van Oers HAM, Stronks K, Kunst AE. Change in neighborhood traffic safety: does it matter in terms of physical activity? *Plos One* 2013;8:e62525
22. Jongeneel-Grimen B, Droomers M, van Oers HAM, Stronks K, Kunst AE. The relationship between physical activity and the living environment: a multi-level analyses focusing on changes over time in environmental factors. *Health Place* 2014;26:149-160.
23. Wendel-Vos GCW, Schuit AJ, Saris WHM, Kromhout D. Reproducibility and relative validity of the Short Questionnaire to Assess Health-enhancing physical activity. *J Clin Epidemiol* 2003;56:1163-1169.
24. Wagenmakers R, van den Akker-Scheek I, Groothoff JW, Zijlstra W, Bulstra SK, Kootstra JWJ, et al. Reliability and validity of the short questionnaire to assess health-enhancing physical activity (SQUASH) in patients after total hip arthroplasty. *BMC Musculoskel Dis* 2008;9.
25. Crosnick JA. Survey Research. *Ann Rev Psychol* 1999;50:537-567.

26. Prince SA, Adamo KB, Hamel ME, Hardt J, Gorber SC, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *I J Behav Nutr Phys Act* 2008;5:56.
27. McGinn AP, Evenson KR, Herrin AH, Huston SL, Rodriguez DA. Exploring associations between physical activity and perceived and objective measures of the built environment. *J Urban Health* 2007;84:162–184.
28. Ball K, Jeffery RW, Crawford DA, Roberts RJ, Salmon J, Timperio AF. Mismatch between perceived and objective measures of physical activity environments. *Prev Med* 2008;47:294-298.
29. Gebel K, Bauman AE, Sugyjama T, Owen N. Mismatch between perceived and objectively assessed neighbourhood walkability attributes: prospective relationships with walking and weight gain. *Health Place* 2011;17:519-524.
30. Saelens BE, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc* 2008;40:550-566.
31. Lorenc T, Petticrew M, Whitehead M, Neary D, Clayton S, Wright K, et al. Fear of crime and the environment: systematic review of UK qualitative evidence. *BMC Public Health* 2013;13:496.
32. Burgoyne LN, Woods C, Coleman R, Perry IJ. Neighbourhood perceptions of physical activity: a qualitative study. *BMC Public Health* 2008;8:101.
33. Annear MJ, Cushman G, Gidlow B. Leisure time physical activity differences among older adults from diverse socioeconomic neighborhoods. *Health Place* 2009; 15:482-490.

PART

II

**Area-based initiatives
and neighbourhood safety**

CHAPTER

5

Are area-based initiatives able to improve area safety in deprived areas? A quasi- experimental evaluation of the Dutch District Approach

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ABSTRACT

Background Numerous area-based initiatives have been implemented in deprived areas across Western-Europe with the aim to improve the socio-economic and environmental conditions in these areas. Only few of these initiatives have been scientifically evaluated for their impact on key social determinants of health, like area safety. Therefore, this study aimed to assess the impact of a Dutch area-based initiative called the District Approach on trends in self-reported area safety in deprived target districts.

Methods A quasi-experimental design was used. Repeated cross-sectional data on self-reported area safety were obtained from the National Safety Monitor (2005-2008) and its successor the Integrated Safety Monitor (2008-2011). Study population consisted of 133 522 Dutch adults, including 3 595 adults from target districts. Multilevel logistic regression analyses were performed to assess trends in self-reported general safety, physical order, social order, and non-victimization before and after the start of the District Approach mid-2008. Trends in target districts were compared with trends in various control groups.

Results Residents of target districts felt less safe, perceived less physical and social order, and were victimized more often than adults elsewhere in the Netherlands. For non-victimization, target districts showed a somewhat more positive change in trend after the start of the District Approach than the rest of the Netherlands or other deprived districts. Differences were only statistically significant in women, older adults, and lower educated adults. For general safety, physical order, and social order, there were no differences in trend change between target districts and control groups.

Conclusions Results suggest that the District Approach has been unable to improve perceptions of area safety in deprived areas, but that it did result in declining victimization rates, especially among more vulnerable and exposed groups.

Key words: safety, victimization, disorder, area-based initiative, quasi-experimental evaluation

INTRODUCTION

In the past decade, numerous area-based initiatives (ABIs) have been implemented in deprived areas across Western-Europe with the aim to improve their socio-economic and environmental conditions [1]. These initiatives have the potential to improve health and reduce health inequalities by improving key social determinants of health, such as employment, housing, and area safety [2-4]. However, only few evaluation studies have been able to assess the impact of ABIs on health [2,3]. Where impacts have been assessed, health improvements were often small [3]. It has been suggested that this lack of evidence is due to the long time needed to detect health impacts [2]. An alternative strategy may therefore be to assess the impact of ABIs on key social determinants of health, such as area safety, which may change more quickly in response to local policies.

Residents of deprived areas feel less safe than residents of non-deprived areas [5,6]. Perceived lack of area safety has been identified as a risk factor for health [7,8]. Safety concerns may induce psychological stress or may keep people from going outdoors, which limits social interaction and physical activity. Traditionally, researchers have focused on criminal victimization as the main cause of safety concerns, but safety concerns are far more widespread than crime, suggesting additional causes [9-11]. The incivilities thesis posits that safety concerns are the result of disorder, i.e. incivilities [12]. Signs of disorder may be physical (e.g. litter, graffiti) or social (e.g. public drinking, drug use, nuisance from youth). Residents may interpret disorder as a sign that fellow residents and officials are unable or unwilling to solve problems. As a result, residents may feel personally at risk of more serious crime, causing them to feel unsafe. There is strong quantitative and qualitative evidence for the association between disorder and safety concerns [7,8].

In addition, safety concerns are suggested to be the result of poor neighbourhood conditions, although the evidence here is less consistent [7,8,13]. Poorly designed areas (e.g. areas that are poorly lit, isolated, or where sight-lines are obstructed by vegetation or buildings) provide limited options for surveillance from fellow residents. This may cause people to feel more vulnerable to crime, resulting in safety concerns. Strong social networks may safeguard against the fear resulting from poor physical conditions by reducing feelings of vulnerability. Limited surveillance options may also increase crime and disorder by increasing the amount of potential hiding places for offenders. Again, strong social networks may mitigate this effect by signalling to offenders that residents are willing to intervene for the community's benefit [14].

ABIs have the potential to improve perceptions of area safety in deprived areas, either by tackling underlying problems of crime and disorder, or by improving physical and social neighbourhood conditions. A recent review has identified only two ABIs that have been evaluated for their impact on safety concerns and related safety problems [15]. Both ABIs were implemented in the most deprived areas of England. At five year follow-up, target areas of the Single Regeneration Budget (SRB) saw larger reductions in the number of residents feeling very unsafe than the rest of England [16]. However, differences were not tested for statistical significance. There were no effects on crime, vandalism, problems with dogs, and litter. At six year follow-up, target areas of the New Deal for Communities (NDC) saw significantly larger reductions in the number of residents reporting victimization, and lawlessness and dereliction than similarly deprived areas [17]. There were no effects on fear of crime or feeling unsafe after dark in general. However, positive effects on fear of crime were found in areas with larger safety interventions [18].

The impact of ABIs on area safety may differ between population groups. Safety concerns are more prevalent among women, elderly, ethnic minorities, and individuals with lower socio-economic status [19]. These groups are suggested to feel more unsafe because of higher physical and social vulnerability, which causes them to feel more at risk of crime [19]. ABIs may be particularly beneficial for these groups, as they try to reduce perceived risk of crime in various ways. To our knowledge, the differential safety impact of ABIs has been explored only once so far. Contrary to what might be expected, the impact of the NDC on fear of crime at two year follow-up did not significantly differ by gender, age, educational level, and ethnicity [20].

So far, studies on the safety impact of ABIs have been limited to England and have paid minimal attention to subgroup differences. Moreover, they have included only a baseline and one follow-up measurement, ignoring trends in outcome over time. An opportunity to address these issues has arisen with the implementation of a Dutch ABI called the "District Approach" mid 2008. In the current study we assessed the impact of the District Approach on trends in self-reported area safety (perceived general safety, perceived physical and social order, non-victimization) in deprived target districts. A quasi-experimental interrupted time-series design was used. We aimed to assess to what extent the trends in area safety changed mid 2008 in the target districts. These trend changes were compared with those in various control groups. Moreover, we aimed to assess whether results differed by subgroup. We expected to find a more positive trend change in self-reported area safety in target districts than in control groups, especially among women, elderly, lower educated people, and target districts with more intensive safety interventions.

METHODS

This study was based on secondary analyses of anonymized survey data. The Medical Ethics Committee of the Academic Medical Centre in Amsterdam, the Netherlands, has confirmed that ethics approval is not necessary as the Medical Research Involving Human Subjects Act (WMO) does not apply to our study.

The District Approach

The District Approach was launched by the Dutch government in 2007 with the aim to improve the living conditions in the 40 most deprived districts of the Netherlands. Districts were selected based on objective and subjective measures of physical and socioeconomic deprivation. Interventions were aimed at safety, employment, education, housing and the physical environment, and social cohesion. Each district developed a set of locally tailored interventions, which were implemented from mid-2008 onwards.

Data on the content, duration, and scale of interventions implemented as part of the District Approach since 2008 were retrospectively collected using standardized questionnaires and face-to-face interviews with local district managers [4]. Various interventions were identified that could potentially improve area safety. A first group of potentially effective interventions aimed to tackle underlying safety problems such as general social disorder, youth social disorder, physical disorder, and burglary. Examples of interventions are extra police surveillance, youth leisure activities, youth counselling, bins, and cleaning services. A second group of potentially effective interventions aimed to improve neighbourhood conditions such as housing quality, housing stock, green space, playgrounds, sports facilities/activities, trails, and social capital. Examples of interventions are demolition of rundown homes, housing renewal, (re)construction of green space and playgrounds, extra sports facilities and activities.

Data and study population

Repeated cross-sectional data were derived from the National Safety Monitor (NSM) years 2005-2008 and its successor the Integrated Safety Monitor (ISM) years 2008-2011. Both surveys were targeted at non-institutionalized persons of 15 years and older nationwide. The sampling frame was derived from the national population registry. The sampling frame was renewed each year to assure independence of observations, and it was stratified by police region to assure coverage of each Dutch police region. Monthly samples were drawn from the sampling frame using a two-step design, with sub-municipalities in step one and individuals in step two. For NSM,

individuals were approached by telephone or interviewer between January and March. For ISM, individuals were sent a letter between mid-September and December in which they were asked to participate by internet or paper-and-pencil survey. Non-respondents were approached by telephone or interviewer. A total of 226 165 individuals were approached between 2005 and 2011. Overall response rate was 62%. Respondents were excluded when they had no personal identification number (N=269), no zip code information (N=362), or were under 18 years old (N=6 609). A total remained of 133 522 adult respondents of which 3 595 resided in the target districts.

Measures

Self-reported area safety

The dependent variable was self-reported area safety. Four safety indicators were included:

Perceived general safety

Respondents were asked whether they sometimes felt unsafe in their own neighbourhood. They could answer yes or no.

Perceived physical and social order

Respondents were asked whether they judged nine problems to occur often (1), sometimes (2), or (almost) never (3) in their neighbourhood. A physical order variable was computed by averaging the scores on graffiti, litter, dog waste, and demolition of phone booths/bus-cubicles/tram-cubicles. Cronbach's alpha of the four items was 0.61, indicating fair reliability. A social order variable was computed by averaging the scores on nuisance from youth, nuisance from drugs, nuisance from neighbours, drunken people on the street, and people who get harassed on the street. Cronbach's alpha of the five items was 0.68, indicating fair reliability. As the distribution of mean scores on both disorder variables was highly skewed, mean scores were dichotomized into 'disorder generally occurs sometimes or often' (mean score ≤ 2) and 'disorder generally occurs (almost) never' (mean score > 2).

Self-reported victimization

Respondents were asked whether they had been a victim of any of the following fourteen crimes in the past five years: attempted burglary, burglary, bicycle theft, car theft, theft from their car, car damaging, pick pocketing, violent robbery, other thefts, other damaging, sexual abuse, threat of physical abuse, physical abuse, and other crimes. Respondents could answer yes or no. If they answered yes to any of the crimes, they were asked if they were victimized before or after January 1st of last year (NSM), or this year, last year, or earlier (ISM). If respondents were victimized after

January 1st of last year (NSM) or this year (ISM) they were asked whether they were last victimized in the own neighbourhood, somewhere else in the municipality, somewhere else in the Netherlands, or in a foreign country. This information was used to compose a dichotomous variable that measured whether or not the respondent had been a victim of one or more crimes after January 1st of last year (NSM) or this year (ISM) in their own neighbourhood.

Time variables

The main predictor variable was survey year. We also included the variable survey period, which was dichotomized into 'pre-intervention period' (years 2005 to 2008 from the NSM) and 'intervention period' (years 2008 to 2011 from the ISM).

Districts

The respondents' district of residence was measured using data on the 4-digit zip codes obtained from the national population registry. The intervention group consisted of all respondents living within the 83 zip codes of the target districts. In stratified analyses, the intervention group was split based on the intensity of their safety interventions. Intensity was determined by listing all interventions with a duration of at least one year within the fields of general social order, youth social order, physical order, burglary [4]. Within each field, the scale of combined interventions was graded as smaller (no change expected), intermediate (small changes expected), or larger (substantial changes expected). Per district, an overall intensity score was calculated by summing the grades in all four fields of action (smaller=0, intermediate=1, larger=2). Target districts with less intensive safety interventions (score <5, $n=13$) were distinguished from those with more intensive safety interventions (score ≥ 5 , $n=23$).

Three control groups were included. The first consisted of all other districts in the Netherlands. As these districts may have been dissimilar at baseline in ways related to the study outcome, we identified two additional control groups that were matched with the target districts in terms of deprivation level and/or geographical location. The first group consisted of the number 41 to 140 on the list of most deprived districts in the Netherlands ('other deprived districts'). The second group consisted of only those other deprived districts that were located in the same city as the target districts ('other deprived districts in same city'). Because of lower levels of power and the possibility of spill-over effects of the District Approach in these two matched control groups, the rest of the Netherlands was the main control group.

Control variables

Control variables included age (seven categories: 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 years and older), gender (men, women), ethnicity (ethnic Dutch, non-ethnic Dutch) and educational level (primary-, lower secondary-, higher secondary-, and tertiary level).

Statistical analyses

Interrupted time series analyses were used to assess whether trends in the four self-reported area safety indicators have changed with the implementation of the District Approach in 2008. Multilevel logistic regression models were applied to assess the association between year and area safety, i.e. the annual rate of change in area safety. Hereafter, this is called the *trend*. The variable district was included to measure differences in area safety between the target districts and various control groups at the start of the District Approach. The variable period was included to account for any difference in outcome related to the change in survey design in 2008. An interaction term for the variables year and district was included to assess differences in trend between the target districts and various control groups. An interaction term for year and period was included to assess differences in trend between the pre-intervention period and the intervention period. Hereafter, this is called the *trend change*. An interaction term for the variables year, district, and period was included to assess whether trend change varied between the target districts and various control groups.

All analyses were controlled for age, gender, ethnicity and education. Additional analyses were stratified by gender (men versus women), age (under 55 years old versus 55 years and older), education (primary- and lower secondary level versus higher secondary- and tertiary level), and intensity of the safety interventions (less intensive districts versus more intensive districts). Multilevel regression analyses were applied to take into account clustering of respondents in districts. Level 1 represented individuals and level 2 represented zip codes. All analyses were carried out using STATA 11.0 software. Statistical significance was set at 0.05.

RESULTS

Adults in target districts were more often under 35 years old, of non-Dutch origin, and lower educated compared to adults in all control groups (Table 1). Moreover, they reported lower levels of generally safety, physical order, social order, and non-victimization compared to adults in the rest of the Netherlands (Figure 1). Prevalence of all four safety indicators remained relatively stable over time in both groups, with two exceptions. First, between the first and second half of 2008, both groups showed a

sharp decline in the number of people feeling generally safe and perceiving order. Second, after the implementation of the District Approach, target districts showed a small increase in non-victimization.

TABLE 1. Characteristics of the study population

| | Target districts | Control groups | | |
|------------------------------------|------------------|-------------------------|--------------------|-------------------------------|
| | | Rest of the Netherlands | Deprived districts | Deprived districts, same city |
| Numbers | | | | |
| <i>n</i> 4-digit zipcodes | 83 | 3 697 | 257 | 119 |
| <i>n</i> individuals in total | 3 595 | 129 927 | 11 248 | 6 022 |
| Characteristics¹ | | | | |
| Age (%) | | | | |
| 15-24 years old | 14.6 | 9.2 | 12.7 | 14.2 |
| 25-34 years old | 21.2 | 13.5 | 18.2 | 20.4 |
| 35-44 years old | 17.6 | 19.8 | 17.8 | 18.3 |
| 45-54 years old | 16.9 | 20.0 | 16.6 | 15.4 |
| 55-64 years old | 13.4 | 18.5 | 15.8 | 14.6 |
| 65-74 years old | 9.5 | 11.9 | 11.1 | 9.6 |
| 75 years and older | 6.8 | 7.1 | 7.8 | 7.5 |
| Gender (%) | | | | |
| Women | 52.6 | 52.0 | 52.4 | 52.5 |
| Men | 47.4 | 48.0 | 47.6 | 47.5 |
| Ethnicity (%) | | | | |
| Ethnic Dutch | 60.6 | 88.4 | 80.0 | 76.6 |
| Non-ethnic Dutch | 39.2 | 11.5 | 20.0 | 23.3 |
| Education (%) | | | | |
| Primary level | 36.0 | 26.0 | 28.4 | 24.6 |
| Lower secondary level | 8.2 | 9.9 | 8.9 | 7.8 |
| Higher secondary level | 26.8 | 32.5 | 29.7 | 27.8 |
| Tertiary level | 21.8 | 25.3 | 26.7 | 33.3 |

¹ Characteristics represent mean values for years 2005 to 2011

Table 2 to 4 show the results of the regression analyses. Table 2 displays the safety trends in target districts versus the rest of the Netherlands. For general safety, the trend in target districts changed from a nearly significantly positive trend in the pre-intervention period into a flat trend in the intervention period. This negative trend change was not statistically significant. A similar but significantly negative trend change was found in the rest of the Netherlands. As a result, there was no difference in trend change between target districts and the rest of the Netherlands. For physical order, target districts and the rest of the Netherlands showed similar slightly positive trend changes, though the trend change was only statistically significant in the latter group. For social order, target districts showed a slightly negative trend change, while the rest of the Netherlands showed a slightly positive trend change. Thus, target districts showed a more negative trend change than in the rest of the Netherlands. However, neither the trend changes themselves, nor the between-district differences

in trend change were statistically significant. For non-victimization, target districts showed a positive trend change, while the rest of the Netherlands showed a slightly negative trend change. Thus, target districts showed a more positive trend change than the rest of the Netherlands. Even though the trend changes themselves were not statistically significant, between-district differences in trend change were nearly significant. Overall, adjustment for individual-level demographic and socio-economic factors did not alter the results.

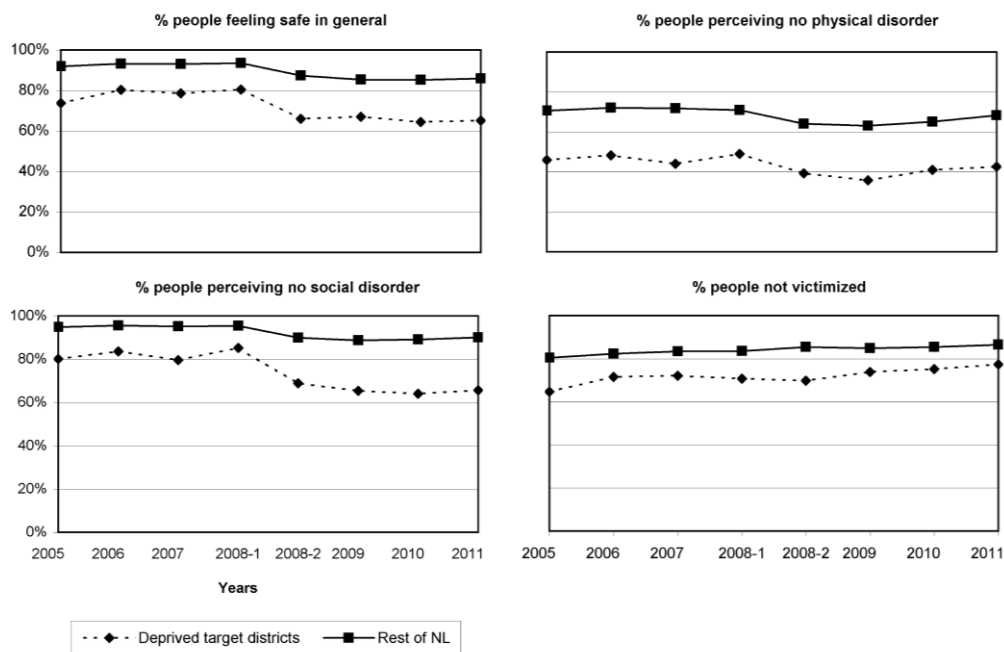


FIGURE 1. Trend in area safety outcomes in target districts and in the rest of the Netherlands, period 2005-2011

Table 3 compares the safety trends in target districts with those in three different control groups. Overall, results were similar across control groups. For general safety, the slightly negative trend change in target districts was similar to that in the rest of the Netherlands, but somewhat more negative than in both groups of other deprived districts. For physical order, the slightly positive trend change in target districts was similar to that in all control groups. For social order, the somewhat negative trend change in target districts was slightly more negative than in the rest of the Netherlands, but somewhat more positive than in both groups of other deprived districts, especially those located in the same city as target districts. For non-

victimization, the somewhat positive trend change in target districts was somewhat more positive than in all control groups. None of the between-district differences in trend change were statistically significant. However, for non-victimization, differences with the rest of the Netherlands and other deprived districts in the same city were nearly significant.

TABLE 2. Trend in self-reported area safety in target districts and the rest of the Netherlands (NL) in the period 2005 to 2011

| Model | | Trend in area safety (regression coefficient β (95% Confidence Interval)) | | |
|--------------------------|----------------------|---|--------------------------|---|
| | | Pre intervention (2005-2008) | Intervention (2008-2011) | Intervention versus pre intervention period |
| General safety | | | | |
| 1 | Target districts (A) | 0.08 (-0.00 - 0.15) | -0.01 (-0.10 - 0.07) | -0.09 (-0.23 - 0.05) |
| | Rest of NL (B) | 0.05 (0.02 - 0.09)* | -0.04 (-0.06 - -0.02)* | -0.09 (-0.13 - -0.05)* |
| | A versus B | | | 0.00 (-0.14 - 0.15) |
| 2 ¹ | Target districts (A) | 0.08 (-0.00 - 0.16) | -0.00 (-0.09 - 0.08) | -0.08 (-0.22 - 0.06) |
| | Rest of NL (B) | 0.05 (0.02 - 0.08)* | -0.03 (-0.05 - -0.01)* | -0.08 (-0.12 - -0.04)* |
| | A versus B | | | 0.00 (-0.15 - 0.15) |
| Physical order | | | | |
| 1 | Target districts (A) | 0.00 (-0.06 - 0.07) | 0.06 (-0.01 - 0.14) | 0.06 (-0.07 - 0.19) |
| | Rest of NL (B) | -0.01 (-0.03 - 0.00) | 0.07 (0.06 - 0.09)* | 0.09 (0.06 - 0.11)* |
| | A versus B | | | -0.03 (-0.16 - 0.10) |
| 2 ¹ | Target districts (A) | 0.00 (-0.07 - 0.07) | 0.07 (-0.01 - 0.15) | 0.07 (-0.06 - 0.20) |
| | Rest of NL (B) | -0.01 (-0.03 - 0.00) | 0.08 (0.07 - 0.10)* | 0.09 (0.07 - 0.12)* |
| | A versus B | | | -0.02 (-0.16 - 0.11) |
| Social order | | | | |
| 1 | Target districts (A) | 0.03 (-0.05 - 0.11) | -0.03 (-0.12 - 0.05) | -0.06 (-0.21 - 0.08) |
| | Rest of NL (B) | 0.00 (-0.04 - 0.04) | 0.01 (-0.01 - 0.03) | 0.01 (-0.04 - 0.06) |
| | A versus B | | | -0.07 (-0.22 - 0.08) |
| 2 ¹ | Target districts (A) | 0.03 (-0.06 - 0.11) | -0.02 (-0.10 - 0.07) | -0.04 (-0.19 - 0.10) |
| | Rest of NL (B) | -0.00 (-0.04 - 0.04) | 0.02 (-0.00 - 0.05) | 0.03 (-0.02 - 0.07) |
| | A versus B | | | -0.07 (-0.22 - 0.08) |
| Non-victimization | | | | |
| 1 | Target districts (A) | 0.01 (-0.06 - 0.08) | 0.10 (0.02 - 0.19)* | 0.09 (-0.05 - 0.23) |
| | Rest of NL (B) | 0.06 (0.04 - 0.08)* | 0.04 (0.02 - 0.06)* | -0.02 (-0.05 - 0.01) |
| | A versus B | | | 0.11 (-0.03 - 0.26) |
| 2 ¹ | Target districts (A) | 0.01 (-0.06 - 0.08) | 0.11 (0.02 - 0.20)* | 0.10 (-0.04 - 0.24) |
| | Rest of NL (B) | 0.05 (0.03 - 0.07)* | 0.03 (0.01 - 0.05)* | -0.02 (-0.05 - 0.01) |
| | A versus B | | | 0.12 (-0.02 - 0.27) |

* $P \leq 0.05$

¹Adjusted for age, gender, ethnicity, and education.

TABLE 3. Trend in self-reported area safety in target districts and various control groups in the period 2005 to 2011

| | Trend in area safety ¹ (regression coefficient β (95% Confidence Interval)) | | |
|---|---|-----------------------------|---|
| | Pre intervention (2005-2008) | Intervention (2008-2011) | Intervention versus pre intervention |
| General safety | | | |
| Target districts (A) | 0.08 (-0.00 – 0.16) | -0.00 (-0.09 – 0.08) | -0.08 (-0.22 – 0.06) |
| Rest of NL (B) A versus B | 0.05 (0.02 – 0.08)* | -0.03 (-0.05 – -0.01)* | -0.08 (-0.12 – -0.04)* 0.00 (-0.15 – 0.15) |
| Deprived districts (C) A versus C | -0.00 (-0.08 – 0.08) | -0.02 (-0.08 – 0.04) | -0.02 (-0.12 – 0.09) -0.04 (-0.21 – 0.13) |
| Deprived districts, same city (D) A versus D | 0.03 (-0.07 – 0.12) | 0.01 (-0.07 – 0.08) | -0.02 (-0.15 – 0.11) -0.04 (-0.22 – 0.15) |
| Physical order | | | |
| Target districts (A) | 0.00 (-0.07 – 0.07) | 0.07 (-0.01 – 0.15) | 0.07 (-0.06 – 0.20) |
| Rest of NL (B) A versus B | -0.01 (-0.03 – 0.00) | 0.08 (0.07 – 0.10)* | 0.09 (0.07 – 0.12)* -0.02 (-0.16 – 0.11) |
| Deprived districts (C) A versus C | -0.01 (-0.07 – 0.04) | 0.06 (-0.01 – 0.10) | 0.07 (-0.00 – 0.15) 0.01 (-0.14 – 0.16) |
| Deprived districts, same city (D) A versus D | -0.01 (-0.09 – 0.06) | 0.06 (0.00 – 0.13)* | 0.08 (-0.02 – 0.18) 0.01 (-0.15 – 0.17) |
| Social order | | | |
| Target districts (A) | 0.03 (-0.06 – 0.11) | -0.02 (-0.10 – 0.07) | -0.04 (-0.19 – 0.10) |
| Rest of NL (B) A versus B | -0.00 (-0.04 – 0.04) | 0.02 (-0.00 – 0.05) | 0.03 (-0.02 – 0.07) -0.07 (-0.22 – 0.08) |
| Deprived districts (C) A versus C | -0.01 (-0.10 – 0.07) | -0.06 (-0.12 – -0.00)* | -0.05 (-0.16 – 0.06) 0.02 (-0.15 – 0.20) |
| Deprived districts, same city (D) A versus D | 0.04 (-0.06 – 0.14) | -0.06 (-0.14 – 0.01) | -0.10 (-0.23 – 0.03) 0.07 (-0.12 – 0.26) |
| Non-victimization | | | |
| Target districts (A) | 0.01 (-0.06 – 0.08) | 0.11 (0.02 – 0.20)* | 0.10 (-0.04 – 0.24) |
| Rest of NL (B) A versus B | 0.05 (0.03 – 0.07)* | 0.03 (0.01 – 0.05)* | -0.02 (-0.05 – 0.01) 0.12 (-0.02 – 0.27) |
| Deprived districts (C) A versus C | 0.01 (-0.05 – 0.08) | 0.02 (-0.04 – 0.07) | 0.01 (-0.09 – 0.09) 0.09 (-0.07 – 0.25) |
| Deprived districts, same city (D) A versus D | 0.07 (-0.01 – 0.15) | -0.01 (-0.08 – 0.06) | -0.08 (-0.20 – 0.03) 0.17 (-0.01 – 0.35) |

* $P \leq 0.05$ ¹Trend represents the yearly change in ln(odds) of safety, adjusted for age, gender, ethnicity, and education.

TABLE 4. Trend in self-reported non-victimization in target districts and the rest of the Netherlands in the period 2005 to 2011; stratified by subgroup

| | | Trend in non-victimization ¹ | | |
|--|----------------------|--|-----------------------------|---|
| | | (regression coefficient β (95% Confidence Interval)) | | |
| | | Pre intervention (2005-2008) | Intervention (2008-2011) | Intervention versus pre intervention |
| Gender | | | | |
| Men | Target districts (A) | 0.07 (-0.03 - 0.18) | 0.04 (-0.09 - 0.17) | -0.03 (-0.24 - 0.17) |
| | Rest of NL (B) | 0.04 (0.01 - 0.07)* | 0.04 (0.01 - 0.07)* | 0.00 (-0.04 - 0.04) |
| | A versus B | | | -0.03 (-0.23 - 0.18) |
| Women | Target districts (A) | -0.04 (-0.14 - 0.06) | 0.18 (0.05 - 0.30)* | 0.22 (0.02 - 0.41)* |
| | Rest of NL (B) | 0.06 (0.03 - 0.10)* | 0.02 (-0.01 - 0.05) | -0.04 (-0.09 - -0.00)* |
| | A versus B | | | 0.26 (0.06 - 0.46)* |
| Age | | | | |
| Younger | Target districts (A) | 0.04 (-0.04 - 0.12) | 0.04 (-0.06 - 0.14) | -0.00 (-0.16 - 0.16) |
| | Rest of NL (B) | 0.06 (0.03 - 0.08)* | 0.03 (0.00 - 0.05)* | -0.03 (-0.06 - 0.01) |
| | A versus B | | | 0.03 (-0.13 - 0.19) |
| Older | Target districts (A) | -0.09 (-0.25 - 0.06) | 0.38 (0.18 - 0.58)* | 0.47 (0.17 - 0.78)* |
| | Rest of NL (B) | 0.06 (0.01 - 0.10)* | 0.05 (0.01 - 0.08)* | -0.01 (-0.07 - 0.05) |
| | A versus B | | | 0.48 (0.17 - 0.80)* |
| Educational level | | | | |
| Lower | Target districts (A) | -0.10 (-0.21 - 0.01) | 0.21 (0.07 - 0.36)* | 0.31 (0.09 - 0.54)* |
| | Rest of NL (B) | 0.04 (-0.00 - 0.08) | 0.01 (-0.02 - 0.05) | -0.02 (-0.08 - 0.03) |
| | A versus B | | | 0.34 (0.10 - 0.57)* |
| Higher | Target districts (A) | 0.12 (0.02 - 0.22)* | 0.06 (-0.06 - 0.17) | -0.06 (-0.25 - 0.13) |
| | Rest of NL (B) | 0.06 (0.03 - 0.09)* | 0.04 (0.01 - 0.06)* | -0.02 (-0.06 - 0.02) |
| | A versus B | | | -0.04 (-0.23 - 0.15) |
| Intensity of safety interventions | | | | |
| Lower | Target districts (A) | -0.07 (-0.19 - 0.06) | 0.12 (0.03 - 0.27) | 0.18 (-0.06 - 0.43) |
| | Rest of NL (B) | 0.05 (0.03 - 0.07)* | 0.03 (0.01 - 0.05)* | -0.02 (-0.06 - 0.01) |
| | A versus B | | | 0.21 (-0.04 - 0.46) |
| Higher | Target districts (A) | 0.08 (-0.02 - 0.17) | 0.09 (-0.03 - 0.20) | 0.01 (-0.18 - 0.20) |
| | Rest of NL (B) | 0.05 (0.03 - 0.07)* | 0.03 (0.01 - 0.05)* | -0.02 (-0.06 - 0.01) |
| | A versus B | | | 0.03 (-0.16 - 0.22) |

*P \leq 0.05
¹Trend represents the yearly change in ln(odds) of non-victimization, adjusted for age, and/or ethnicity, and/or education.

Table 4 displays the non-victimization trends in target districts versus the rest of the Netherlands, stratified by subgroup. Women, older adults, and lower educated adults living in target districts showed a statistically significantly more positive trend change than those living in the rest of the Netherlands. Target districts with less intensive safety interventions showed a somewhat more positive trend change than the rest of the Netherlands, but this difference was not significant. There were no between-district differences in trend change for men, younger adults, higher educated adults, and target districts with more intensive safety interventions. For the other safety

indicators, there were no significant between-district differences in trend change for any of the subgroups, though some groups showed slight indications of differences (results not shown). Patterns were inconsistent across safety indicators. For general safety, between-district trend change differences were somewhat negative for men, but somewhat positive for women. For physical order, between-district trend change differences were slightly negative for women and lower educated adults. For social order, between-district trend change differences were somewhat negative for men, older adults, and lower educated adults.

DISCUSSION

Compared to the national average, a lower percentage of adults in target districts felt generally safe, perceived physical and social order, and were not victimized. These differences hardly changed with the implementation of the District Approach in the target districts, starting in 2008. However, the proportion of non-victimized people increased somewhat more in target districts than in the rest of the Netherlands or in other deprived districts. These between-district differences were significant for women, older adults, and lower educated adults only.

Limitations

In a natural experiment like the District Approach, individuals are not randomly allocated to an intervention or control group. As a result, the two groups may differ at baseline in ways related to the study outcome. We tried to reduce this bias in ways recommended by the Medical Research Council guidance for evaluating natural experiments [21]. To account for possible unobservable group differences, we adopted a quasi-experimental time-series design in which changes over time are compared between the intervention and control group. To account for possible observable group differences, we included matched control groups and we adjusted our analyses for various observable demographic and socio-economic characteristics.

An important condition for a quasi-experimental time-series design is that the composition of both groups remains stable over time [21]. In our study, the use of repeated cross-sectional data may have caused variations in group compositions over time in two ways. First, our *sample* may have varied over time. However, given that the same sampling design was used each year, there is little reason to expect the variation to be systematic. Second, the *source population* for the sample may have varied over time as a result of selective migration. Adults that have benefited from the District Approach, for example by acquiring new skills that allow access to better jobs, may have moved out of the target districts. If movers experienced better perceived

area safety than the ones staying behind, this may have caused us to underestimate the safety impact of the District Approach. However, there were no indications of such selective migration patterns in the target districts. The number of people moving up the socio-economic ladder and the number of those moving out of their neighbourhood did not increase after implementation of the District Approach [22]. Evaluation studies of the NDC also failed to find indications of selective migration effects. There was no significant association between residential mobility and change in safety concerns [23] and panel data yielded similar changes in safety outcomes as the use of repeated cross-sectional data [17,24]. Moreover, to take possible variations in group composition into account, we adjusted our analyses for various demographic and socio-economic factors.

Total non-response was nearly 40%. A comparison of weighted and non-weighted characteristics of the total sample revealed a small overrepresentation of people over 45 years old, women, ethnic Dutch, and higher educated people (data not shown). Even though the population of non-respondents did not appear to be selective in socio-demographic terms, it may have been selective in other ways related to our study outcome. However, this will only bias our results if selectivity changed over time, which we perceive to be unlikely.

In 2008, the main survey mode of the safety monitor changed from telephone to internet. This may explain the sharp decreases in 2008 in the number of people that reported feeling safe and that perceived physical or social order (Figure 1). Adults who participated by internet reported more disorder than those who participated by telephone [25]. When interviewed by telephone, people may be more inclined to give socially desirable answers or to choose the last mentioned option of “no disorder” [26]. To take the change in survey design into account, we have controlled all our regression analyses for the variable period. For all safety indicators except non-victimization, period appeared to be a confounder.

Interpretation of results

Results of our study are generally in line with a recent non peer-reviewed evaluation of the District Approach [22]. Using a regression discontinuity design, the researchers concluded that there was no demonstrable overall positive effect of the District Approach on self-reported area safety. Using a different and more elaborate design, results of our study were consistent with these results. In the peer-reviewed literature, only two ABIs have been evaluated for their impact on self-reported area safety. Like the Dutch District Approach, the English SRB appeared to have had only limited effects on area safety [16]. Evaluations of the English NDC, on the other hand, indicated positive effects regarding perceived order and non-victimization [17].

The NDC study may have yielded a larger number of positive results with respect to area safety than the current study because of an almost twice as long follow-up time. Perhaps, area safety – especially perceptions of area safety – needs more time to change in response to ABIs. However, an NDC evaluation found safety changes to be larger at two year follow-up than at four and six year follow-up, suggesting safety effects to be visible already at the short term [27]. An alternative explanation for the larger number of positive results in the NDC study may be the larger sample size [28]. Therefore, they might have had more power to also detect small safety effects. Finally, differences in results may have been due to differences in the content of the ABIs. The NDC and the District Approach have both invested in the same problems (employment, education, housing and the physical environment, safety, and social cohesion), and both have given each area the autonomy to develop its own set of tailored interventions. However, the NDC did seem to have made larger investments with respect to social cohesion and crime than the District Approach [4,27].

We did not find a general improvement in self-reported indicators of area safety in the target districts. One reason for this lack of change may be that the target districts varied greatly with respect to the interventions that were implemented and the context in which they were implemented [4]. Specific interventions may have successfully improved area safety in specific contexts, but analyses of all 40 target districts combined may have concealed these successes. Another reason for a lack of improvement in self-reported area safety may be that *actual* improvements in underlying safety problems and neighbourhood conditions have failed to translate into *perceived* improvements. Translation may have failed because a large part of residents may not have been exposed to the actual changes. However, research indicates that most of the District Approach's environmental interventions reached a substantial number of participants [4]. Moreover, actual improvements may have had opposite effects on people's perceptions. For example, security measures such as locks and fences may cause people to feel more protected, but it may also create an unpleasant and hostile environment and make people more aware of the threats in the area, causing them to feel unsafe [8]. In a similar way, stronger social networks may cause people to feel less vulnerable to crime, but may also increase communication about events of crime [7,8,13].

There were indications of improvements in more objective safety indicators, i.e. the prevalence of non-victimization. However, improvements were only visible among women, older adults, and lower educated adults, and not among their counterparts. These subgroup differences may be the result of differences in neighbourhood exposure. In Dutch society, women spend more time taking care of the children and doing household chores than men [29]. Dutch older adults and lower educated adults are less often employed than their counterparts [29]. As a result, these population groups may spend more time in their local neighbourhood. Alternatively, differences

in effect may be the result of differences in vulnerability. Women, older adults, and lowed educated adults are suggested to be more physically and socially vulnerable than their counterparts, increasing their risk of victimization [19]. The vulnerability of these groups may have been reduced by the physical and social environmental interventions of the District Approach.

CONCLUSIONS

The current study provides limited evidence to suggest that ABIs may improve health in deprived areas by improving key social determinants of health such as area safety. At least at the short term, the Dutch District Approach was not followed by improvements in area safety as perceived by adults living in the deprived target districts. However, there were indications of a positive impact of the District Approach on more objective indicators of area safety, that is, the amount of adults who were victimized in deprived target areas. Improvements were only visible among women, older adults, and lower educated adults. This suggests that ABIs are most likely to have an impact on objective safety indicators among population groups that are more exposed and vulnerable to crime.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

DK and AEK developed the study design. DK prepared the data and performed all statistical analyses. With the help of AEK, DK wrote a draft of the manuscript. AEK, BJ-G, KS, and MD critically reviewed intermediate results and manuscript versions and made substantial contributions to subsequent versions. All authors have read and approved the final version of the manuscript.

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REFERENCES

1. Atkinson R. European urban policies and the neighbourhood: an overview. *Urban Des Plann* 2008;161:115-122.
2. Atkinson R, Thomson H, Kearns A, Petticrew M. Giving urban policy its 'medical': assessing the place of health in area-based regeneration. *Policy Polit* 2006;34:5-26.
3. Thomson H, Atkinson R, Petticrew M, Kearns A. Do urban regeneration programmes improve public health and reduce health inequalities? A synthesis of the evidence from UK policy and practice (1980-2004). *J Epidemiol Community Health* 2006;60:108-115.
4. Droomers M, Harting J, Jongeneel-Grimen B, Rutten L, van Kats J, Stronks K. Area-based interventions to ameliorate deprived Dutch neighborhoods in practice: Does the Dutch District Approach address the social determinants of health to such an extent that future health impacts may be expected? *Prev Med* 2014;61:122-127.
5. Baum FE, Ziersch AM, Zhang G, Osborne K. Do perceived neighbourhood cohesion and safety contribute to neighbourhood differences in health? *Health Place* 2009;15:925-934.
6. Chandola T. The fear of crime and area differences in health. *Health Place* 2001;7:105-116.
7. Lorenc T, Clayton S, Neary D, Whitehead M, Petticrew M, Thomson H, et al. Crime, fear of crime, environment, and mental health and wellbeing: mapping review of theories and causal pathways. *Health Place* 2012;18:757-765.
8. Lorenc T, Petticrew M, Whitehead M, Neary D, Clayton S, Wright K, et al. Fear of crime and the environment: systematic review of UK qualitative evidence. *BMC Public Health* 2013;13:496.
9. Taylor RB, Hale M. Testing alternative models of fear of crime. *J Crim Law Crim* 1986;77:151-189.
10. Covington J, Taylor RB. Fear of crime in urban residential neighborhoods: implications of between- and within-neighbourhood sources for current models. *Sociol Quart* 1991;32:231-249.
11. Ferraro KF. *Fear of crime: interpreting victimization risk*. Albany: State University of New York Press, 1995.
12. Taylor RB. The incivilities thesis: theory, measurement, and policy. In Reno J, Fisher RC, Robinson L, Brennan N, Travis J, Brann JE (eds). *Measuring what matters*. Washington: U.S. Department of Justice, 1999.
13. Foster S, Giles-Corti B. The built environment, neighbourhood crime and constrained physical activity: an exploration of inconsistent findings. *Prev Med* 2008;47:241-251.
14. Sampson RJ, Raudenbush SW, Earls F. Neighborhoods and violent crime: a multilevel study of collective efficacy. *Science* 1997;277:918-924.
15. Lorenc T, Petticrew M, Whitehead M, Neary D, Clayton S, Wright K, et al. Environmental interventions to reduce fear of crime: systematic review of effectiveness. *Syst Rev* 2013;2:30.

16. Rhodes J, Tyler P, Brennan A. Assessing the effect of area based initiatives on local area outcomes: some thoughts based on the national evaluation of the Single Regeneration Budget in England. *Urban Stud* 2005;42:1919-1946.
17. Lawless P. Understanding the scale and nature of outcome change in area-regeneration programmes: evidence from the New Deal for Communities programme in England. *Environ Plann C* 2011;29:520-532.
18. Foden M, Grimsley M, Lawless P, Wilson I. Linking interventions to outcomes in area regeneration. *TPR* 2010;81:151-172.
19. Skogan WG, Maxfield MG. *Coping with crime. Individual and neighbourhood reactions*. London: Sage Publications, 1981.
20. Stafford M, Nazroo J, Popay JM, Whitehead M. Tackling inequalities in health: evaluating the New Deal for Communities initiative. *J Epidemiol Community Health* 2008;62:298-304.
21. Craig P, Cooper C, Gunnell D, Haw S, Lawson K, et al. Using natural experiments to evaluate population health interventions: new Medical Research Council guidance. *J Epidemiol Community Health* 2012;66:1182-1186.
22. Permentier M, Kullberg J, van Noije L. *Werk aan de wijk. Een quasi-experimentele evaluatie van het krachtwijkenbeleid*. Den Haag: Sociaal en Cultureel Planbureau, 2013.
23. Pearson S, Lawless P. Population mobility in regeneration areas: trends, drivers, and implications; evidence from England's New Deal for Communities Programme. *Environ Plann A* 2012;44:2023-2039.
24. Wilson I. Outcomes for 'stayers' in urban regeneration areas: the New Deal for Communities Programme in England. *Urban Res Pract* 2013;6:174-193.
25. Centraal Bureau voor de Statistiek. *Integrale Veiligheidsmonitor 2009: proces- en onderzoeksdocumentatie*. Den Haag: Centraal Bureau voor de Statistiek, 2010.
26. Krosnick JA. Survey Research. *Annual Review of Psychology* 1999;50:537-567.
27. Batty E, Beatty C, Foden M, Lawless P, Pearson S, Wilson I. *Making deprived areas better places to live: evidence from the New Deal for Communities Programme*. London: Department for Communities and Local Government, 2010.
28. Lawless P, Beatty C. Exploring change in local regeneration areas: evidence from the New Deal for Communities programme in England. *Urban Stud* 2012;1-17.
29. Cloin M, van den Broek A, van den Dool R, de Haan J, de Hart J, van Houwelingen P, et al. *Met het oog op de tijd. Een blik op de tijdsbesteding van Nederlanders*. Den Haag: Sociaal en Cultureel Planbureau, 2013.

CHAPTER 6

Understanding the impact of area-based interventions on area safety in deprived areas: realist evaluation of a neighbour nuisance intervention in Arnhem, the Netherlands

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ABSTRACT

Background Area-based health inequalities may partly be explained by higher levels of area disorder in deprived areas, which may cause safety concerns and hence impair health. There is limited insight into the inner workings of interventions that aim to reduce disorder and safety concerns in deprived areas. The current study assessed whether and how the intervention Meeting for Care and Nuisance (MCN) had an impact on neighbour nuisance and area safety in four deprived districts in Arnhem, the Netherlands.

Methods Realist evaluation methodology was applied to uncover how, for whom, and under what conditions MCN was expected to and actually produced change. Expected change was based on action plans and scientific theories. Actual change was based on progress reports, media articles, interviews with district managers, and quantitative surveys.

Results MCN produced change at three levels. At the organisational level, MCN applied a coordinated partnership strategy. Partly as expected, this strategy enabled role alignment, communication, and leadership, which resulted in a more efficient approach of nuisance households. It was important to resolve privacy issues and to include a small group of nuisance oriented organisations as key partners. At the level of nuisance households, MCN applied a joint assistance and enforcement strategy. As expected, this strategy removed the underlying reasons for nuisance, which resulted in less neighbour nuisance. At the district level, as expected, perceptions of social control improved, which resulted in better perceived area safety, but only in one district. It was important that MCN was part of a wider safety approach and that districts were centrally located and densely populated.

Conclusions Our findings indicate that in certain conditions, area-based interventions like MCN have the potential to reduce neighbour nuisance and hence improve area-level safety perceptions. We highlight key mechanisms and conditions for change that should be taken into account in future initiatives.

Key words The Netherlands, safety, neighbour nuisance, disorder, area deprivation, realist evaluation, mechanisms, intervention

INTRODUCTION

There is ample evidence of differences in health between deprived and non-deprived areas. Residents of deprived areas report worse health than those in non-deprived areas [1-4]. Several studies suggest that these health inequalities can partly be explained by different levels of area disorder [5-9]. Residents of deprived areas perceive more physical disorder (e.g. litter, graffiti) and social disorder (e.g. nuisance from neighbours or youth) than residents of non-deprived areas [6,7,9]. Area disorder may cause people to feel unsafe, which may negatively affect their health by increasing stress, anxiety, physical inactivity, or social exclusion [10].

In the past decade, numerous area-based initiatives have been implemented in deprived areas across Western-Europe [11]. These initiatives consist of multiple interventions that aim to tackle the various socio-economic and environmental problems in deprived areas, including physical and social disorder. Several area-based initiatives have been evaluated for their impact on area disorder and subsequent safety concerns. Results were mixed. After six years, target areas of the English New Deal for Communities had significantly larger reductions in perceived lawlessness and dereliction than other deprived areas [12]. There were no differences in reductions of fear of crime and feeling unsafe after dark. After five years, target areas of the English Single Regeneration Budget saw larger reductions in the number of residents feeling very unsafe than the rest of England [13]. However, differences were small and not tested for significance. There were no differences in reductions of disorder such as vandalism, loose dogs, and litter.

These quantitative evaluation studies have been criticized for their lack of attention to mechanisms of change and programme theory [14-16]. To improve future initiatives, research needs to extend its attention from outcomes towards the processes leading to these outcomes. Pawson and Tilley's [17] realist evaluation methodology offers a useful approach to understand the inner workings of complex initiatives. The realist methodology aims to uncover how an intervention works, for whom, and under what conditions. More specifically, it tries to identify the so called mechanisms of change. Mechanisms refer to individuals' responses triggered by the intervention that lead to change. These mechanisms will only be activated under certain conditions. Interventions are often based on assumptions about possible mechanisms and conditions, but these so called programme theories are rarely made explicit. A key purpose of the realist methodology is to identify these programme theories, and to try and refine it using evidence on how the interventions worked in practice.

Only few studies have applied the realist methodology to understand how area-based interventions have influenced area disorder and safety concerns. A good example is

that of Nanninga and Glebbeek [18]. They explored whether and how two new sports fields had an influence on nuisance from youth and related crime in the Netherlands. Anticipated mechanisms of change included 'boredom reduction' and 'role modelling'. Police records showed that since the arrival of the sports fields, there were less reports of nuisance, but more reports of crime. The drop in nuisance could be explained by the anticipated 'boredom reduction' mechanism and the newfound 'confrontation reduction' mechanism.

Little is known about how area disorder and safety are affected by area-based interventions that are oriented at households. A pioneering intervention in this field is the Dundee Families Project of 1996 [19]. This project aimed to help families that have been evicted or are at risk of eviction because of neighbour nuisance. A mix of counselling, family support, surveillance, and regulations was offered to families in one of three ways: by admission of families to a core block, by supporting families in a few dispersed flats run by the project, or by reaching out to selected families in their existing homes. Evaluation studies revealed that the intervention was able to reduce nuisance caused by these families. Unfortunately, these studies did not explore how, for whom or under what conditions this intervention was able to reduce neighbour nuisance and related safety concerns.

An opportunity to acquire such knowledge arose with the introduction of the Meeting for Care and Nuisance (MCN) (*Overleg Zorg en Overlast*) in the four most deprived districts of Arnhem, a mid-sized city in the east of the Netherlands. This intervention is part of a large area-based initiative that was implemented in 2008 in the forty most deprived districts of the Netherlands, including the four deprived districts in Arnhem. MCN aimed to reduce neighbour nuisance (e.g. loud music, fights, neglected property), which was regarded to be the main cause of perceived unsafety in these areas. The current study aimed to explore how, for whom, and under what conditions MCN had an impact on neighbour nuisance and area-level safety in the four target districts. Following the realist methodology, we first identified the programme theory on how MCN was anticipated to work. Then, we used this programme theory as a guide to assess how MCN actually worked.

METHODS

Design

An embedded case study design was applied [20]. Each of the four deprived target districts in Arnhem represented a separate case. Within each case, three levels of analysis were distinguished: 1) the organisations that were involved in the

implementation of MCN, 2) the households that were causing nuisance, 3) the four districts at large.

The intervention

Neighbour nuisance is addressed by MCN in different steps. To start with, each district holds monthly meetings with the police, local housing corporations, the care coordinator, and the district manager. Under the leadership of the district manager, organisations exchange information about new and existing nuisance households during the meetings. New households are included based on signals of nuisance reported by the participating organisations, neighbours, care professionals, or others. For each new nuisance household, the care coordinator develops a plan of action that specifies what needs to be done and which organisation is responsible for what action. Plans of action are discussed with the organisations during the monthly meetings. When plans are agreed upon, the households are paid a visit by the care coordinator and a representative of one of the other organisations. The care coordinator discusses the plan of action with the household. The household's vision on the plan is incorporated in a guidance agreement that specifies what the household should do to reduce the nuisance (e.g. turning down their music after 10 p.m). Usually, the guidance agreement is accompanied with assistance from care professionals, as many of the households deal with unresolved underlying problems (e.g. debt, addiction, psychiatric illness, unemployment, or neglect). For households who have received assistance in the past, such assistance can be conditional (e.g. households first have to clean their front yard in order to receive debt assistance). If households are unwilling to cooperate, their case is forwarded to the justice department, who decides on whether households will be threatened with sanctions such as eviction or benefit reduction. Cases are closed when no new nuisance signals are reported. During the entire process, the care coordinator monitors the progress of the households and organisations.

The cases

MCN was first implemented in 2006 in district 1. This district is a pre-WOII working-class district characterized by low levels of social cohesion and trust in the municipality. It has a long history of social problems and neighbour conflicts. Many repressive and restructuring interventions have been implemented in the past, but without success. In 2010, MCN was extended to districts 2 to 4. District 2 is a centrally located and densely populated pre-WOII district that is characterized by high levels of creative enterprises and students. Problems related to drug users, criminal activities, and deterioration of public spaces have prompted past interventions that have been somewhat successful. Districts 3 and 4 are both post-WOII districts that are characterised by uniform low-quality housing occupied by people of low socio-

economic status and starters at the housing market. Various restructuring and social interventions have been implemented in the past, but with limited success.

Data collection

Based on the principles of the realist evaluation, data collection was iterative and included a wide range of sources (table 1).

TABLE 1. Data sources

| Content | Author | Name | Year | District | | | | | |
|---|------------------------|--|---------------------------------|----------|------|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | | |
| Documents | | | | | | | | | |
| Action plans | | | | | | | | | |
| Description of interventions planned for district 1-4 as part of the larger area-based initiative (incl. MCN) | Municipality of Arnhem | DOC1 | 2007 | X | | | | | |
| | | DOC2 | 2007 | | | | X | | |
| | | DOC3 | 2007 | | | X | | | |
| | | DOC4 | 2007 | X | | | | | |
| | | DOC5 | 2007 | X | | | | | |
| Progress reports | | | | | | | | | |
| Progress report of interventions in district 1-4 as part of the larger area-based initiative (incl. MCN) | Municipality of Arnhem | DOC6 | 2009 | X | X | X | X | | |
| | | DOC7 | 2009 | X | X | X | X | | |
| | | DOC8 | 2010 | X | X | X | X | | |
| | | DOC9 | 2010 | X | X | X | X | | |
| | | DOC10 | 2010 | X | X | X | X | | |
| | | DOC11 | 2011 | X | X | X | X | | |
| | | DOC12 | 2011 | X | X | X | X | | |
| | | DOC13 | 2011 | X | X | X | X | | |
| | | DOC14 | 2013 | X | X | X | X | | |
| | | Progress report of household interventions (incl. MCN) | Government Welfare organisation | DOC15 | 2010 | X | | | |
| | | | | DOC16 | 2011 | X | X | X | X |
| | | | | DOC17 | 2011 | X | X | X | X |
| | | | | DOC18 | 2012 | X | X | X | X |
| | | Media reports | | | | | | | |
| Online news report about a guided tour to district 1-4 (incl. MCN) | Journalist | DOC19 | 2009 | X | X | | | | |
| | | DOC20 | 2010 | X | X | X | X | | |
| Online news report about MCN | Journalist | DOC21 | 2009 | X | | | | | |
| Newspaper section about safety in Arnhem (incl. MCN) | Journalist | DOC22 | 2010 | X | X | X | X | | |
| Magazine about Dutch social enterprises (incl. MCN) | Journalist | DOC23 | 2011 | X | | | | | |
| Short video of an interview with an MCN care coordinator | Journalist | DOC24 | 2011 | | | X | | | |
| Surveys | | | | | | | | | |
| Survey about liveability and safety as perceived by residents of Arnhem of 15 (2009,2011) or 18 (2005, 2007) years and older (incl. district 1-4) | Municipality of Arnhem | SURV1 | 2005 | X | X | X | X | | |
| | | | 2007 | X | X | X | X | | |
| | | SURV2 | 2009 | X | X | X | X | | |
| | | SURV3 | 2011 | X | X | X | X | | |
| Interviews | | | | | | | | | |
| Interviews with the district managers of district 1-3 | n.a. | INT1 | 2012 | X | | | | | |
| | | INT2 | 2013 | X | | | | | |
| | | INT3 | 2012 | X | X | X | | | |
| | | INT4 | 2013 | X | X | X | | | |
| | | INT5 | 2012 | | X | | | | |
| | | INT6 | 2013 | | X | | | | |

Two types of qualitative evidence were obtained to assess how MCN was expected to work, i.e. the programme theory underlying MCN. First, we searched the internet for action plans that set out how policy makers expected MCN to work. Five action plans were included. Second, we searched the literature for scientific theories that complemented the expectations set out in the action plans.

Three types of qualitative and quantitative evidence were obtained to assess how MCN actually worked. First, we searched the internet for documents that reported on experiences with MCN. Search terms included “OZO”, “Overleg Zorg en Overlast”, “Zorgcoordinator”, and “Arnhem”. Seventeen progress reports and media reports were included that contained information on mechanisms, outcomes and/or contexts specific to MCN in practice.

Second, we obtained quantitative data on district-level perceptions of neighbour nuisance and area safety from the Survey for Liveability and Safety (2005, 2007), and the Integrated Safety Monitor (2009, 2011). Both surveys aimed to assess residents’ perceptions of safety and liveability and asked respondents about overall safety perception, criminal victimization, perceived neighbourhood problems, and judgement of police and municipal government. In 2005 and 2007, individuals of 18 years and older were asked to fill in a paper-and-pencil or web-based questionnaire. In 2009 and 2011, individuals of 15 years and older were asked to fill in a paper-and-pencil or web-based questionnaire, or were interviewed by telephone. See table 2 for response rates per year and district.

TABLE 2. Yearly response rates to the surveys, by target district

| Year | Response (response rate) | | | | |
|------|--------------------------|-------------------|-------------------|-------------------|-------------------|
| | City average | Target district 1 | Target district 2 | Target district 3 | Target district 4 |
| 2005 | 5.803 (29%) | 340 (22%) | 354 (22%) | 785 (25%) | 354 (22%) |
| 2007 | 5.708 (37%) | 172 (24%) | 264 (29%) | 534 (28%) | 240 (27%) |
| 2009 | ~ 6.000 (~40%) | Unknown | Unknown | Unknown | Unknown |
| 2011 | 5.282 (42%) | 241 (35%) | 272 (35%) | 608 (35%) | 342 (35%) |

Third, we performed two rounds of individual semi-structured interviews with the district managers of three target districts. The district manager of district 4 was unwilling to participate. The first round of interviews took place after we constructed the programme theory, in September 2012. District managers were asked to confirm, falsify or refine our programme theory based on their experiences with MCN in practice. The second round of interviews took place in November 2013, after we assembled and integrated the available evidence on how MCN actually worked. District managers were asked to confirm, falsify, or refine our integration of the evidence, taking into account their own experiences with MCN. During the interviews,



the district managers provided us with two extra progress reports not available on the internet.

Data analysis

Data analysis was guided by the framework approach of Ritchie and Spencer [21]. First, we articulated the programme theory. We extracted information from the action plans about the outcomes and mechanisms that were anticipated to result from MCN. These expectations were complemented with information from the scientific theories. Second, we indexed the evidence on how MCN actually worked, using the programme theory as a guide. We flagged information about the mechanisms and outcomes set out in the programme theory, but were also alert for unanticipated mechanisms, outcomes, or conditions. For each extracted piece of information, we specified the data source, year, and district (if applicable). Third, we charted the extracted information. The information was separated into three datasets: one on the mechanisms, one on the conditions, and one on the outcomes. Within each dataset, information was sorted by level of analysis: organisations, nuisance households, and districts. Finally, we mapped and interpreted the information. Recurrent patterns of information were grouped and labeled. When new patterns emerged, data sources were checked again for possible additional information. Patterns were regularly discussed with the members of the research team. Where possible, patterns were compared across cases.

RESULTS

Programme theory

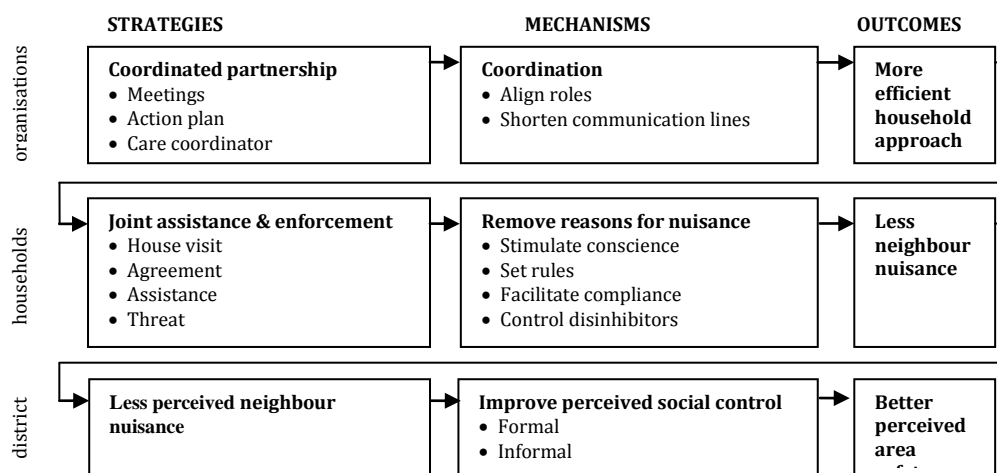


FIGURE 1. programme theory on MCN's strategies and anticipated mechanisms and outcomes

The programme theory specifies the mechanisms and outcomes expected to result from MCN at the levels of organisations, nuisance households, and districts (Figure 1). Expectations were identical across the four cases. No conditions were made explicit in the action plans. The following sections specify the mechanisms and outcomes expected to result from MCN at each level, starting with the level of districts.

Districts

At the level of districts, a reduction in neighbour nuisance was expected to improve perceptions of social control, leading to improved perceptions of area safety. The action plans describe how safety concerns in the four target districts were believed to be the result of soft crimes like physical disorder, disobedience of rules, and nuisance (DOC1-4). Even though nuisance was caused by only a handful of households, their behaviour was suggested to greatly affect the atmosphere and image of the district: *“People are no longer willing and able to confront others or inform organisations about what they see happening in their neighbourhood (DOC1-4)”*. A reduction in neighbour nuisance was expected to improve district-wide perceptions of area safety. The incivilities thesis endorses this hypothesis, and suggests this change to be the result of improved perceptions of social control [22]. The incivilities thesis posits that residents may interpret incivilities such as neighbour nuisance as a sign that fellow residents (informal control) and authorities (formal control) are unwilling or unable to preserve order in their neighbourhood. This perceived lack of informal and formal social control may cause residents to feel personally at risk of serious crime.

Nuisance households

At the level of nuisance households, the joint assistance and enforcement strategy (house visit, agreement, assistance, and threat) applied by MCN was expected to remove underlying reasons for nuisance, leading to a reduction in neighbour nuisance. The action plans describe how neighbour nuisance in the four target districts was believed to be partly due to a lack of enforcement: *“Due to a long-lasting lack of enforcement, (part of) neighbourhoods have been able to withdraw from society and some places have developed their own rules and norms (DOC1-4)”*. As many of the problem households dealt with underlying problems, it was said that enforcement needed to be combined with assistance to help solve these problems. The joint assistance and enforcement strategy applied by MCN was expected to reduce the amount of neighbour nuisance. Clarke’s situational crime prevention theory suggests this to be the result of a reduction in the underlying reasons for nuisance [23]. This theory proposes four main mechanisms to prevent crime: 1) increase perceived risk of getting caught, 2) increase perceived efforts to commit the crime, 3) reduce perceived rewards of the crime, and 4) reduce reasons for committing the crime. While the first three mechanisms are mostly applicable to hard crimes, the fourth mechanism is

relevant to soft crimes like neighbour nuisance. Clarke proposes four sub mechanisms to reduce reasons: 1) stimulate conscience of the unaccepted behaviour, 2) set rules to remove any ambiguity concerning the acceptability of the behaviour, 3) control disinhibitors like alcohol or drugs, that reduce people's capacity to manage their behaviour, and 4) facilitate compliance to the accepted behaviour. A variety of strategies can be introduced to trigger these mechanisms. While Clarke proposes various physical environmental strategies, MCN focuses on social strategies, i.e. a combination of assistance and enforcement.

Organisations

At the level of organisations, the partnership strategy (meetings, action plan, and care coordinator) applied by MCN was expected to improve the coordination of the actions of all participating organisations, leading to a more efficient approach of nuisance households. The action plans describe how past attempts to reduce neighbour nuisance in the four target districts were believed to have been inefficient due to a lack of coordination among organisations: *"One of the biggest problems when approaching and helping the problem households, is the bad coordination between the various organisations who are, more than incidental, working with an individual or family without being aware of each other's work (DOC5)".* The organisational strategy applied by MCN was expected to improve coordination and hence lead to a more efficient approach of households. The type of partnership chosen by MCN fits nicely into the partnership typology of Winer and Karen [24]. They distinguish three types of partnerships: cooperative, coordinated, and collaborative. Of these, MCN belongs to the category of coordinated partnership. This type of partnership refers to a longer-term interaction around a specific effort, in this case neighbour nuisance. It aims to increase coordination by aligning roles and by opening up communication channels. Authority remains with the organisations, which may cause power issues. In contrast, a cooperative partnership refers to a less intense short-term interaction with the aim to exchange information without any common mission, structure, or planning. On the other hand, a collaborative partnership refers to a more intense long-term interaction with the aim to create new structures with a common mission, comprehensive planning, and well-defined communication channels.

Evidence on how MCN actually worked

The next sections describe the mechanisms and outcomes actually resulting from MCN, and the conditions under which they were activated. Results will be discussed consecutively for the levels of organisations, nuisance households, and districts.

Organisations

Mechanisms

(I) Align roles

In line with the programme theory, the coordinated partnership strategy was mentioned to increase the amount of role alignment among the participating organisations (DOC9,13,16-18,21-24; INT1). Because of the alignment, each organisation knew what was expected from them. A programme manager mentioned that “*there is a much clearer picture of actions, responsibilities, and tasks* (DOC16)”.

(II) Shorten communication lines

In line with the programme theory, the coordinated partnership strategy was found to shorten the lines of communication between organisations in three ways (DOC16-18). First, the monthly meetings enabled organisations to familiarize with each other, making it easier for them to contact each other outside the meetings. Third, the care coordinator brought organisations in contact with each other outside the monthly meetings. Fourth, the care coordinator acted as a central contact person for all organisations.

(III) Increase leadership

In addition to the programme theory, the coordinated partnership strategy was noted to facilitate leadership in three ways (DOC16,27,22; INT3). First, the district managers were the leaders of the monthly meetings. Second, the care coordinators monitored the progress of the approach. They ensured that organisations fulfilled their duties and that they adhered to the plan of action. Third, the care coordinators had a final say in which actions to take and which organisations to involve.

Outcomes

In line with the programme theory, the abovementioned mechanisms were described to increase the speed and efficiency with which organisations were able to approach and help the nuisance households (DOC6-8,10-13,16-18,20,23,24; INT1,3,6). Nuisance households were identified more quickly, their background was clear much faster, the speed with which they were helped increased, and duplication of work was prevented.

Conditions

(I) Settle privacy issues

For the coordinated partnership strategy to produce the abovementioned changes it was said to be important to resolve any privacy issues. (DOC15,16; INT1,3,6). Initially, organisations were reluctant to exchange information about households because of

privacy issues. A care professional mentioned that “*when the care coordinator tried to connect organisations or asked organisations for information, issues of privacy violation and privacy agreements arose (DOC16)*”. In response, protocols were established, but these measures were not able to entirely resolve the issue. However, experiences from pilot district 1 suggested that privacy issues may resolve further over time, as organisations got more familiar with the approach and with each other, and as success stories started to emerge.

(II) Include small group of nuisance-oriented organisations as key partners

For the coordinated partnership strategy to produce abovementioned changes it was mentioned to be important to include a small group of nuisance-oriented organisations as key partners (DOC11,16; INT2-6). Meetings were restricted to the key partners to keep them manageable. Key partners were the organisations with most information on neighbour nuisance and who took most interest in the reduction in neighbour nuisance, i.e. the police and local housing associations. In practice, this meant that care professionals were generally not present during meetings. They were only involved in the execution of the approach.

Nuisance households

Mechanisms

(I) Stimulate conscience

In line with the programme theory, the house visit was mentioned to make nuisance households aware of their behaviour and its impact on others (DOC16; INT3). Many households perceived their behaviour to be normal, and were not aware of the consequences of their behaviour for their neighbours and more distant residents. House visits urged nuisance households to reflect on their behaviour, which raised awareness about its impact on others.

(II) Facilitate compliance and control disinhibitors

In line with the programme theory, assistance was found to help nuisance households solve some of the underlying problems that kept them from changing their behaviour (DOC16,17,23,24; INT1-4,6). This mechanism was mentioned to be essential to achieve long-term changes in nuisance behaviour. Households that had difficulties finding the right assistance for their problems were guided to the right professionals. If households refused to accept the assistance offered to them, they were tempted to use assistance by offering them something in return. For example, when a household was dealing with rent arrears, the housing corporation would be willing to postpone eviction, on the condition that the household would accept assistance.

(III) Set rules

In line with the programme theory, the guidance agreement was noted to provide nuisance households with a set of rules for the desired behaviour, which urged households to take responsibility for their behaviour (DOC16,17,21; INT3,4,6). In the past, assistance was often offered to nuisance households without setting any rules. For these households, the rules often acted as conditions for assistance. A care manager described that *“more than ever, we call on the own responsibility of the client. Often, these people already have a long history of assistance. Then, it can be necessary to set conditions for the offered assistance. For example, we offer clients a final debt assistance trajectory, under the condition that he cleans his yard (DOC16)”*.

(IV) Increase surveillance

In addition to the programme theory, the house visit and guidance agreement was mentioned to increase feelings of surveillance among nuisance households (DOC16; INT4,6). Households realised that organisations would keep an eye on them and would approach them when breaking the rules set out in the agreement.

(V) Put pressure

In addition to the programme theory, threatening with consequences was found to increase the amount of pressure among nuisance households to change their behaviour (DOC16,17,23; INT1,3). This mechanism was only set in motion among a handful of nuisance households for whom the first four mechanisms did achieve the desired change in nuisance. A programme manager described that *“with some of the five remaining households, we got in touch and told them that it has to change. Otherwise we would, if possible, gnaw at their benefits or evict them. (These are) all measures that you don’t directly have to put into action, but that do apply some pressure (DOC23)”*

Outcomes

In line with the programme theory, the abovementioned mechanisms were noted to reduce the amount of neighbour nuisance (DOC6-10,13-19,21-23; INT2,3). Over the years, nearly all nuisance households that were approached by MCN were enrolled in the programme. As a result, the amount of nuisance signals drastically dropped. These outcomes were mainly the result of increased conscience, facilitated compliance, rule setting, and surveillance. A handful of households remained for whom these mechanisms were not sufficient to reduce nuisance. A few of them were successfully targeted with pressure.

Conditions

No conditions were identified.

Districts

Mechanisms

For the four target districts and the city as a whole, table 3 displays residents' perceptions of formal and informal social control before and after implementation of MCN (SURV1,3).

(I) Perceived formal social control

In line with the programme theory, perceptions of formal social control improved in districts 1 and 2. In district 1, where MCN was implemented in 2006, the amount of people perceiving much formal social control increased from 22% in 2005 to 36% in 2007. In district 2, where MCN was implemented in 2010, numbers increased from 63% in 2009 to 65% in 2011. For both districts, changes were more positive than the city average. As opposed to the programme theory, districts 3 and 4, where MCN was implemented in 2010, perceptions of formal social control deteriorated between 2009 and 2011. These changes were more negative than the city average.

(II) Perceived informal social control

In line with the programme theory, perceptions of informal social control improved in district 2. The amount of people perceiving much informal social control increased from 5.6 in 2009 to 5.8 in 2011. This change was more positive than the city average, which did not change over time. As opposed to the programme theory, perceptions of informal social control did not change in district 3 and even deteriorated in districts 1 and 4.

TABLE 3. Perceptions of formal and informal social control across districts over time

| Districts ³ | Formal social control (%yes) ¹ | | | | Informal social control (0=low;10=high) ² | | | |
|------------------------|---|------|------|------|---|------|------|------|
| | 2005 | 2007 | 2009 | 2011 | 2005 | 2007 | 2009 | 2011 |
| Target district 1 | 22 | 36 | 57 | 52 | 5.4 | 4.5 | 5.0 | 5.0 |
| Target district 2 | | | 63 | 65 | | | 5.6 | 5.8 |
| Target district 3 | | | 60 | 53 | | | 5.2 | 5.3 |
| Target district 4 | | | 52 | 48 | | | 5.1 | 4.8 |
| City average | 21 | 25 | 50 | 50 | 5.9 | 5.7 | 5.8 | 5.8 |

¹Percentage agreeing with the item 'municipality pays (a lot of) attention to liveability- and safety problems in my neighbourhood'. The question was rephrased from 'a lot of attention' in 2005/2007 to 'attention' in 2009/2011.

²Mean score on the items 'the people in this neighbourhood interact well', 'I feel at home with the people living in my neighbourhood', 'I live in a nice neighbourhood where there is a lot of solidarity' and 'the people in this neighbourhood barely know each other'.

³MCN was introduced in 2006 in target district 1, and in 2010 in target districts 2 to 4

Outcomes

For the four target districts and the city as a whole, table 4 displays residents' perceptions of neighbour nuisance and general safety before and after implementation of MCN (SURV1-3). In line with the programme theory, perceptions of area safety improved in district 2. The amount of people agreeing that neighbour nuisance occurred often in their neighbourhood decreased from 17% in 2009 to 12% in 2011. In the same district, the amount of people agreeing that they sometimes felt unsafe in their neighbourhood decreased from 32% in 2009 to 30% in 2011. Both changes were more positive than the city average. As opposed to the programme theory, perceptions of area safety deteriorated in the other districts. These changes were more negative than the city average.

TABLE 4. Perceptions of neighbour nuisance and general safety across districts over time

| Districts ³ | Neighbour nuisance (% yes) ¹ | | | | General safety (% unsafe) ² | | | |
|------------------------|---|------|------|------|--|------|------|------|
| | 2005 | 2007 | 2009 | 2011 | 2005 | 2007 | 2009 | 2011 |
| Target district 1 | 16 | 17 | 17 | 18 | 35 | 47 | 34 | 37 |
| Target district 2 | | | 17 | 12 | | | 32 | 30 |
| Target district 3 | | | 11 | 14 | | | 30 | 35 |
| Target district 4 | | | 15 | 17 | | | 35 | 45 |
| City average | 12 | 10 | 9 | 9 | 30 | 29 | 25 | 26 |

¹Percentage agreeing with the item 'neighbour nuisance occurs often in my neighbourhood'

²Percentage agreeing with the item 'I sometimes feel unsafe in my neighbourhood'

³MCN was introduced in 2006 in target district 1, and in 2010 in target districts 2 to 4

Conditions

(1) Part of wider safety approach

Interviewees generally agreed that a wider safety approach was a key condition for change (INT1-4,6). District-wide safety perceptions were mentioned to be affected by neighbour nuisance, as well as other problems. District managers talked about how improved safety perceptions were due to an integral approach that consisted of MCN, maintenance of public space, coordinated policing, housing restructuring, and stimulation of local economy. These last two interventions did not only make people feel safer via improved perceptions of public space, but also via gentrification. Housing restructuring and stimulation of local economy were mentioned to attract new residents from higher socio-economic classes. This gentrification process should make people feel safer. In district 1, housing restructuring was found to attract many of its original residents and families from closed communities, which restricted gentrification. In district 2, stimulation of local economy was found to attract new, higher-income residents, which created gentrification. Combined with extra

maintenance of public space and coordinated policing, this may explain why positive outcomes were restricted to district 2.

(II) Small and centrally located district

Some interviewees mentioned a central location and small district size as key conditions for change (INT5,6). District managers suggested that the central location and smaller size of district 2 facilitated the success of the wider safety approach.

DISCUSSION

This realist evaluation study aimed to explore the inner workings of MCN, an area-based intervention to reduce neighbour nuisance in the four most deprived districts of Arnhem, the Netherlands. Results indicate that interventions like MCN may contribute to population health in deprived areas as they may successfully improve one of its major determinants: area safety. We uncovered how, for whom, and in what conditions MCN was able to improve local perceptions of area safety in deprived target districts.

Limitations

This study had some potential limitations that should be taken into account when interpreting the results of this study. According to the realist evaluation method, the impact of the mechanisms that are activated by a programme largely depends on conditions in which they are activated [17]. One of the central aims of a realist evaluation is to identify such conditions. At the district level we were able to identify several conditions that enabled or constrained the success of MCN, such as population density and the integration of MCN into a wider safety approach. However, our assessment of the role of contextual factors at the district level was restricted because we had no detailed information on how the implementation process of MCN differed between districts. As a result, we were limited in our ability to explain between-district differences in effects of MCN on safety perceptions. However, as Pawson et al. [25] also acknowledge, there is a limit to the amount of information that can be retrieved in a single study.

Information on the mechanisms and outcomes at the level of nuisance households originated mostly from the participating organisations. We acknowledge that the views of the residents and especially those of the nuisance households may have been underrepresented, and that they might have disclosed alternative views on the mechanisms and outcomes of MCN. More specifically, the organisations may have been overly positive about the success of MCN, and a more sober picture may have arisen from interviews with household members or their neighbours. To some extent,

we were able to include the views of the residents in our outcome of interest at the household level, i.e. the amount of nuisance signals. These signals were not only provided by organisations such as the police or housing corporations, but also by direct neighbours of the nuisance households or other neighbourhood residents.

Refining the programme theory

Among residents of one of the four districts, the reduction in neighbor nuisance that was accomplished by MCN led to improved district-wide perceptions of area safety. As anticipated by Taylor's incivilities thesis [22], this outcome was the result of improved district-wide perceptions of informal and formal social control. The fact that results were only visible in one of the four districts, suggests that the incivilities thesis only holds under certain conditions. A first condition is that the intervention is best to be part of a wider safety approach. Perceptions of area safety are not only affected by neighbour nuisance but also by problems like litter, crime, or decay, and by processes like gentrification. A second condition is that the target area are best to be small and centrally located within the city. This seemed to facilitate the success of the wider safety approach. Moreover, we suggest that this type of area may also be more densely populated, as was the case with district 4, which increases exposure to the nuisance and subsequent actions taken by organizations.

Among the majority of the nuisance households, the joint assistance and enforcement strategy applied by MCN led to a reduction in nuisance. As anticipated by Clarke's situational crime prevention theory [23], this outcome was the result of a reduction in the underlying reasons for nuisance, which limited the opportunities for nuisance. Reasons for nuisance were successfully tackled by stimulating conscience, setting rules, facilitating compliance, and controlling disinhibitors. While Clarke suggests using physical strategies (e.g. signs, facilities) to activate these mechanisms, our results show that more socially oriented strategies may be effective as well. Conscience was stimulated by means of the house visit, which made households aware of their behaviour and its impact on others. Rules were set by means of the guidance agreement, which urged households to take responsibility for their behaviour. Compliance was facilitated and disinhibitors were controlled by means of assistance, which helped households to solve problems like debt, addiction, etc. MCN was able to reduce nuisance among most households not only because it reduced the underlying reasons for nuisance but also because it increased feelings of formal surveillance. This mechanism relates to one of Clarke's other opportunity-reducing measures: increasing risk. In a few households, MCN was unable to reduce nuisance by tackling reasons or increasing perceived surveillance. For some of these families, pressure proved to be a successful mechanism to reduce nuisance. We should note that this mechanism operated in only a small minority of households.

Among participating organisations, the coordinated partnership strategy applied by MCN led to an increase in the efficiency with which households were approached and helped. As anticipated by Winer and Karen [24], this outcome was the result of improved coordination among organisations. Coordination was improved by aligning the roles of the organisations, and by shortening the communication lines. MCN was able to increase efficiency not only because of improved coordination, but also because of improved leadership. This mechanism may explain why power issues have not been a problem with MCN, as was implied by Winer and Karen [24]. Our results further suggest that two conditions should be met in order for this type of partnership to produce the abovementioned mechanisms. First, privacy issues need to be settled, f.e. by means of protocols, in order to ensure free exchange of confidential information. Second, it is important to select a small group of organisations that are all oriented at the same goal, nuisance reduction in this case.

CONCLUSIONS

By means of a realist evaluation, this study assessed how area-based interventions like MCN may contribute to population health of deprived areas by improving a major environmental determinant of health: area safety. Conventional studies would have estimated the impact of MCN using quantitative methods such as a before-and-after measurements of area-level safety. Such evaluations would have concluded that MCN had failed since it was not followed by improvements of safety perceptions in most of the target districts. Results of our study indicate that interventions like MCN are too complex to judge them using a simple pass or fail verdict. By means of a realist evaluation, we were able to capture the complexity of processes set in motion by interventions like MCN. We gained more insight in the mechanisms by which MCN was able to efficiently and effectively reduce neighbour nuisance. By exploring conditions for change, we understood why the reduction in neighbour nuisance led to improved perceptions of area safety in some districts but not in others. This information may help improve future initiatives elsewhere.

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REFERENCES

1. Pickett KE, Pearl M. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *J Epidemiol Community Health* 2001;55:111-122.
2. Riva M, Gauvin L, Barnett TA. Toward the next generation of research into small area effects on health: a synthesis of multilevel investigations published since July 1998. *J Epidemiol Community Health* 2007;61:853-861.
3. Yen IH, Michael YL, Perdue L. Neighbourhood environment in studies of health in older adults. A systematic review. *Am J Prev Med* 2009;37:455-463.
4. Meijer M, Röhl J, Bloomfield K, Grittner U. Do neighbourhoods affect individual mortality? A systematic review and meta-analysis of multilevel studies. *Soc Sci Med* 2012;74:1204-1212.
5. Chandola T. The fear of crime and area differences in health. *Health Place* 2001;7:105-116.
6. Ross CE, Mirowsky J. Neighbourhood disadvantage, disorder, and health. *J Health Soc Behav* 2001;42:258-276.
7. Poortinga W, Dunstan FD, Fone DL. Neighbourhood deprivation and self-rated health: the role of perceptions of the neighbourhood and of housing problems. *Health Place* 2008;14:562-575.
8. Baum FE, Ziersch AM, Zhang G, Osborne K. Do perceived neighbourhood cohesion and safety contribute to neighbourhood differences in health? *Health Place* 2009;15: 925-934.
9. Kim J. Neighborhood disadvantage and mental health: the role of neighbourhood disorder and social relationships. *Soc Sci Res* 2010;39:260-271.
10. Lorenc T, Clayton S, Neary D, Whitehead M, Petticrew M, Thomson H, et al. Crime, fear of crime, environment, and mental health and wellbeing: mapping review of theories and causal pathways. *Health Place* 2012;18:757-765.
11. Atkinson R. European urban policies and the neighbourhood: an overview. *Urban Des Plann* 2008;161:115-122.
12. Lawless P. Understanding the scale and nature of outcome change in area-regeneration programmes: evidence from the New Deal for Communities programme in England. *Environ Plann C* 2011;29:520-532.
13. Rhodes J, Tyler P, Brennan A. Assessing the effect of area based initiatives on local area outcomes: some thoughts based on the national evaluation of the Single Regeneration Budget in England. *Urban Stud* 2005;42:1919-1946.
14. Hills D. *Evaluation of community-level interventions for health improvement: a review of experience in the UK*. London: Health Development Agency, 2004.
15. Thomson H, Atkinson R, Petticrew M, Kearns A. Do urban regeneration programmes improve public health and reduce health inequalities? A synthesis of the evidence from UK policy and practice (1980 – 2004). *J Epidemiol Community Health* 2006;60:108-115.
16. Thomson H. A dose of realist for healthy urban policy: lessons from area-based initiatives in the UK. *J Epidemiol Community Health* 2007;62:932-936.
17. Pawson R, Tilley N. *Realistic evaluation*. London: SAGE Publications Ltd, 1997.
18. Nanninga M, Glebbeek A. Employing the teacher-learner cycle in realistic evaluation: a case study of the social benefits of young people's playing fields. *Eval* 2011;17.
19. Dillane J, Hill M, Bannister J, Scott S. *Evaluation of the Dundee Families Project: final report*. Glasgow: University of Glasgow, 2001.

20. Yin RK. *Case study research. Designs and methods*. Thousand Oaks: SAGE Publications Inc, 1994.
21. Ritchie J, Spencer L. Qualitative data analysis for applied policy research. In Bryman A, Burgess RG (Eds.), *Analyzing qualitative data*. Oxon: Routledge, 1994.
22. Taylor RB. The incivilities thesis: theory, measurement, and policy. In Reno J, Fisher RC, Robinson L, Brennan N, Travis J, Brann JE (Eds). *Measuring what matters*. Washington: U.S. Department of Justice, 1999.
23. Clarke RV. *Situational crime prevention. Successful case studies*. New York: Harrow and Heston, 1997.
24. Winer M, Karen R. *Collaboration handbook: creating, sustaining, and enjoying the journey*. Sint Paul: Amherst H. Wilder Foundation, 1994.
25. Pawson R, Greenhalgh T, Harvey G, Walshe K. Realist review – a new method of systematic review designed for complex policy interventions. *J Health Serv Res Policy* 2005;10:21-34.

PART

III

**Area-based initiatives
and physical activity**

CHAPTER

7

The impact of area-based initiatives on physical activity trends in deprived areas: a quasi-experimental evaluation of the Dutch District Approach

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ABSTRACT

Background. Numerous area-based initiatives (ABIs) have been implemented in deprived neighbourhoods across Europe. These large-scale initiatives aim to tackle the socio-economic and environmental problems in these areas that might influence physical activity (PA). There is little robust evidence of their impact on PA. This study aimed to assess the impact of a Dutch ABI called the District Approach on trends in leisure-time PA in deprived districts.

Methods. Repeated cross-sectional data on 48401 adults across the Netherlands were obtained from the Integrated Survey on Household Living Conditions (POLS) 2004–2011. 1517 of these adults resided in deprived target districts and 46884 adults resided elsewhere in the Netherlands. In a quasi-experimental interrupted time-series design, multilevel logistic regression analyses were performed to assess trends in leisure-time walking, cycling, and sports before and during the intervention. Trends in deprived target districts were compared with trends in various control groups. The role of the intensity of environmental interventions was also assessed.

Results. Deprived target districts showed a significantly positive change in walking trend between the pre-intervention and intervention period. The trend change in the deprived target districts was significantly larger compared to the rest of the Netherlands, but not compared to other deprived districts. For cycling and sports, neither deprived districts nor control districts showed a significant trend change. For all leisure-time PA outcomes, trend changes were not related to the intensity of environmental interventions in the deprived target districts.

Conclusion. Some evidence was found to suggest that ABIs like the District Approach have a positive impact on leisure-time PA in deprived districts, regardless of the intensity of environmental interventions.

Keywords area-based initiatives, evaluation, physical activity, quasi-experimental design, deprivation

INTRODUCTION

Residents of deprived neighbourhoods have consistently been found to be less physically active than residents of non-deprived neighbourhoods, independent of their individual socio-economic status [1-6]. In the past decade, numerous area-based initiatives (ABIs) have been implemented in deprived neighbourhoods across Western-Europe [7]. These large-scale initiatives aim to tackle the multitude of socio-economic and environmental problems in these neighbourhoods that might influence physical activity (PA) behaviour, including employment, income, housing, crime, and social cohesion. There is little robust evidence of their effect on PA [8-10]. Quasi-experimental evaluations of natural experiments may be useful to assess their effectiveness [10-13]. However, in the field of PA, this type of evaluations is still in its infancy [14].

ABIs may affect PA behaviour via different pathways. Better economic position may improve access to social and material resources for PA [15]. Stronger community bonds may enlarge social support and companionship for PA, which have consistently been associated with higher levels of PA [15,16]. Stronger community bonds may also reinforce positive social norms for healthy behaviours such as PA [15]. Improvements with respect to housing and the physical environment may improve neighbourhood aesthetics, pedestrian infrastructure and recreational facilities, which have all been consistently associated with PA [16-22]. A safer neighbourhood may reduce the fear of outdoor activities, although evidence for an association between neighbourhood safety and PA is less consistent [23].

The English New Deal for Communities (NDC) is one of the few ABIs that has been used as a natural experiment to explore its impact on PA [24,25]. The NDC aimed to improve the socio-economic and environmental situation in England's most deprived areas. At 4-year and 6-year follow-up, a flat post-intervention trend in PA was found for NDC areas and control areas [24,25]. The authors concluded that the NDC had no impact on PA.

However, the impact of the NDC on PA may have been underestimated, as no pre-intervention trends were included in the evaluations. Moreover, previous research has suggested that the impact might depend on the ability of interventions to influence the outcome and on the quality of their implementation [9,26]. Interventions that are aimed at environmental problems instead of socio-economic problems may be more likely to cause district-wide changes in LTPA within a relatively short period of time because of a wider reach and shorter lag-times of effect. Studies are needed that assess changes in PA trends before and during the intervention and that focus on areas where intensive environmental interventions have been implemented.

An opportunity for such a study arose in 2008 with the implementation of a Dutch ABI called the District Approach. The District Approach aims to alleviate problems of employment, education, housing and the physical environment, safety, and social integration in 40 of the most deprived districts of the Netherlands. Districts have been selected based on their accumulation of economic, physical, and social problems, judged on statistics and survey data. Each district developed its own mix of socio-economic and environmental interventions, resulting in large between-district variations in the intensity of interventions [27].

This study aimed to evaluate the short-term impact of the District Approach on trends in leisure-time PA (walking, cycling, and sports) using a quasi-experimental interrupted time-series design. First, PA trends before and during the intervention were assessed in all deprived target districts and in various control groups. Next, trends were assessed in those deprived target districts where environmental interventions have been implemented most intensively. We expected to find a more positive PA trend change in deprived target districts than in the control groups, especially in deprived target districts with intensive environmental interventions.

METHODS

Study population

Repeated cross-sectional data for years 2004 to 2011 were obtained from the Dutch Integrated Survey on Household Living Conditions (POLS). A random nationwide sample of non-institutionalized individuals of all ages was drawn from a subset of the national population registry. The subset consisted of individuals whose seventh digit of their personal identification number corresponded with the current year, e.g. 9 for 2009. This prevented individuals from being sampled twice over the years. Throughout the year, the individuals in the sample were approached by an interviewer for the basic survey. Questions on PA were asked in a supplementary internet or paper-and-pencil survey, administered only among individuals of age 12 and older. Between 2004 and 2011, 53778 individuals completed the additional survey. Total non-response was 40%.

For the analyses, respondents were excluded if younger than 18 and if PA scores were missing or unrealistic (scores exceeding 3360 minutes per week). Three different samples resulted as the number of missing and unrealistic scores was different for each of the PA outcomes. For walking, cycling, and sports, there were 48401, 48420, and 48906 adults with valid scores, respectively. Of these adults, 1517, 1544, and

1555, respectively, resided in deprived target districts. The remaining 46884, 46876, and 47351 adults, respectively, resided elsewhere in the Netherlands.

Measures

Leisure-time physical activity

The dependent variable was self-reported leisure-time PA. PA was measured in POLS using the Dutch Short QUEStionnaire to ASsess Health-enhancing physical activity (SQUASH). This instrument has shown to be fairly reliable and valid for measuring PA [28,29]. Respondents were asked to report the duration (hours and minutes per day) and frequency (days per week) of leisure-time walking, cycling, and sports. Water-related sports (e.g. skiing, surfing, diving) were excluded from the analyses because they were strongly bound to spaces that were usually outside of residential areas. Agility sports (e.g. bowling, darts, golf) and mental sports (e.g. chess) were excluded from the analyses because their intensity was too low to be considered as intense PA. Total minutes per week spent on leisure-time walking, cycling, and sports were calculated by multiplying duration and frequency. Distribution of the three PA outcomes was highly skewed, with almost half of the respondents not engaging in PA. Therefore, PA was dichotomised into 'inactive' (0 minutes per week) versus 'active' (any minutes per week). Sensitivity analyses have found results to be robust against alternative cut-off points (30 or 60 minutes per week) (results not shown).

Time variables

The main predictor variable was survey year. The survey was administered from 2004 to 2011. Respondents filled in the questionnaire at any time during these years. To make more accurate trend estimates, survey years were grouped into half year sections. One of the main effect modifiers was the survey period. Survey years were grouped into a pre-intervention period (January 2004 to June 2008) and an intervention period (July 2008 to December 2011).

Districts

The second main effect-modifier was the respondents' district of residence. Data on 4-digit zip codes were obtained from the national population registry and linked to the POLS data. Subsequently, various groups of districts were identified. The main intervention group consisted of all deprived districts targeted by the District Approach. Three control groups were included. The first consisted of all other districts in the Netherlands ('rest of the Netherlands'). As these districts may have been dissimilar at baseline in ways related to the study outcome, two additional control groups were included that were matched with the deprived target districts in terms of

deprivation level and/or geographical location. The first matched control group consisted of other deprived districts with deprivation levels similar to that of the deprived target districts, but where the District Approach had not been introduced ('other deprived districts'). The second matched control group consisted of only those other deprived districts that were located in the same city as the deprived target districts ('other deprived districts same city'). Because of lower levels of power and the possibility of spill-over effects in the two matched control groups, the rest of the Netherlands was the main control group.

Intensity of environmental interventions

Within the District Approach, twelve types of environmental interventions were identified (housing quality, neighbourhood regeneration, green space, footpaths and cycle tracks, play grounds, sports facilities and activities, social capital, nuisance and conflicts, nuisance from youth, physical disorder, burglary, traffic safety). For each district, we first listed all activities implemented in each of these twelve fields of action for longer than one year [27]. Next, we specified the number of residents reached or the amount of neighbourhood change for each of the activities. Finally, this information was used to estimate the potential impact of all activities within a specific field of action. This impact was graded as low (no change expected in this field), intermediate (small changes expected) or high (substantial changes expected). For each district, we calculated overall intensity score by summing the grades in all twelve fields of action (low=0, intermediate=1, high=2). The average overall intensity score over all areas was 11.47. We distinguished deprived target districts with less intensive environmental interventions (score ≤ 12 , $n=16$) from those with more intense environmental interventions (score ≥ 12 , $n=20$). For four districts, no detailed programme information was available. See Droomers et al. [27] for more detailed information on the implementation of interventions.

Potential confounders

Data on age (continuous), gender, household composition (five categories), and highest level of education completed (five ordinal groups based on the International Standard Classification of Education (ISCED)) were obtained from the POLS survey. Data on ethnicity (four categories) were derived from the national population registry. Information on equivalent disposable household income (quintiles) was obtained from the national tax registry.

Statistical analyses

Interrupted time-series analyses were performed in 2013 to assess whether trends in leisure-time walking, cycling and sports have changed with the implementation of the

District Approach. Multilevel logistic regression models were used to assess the association between year and PA, i.e. the half-yearly amount of change in prevalence of PA. Hereafter, this is called the *trend*. The trend was estimated for both the pre-intervention and intervention period. The difference in trends between these two periods was assessed by means of an interaction term for year and period. Hereafter, this will be called the *trend change*.

An interaction term for year and district was included to assess differences in PA trends between the deprived target districts and the various control groups. An interaction term for year, district, and period was included to assess differences in PA trend changes between the deprived target districts and the various control groups. The role of the intensity of the environmental interventions was assessed by focussing the analyses on deprived target districts with either less intensive or more intensive environmental interventions.

Analyses were adjusted stepwise. Model 1 controlled for age, gender, household composition, and ethnicity. To explore the moderating effect of socio-economic factors, model 2 further controlled for education and income. Multilevel regression analyses were applied to take clustering of respondents in districts into account. Level 1 represented individuals and level 2 represented neighbourhoods. All analyses were carried out using STATA 11.0 software. Statistical significance was set at 0.05.

This study was based on secondary analyses of anonymized survey data. The Medical Ethics Committee of the Academic Medical Centre in Amsterdam, the Netherlands, has confirmed that ethics approval is not necessary, because the Medical Research Involving Human Subjects Act (WMO) does not apply to our study.

RESULTS

Residents of the deprived target districts differed significantly from those of the control groups, especially from the rest of the Netherlands, with respect to most characteristics (table 1). Compared with all control groups, a higher percentage of residents of deprived target districts was single, non-Western non-ethnic Dutch, had lower educational levels, had lower income levels, and did no leisure-time cycling and sports. No between-district differences were noted in the average prevalence of leisure-time walking.

TABLE 1. Characteristics of the study population

| | Total | Deprived target districts | Control groups | | |
|---|-----------|---------------------------|-------------------------|---------------------------------------|--|
| | | | Rest of the Netherlands | Other deprived districts ^b | Other deprived districts, same city ^c |
| Numbers | | | | | |
| <i>n</i> 4-digit zipcodes | 3502 | 83 | 3419 | 250 | 119 |
| <i>n</i> adults in total | 48401 | 1517 | 46884 | 4277 | 2389 |
| <i>n</i> adults per half year (mean±SD) | 3025±293 | 95±16 | 2 930±286 | 267±26 | 149±15 |
| <i>n</i> adults per zipcode (mean±SD) | 14±12 | 18±8 | 14±12 | 17±11 | 20±11 |
| Characteristics^a | | | | | |
| Age (mean±SD) | 49.4±16.9 | 48.1±17.9 | 49.4±16.9* | 48.8±17.2 | 48.2±17.0 |
| Gender (%) | | | | | |
| Men | 47.7 | 46.1 | 47.8 | 46.0 | 45.6 |
| Women | 52.3 | 53.9 | 52.2 | 54.0 | 54.4 |
| Household composition (%) | | | | | |
| Partner/married with child(ren) | 39.4 | 35.2 | 39.5 | 33.9 | 33.2 |
| Partner/married without child(ren) | 38.4 | 28.3 | 38.7 | 36.1 | 32.7 |
| Single without child(ren) | 16.9 | 25.4 | 16.6 | 23.0 | 26.2 |
| Single with child(ren) | 4.1 | 8.2 | 4.0 | 5.1 | 5.6 |
| Other | 1.2 | 2.8 | 1.1 | 1.9 | 2.3 |
| Ethnicity (%) | | | | | |
| Ethnic Dutch | 87.8 | 66.1 | 88.5 | 80.5 | 77.2 |
| Non-ethnic Dutch, western | 7.1 | 9.7 | 7.1 | 9.4 | 10.6 |
| Non-ethnic Dutch, non-western | 3.4 | 19.1 | 2.8 | 7.1 | 8.8 |
| Non-ethnic Dutch, origin unknown | 1.2 | 3.3 | 1.1 | 1.8 | 2.2 |
| Educational level (%) | | | | | |
| Primary | 13.4 | 22.0 | 13.2 | 16.9 | 15.9 |
| Lower secondary | 23.3 | 25.1 | 23.2 | 20.6 | 17.6 |
| Higher secondary | 35.1 | 29.1 | 35.3 | 29.9 | 26.8 |
| Tertiary | 26.3 | 21.9 | 26.4 | 30.3 | 37.0 |
| Income (%) | | | | | |
| First quintile (< €15037) | 16.5 | 27.9 | 16.1 | 21.3 | 22.6 |
| Second quintile (€15037 – €19000) | 18.9 | 23.8 | 18.7 | 20.2 | 18.9 |
| Third quintile (€19001 - €23317) | 19.8 | 19.6 | 19.8 | 19.0 | 17.8 |
| Fourth quintile (€23318 - €29746) | 21.3 | 15.0 | 21.5 | 19.0 | 18.5 |
| Fifth quintile (> €29746) | 22.0 | 11.7 | 22.3 | 19.0 | 20.7 |
| Physical activity (% active) | | | | | |
| Leisure-time walking | 62.6 | 63.3 | 62.6 | 60.8 | 62.7 |
| Leisure-time cycling | 54.6 | 42.0 | 55.0* | 49.5* | 48.7* |
| Sports | 43.0 | 36.7 | 43.2* | 41.2* | 42.9* |

* Differs significantly from deprived target districts

^a Percentages may not add up to 100% due to the category 'missings' which has not been reported.

^b Districts with levels of deprivation similar to that of the deprived target districts, but where the District Approach had not been introduced.

^c Districts with levels of deprivation similar to that of the deprived target districts and that are situated in the same cities as the deprived target districts, but where the District Approach had not been introduced.

Figure 1 displays the trends in prevalence of leisure-time walking, cycling, and sports between 2004 and 2011. In the deprived target districts, prevalence of cycling slightly increased between 2004 and 2011, while prevalence of sports remained unchanged.

For walking, the trend in deprived target districts differed between the pre-intervention and intervention period. In the pre-intervention period, prevalence decreased from 72% in the first half of 2004 to 63% in the first half of 2008. In the intervention period, prevalence increased from 57% in the second half of 2008 to 70% in the second half of 2011. For all PA outcomes, the rest of the Netherlands showed a steady trend over the years.

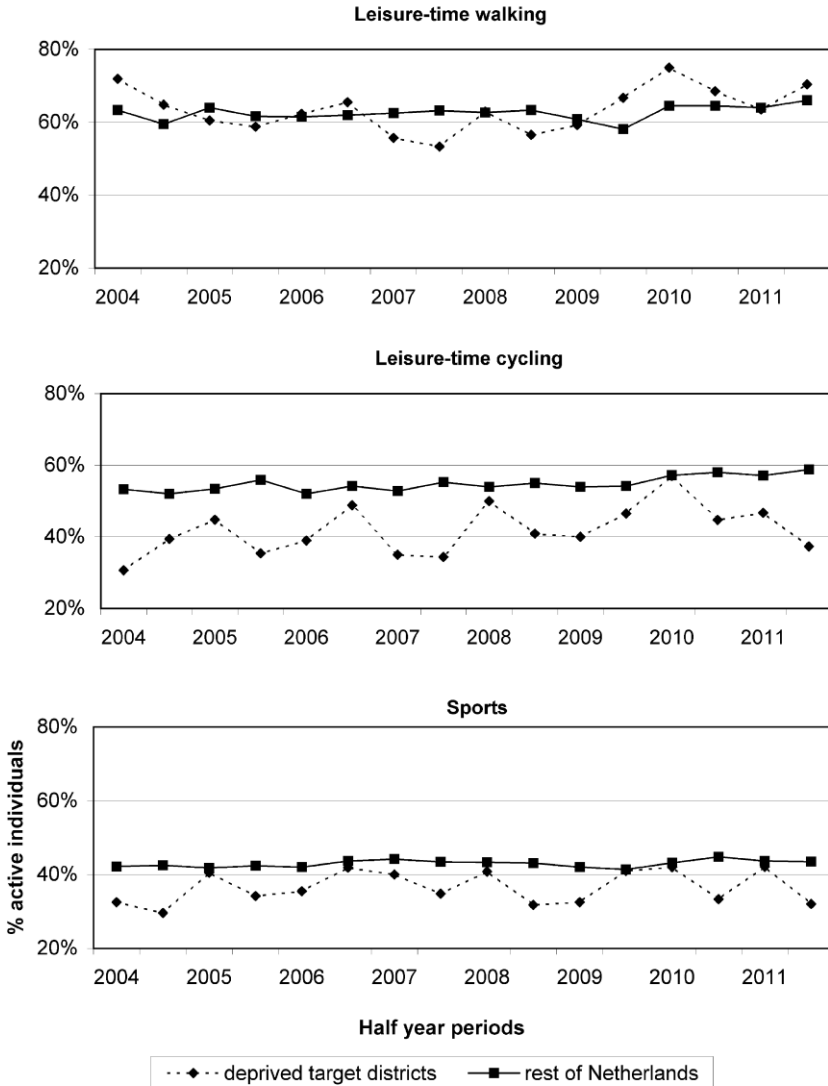


FIGURE 1. Trends in leisure-time physical activity in deprived target districts and the rest of the Netherlands

TABLE 2. Trends in leisure-time physical activity in deprived target districts versus the rest of the Netherlands

| | | Trend in walking/cycling/sports ^a (regression coefficient β (95% Confidence Interval)) | | |
|-----------------------------|--|--|----------------------|---|
| | | Pre intervention period | Intervention period | Intervention versus pre intervention period |
| Leisure-time walking | | | | |
| M0 ^b | Deprived target districts | -0.04 (-0.08 – 0.00) | 0.11 (0.04 – 0.18)* | 0.15 (0.04 – 0.25)* |
| | Rest of the Netherlands | -0.00 (-0.01 – 0.00) | 0.02 (0.01 – 0.04)* | 0.03 (0.01 – 0.04)* |
| | Deprived target districts versus rest of the Netherlands | | | 0.12 (0.02 – 0.22)* |
| M1 ^b | Deprived target districts | -0.04 (-0.08 – 0.01) | 0.11 (0.04 – 0.19)* | 0.15 (0.04 – 0.30)* |
| | Rest of the Netherlands | -0.00 (-0.01 – 0.00) | 0.02 (0.01 – 0.03)* | 0.03 (0.01 – 0.04)* |
| | Deprived target districts versus rest of the Netherlands | | | 0.12 (0.02 – 0.23)* |
| M2 ^b | Deprived target districts | -0.04 (-0.08 – 0.00) | 0.11 (0.03 – 0.18)* | 0.14 (0.04 – 0.25)* |
| | Rest of the Netherlands | -0.00 (-0.01 – 0.00) | 0.02 (0.01 – 0.03)* | 0.02 (0.00 – 0.04)* |
| | Deprived target districts versus rest of the Netherlands | | | 0.12 (0.02 – 0.23)* |
| Leisure-time cycling | | | | |
| M0 | Deprived target districts | 0.04 (0.00 – 0.08)* | 0.00 (-0.07 – 0.07) | -0.04 (-0.14 – 0.06) |
| | Rest of the Netherlands | 0.00 (-0.00 – 0.01) | 0.03 (0.02 – 0.04)* | 0.02 (0.01 – 0.04)* |
| | Deprived target districts versus rest of the Netherlands | | | -0.06 (-0.16 – 0.04) |
| M1 | Deprived target districts | 0.05 (0.00 – 0.09)* | 0.00 (-0.07 – 0.07) | -0.04 (-0.14 – 0.06) |
| | Rest of the Netherlands | 0.01 (-0.00 – 0.01) | 0.03 (0.02 – 0.04)* | 0.03 (0.01 – 0.04)* |
| | Deprived target districts versus rest of the Netherlands | | | -0.07 (-0.17 – 0.03) |
| M2 | Deprived target districts | 0.05 (0.01 – 0.09)* | -0.00 (-0.07 – 0.07) | -0.05 (-0.15 – 0.05) |
| | Rest of the Netherlands | 0.01 (-0.00 – 0.01) | 0.03 (0.01 – 0.04)* | 0.02 (0.00 – 0.04)* |
| | Deprived target districts versus rest of the Netherlands | | | -0.07 (-0.17 – 0.03) |
| Sports | | | | |
| M0 | Deprived target districts | 0.02 (-0.02 – 0.06) | -0.01 (-0.08 – 0.06) | -0.03 (-0.13 – 0.07) |
| | Rest of the Netherlands | 0.00 (-0.00 – 0.01) | 0.00 (-0.01 – 0.02) | 0.00 (-0.02 – 0.02) |
| | Deprived target districts versus rest of the Netherlands | | | -0.03 (-0.13 – 0.07) |
| M1 | Deprived target districts | 0.02 (-0.02 – 0.06) | -0.02 (-0.09 – 0.05) | -0.04 (-0.14 – 0.07) |
| | Rest of the Netherlands | 0.01 (0.00 – 0.02)* | 0.01 (0.00 – 0.02)* | 0.00 (-0.02 – 0.02) |
| | Deprived target districts versus rest of the Netherlands | | | -0.04 (-0.14 – 0.07) |
| M2 | Deprived target districts | 0.02 (-0.02 – 0.06) | -0.04 (-0.12 – 0.03) | -0.06 (-0.17 – 0.04) |
| | Rest of the Netherlands | 0.00 (-0.00 – 0.01) | -0.01 (-0.02 – 0.00) | -0.01 (-0.03 – 0.01) |
| | Deprived target districts versus rest of the Netherlands | | | -0.05 (-0.16 – 0.06) |

*P \leq 0.05^aTrend represents the half yearly change in ln(odds)^bM0: unadjusted. M1: adjusted for age, gender, household composition, ethnicity. M2: additional adjustment for education, income.

Table 2 shows the change in PA trends between the pre-intervention period and the intervention period for deprived target districts and the rest of the Netherlands. In deprived target districts, the trend in walking changed from a slightly negative trend before the District Approach (β : -0.04; 95% confidence interval (CI): -0.08 – 0.00) to a positive trend during the District Approach (β : 0.11; 95% CI: 0.04 – 0.18). This change

in trend was found to be significant (β : 0.15; 95% CI: 0.04 – 0.25). In the rest of the Netherlands too, there was a significantly positive trend change in walking, though smaller (β : 0.03; 95% CI: 0.01 – 0.04). The trend change in walking was significantly more positive in the deprived target districts than in the rest of the Netherlands (β : 0.12; 95% CI: 0.02 – 0.22). Adjustment for potential confounders did not substantially alter the results. For cycling and sports, trend changes were slightly negative in deprived target districts. However, trend changes were not significant and did not significantly differ from those in the rest of the Netherlands.

TABLE 3. Trends in leisure-time physical activity in deprived target districts versus various control groups

| | Trend in walking/cycling/sports ^a (regression coefficient β (95% Confidence Interval)) | | |
|--|--|----------------------|---|
| | Pre intervention period | Intervention period | Intervention versus pre intervention period |
| Leisure-time walking | | | |
| Deprived target districts | -0.04 (-0.08 – 0.00) | 0.11 (0.03 – 0.18)* | 0.14 (0.04 – 0.25)* |
| Rest of the Netherlands | -0.00 (-0.01 – 0.00) | 0.02 (0.01 – 0.03)* | 0.02 (0.00 – 0.04)* |
| Deprived target districts versus rest of the Netherlands | | | 0.12 (0.02 – 0.23)* |
| Other deprived districts | -0.01 (-0.04 – 0.01) | 0.02 (-0.02 – 0.06) | 0.04 (-0.02 – 0.10) |
| Deprived target districts versus other deprived districts | | | 0.11 (-0.01 – 0.23) |
| Other deprived districts, same city | -0.02 (-0.05 – 0.01) | 0.04 (-0.01 – 0.10) | 0.06 (-0.02 – 0.14) |
| Deprived target districts versus other deprived districts, same city | | | 0.09 (-0.04 – 0.22) |
| Leisure-time cycling | | | |
| Deprived target districts | 0.05 (0.01 – 0.09)* | -0.00 (-0.07 – 0.07) | -0.05 (-0.15 – 0.05) |
| Rest of the Netherlands | 0.01 (-0.00 – 0.01) | 0.03 (0.01 – 0.04)* | 0.02 (0.00 – 0.04)* |
| Deprived target districts versus rest of the Netherlands | | | -0.07 (-0.17 – 0.03) |
| Other deprived districts | 0.01 (-0.02 – 0.03) | 0.05 (0.01 – 0.09)* | 0.04 (-0.02 – 0.10) |
| Deprived target districts versus other deprived districts | | | -0.10 (-0.22 – 0.02) |
| Other deprived districts, same city | 0.01 (-0.02 – 0.05) | 0.03 (-0.02 – 0.08) | 0.02 (-0.06 – 0.09) |
| Deprived target districts versus other deprived districts, same city | | | -0.08 (-0.21 – 0.04) |
| Sports | | | |
| Deprived target districts | 0.02 (-0.02 – 0.06) | -0.04 (-0.12 – 0.03) | -0.06 (-0.17 – 0.04) |
| Rest of the Netherlands | 0.00 (-0.00 – 0.01) | -0.01 (-0.02 – 0.00) | -0.01 (-0.03 – 0.01) |
| Deprived target districts versus rest of the Netherlands | | | -0.05 (-0.16 – 0.06) |
| Other deprived districts | 0.00 (-0.02 – 0.03) | 0.01 (-0.04 – 0.05) | 0.00 (-0.06 – 0.07) |
| Deprived target districts versus other deprived districts | | | -0.05 (-0.18 – 0.07) |
| Other deprived districts, same city | -0.01 (-0.04 – 0.03) | -0.01 (-0.07 – 0.04) | -0.00 (-0.09 – 0.08) |
| Deprived target districts versus other deprived districts, same city | | | -0.05 (-0.18 – 0.08) |

* $P \leq 0.05$

^aTrend represents the half yearly change in ln(odds), adjusted for age, gender, household composition, ethnicity, education, and income.

For walking, differences in trend change were of similar magnitude but not statistically significant when deprived target districts were compared with two matched control groups (table 3). The trend change was slightly more positive in the two matched control groups than in the rest of the Netherlands. As a result, the significantly positive trend change in deprived target districts did not significantly differ from that in the two matched control groups. For cycling and sports, trend changes were similar across all control groups.

TABLE 4. Trends in leisure-time physical activity in deprived target districts with less and more intensive environmental interventions

| | Trend in walking/cycling/sports ^a (regression coefficient β (95% Confidence Interval)) | | |
|---|--|----------------------|---|
| | Pre intervention period | Intervention period | Intervention versus pre intervention period |
| Leisure-time walking | | | |
| Rest of the Netherlands | -0.00 (-0.01 – 0.00) | 0.02 (0.01 – 0.03)* | 0.02 (0.00 – 0.04)* |
| Low-intensity deprived target districts | -0.07 (-0.15 – 0.01) | 0.13 (-0.00 – 0.27) | 0.20 (0.01 – 0.40)* |
| Low-intensity deprived target districts versus rest of the Netherlands | | | 0.18 (-0.01 – 0.38) |
| High-intensity deprived target districts | -0.02 (-0.07 – 0.04) | 0.08 (-0.01 – 0.18) | 0.10 (-0.04 – 0.24) |
| High-intensity deprived target districts versus rest of the Netherlands | | | 0.08 (-0.06 – 0.22) |
| Leisure-time cycling | | | |
| Rest of the Netherlands | 0.01 (-0.00 – 0.01) | 0.03 (0.01 – 0.04)* | 0.02 (0.00 – 0.04)* |
| Low-intensity deprived target districts | 0.04 (-0.04 – 0.11) | -0.03 (-0.16 – 0.11) | -0.06 (-0.25 – 0.13) |
| Low-intensity deprived target districts versus rest of the Netherlands | | | -0.08 (-0.27 – 0.11) |
| High-intensity deprived target districts | 0.06 (-0.00 – 0.11) | 0.01 (-0.08 – 0.10) | -0.05 (-0.18 – 0.08) |
| High-intensity deprived target districts versus rest of the Netherlands | | | -0.07 (-0.20 – 0.06) |
| Sports | | | |
| Rest of the Netherlands | 0.01 (-0.00 – 0.01) | -0.01 (-0.02 – 0.00) | -0.01 (-0.03 – 0.01) |
| Low-intensity deprived target districts | -0.00 (-0.09 – 0.08) | -0.02 (-0.15 – 0.12) | -0.01 (-0.21 – 0.19) |
| Low-intensity deprived target districts versus rest of the Netherlands | | | -0.00 (-0.20 – 0.20) |
| High-intensity deprived target districts | 0.04 (-0.02 – 0.10) | -0.08 (-0.17 – 0.02) | -0.12 (-0.26 – 0.02) |
| High-intensity deprived target districts versus rest of the Netherlands | | | -0.11 (-0.25 – 0.03) |

* $P \leq 0.05$
^aTrend represents the half yearly change in $\ln(\text{odds})$, adjusted for age, gender, household composition, ethnicity, education, and income

Table 4 shows the change in PA trends for deprived target districts with less and more intensive environmental interventions. Both low- and high-intensity districts showed a positive trend change in walking. The trend change was somewhat larger in low-intensity districts (β : 0.20; 95% CI: 0.01 – 0.40) than in high-intensity districts (β :

0.10; 95% CI: -0.04 – 0.24), but confidence intervals greatly overlapped. For both districts, trend changes did not significantly differ from those in the rest of the Netherlands. For cycling, trend changes were similar in the high- and low-intensity districts. Trend changes in both districts were slightly more negative than in the rest of the Netherlands, but differences were small and not statistically significant. For sports, no trend change was apparent in low-intensity districts (β : -0.01; 95% CI: -0.21 – 0.19), while high-intensity districts showed a slightly negative trend change (β : -0.12; 95% CI: -0.26 – 0.02). Again, confidence intervals greatly overlapped. The trend change in high-intensity districts was not significant and did not significantly differ from that in the rest of the Netherlands (β : -0.11; 95% CI: -0.25 – 0.03).

DISCUSSION

This study provides novel insights into the impact of ABIs on leisure-time PA. In the deprived target districts, there was a positive trend change in walking between the periods before and during the District Approach. This trend change was significantly larger than in the rest of the Netherlands. Neither deprived target districts nor control districts showed a significant trend change in cycling or sports. Trend changes in PA appeared to be unrelated to the intensity of environmental interventions in the deprived target districts.

Limitations

Total non-response was 40%. Non-response may have been selective in ways related to our study outcome. A comparison of weighed and non-weighed characteristics of the total study population revealed a small overrepresentation of older people, women, couples with children, ethnic Dutch, people with higher income, and active people (data not shown). Unfortunately, information on non-response was not available for the deprived target districts specifically. However, even if non-response would have been selective in the deprived target districts, it would have only affected our trend estimates if non-response rates would have differed over time. In our study, non-response rates appeared to remain stable over time.

We used repeated cross-sectional data for time points of half year each. The characteristics of the survey samples may have varied between these half years. However, given the sampling design that was used, there is little reason to expect the time variation to be systematic. Moreover, we controlled our analyses for possible systematic variations in the demographic and socio-economic characteristics of respondents.

We compared trends in deprived target districts with those in various control groups. Comparison with other deprived districts has the advantage of increasing similarity between the intervention and control groups. On the downside, these districts may have received ABIs similar to the District Approach. Moreover, deprived control districts that are located near the deprived target districts might have experienced spill-over effects of the District Approach. Comparison with such districts may thus cause an underestimation of the impact of the District Approach. The use of a national control group minimized these problems, at the price of greater dissimilarity between the intervention and control group. To control for some of these dissimilarities in population composition, analyses were adjusted for various demographic and socio-economic characteristics.

Our results might have been biased by selective migration of residents [11,30]. The District Approach might have led to the migration of more affluent (and active) individuals into the deprived target districts. Consequently, changes in PA might have been the result of population changes rather than environmental changes. However, such selective migration seems to have played a minor role as adjustment for socio-economic factors did not substantially change our key findings. Moreover, previous evaluation studies of the NDC have found changes in PA to be similar in high- and low-mobility areas, indicating selective migration to be absent [30].

This evaluation study has a limited post-intervention evaluation time of 3.5 years. Longer follow-up time is needed to address the long-term impact of the District Approach on PA.

Interpretation of results

Evaluation studies of the NDC found no evidence of an effect on PA [24,25]. We initially hypothesised this absence of effect to be partly due to lack of inclusion of the pre-intervention trend. In the current study, however, key results were similar regardless of the inclusion of pre-intervention trends.

The NDC evaluations examined overall PA [24,25]. Results of the current study illustrate the need to distinguish different types of PA, as a positive effect of the District Approach was observed for leisure-time walking only, and not for leisure-time cycling or sports. The District Approach might have had an impact on leisure-time walking only, as walkers are most likely to be exposed to their immediate neighbourhood environment. In the Netherlands, 40% of the walking trips take place within 5 kilometres of home, compared to only 4% of the cycling trips [31]. Exposure to the neighbourhood environment is limited with many sports, as more than half of the sports activities take place at indoor sports clubs [32]. A recent review has also

found various aspects of the physical neighbourhood environment to be associated with walking, but less so with other types of PA [33].

Trends in walking in deprived target districts were not related to the intensity of environmental interventions. Perhaps PA trends were affected less by environmental interventions and more by interventions that were aimed at the individual, such as employment- and education-related initiatives. However, we found no indications for an impact of individual-level interventions on PA. First, adjustment for education and income levels had little or no effect on the results. Second, individual-level interventions as carried out in the District Approach reached only a small part of the population, and their impact on PA among these people is likely to have long lag-times. As a result, it is unlikely that the individual-level interventions have caused short-term district-wide changes in PA.

The finding that PA trends were unrelated to the intensity of interventions suggests that factors other than intensity were more important determinants of the outcomes of the District Approach. Prior research of the NDC has also found expenditure and number of interventions to be unrelated to the outcome of the programme [34]. The impact of the NDC on various place- and people-based outcomes was found to vary according to the size and socio-demographic composition of the population, the urbanization level of the area, and the amount of problems in the area at the start of the programme [34]. Unfortunately, we were unable to make such distinctions.

Future studies should use longitudinal data to prevent variations in study population over the years, which may result either from selective migration or from variations in sampling. Longitudinal studies may also be useful to explore the underlying mechanisms of change, for example by relating PA changes to changes in socio-economic and environmental factors, or by comparing PA changes between beneficiaries and non-beneficiaries of specific projects. Moreover, future studies should take into account the local context to capture possible variations in effect between areas.

CONCLUSIONS

There was some evidence that ABIs like the Dutch District Approach might have a positive effect on leisure-time PA behaviour in deprived areas. The District Approach appeared to improve trends in leisure-time walking, regardless of the intensity of environmental interventions. By applying a quasi-experimental time-series design, this study offers new evidence for the impact of ABIs on leisure-time PA. This design could be applied to future evaluations of ABIs. However, complementary studies are

needed to uncover the mechanisms through which ABIs might affect leisure-time PA behaviour in deprived districts.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

DK and AEK developed the study design. DK and MW prepared the data. DK performed the statistical analyses and MW checked the execution of the analyses. With the help of AEK, DK wrote a draft of the manuscript. AEK, MD, BJ-G, KS and MW critically reviewed intermediate results and manuscript versions and made substantial contributions to subsequent versions. All authors have read and approved the final version of the manuscript.

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REFERENCES

1. Turrell G, Haynes M, Burton N, Giles-Corti B, Oldenburg B, Wilson L, et al. Neighborhood disadvantage and physical activity: baseline results from the HABITAT multilevel longitudinal study. *Ann Epidemiol* 2010;20:171-181.
2. Shishehbor MH, Gordon-Larsen P, Kiefe CI, Litaker D. Association of neighbourhood socioeconomic status with physical fitness in healthy young adults: the coronary artery risk development in young adults (CARDIA) study. *Am Heart J* 2008;155:699-705.
3. Kamphuis CBM, Giskes K, Kavanagh AM, Thornton LE, Thomas LR, van Lenthe FJ, et al. Area variation in recreational cycling in Melbourne: a compositional or contextual effect? *J Epidemiol Community Health* 2008;62:890-898.
4. Hillsdon M, Lawlor DA, Ebrahim S, Morris JN. Physical activity in older women: associations with area deprivation and with socioeconomic position over the life course: observations in the British Women's Health and Health Study. *J Epidemiol Community Health* 2008;62:344-350.

5. Pascual C, Regidor E, Astasio P, Ortega P, Navarro P, Dominguez V. The association of current and sustained area-based adverse socioeconomic environment with physical inactivity. *Soc Sci Med* 2007;65:454-466.
6. Cubbin C, Sundquist K, Ahlén H, Johansson SE, Winkleby MA, Sundquist J. Neighbourhood deprivation and cardiovascular disease risk factors : protective and harmful effects. *Scand J Public Health* 2006;34:228-237.
7. Atkinson, R. European urban policies and the neighbourhood: an overview. *Urban Des Plann* 2008;161:115-122.
8. Atkinson R, Thomson H, Kearns A, Petticrew M. Giving urban policy its 'medical': assessing the place of health in area-based regeneration. *Policy Polit* 2006;34:5-26.
9. Thomson H, Atkinson R, Petticrew M, Kearns A. Do urban regeneration programmes improve public health and reduce health inequalities ? A synthesis of the evidence from UK policy and practice (1980 – 2004). *J Epidemiol Community Health* 2006;60:108-115.
10. Egan M, Kearns A, Mason P, Tannahill C, Bond L, Coyle J, et al. Protocol for a mixed methods study investigating the impact of investment in housing, regeneration and neighbourhood renewal on the health and wellbeing of residents: the GoWell programme. *BMC Med Res Methodol* 2010;10:41.
11. Cotteril S, Parry J, Richardson M, Mathers J. Quasi-experimental evaluation of the health impacts of the New Deal for Communities Urban Regeneration scheme. *Crit Public Health* 2008;18:311-332.
12. Thomson H. A dose of realism for healthy urban policy: lessons from area-based initiatives in the UK. *J Epidemiol Community Health* 2007;62:932-936.
13. Petticrew M, Cummins S, Ferrell C, Findlay A, Higgins C, Hoy C, et al. Natural experiments: an underused tool for public health? *Public Health* 2005;119:751-757.
14. McGormack GR, Shiell A. In search of causality: a systematic review of the relationship between the built environment and physical activity among adults. *I J Behav Nutr Phys Act* 2011;8.
15. McNeill LH, Kreuter MW, Subramanian SV. Social environment and physical activity: a review of concepts and evidence. *Soc Sci Med* 2006;63:1011-1022.
16. Wendel-Vos W, Droomers M, Kremers S, Brug J, van Lenthe F. Potential environmental determinants of physical activity in adults: a systematic review. *Obes Rev* 2007;8:425-440.
17. Frost SS, Goins RT, Hunter RH, Hooker SP, Bryant LL, Kruger J, et al. Effects of the built environment on physical activity of adults living in rural settings. *Am J Health Promot* 2010;24:267-283.
18. Saelens B, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc* 2008;40:550-566.
19. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJF, Martin BW. Correlates of physical activity: why are some people physically active and others not. *Lancet* 2012;380:258-271.
20. Sugiyama T, Neuhaus M, Cole R, Giles-Corti B, Owen N. Destination and route attributes associated with adults' walking: a review. *Med Sci Sports Exerc* 2012;44:1275-1286.
21. van Holle V, Deforche B, van Cauwenberg J, Goubert L, Maes L, van de Weghe N, et al. Relationship between the physical environment and different domains of physical activity in European adults: a systematic review. *BMC Public Health* 2012;12:807.
22. Duncan MJ, Spence JC, Mummery WK. Perceived environment and physical activity: a meta-analysis of selected environmental characteristics. *Int J Behav Nutr Phys Act* 2005;2:11.

23. Foster S, Giles-Corti B. The built environment, neighbourhood crime and constrained physical activity: an exploration of inconsistent findings. *Prev Med* 2008;47:241-251.
24. Lawless P, Foden M, Wilson I, Beatty C. Understanding area-based regeneration: the New Deal for Communities Programme in England. *Urban Stud* 2010;47:257-275.
25. Batty E, Beatty C, Foden M, Lawless P, Pearson S, Wilson I. *The New Deal for Communities Experience: a final assessment. Communities and local governments*. West Yorkshire: Department of Communities and Local Government, 2010.
26. Rychetnik L, Frommer M, Hawe P, Shiell A. Criteria for evaluating evidence on public health interventions. *J Epidemiol Community Health* 2002;56:119-127.
27. Droomers M, Harting J, Jongeneel-Grimen B, Rutten L, van Kats J, Stronks K. Area-based interventions to ameliorate deprived Dutch neighborhoods in practice: Does the Dutch District Approach address the social determinants of health to such an extent that future health impacts may be expected? *Prev Med* 2014;61:122-127.
28. Wagenmakers R, van den Akker-Scheek I, Groothoff JW, Zijlstra W, Bulstra SK, Kootstra JWJ, et al. Reliability and validity of the short questionnaire to assess health-enhancing physical activity (SQUASH) in patients after total hip arthroplasty. *BMC Musculoskel Dis* 2008;9:141.
29. Wendel-Vos GCW, Schuit AJ, Saris WHM, Kromhout D. Reproducibility and relative validity of the Short Questionnaire to Assess Health-enhancing physical activity. *J Clin Epidemiol* 2003;56:1163-1169.
30. Beatty C, Lawless P, Pearson S, Wilson I. *Residential mobility and outcome change in deprived areas: evidence from the New Deal for Communities Programme*. West Yorkshire: Department of Communities and Local Government, 2009.
31. Centraal Bureau voor de Statistiek. *Toerisme en recreatie in 2011*. Den Haag: Centraal Bureau voor de Statistiek, 2011.
32. van den Dool R, Elling A, Hoekman R. *Sportersmonitor*. 's Hertogenbosch: Mulier Instituut, 2009.
33. Durand CP, Andalib M, Dunton GF, Wolch J, Pentz MA. A systematic review of built environment factors related to physical activity and obesity risk: implications for smart growth urban planning. *Obesity Rev* 2011;12:173-182.
34. Lawless P, Beatty C. Exploring change in local regeneration areas: evidence from the New Deal for Communities programme in England. *Urban Stud* 2012:1-17.

CHAPTER 8

Uncovering how area-based initiatives may stimulate leisure-time walking among adults in deprived areas: a realist review

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ABSTRACT

Background Numerous area-based initiatives (ABIs) have been implemented in deprived areas across Western-Europe with the aim to improve the living conditions of its inhabitants. There is evidence that these initiatives can stimulate leisure-time walking (LTW), but underlying pathways remain unclear. This study aimed to explore how ABIs might enhance LTW in deprived areas.

Methods Realist review methodology was applied. First, we developed an initial programme theory explaining how ABIs may be expected to enhance LTW. This initial theory was tested and refined using evidence from the peer-reviewed literature. We searched three electronic databases for evidence on how LTW in deprived areas is influenced by the neighbourhood environment or related interventions.

Results A synthesis of thirteen studies revealed three main pathways by which ABIs may stimulate LTW in deprived areas. First, all studies indicated that less safety problems and better physical neighbourhood design may reduce the fear to use existing LTW facilities (e.g. parks, sidewalks). Second, seven studies indicated that better neighbourhood aesthetics might make LTW facilities more relaxing and stress releasing. Third, seven studies indicated that better infrastructure might make existing LTW facilities more convenient. Three additional, less well supported pathways were identified. First, two studies indicated that more LTW facilities might create more settings for LTW. Second, two studies indicated that more social capital might improve social support for LTW. Third, two studies indicated that more social capital might increase social interaction while walking.

Conclusions This realist review indicates that ABIs might stimulate adult LTW in deprived areas primarily by making existing LTW facilities less frightening, more relaxing, and more convenient.

Keywords walking, neighbourhood, area deprivation, area-based initiative, realist review

INTRODUCTION

Despite the well-known health benefits of physical activity (PA), 34.8 % of the European adult population do not meet recommended levels of PA [1]. These numbers are even higher in deprived areas as compared to non-deprived areas, especially when it comes to PA in leisure time [2-4]. These area differences in PA can only partly be explained by differences in individual characteristics [2-4]. Ecological models posit that PA is determined by the interaction of an individual with its environment [5-8]. Several reviews have pointed to associations of PA with various physical and social neighbourhood characteristics including aesthetics, infrastructure, recreational facilities, and social networks [9-13]. Compared to adults in non-deprived areas, those living in deprived areas generally perceive poorer neighbourhood aesthetics, less public recreational facilities, less social support, more safety problems, and lower levels of trust and social cohesion [2,14-16]. These results imply that area differences in adult PA can potentially be explained by poorer neighbourhood conditions.

In the past decade, numerous area-based initiatives (ABIs) have been implemented in deprived areas across Western-Europe with the aim to improve the socio-economic position of its residents as well as their living conditions [17]. As such, ABIs have the potential to reduce area-based PA inequalities. Only few ABIs have been evaluated for their impact on PA, and resulting evidence is conflicting. In 1998, the New Deal for Communities was introduced in the 39 most deprived areas of England. A wide array of interventions was implemented to tackle problems related to health, education, employment, crime, community, housing, and the physical environment. At 4 and 6 year follow-up, adult PA had not improved in the target areas, neither when looking at absolute change, nor when looking at change relative to that in similarly deprived areas [18,19]. In 2007, the District Approach was introduced in the forty most deprived districts of the Netherlands. This ABI aimed to improve the living conditions in these forty areas by tackling problems related to employment, education, housing, the physical environment, safety, and social interaction. At 3 year follow-up, target areas saw larger improvements in leisure-time walking (LTW) trends than the rest of the country [20]. There were no changes in trends of leisure-time cycling and sports among adults.

None of these studies have explored *how* these ABIs have influenced PA of adults living in deprived areas. To be able to improve future ABIs, various researchers have expressed the need to go beyond the quantitative changes in PA and try to understand how these changes have been produced [21-24]. Therefore, the current study aimed to explore the pathways by which ABIs might influence PA of adults living in deprived areas. More specifically, we aimed to explore the pathways by which the environmental interventions of ABIs might stimulate LTW among adults in deprived

areas. We focused on LTW because prior quantitative evaluation studies have identified this to be the only PA outcome that had improved following an ABI [18-20].

METHODS

We applied a realist approach [25,26]. This theory driven evaluation approach is very much suited to uncover the inner workings of complex programmes like ABIs. The realist approach aims to uncover how programmes work, for whom, and in what conditions. Three concepts are central to the realist approach: mechanisms, contexts, and outcomes. *Mechanisms* refer to the choices and capacities that are offered to a person by the programme. Whether and how these mechanisms are enacted upon and what *outcomes* they produce, depends on the *context* in which they are activated. Contextual factors may reside at the individual or environmental level. Each programme has an underlying theory of how the programme is assumed to work and what outcomes are expected from it. A realist researcher has the task of identifying this programme theory and of systematically gathering evidence to test and refine this theory.

Our realist review was guided by the key steps described by Pawson et al. [26]. Each step is described in the following sections.

Step 1: articulate the initial programme theory

First, we developed an initial programme theory on how the environmental interventions of ABIs may be expected to stimulate LTW in deprived areas. We performed an exploratory search of the peer-reviewed literature to identify frameworks and theories that describe how the neighbourhood environment can potentially influence PA. We did not specifically focus on LTW and deprived areas, as such frameworks and theories are currently not available (to our knowledge). We selected frameworks and theories that focused on the neighbourhood environment as point of entry for interventions, thereby excluding the multitude of psychosocial theories that focus exclusively on the individual. The search was non-systematic and meant to identify the key ideas set out in the literature.

Step 2: search for evidence

We searched the peer-reviewed literature for evidence to test and refine our initial programme theory. The search was iterative and ongoing throughout the study. The search was limited to articles published in English or Dutch. Three databases were searched: two multidisciplinary databases (Google Scholar, Web of Science) and one health-specific database (PubMed). Search terms included various combinations of

synonyms for “neighbourhood”, “deprivation”, and “walking”. We additionally searched for articles which cited or were cited by the articles that were eligible for inclusion (see step 3).

Step 3: appraise the evidence

Following the realist principles, articles were not included or excluded based solely on their study design [26]. Rather, articles were judged on their ability to provide evidence for theory testing, i.e. their relevance, which was appraised in two steps. First, abstracts were judged based on three criteria: a) study focused on the relation of the neighbourhood environment or neighbourhood environmental interventions with general walking, LTW, general PA, or health, b) study focused on adults or older adults, c) study focused on deprived areas or made comparisons between deprived and non-deprived areas. Second, full-text articles of all eligible abstracts were judged based on three additional criteria: d) results referred to general walking or LTW, e) results provided evidence on the mechanisms by which the neighbourhood environment or neighbourhood environmental interventions influence general walking or LTW, f) in case the study focused on both deprived and non-deprived areas, results were clearly sorted by area.

Step 4: extract and synthesize the evidence

Data extraction and synthesis was guided by the framework approach of Ritchie and Spencer [27]. First, we indexed the evidence in the articles. We did so by flagging evidence about the mechanisms by which the neighbourhood environment or a neighbourhood environmental intervention influenced general walking or LTW, and evidence about personal factors that influenced whether these mechanisms were activated. Evidence was not flagged when about general PA, health, types of walking other than LTW, types of PA other than walking, adolescents, children, or non-deprived areas. Flagging was guided by our programme theory, but we were also alert for unanticipated mechanisms and contextual factors. Second, we charted the extracted evidence. Evidence from all articles was collected in a word document and sorted by type of mechanism. Finally, we mapped and interpreted the evidence. Recurrent patterns of evidence were grouped and labeled. Patterns were regularly discussed with the members of the research team. Data extraction and analysis was iterative, in that when new patterns emerged, data sources were checked again for additional evidence.

RESULTS

Initial programme theory

Figure 1 displays our initial programme theory and describes how the environmental interventions of ABIs may be expected to stimulate LTW in the context of area deprivation. The outline of the theory was based on conceptual frameworks developed by Kremers et al. [28] and Ogilvie et al. [29]. ABIs may cause various environmental changes in deprived areas, which may in turn activate a wide range of cognitive processes (i.e. mechanisms) that may stimulate LTW among adults. Whether these mechanisms are activated may depend on personal factors, such as age and gender.

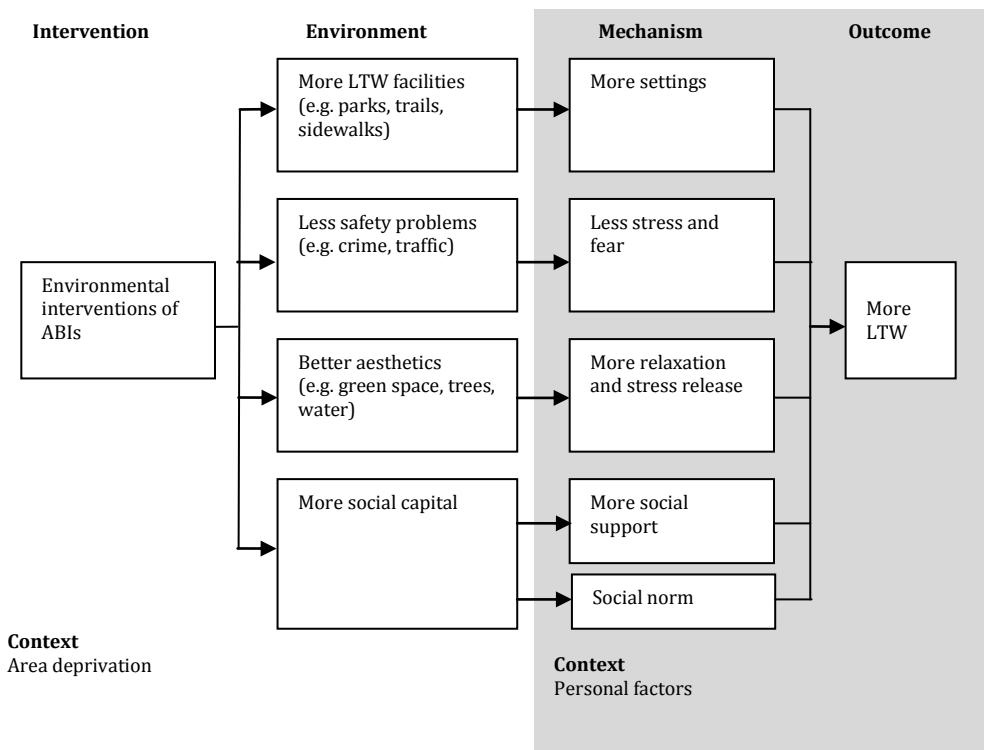


FIGURE 1. Initial programme theory

More specific information on what environmental changes may activate what mechanisms was derived from two reviews of theories on how the physical [30] and social [31] environment may influence leisure-time PA. Five potential pathways were identified. First, Barker's behavior setting theory posits that an increase in parks,

trails, sidewalks, and other LTW facilities may create more *settings* for LTW, and hence stimulate LTW [30]. Second, Evan and Cohen's environmental stress theory posits that a reduction in crime, traffic, and other safety problems may lower levels of *stress and fear*. Hence, levels of LTW may increase [30]. Third, Kaplan's restorative environments theory posits that an increase in green space, trees, water, and other aesthetic features may create more fascination and a sense of being away, thereby enabling more *relaxation and stress release*. Hence, levels of LTW may increase [30]. Fourth, Berkman and Kawachi posit that higher levels of social capital may create more *social support* (including emotional, instrumental, informational support) for LTW, and hence stimulate LTW [30]. Fifth, Berkman and Kawachi posit that higher levels of social capital may reinforce positive *social norms* for LTW, and hence stimulate LTW [31].

Evidence

A total of 13 articles were included to test and refine our initial programme theory (Table 1). Publication dates ranged from 2006 to 2013. All studies applied a qualitative research design. We excluded all quantitative studies due to a lack of evidence on mechanisms. Studies were performed in New Zealand (N=1), Canada (N=1), USA (N=3), the Netherlands (N=1), Scotland (N=1), Ireland (N=2), and England (N=4). Study populations included older adult residents (N=4), adult residents (N=6), Latino female mothers (N=1), African American adult residents (N=2), young adult residents (N=3), key neighbourhood informants (N=1), and planners (N=1) (some studies include multiple study populations). Studies either aimed to explore associations of the neighbourhood environment with walking, PA, or health (N=10), or evaluated the impact of a specific PA intervention (N=3).

From the evidence we derived a total of six mechanisms by which ABIs in deprived areas might stimulate walking among adults that live in these areas. These mechanisms are detailed below. The first four mechanisms were in line with our initial programme theory.

1. More settings

Two studies indicated that adults in deprived areas refrained from walking because their neighbourhood did not provide enough settings for walking [39,43]. Sidewalks, trails, and local parks were mentioned as primary walking settings [43]. Adults in the two studies mentioned that their neighbourhood did not provide any of these.

TABLE 1. Characteristics of included articles

| # | Authors, year | Design | Context | Aim |
|----|-----------------------|---|---|--|
| 32 | Annear et al., 2009 | <ul style="list-style-type: none"> • Case study • Interviews • Qualitative | <ul style="list-style-type: none"> • Christchurch, New Zealand • 1 deprived suburban area; 1 non-deprived suburban area • 63 elderly (65-91 years old) | How does area deprivation affect leisure-time physical activity among older adults? |
| 33 | Burgoyne et al., 2007 | <ul style="list-style-type: none"> • Case study/evaluation • Focus groups • Qualitative | <ul style="list-style-type: none"> • Countryside, Ireland • 2 deprived areas • 53 adults (18-60 years old) | How does the neighbourhood environment affect walking? What was the impact of the Sli-na-Slaime walking route? |
| 34 | Burgoyne et al., 2008 | <ul style="list-style-type: none"> • Case study • Focus groups; interviews • Qualitative | <ul style="list-style-type: none"> • Cork, Ireland • 2 adjacent deprived areas • 80 adults | What are determinants of engaging in physical activity? |
| 35 | Coulson et al., 2011 | <ul style="list-style-type: none"> • Case study/evaluation • Focus groups before, after, and during the intervention • Qualitative | <ul style="list-style-type: none"> • Bristol, England • 1 deprived area • 36 adults | How has home zone remodeling and construction of the renewal of an existing cycle-walkway in a deprived area affected quality of life and physical activity? |
| 36 | Day, 2008 | <ul style="list-style-type: none"> • Case study • Focus groups; interviews • Qualitative | <ul style="list-style-type: none"> • Glasgow, Scotland • 1 highly deprived urban area; 1 medium deprived suburban area; and 1 non-deprived coastal area • 45 retired elderly (62-90 years old). | How does the local outdoor neighbourhood environment affect older people's health? |
| 37 | Gidlow & Ellis, 2011 | <ul style="list-style-type: none"> • Case study • Focus groups • Qualitative | <ul style="list-style-type: none"> • North Staffordshire, England • 1 deprived urban area • 35 adults (mean age 48); 23 young people (12-15 years old) | How do people perceive their local green space and what are barriers for use? |
| 38 | Grant et al., 2010 | <ul style="list-style-type: none"> • Case study • Focus groups; interviews; observations • Qualitative | <ul style="list-style-type: none"> • Ottawa, Canada • 1 deprived urban area; 1 deprived suburban area; 1 non-deprived urban area; 1 deprived suburban area • 75 elderly (65+ years old); 19 neighbourhood key informants | How do urban form and area SES affect walking among older adults? |
| 39 | Griffin et al., 2008 | <ul style="list-style-type: none"> • Case study • Focus groups • Qualitative | <ul style="list-style-type: none"> • South Carolina, USA • 1 deprived suburban area; 1 non-deprived suburban area • 27 African American adults (age unknown) | How does safety and other environmental factors influence physical activity among African American residents of low-income, high-crime areas? |
| 40 | Kamphuis et al., 2007 | <ul style="list-style-type: none"> • Case study • Focus groups • Qualitative | <ul style="list-style-type: none"> • Eindhoven, the Netherlands • 1 group of high educated individuals in non-deprived areas; 1 group of low educated individuals in deprived areas • 38 adults (29-81 years old) | How do perceptions of the neighbourhood environment influence physical activity and fruit and vegetable consumption across socio-economic groups? |
| 41 | Parry et al., 2007 | <ul style="list-style-type: none"> • Case study • Focus groups | <ul style="list-style-type: none"> • Birmingham and the Black Country, England | How do residents of disadvantaged communities |

| | | | | |
|----|----------------------|--|--|--|
| | | <ul style="list-style-type: none"> • Qualitative | <ul style="list-style-type: none"> • 3 highly deprived areas targeted by the area-based initiative New Deal for Communities • Young adults (16-20 years old); older adults (60+ years old). Numbers unknown. | believe where they live influences their health? |
| 42 | Trayers et al., 2006 | <ul style="list-style-type: none"> • Case study/evaluation • Focus groups before the intervention • Qualitative | <ul style="list-style-type: none"> • Bristol, England • 1 deprived area • 10 local residents; 9 primary school pupils (9-10 years old); 10 college students and tutors; 3 local planners | What health and physical activity benefits do diverse groups of stakeholders perceive from the proposed home zone remodeling and new cycle-walkway? |
| 43 | Wilson et al., 2013 | <ul style="list-style-type: none"> • Case study • Focus groups • Qualitative | <ul style="list-style-type: none"> • South Carolina, USA • 2 low income and high crime areas • 52 African American adults (18-65 years old) | How do African American adults perceive that neighbourhood walking can be promoted using the 5 social marketing principles of product, price, place, promotion, and positioning? |
| 44 | Yen et al., 2007 | <ul style="list-style-type: none"> • Case study • Focus groups • Qualitative | <ul style="list-style-type: none"> • Salinas, USA • 1 highly deprived area; 1 medium deprived area; 1 non-deprived area • 52 women with at least one child under 18 living at home (age unknown). Most Latinos. | How do women perceive their neighbourhood to promote or hinder diet, physical activity, and smoking? |

2. Less fear and stress

All thirteen studies indicated that adults in deprived areas refrained from walking because their neighbourhood environment induced fear [32-44]. Various neighbourhood problems were mentioned to make adults fearful, scared, afraid, unsafe, intimidated, concerned, and uncomfortable, hence causing them to refrain from walking altogether or from walking in specific places like local parks:

First, nine studies mentioned that *crime and antisocial behaviour* created fear [32-34,36,37,39-41,44]. Problems that were cited included burglary, vandalism, assault, drug dealing, drunk people, unfriendly neighbours, and youth gangs. Youth gangs were most often mentioned to be problematic. Interestingly, while some adults requested more police presence to deal with some of these problems and hence feel safer, others mentioned how high police presence acted as an indicator of high levels of crime and antisocial behavior and hence created fear [32].

Second, seven studies indicated that *lack of lighting* created fear [33-35,37,39,41,43,44]. Adults mentioned how they did not walk at night, because that is when youth gangs and other unreliable people were perceived to be most active

[33,37,40,44]. Adults also mentioned that poorly lit areas caused them to be fearful [34,37,39,41,43]. However, two studies indicated that increased lighting may not be the solution to fear. In one study, a woman mentioned to be fearful even in lighted areas [43]. Moreover, an evaluation study revealed that despite the installment of adequate lighting, adults still avoided walking on the renewed cycle-walkway [35].

Third, four studies described how *dense areas of trees and isolation* caused fear [35,37,42,43]. These features were suggested to cause fear because they impaired visibility. First, visibility was impaired because subjects weren't able to see potential offenders. An evaluation study of a renewed cycle-walkway indicated that, despite the installment of lighting, adults still avoided walking on it because they remained fearful as a result of overgrowing trees on the trail which provided potential hiding places for offenders [35]. This issue was also mentioned by adults in another study when asked why they avoided walking in the nearby park [37]. Second, visibility was impaired because other residents weren't able to see the subjects. Adults remained fearful on the renewed cycle-walkway not only because of overgrown trees, but also because of its isolated location [35,42]. Most relished the prospect that more users would give the route a busier and safer feel [35]. In another study, adults mentioned the desire for an open view of surroundings, so they could keep an eye on their children and other people could keep an eye on them [43].

Fourth, four studies indicated that *traffic* imposed fear [32,33,36,38]. High traffic volume of motorized vehicles was mentioned to induce fear [32,33,36,38]. Older adults suggested that having a sidewalk may relieve some of this fear [38]. However, they also mentioned that the presence of cyclists and skateboarders on these sidewalks and on trails induced fear [38]. In one study, adults mentioned that high traffic volume may actually reduce stress because it increases visibility and thereby reduces the chance that people will commit crime or behave in an antisocial manner [33].

Fifth, four studies mentioned that the presence of *stray dogs* caused fear [32,33,39,43]. Sixth, two studies mentioned that *uneven surfaces* created a fear of getting hurt [36,43].

Certain personal and interpersonal factors were mentioned to affect the amount of fear created by the abovementioned neighbourhood problems. First, two studies mentioned that *women* were more fearful of crime, antisocial behaviour, and dogs than were men [39,43]. Second, one study mentioned that adults *with children* were especially fearful of traffic [33]. Finally, two studies indicated that *walking with others* may relieve some of the fear associated with neighbourhood problems. In the one study, a woman mentioned that safety had become a really big issue for walking, especially when walking alone [43]. The other study mentioned that only a small

number of individuals used the renewed cycle-walkway, particularly with company [35].

3. More relaxation and stress release

Eight studies indicated that adults in deprived areas refrained from walking because the poor aesthetics of existing settings for LTW did not enable relaxation and enjoyment [32-36,39,40,43]. Two neighbourhood features were mentioned to enable relaxation and enjoyment. First, four studies mentioned that adults liked to walk in *nature*, because the scenery, trees, animals, and fresh air offered them relaxation and stress release, attracted their attention, offered them the chance to experience the country side, and made walking fun and enjoyable [33,34,40,43]. Second, one study mentioned that adults were motivated to walk for pleasure in areas with nice *architecture* because they were experienced to be interesting [36].

Unfortunately, various neighbourhood factors were mentioned to compromise the relaxation and enjoyment offered by architecture and nature, thereby constraining its positive influence on walking. First, six studies mentioned that current settings for walking were *neglected* and filled with litter, graffiti, glass, dog excrement, and rubbish [32-36,39]. This kept adults from walking by creating an unattractive, unclean, unappealing environment for walking. An evaluation study revealed that it compromised greater usage of a renewed cycle-walkway [35]. Second, two studies indicated that local open green spaces did not attract people's attention because they were *dull to look at* and hence did not stimulate walking [36,40]. Third, the evaluation study of a new walking route revealed that because of its *location* near the road and estates, it did not meet the need for fresh air and experience of the countryside [33].

4. More social support

Six studies indicated that adults' decision to walk in deprived areas was influenced by the amount of social support – especially emotional support – offered by the social neighbourhood environment [32-34,36,39,43]. Adults mentioned that they often walked with friends, family, or neighbours [33,34,43]. Having someone to walk with appeared to provide various types of emotional support, including motivation, stimulation, and enjoyment [32-34,36,39,43]. In only two studies adults mentioned that not having anyone to walk with was a barrier to walking [32,43]. Two other studies mentioned that some adults preferred to walk alone, because they did not want to be slowed down or depend on others [34,43]. Certain personal factors were mentioned to affect the importance of social support for LTW. *Women* tended to value social support more than did men [33,34,39,43].

As opposed to our theory, instrumental support did not appear to be important for walking, as walking was associated with less cost than other types of PA like sports [34].

We identified two additional mechanisms that were not covered by our initial programme theory.

5. More convenience

Seven studies indicated that adults in deprived areas refrained from walking because the poor infrastructure surrounding existing LTW facilities made it inconvenient to reach and use them [32,35,36,38,39,42,43]. Studies mentioned how specific problems made walking settings inconvenient to use. First, existing settings were located *too far away* from home [32,38,39,43]. This was mentioned to be inconvenient, especially among older adults, who were unable to drive or walk up there [32]. Second, existing settings *lacked connectivity* [35,42]. Evaluation studies of a renewed cycle-walkway indicated that adults did not use the setting for walking because it represented a place to nowhere, even though beforehand it was expected to provide easier routes to walking settings located further away [35,42]. Third, existing settings *lacked benches* [36,38]. Studies mentioned that older adults needed frequent places to sit and rest along the route to be able to walk longer distances [36,38]. Some benches were available, but they were often vandalized [36].

6. More social interaction

Two studies indicated that adults' decision to walk in deprived areas was influenced by the amount of opportunities for social interaction while walking offered by the social neighbourhood environment [36,43]. Adults mentioned that the potential for impromptu social interaction when outside was highly valued [36]. The possibility of running into familiar people was mentioned to make walking fun [43].

Refined programme theory

Using the evidence derived from the 13 studies, we refined our initial programme theory (Figure 2). The refined programme theory posits that there are three main pathways by which ABIs might stimulate LTW among adults in the context of area deprivation (these are displayed in bold). First, by reducing safety problems and improving the physical neighbourhood design, ABIs may reduce the amount of fear to use existing walking facilities. Second, by improving the infrastructure surrounding existing walking facilities, ABIs may make them more convenient to be use. Third, by improving neighbourhood aesthetics, ABIs may make existing walking facilities more relaxing and stress releasing. The refined programme theory posits three additional

pathways by which ABIs may stimulate LTW among adults in the context of area deprivation, but these are less well supported by the evidence. First, by increasing the amount of LTW facilities, ABIs may increase the amount of settings for LTW. Second, by improving social capital, ABIs may increase the amount of social support for LTW. Third, by improving social capital, ABIs may increase opportunities for social interaction while doing LTW. There was some evidence to suggest that a reduction in fear following an ABI might have more impact on the LTW behaviour of women, families, and lone walkers, but evidence was limited and restricted to the pathway of fear.

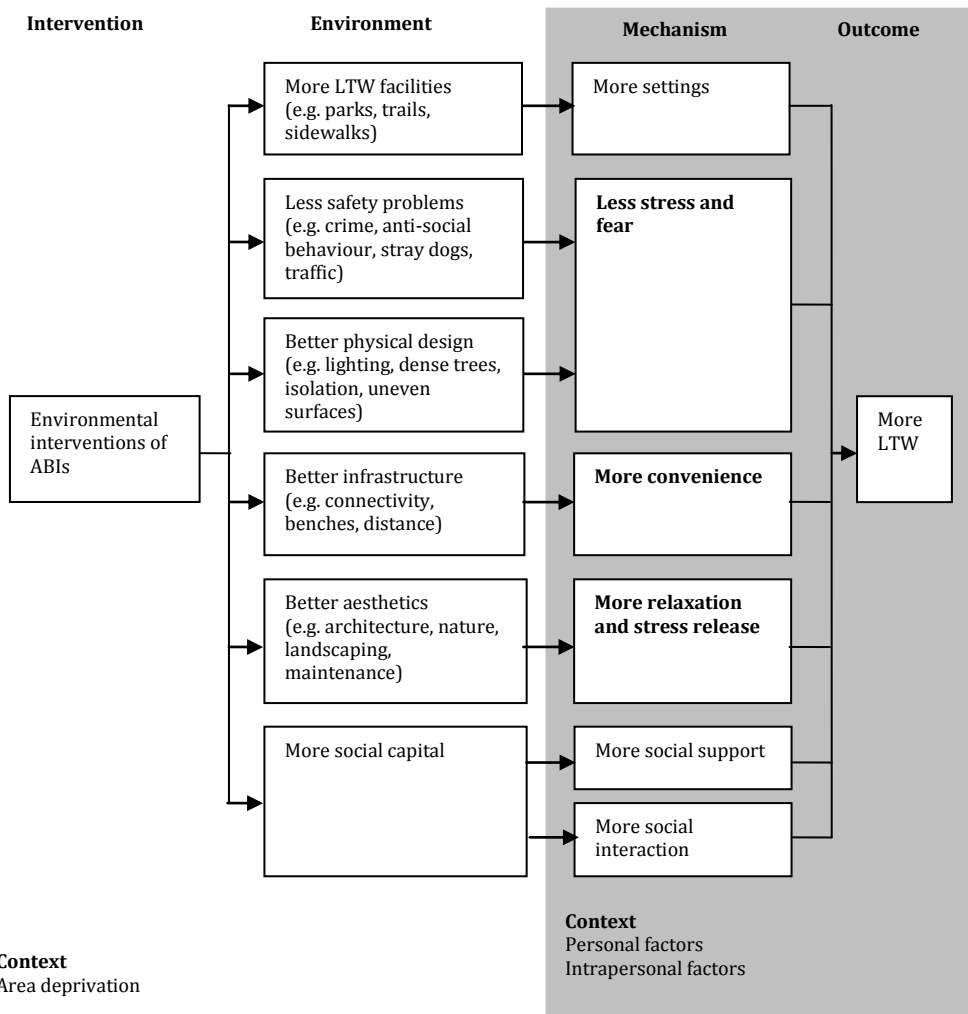


FIGURE 2. refined programme theory

DISCUSSION

This study aimed to explore the pathways by which ABIs might stimulate LTW among adults in deprived areas. A realist review of 13 peer-reviewed articles revealed three main pathways. First, all studies indicated that less safety problems and better physical neighbourhood design might reduce levels of stress and fear in existing LTW facilities. Second, half of the studies indicated that better neighbourhood aesthetics might improve opportunities for relaxation and stress release in existing LTW settings. Third, half of the studies indicated that better infrastructure of existing LTW facilities might increase the convenience with which they can be reached and used. Three additional, less well supported pathways were identified. First, some studies indicated that more LTW facilities might create more settings for LTW. Second, a few studies indicated that more social capital might provide more social support for LTW. Third, some studies indicated that more social capital might provide more opportunities for social interaction while walking.

Limitations

Several considerations need to be taken into account when interpreting the results of this realist review. Evidence to test and refine our initial programme theory was not gathered in a systematic way. Rather, we aimed to seek out a representative body of literature on which to test and refine our initial programme theory. The realist approach acknowledges that it cannot identify all potentially relevant evidence [26]. However, we may have missed out on some relevant evidence.

Only few studies included in this review evaluated how environmental interventions changed the neighbourhood environment and hence influenced LTW. The majority of studies explored how the neighbourhood environment had an impact on LTW. While this type of study provides valuable information on how environmental changes might affect LTW, people may respond differently to actual neighbourhood change. More evaluation studies of how interventions in deprived areas influence LTW are needed.

The realist approach aims to uncover how, for whom, and in what conditions programmes work or don't work. We were able to shed much light onto how ABIs may stimulate LTW. However, we gained only limited insight into for whom and in what conditions ABIs may stimulate LTW, besides the fact that our findings were restricted to adults and deprived areas. We found some evidence to suggest that interventions that aim to reduce fear may have more of an impact on women, families, and lone walkers, but evidence was limited and restricted to the pathway of fear. Moreover, we gained no insight into the potentially moderating role of higher-level contextual factors. The studies included in our review originated from a wide range of countries. Country-level factors such as culture and geographical characteristics may likely affect

how ABIs influence LTW, but these were not explicitly mentioned. While some pathways seemed to be universal, such as the role of fear, others were only mentioned in studies from certain countries. Therefore, it is difficult to determine the generalisability of our refined programme theory across countries.

Implications for theory

The results of this study have some implications for existing theories on how the neighbourhood environment may influence PA among adults. One of the most important implications is that existing theories are too fragmented and too focused on one single neighbourhood aspect to be able to fully explain the complexity of environmental influences on PA in general and LTW in specific. All studies included in our review highlighted a wide range of neighbourhood problems that simultaneously influenced LTW. Moreover, results of the three evaluation studies indicated that improving just one or two aspects of the neighbourhood environment was not sufficient to improve LTW as many other unresolved environmental problems kept hindering LTW.

When looking at individual theories, results of this study provide only limited support for Barker's behavior setting theory [45]. This theory posits that the neighbourhood environment may stimulate PA by providing settings for PA. However, only a limited number of studies mentioned the unavailability of LTW facilities in deprived areas as a barrier for walking.

Our results provide strong evidence for Evan and Cohen's environmental stress theory [46], which posits that a reduction in crime, traffic, and other safety problems may reduce levels of stress and fear, and hence stimulate LTW. All studies included in our review revealed that safety problems indeed kept people from walking in existing LTW facilities in deprived areas because of fear. Results of our review add to Evan and Cohen's environmental stress theory by indicating that fear may not only be caused by safety problems, but also of poor physical neighbourhood design. This is consistent with Newman's theory of defensible spaces [47] which posits that the physical layout of neighbourhoods may influence natural surveillance options, hence influencing how much residents feel in control of the areas around their homes, and consequently how fearful they are.

We found quite some support for Kaplan's restorative environments theory [48], which posits that nature may encourage individuals to participate in PA by offering fascination and a sense of being away, thereby offering relaxation and stress release. Half of the studies included in our review revealed that poor neighbourhood aesthetics indeed kept people from walking in deprived areas because of limited options for relaxation and stress release. Our study adds to Kaplan's restorative

environments theory by indicating that nature will only offer relaxation and stress release if well maintained and properly landscaped. Moreover, there was some evidence to suggest that relaxation may not only be enabled by nature but also by interesting architecture.

There was mixed support for Kawachi and Berkman's ideas about the role of social capital in PA [49]. They posit that higher levels of social capital may stimulate LTW by creating more social support for LTW and helping reinforce positive social norms for LTW. Half of the studies included in our review revealed that high levels of social capital may indeed promote walking in deprived areas by creating more social support. However, levels of social support were generally high in deprived areas, thereby questioning the ability of ABIs to stimulate LTW via this pathway. Only two studies indicated that adults in deprived areas refrained from walking because of low social support. Moreover, social support was not only provided by neighbours but also by family and friends, which are not targeted by ABIs when living in other areas. None of the studies included in our review mentioned anything about social norms for LTW. Our study adds to Kawachi and Berkman's ideas by indicating that higher levels of social capital may also stimulate LTW by offering more opportunities for social interaction while walking. However, only a limited number of studies highlighted this pathway.

CONCLUSIONS

Results of this realist review indicate that ABIs may stimulate LTW among adults in deprived areas, not so much by creating more settings for LTW or by enhancing social stimuli to walk, but more so by making existing LTW facilities less frightening, more convenient, and more relaxing. To improve the quality of existing LTW facilities, policy makers and practitioners are advised to pay attention to safety problems, the physical neighbourhood design, the neighbourhood infrastructure, and neighbourhood aesthetics.

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REFERENCES

1. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet* 2012;380:247-257.
2. Giles-Corti B, Donovan RJ. Socioeconomic differences in recreational physical activity levels and real and perceived access to a supportive physical environment. *Prev Med* 2002;35:601-11.
3. van Lenthe FJ, Brug J, Mackenbach JP. Neighbourhood inequalities in physical inactivity: the role of neighbourhood attractiveness, proximity to local facilities and safety in the Netherlands. *Soc Sci Med* 2005;60:763-75.
4. Kamphuis CBM, Giskes K, Kavanagh AM, Thornton LE, Thomas LR, van Lenthe FJ, et al. Area variation in recreational cycling in Melbourne: a compositional or contextual effect? *J Epidemiol Community Health* 2008;62:890-898.
5. Sallis JF, Bauman A, Pratt M. Environmental and policy interventions to promote physical activity. *Am J Prev Med* 1998;15:379-397.
6. Spence JC, Lee RE. Toward a comprehensive model of physical activity. *Psychol Sport Exerc* 2003;4:7-24.
7. Sallis JF, Certero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. *Annu Rev Public Health* 2006;27:297-322.
8. Sallis JF, Owen N, Fisher EB. Ecological models of health behaviour. In: Glanz K, Rimer BK, Viswanath K (eds). *Health behavior and health education*. San Fransisco: Jossey-Bass, 2008.
9. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking. Review and research agenda. *Am J Prev Med* 2004;27:67-76.
10. Duncan MJ, Spence JC, Mummery WK. Perceived environment and physical activity: a meta-analysis of selected environmental characteristics. *Int J Behav Nutr Phys Act* 2005;2:11.
11. Wendel-Vos W, Droomers M, Kremers S, Brug J, van Lenthe F. Potential environmental determinants of physical activity in adults: a systematic review. *Obes Rev* 2007;8:425-40.
12. Saelens BE, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc* 2008;40:550-566.
13. Sugiyama T, Neuhaus M, Cole R, Giles-Corti B, Owen N. Destination and route attributes associated with adults' walking: a review. *Med Sci Sports Exerc* 2012;44:1275-1286.
14. Chandola T. The fear of crime and area differences in health. *Health & Place* 2001;7:105-116.
15. Wilson DK, Kirtland KA, Ainsworth BE, Addy CL. Socioeconomic status and perceptions of access and safety for physical activity. *Ann Behav Med* 2004;28:20-8.
16. Baum FE, Ziersch AM, Zhang G, Osborne K. Do perceived neighbourhood cohesion and safety contribute to neighbourhood differences in health? *Health Place* 2009, 15:925-934.
17. Atkinson, R. European urban policies and the neighbourhood: an overview. *Urban Des Plann* 2008;161:115-122.
18. Batty E, Beatty C, Foden M, Lawless P, Pearson S, Wilson I. *The New Deal for Communities Experience: a final assessment. Communities and local governments*. West Yorkshire: Department of Communities and Local Government, 2010.
19. Lawless P, Foden M, Wilson I, Beatty C. Understanding area-based regeneration: the New Deal for Communities Programme in England. *Urban Stud* 2010;47:257-275.

20. Kramer D, Droomers M, Jongeneel-Grimen B, Wingen M, Stronks K, Kunst AE. The impact of area-based initiatives on physical activity trends in deprived areas; a quasi-experimental evaluation of the Dutch District Approach. *I J Behav Nutr Phys Act* 2014;11:36.
21. Ho SY. Evaluating urban regeneration programmes in Britain: exploring the potential of the realist approach. *Evaluation* 1999;5:422-438.
22. Judd B, Randolph B. Qualitative methods and the evaluation of community renewal programs in Australia: towards a national framework. *Urban Pol Res* 2006;24:97-114.
23. McGormack GR, Shiell A. In search of causality: a systematic review of the relationship between the built environment and physical activity among adults. *I J Behav Nutr Phys Act* 2011;8.
24. Kamphuis C, van Lenthe F. Socioeconomic differences in physical activity: the role of neighbourhood factors. In: Stock C, Ellaway A (eds). *Neighbourhood structure and health promotion*. New York: Springer science+business media, 2013.
25. Pawson R, Tilley N. *Realistic evaluation*. London: SAGE Publications Ltd, 1997.
26. Pawson R, Greenhalgh T, Harvey G, Walshe K. Realist review – a new method of systematic review designed for complex policy interventions. *J Health Serv Res Policy* 2005;10:21-34.
27. Ritchie J, Spencer L. Qualitative data analysis for applied policy research. In Bryman A, Burgess RG (eds.), *Analyzing qualitative data*. Oxon: Routledge, 1994.
28. Kremers SPJ, de Bruijn GJ, Visscher TLS, van Mechelen W, de Vries N, et al. Environmental influences on energy balance-related behaviors: a dual-process view. *I J Behav Nutr Phys Act* 2006;3:9.
29. Ogilvie D, Bull F, Powell J, Cooper AR, Brand C, Mutrie N, et al. An applied ecological framework for evaluating infrastructure to promote walking and cycling: the iConnect study. *Am J Public Health* 2011;101:473-481.
30. King AC, Stokols D, Talen E, Brassington GS, Killingsworth R. Theoretical approaches to the promotion of physical activity. *Am J Prev Med* 2002;23:15-25.
31. McNeill LH, Kreuter MW, Subramanian SV. Social environment and physical activity: a review of concepts and evidence. *Soc Sci Med* 2007;63:1011-1022.
32. Annear MJ, Cushman G, Gidlow B. Leisure time physical activity differences among older adults from diverse socioeconomic neighborhoods. *Health Place* 2009;15:482-490.
33. Burgoyne L, Coleman R, Perry IJ. Walking in a city neighbourhood, paving the way. *J Public Health* 2007;29:222-229.
34. Burgoyne LN, Woods C, Coleman R, Perry IJ. Neighbourhood perceptions of physical activity: a qualitative study. *BMC Public Health* 2008;8:101.
35. Coulson JC, Fox KR, Lalow DA, Trayers T. Residents' diverse perspectives on the impact of neighbourhood renewal on quality of life and physical activity engagement: improvements but unresolved issues. *Health Place* 2011;17:300-310.
36. Day R. Local environments and older people's health: dimensions from a comparative qualitative study in Scotland. *Health Place* 2008; 14:299-312.
37. Gidlow CJ, Ellis NJ. Neighbourhood green space in deprived urban communities: issues and barriers to use. *Local Environ* 2011;16:989-1002.
38. Grant TL, Edwards N, Sveistrup H, Andrew C, Egan M. Inequitable walking conditions among older people: examining the interrelationship of neighbourhood socio-economic status and urban form using a comparative case study. *BMC Public Health* 2010;10:677.

39. Griffin SF, Wilson DK, Wilcox S, Buck J, Ainsworth B. Physical activity influences in a disadvantaged African American community and the communities' proposed solutions. *Health Promot Pract* 2008;9:180-190.
40. Kamphuis CBM, van Lente FJ, Giskes K, Brug J, Mackenbach JP. Perceived environmental determinants of physical activity and fruit and vegetable consumption among high and low socioeconomic groups in the Netherlands. *Health Place* 2007;13:493-503.
41. Parry J, Mathers J, Laburn-Peart C, Orford J, Dalton S. Improving health in deprived communities: what can residents teach us? *Crit Public Health* 2007;17:123-136.
42. Trayers T, Deem R, Fox KR, Riddoch CJ, Ness AR, et al. Improving health through neighbourhood environmental change: are we speaking the same language? A qualitative study of views of different stakeholders. *J Public Health* 2006;28:49-55.
43. Wilson DK, St George SM, Trumpeter NN, Coulon SM, Griffin SF, et al. Qualitative developmental research among low income African American adults to inform a social marketing campaign for walking. *I J Behav Nutr Phys Act* 2013;10:33.
44. Yen IH, Scherzer T, Cubbin C, Gonzalez A, Winkleby MA. Women's perceptions of neighbourhood resources and hazards related to diet, physical activity, and smoking: focus group results from economically distinct neighborhoods in a mid-sized U.S. city. *Am J Health Promot* 2007;22:98-106.
45. Barker RG. *Ecological psychology*. Stanford: Stanford University Press, 1968.
46. Evans GW, Cohen S. Environmental stress. In: Stokols D, Altman I (eds). *Handbook of environmental psychology*. New York: John Wiley & Sons, 1987.
47. Newman O. *Defensible space*. New York: MacMillan, 1972.
48. Kaplan S. The restorative benefits of nature: toward an integrative framework. *J Environ Psychol* 1995;15:169-182.
49. Kawachi I, Berkman L. Social cohesion, social capital, and health. In: Berkman LF, Kawachi I (eds). *Social epidemiology*. New York: Oxford University Press, 2000.

CHAPTER 9

General discussion

GENERAL DISCUSSION

The overall aim of this thesis was to assess the interplay of leisure-time physical activity (LTPA), neighbourhood safety, and area-based initiatives (ABIs) in deprived areas. More specifically, this thesis aimed to assess associations of neighbourhood safety with LTPA among Dutch adults, and the impact of ABIs like the Dutch District Approach on neighbourhood safety and LTPA among Dutch adults in deprived areas. This chapter provides a discussion of the key findings of this thesis. First, main findings are summarized. Then, the main findings are discussed in light of several methodological considerations and prior research. Finally, implications of this thesis for practice and research are presented.

MAIN FINDINGS

The following sections discuss the main findings for each of the three research questions that were posed in the introduction of this thesis (chapter 1).

To what extent are general neighbourhood safety and specific safety problems associated with leisure-time walking, cycling, and sports in Dutch adults?

In **chapter 2** we explored associations of self-reported general safety, physical order, social order, crime safety, and traffic safety with leisure-time walking and cycling. We also explored effect-modification by age, gender, and educational level. None of the safety indicators were associated with leisure-time walking in the general adult population. However, general safety was negatively associated with leisure-time walking among younger men, older men, and lower educated adults. All neighbourhood safety indicators were found to be positively associated with leisure-time cycling. Associations were strongest for general safety and among older women. In **chapter 3** we explored associations of self-reported social neighbourhood safety (a composite measure of social order and crime safety) with leisure-time sports at various locations. Sports at indoor sports clubs were found to be far more popular than sports at outdoor sports clubs or on streets. Social safety was positively associated with sports at indoor sports clubs, but not with sports at outdoor sports clubs or sports on streets. In **chapter 4** we explored associations of self-reported neighbourhood safety at one point in time as well as *changes* in self-reported neighbourhood safety over time with leisure-time walking, cycling, and sports. Leisure-time walking was found to be negatively associated with levels of social order and non-victimization, but not with levels of general safety and physical order. Similar results were obtained when looking at changes in neighbourhood safety over time. Leisure-time cycling was positively associated with levels of all neighbourhood safety

indicators and with changes therein over time, though these latter associations were weaker. Leisure-time sports was positively associated with levels of all neighbourhood safety indicators, but only with changes in social order and non-victimization over time. Thus, leisure-time cycling and sports were less strongly related with changes in neighbourhood safety than with levels of neighbourhood safety.

To what extent and how is the Dutch District Approach associated with changes in general neighbourhood safety and specific safety problems as reported by adult residents of deprived target districts?

Chapter 5 presented the results of a quasi-experimental study in which we explored *to what extent* the District Approach was associated with changes in trends of neighbourhood safety in the forty deprived target districts. The implementation of the District Approach was found to be associated with a somewhat more positive change in non-victimization trend in deprived target districts than in the rest of the Netherlands or in other deprived areas. This between-district difference in trend change of non-victimization was only significant in women, older adults, and lower educated adults. There were no between-district differences in trend changes of general safety, physical order, and social order. **Chapter 6** described the results of a realist evaluation in which we explored *how* safety perceptions changed as a result of a neighbour nuisance intervention that was implemented in four deprived districts in Arnhem. The implementation of the intervention was found to be associated with change at three different levels. At the organizational level, the coordinated partnership strategy enabled role alignment, communication, and leadership, which resulted in a more efficient approach of nuisance households. At the level of nuisance households, the joint assistance and enforcement strategy enabled the removal of the various underlying reasons for nuisance, which resulted in less neighbor nuisance. At the district level, perceptions of social control improved, which resulted in better perceived neighbourhood safety, but only in one district. Key district level conditions included a wider safety approach, central location, and dense population.

To what extent and how is the Dutch District Approach associated with changes in leisure-time walking, cycling, and sports among adult residents of deprived target districts?

Chapter 7 presented the results of a quasi-experimental study in which we explored *to what extent* the District Approach was associated with changes in LTPA in the deprived target districts. The implementation of the District Approach was found to be associated with a more positive change in leisure-time walking trend in deprived target districts than in the rest of the Netherlands or other deprived districts. There were no significant between-district differences in trend changes of leisure-time

cycling and sports. Trend changes were not related to the intensity of environmental interventions for any of the LTPA outcomes. **Chapter 8** described the results of a realist review in which we explored *how* ABIs like the District Approach might be able to promote leisure-time walking in deprived areas. A synthesis of 13 peer-reviewed articles revealed that ABIs may stimulate leisure-time walking in deprived areas in three main ways: less safety problems and better physical neighbourhood design may reduce the fear to use existing leisure-time walking facilities, better infrastructure may increase the convenience of existing leisure-time walking facilities, and better neighbourhood aesthetics may make leisure-time walking facilities more relaxing and stress releasing. Three additional, less well supported pathways were identified: more leisure-time walking facilities may create more settings for leisure-time walking, more social capital may improve social support for leisure-time walking, and more social capital may improve opportunities for social interaction while walking.

METHODOLOGICAL CONSIDERATIONS

Results of this thesis should be interpreted in light of several methodological considerations. The following sections discuss several issues regarding the various study designs that were used throughout this thesis, the measurement of LTPA, the measurement of neighbourhood safety, and the generalisability of our results.

Study design

Various study designs have been used throughout this thesis. Major advantages and disadvantages of each of the designs are discussed in the following sections.

Cross-sectional study design

We started out with a series of traditional cross-sectional studies, in which we explored to what extent neighbourhood safety at one point in time was associated with LTPA at that same point in time (chapters 2 and 3). This type of study enables researchers to obtain data from a large amount of individuals with relatively little cost and effort. Therefore, they are useful to answer more specific research questions. For example, in this thesis we used it to gain more insight into associations of specific neighbourhood safety indicators with specific physical activity (PA) behaviours among specific population groups. Various studies have expressed the need for such specificity [1-4]. However, a major drawback of traditional cross-sectional studies is that they are unable to establish the causality of the relations between neighbourhood safety and LTPA. Relations may be biased by issues such as residential self-selection, which entails that adults who are active or who like to be active move into neighbourhoods that are most suitable for LTPA [5-9]. Cross-sectional studies that do

not take this bias into account may possibly overestimate associations of neighbourhood safety with PA [6,8,10].

To gain more insight into the role of residential self-selection in safety-LTPA, we explored to what extent neighbourhood safety at one point in time as well as *changes* in neighbourhood safety over time were associated with LTPA afterwards (chapter 4). A major advantage of looking at changes in neighbourhood safety over time is that it minimizes the impact of confounders that are assumed to remain stable over time, such as residential preferences. By comparing results of this more sophisticated analysis with those of the more traditional cross-sectional one, we were able to shed more light on the role of residential self-selection. However, some issues remain. First, we were unable to take possible neighbourhood-level confounders into account. The mechanisms underlying changes in neighbourhood safety are complex. We may have overestimated the causality of the safety-LTPA relation if changes in neighbourhood safety were caused by neighbourhood changes that were also related to LTPA. Second, we were only able to relate changes in neighbourhood safety to levels of LTPA afterwards, rather than to *changes* in LTPA. Again, we may have overestimated the causality of the safety-LTPA relation if changes in neighbourhood safety occurred in neighbourhoods where LTPA levels were already higher at baseline.

Quasi-experimental study design

To deal with some of the biases associated with cross-sectional studies, we performed a series of quasi-experimental studies, in which we explored to what extent the Dutch ABI District Approach was associated with *changes* in neighbourhood safety over time (chapter 5) and with *changes* in LTPA over time (chapter 7) in deprived target districts. These studies may help draw more robust conclusions about the causality of relations between the neighbourhood environment and LTPA. Moreover, it provides insight into whether area-based policies are able to change peoples' behaviour and their neighbourhood perceptions. However, this type of study also has some limitations. Due to the use of repeated cross-sectional data, changes in outcomes may have been the result of selective migration rather than of the initiative itself. Residents of deprived target districts may have acquired new skills that allow access to better jobs, causing them to move out. Alternatively, improved conditions in the target districts may have attracted residents from more affluent areas. This may have biased our results if self-reported neighbourhood safety and LTPA differed between in-movers, out-movers, and stayers. However, there were no indications of such bias. Adjustment for socio-economic factors did not substantially alter our results. Moreover, the District Approach was not associated with an increase in the number of people moving up the socio-economic ladder and the amount of those moving out of the target districts [11]. Finally, evaluation studies of other ABIs found no relation between residential mobility and change in safety concerns or PA [12,13].

Another limitation inherent to quasi-experimental studies is that the intervention and control group may be dissimilar at baseline in ways related to the study outcome, because of a lack of randomization [14,15]. However, by looking at changes in outcome over time, fixed differences between groups are taken into account. Moreover, we tried to increase comparability between groups by including control groups that were similarly deprived and geographically located as the deprived target districts. A limitation of the use of such control groups is that they may not have been intervention-free or may have experienced spill-over effects of the District Approach. This may have caused us to underestimate the impact of the District Approach. Therefore, we also included a national control group.

Realist approach

To gain more insight into the process by which ABIs have an impact on neighbourhood safety and on LTPA, we performed a series of realist studies in which we explored how, for whom, and in what conditions the District Approach had an impact on self-reported neighbourhood safety (chapter 6) and leisure-time walking (chapter 8). This type of study enables researchers to better understand the results of quantitative quasi-experimental studies by showing how ABIs are able to produce change and in what conditions they are and are not able to produce such change. Moreover, it may help policy makers develop more effective ABIs in the future. Though this type of study is very useful to understand the inner workings of complex programmes like ABIs, they are very time-consuming. Moreover, while it helped us to gain more insight into the pathways by which the District Approach had an impact on neighbourhood safety and leisure-time walking, we had difficulties identifying information on the conditions that determined programme success and failure.

Measurement of LTPA

In all studies displayed in this thesis, we used self-reported measures of LTPA. Surveys typically ask respondents to list the amount and type of PA they engaged in during the past month or in a regular week. A major advantage of surveys is that they are less costly and intrusive than more objective measurement devices such as pedometers or accelerometers, making them more suitable for large population studies like ours [16,17]. Moreover, they are able to provide information about the type (e.g. walking, gardening, jogging) and purpose (i.e. leisure, transport) of the activity [16,17]. While the purpose of PA is irrelevant for its impact on health, it is important when exploring environmental correlates, as environmental correlates of LTPA have been found to differ from those of PA for transport reasons [2,9,18-20]. A major drawback of survey data is the chance of information bias [21,22]. Respondents may have difficulties remembering what types of PA they have participated in, and for how long. Moreover, they may be inclined to give socially desirable answers. These

biases may explain why self-reported PA levels are generally higher than those objectively observed by accelerometers and pedometers [17]. However, information bias would have only substantially affected our results if the bias differed systematically between safe and unsafe neighbourhoods or if it differed systematically over time, which we do not perceive to be very likely.

A limitation specific to the survey that we used to measure LTPA is that it does not provide information about the location where people have been active. Adults may have been active within their own neighbourhood, or for example in the area around their workplace or a friend's home. Research has repeatedly expressed the need to use location-specific LTPA measures, as the neighbourhood environment is most likely to affect LTPA that is performed within the neighbourhood [1,3,4,19]. By including LTPA that is performed within the neighbourhood of residence as well as that performed in other neighbourhoods, we may have failed to identify some of the effects of neighbourhood safety and the District Approach on LTPA.

Measurement of neighbourhood safety

The vast majority of neighbourhood safety indicators that we used in this thesis represented adults' perceptions of safety. Perceptions and objective measures of neighbourhood safety and other neighbourhood features have been found to be poorly correlated [23-27]. While objective indicators may more accurately represent the true neighbourhood safety situation, we chose to focus on perceptions of neighbourhood safety as there is evidence to suggest that they are more strongly associated with PA [27]. Even if the neighbourhood is safe or has become safer as a result of an ABI, as long as people do not perceive their neighbourhood to be safe, they will remain fearful and keep constraining their PA accordingly. A limitation of the use of safety perceptions is the possibility that those who are active may perceive their environment differently than those who are not active, leading to spurious relations [2,9,28]. To minimize this source of bias, we measured neighbourhood-wide safety perceptions instead of individual-level perceptions, and used different surveys to measure neighbourhood safety and LTPA.

There is much debate about the appropriate neighbourhood size when assessing environmental characteristics [3]. We defined a neighbourhood as the area within one postal zip code. Within the Netherlands, a postal zip code is on average 8.4 km² large and has a mean population of 4 155 residents [29,30]. When cycling or working out at the gym, adults may very well exceed neighbourhood boundaries. Hence, characteristics of the final destination and neighbourhoods along the route may also be relevant for these type of activities. We were unable to take these influences into account in our studies, causing us to potentially underestimate associations of neighbourhood safety with leisure-time cycling and sports. When walking, adults are

more likely to stay within their neighbourhood of residence, at least if departed from home. As a result, characteristics of the neighbourhood of residence may be most important for walking. However, the area within one postal zip code may even be too large to capture environmental influences on walking, causing us to potentially underestimate associations of neighbourhood safety with leisure-time walking.

While we have extensively controlled our analyses for individual-level confounders, we were unable to control for all potential neighbourhood-level confounders. On the one hand, safe neighbourhoods may have certain other features that stimulate LTPA. For example, studies have found that safer neighbourhoods also tend to have better neighbourhood aesthetics and higher levels of social capital [31,32]. If levels of LTPA are high in these neighbourhoods, it is hard to identify whether this is the result of good neighbourhood safety or of other neighbourhood features. This may result in an overestimation of associations between neighbourhood safety and LTPA. On the other hand, safe neighbourhoods may have certain features that hinder LTPA. For example, studies have found that safer neighbourhoods tend to be less walkable, which means that street connectivity is lower and there are fewer destinations nearby (including sports facilities and parks) [31,33,34]. This may result in an underestimation of the relation between neighbourhood safety and LTPA.

However, we have reason to believe that this residual neighbourhood-level confounding had only limited impact on our findings. First, adjustment for population density had negligible effects on associations of neighbourhood safety with leisure-time walking and cycling, and even slightly strengthened associations with leisure-time sports (chapters 2 and 3). Population density was used as an indicator of various potential environmental influences. Second, adjustment for social capital had an impact on associations of neighbourhood safety with outdoor sports, but had no impact on associations with indoor sports, which made up the major share of total sports participation (chapter 3). Third, other studies have found that associations of various neighbourhood safety indicators with leisure-time walking and cycling did not substantially alter or even strengthened after taking into account other neighbourhood features such as social capital, walkability, PA facilities, and aesthetics [35-39]. The only exception being that associations of crime safety with leisure-time cycling attenuated after taking into account other neighbourhood features [36]. None of the studies explored the role of residual neighbourhood-level confounding in associations of neighbourhood safety with leisure-time sports.

Generalisability

Results of the cross-sectional studies described in chapters 2 to 4 of this thesis are believed to be largely generalisable to the entire Dutch population, as they were based on large, nationwide surveys. While many other studies only obtained data from

adults living in one specific city or area, we obtained data from adults across the Netherlands. However, to obtain reliable measures of neighbourhood-wide safety perceptions and changes therein, neighbourhoods were required to have a minimum amount of valid safety observations. Therefore, very small neighbourhoods may have been excluded from our analyses, which may limit the generalisability of our results. Results of the quasi-experimental studies described in chapters 5 and 7 of this thesis are also thought to be largely generalisable to the entire population of the Netherlands' most deprived areas, as all most deprived areas were included in the analyses.

It is unclear to what extent results of the abovementioned studies are generalisable to other countries. On the one hand, the Netherlands is very conducive of LTPA. It has a mild climate and flat topography. Moreover, it has a high population density, which increases the chance of having facilities such as gyms and parks nearby. Finally, it has a strong cycling infrastructure and cycling culture, in which many adults own a bicycle and know how to ride it. In countries with a hot climate, many hills, low residential density, and weak cycling infrastructure and culture, adults may not be able to participate in LTPA. Hence, neighbourhood safety may be less important. On the other hand, the Netherlands is a relatively safe country. Compared to other countries, relatively few Dutch adults feel unsafe or perceive themselves to be at risk of crime [40]. Self-reported criminal victimization rates are relatively high compared to other countries, but this is mostly due to high levels of bicycle theft [40]. In countries where adults feel less safe and crime is more prevalent, neighbourhood safety may be more important.

The generalisability of the results of our realist studies may be somewhat more complicated (chapters 6 and 8). Our realist evaluation focused on a subset of deprived areas within one particular Dutch city (chapter 6). Due to large variations between areas, generalisability of these results to other deprived areas in the Netherlands may be limited. However, inherent to the realist approach, we outlined the contextual factors at play and made context-dependent conclusions and recommendations. This may enlarge the transferability of results to other settings. Our realist review included studies from several countries across the world (chapter 8). No clear cross-country differences were present in the mechanisms that we identified. This indicates that mechanisms may well be transferable across countries. However, we only included a limited number of studies, and a larger amount of studies are needed to draw more robust inferences about the generalisability of our findings.

INTERPRETATION OF MAIN FINDINGS

The following sections reflect on the main findings of the studies presented in this thesis. First, we discuss whether neighbourhood safety appears to have an impact on LTPA among adults. Then, we discuss whether and how ABIs like the Dutch District Approach appear to be able to influence LTPA among adults in deprived areas.

Does neighbourhood safety have an impact on LTPA among adults?

The answer to this question appears to vary by type of LTPA. This supports earlier calls to use more specific PA measures when assessing environmental correlates [1-4]. The following sections discuss the answer to this question separately for leisure-time walking, and for leisure-time cycling and sports.

Leisure-time walking

For the *general adult population*, there is no evidence to suggest that neighbourhood safety may have an impact on leisure-time walking. We found no associations or in some cases even negative associations of self-reported neighbourhood safety with leisure-time walking among Dutch adults (chapters 2 and 4). These results are in line with the large body of research on this topic. Various reviews indicate that there is limited evidence for an association of neighbourhood safety with leisure-time walking [2,9,19] or with a composite measure of leisure-time walking and cycling [20] among adults.

However, among adults that live in *deprived neighbourhoods*, there is evidence to suggest that neighbourhood safety might have a positive impact on leisure-time walking. Our realist review indicated that poor neighbourhood safety was one of the key issues that kept adults in deprived neighbourhoods from walking in leisure time (chapter 8). These results are generally in line with those of the few quantitative studies that have been performed in deprived neighbourhoods. Self-reported general neighbourhood safety was positively associated with leisure-time walking in deprived neighbourhoods in Australia [33] and Scotland [41,42], and with general neighbourhood walking in deprived neighbourhoods in America [38]. Evidence regarding the role of social disorder is somewhat inconsistent, with some studies finding drunks and burglary to be associated with lower levels of walking [42] and others finding overall social disorder and drug dealing to be associated with higher levels of walking in deprived neighbourhoods [39,42].

There may be two possible explanations for the fact that we found evidence for an impact of neighbourhood safety on leisure-time walking among adults in deprived neighbourhoods, but not among the general adult population. First, we found that

safety problems and concerns were more prevalent in deprived than in non-deprived neighbourhoods (chapter 5). This is consistent with earlier research [23,43-45]. Perhaps, a certain threshold level of unsafety needs to be reached before it influences leisure-time walking. There is a dearth of evidence on whether such a threshold level exists, and if so, how high it is [46]. Second, we found that income levels were substantially lower in deprived compared to non-deprived neighbourhoods (chapter 7). This is consistent with earlier studies [23,45,47,48]. Research has suggested that individuals with a low socio-economic status may have less financial resources to safeguard against crime and to deal with the consequences of crime, thereby being more likely to restrict their walking when feeling unsafe [49]. However, we found no evidence to suggest that associations of neighbourhood safety with leisure-time walking differ by educational level (chapter 2 and 4).

Leisure-time cycling and sports

There is some evidence to suggest that neighbourhood safety may have a positive impact on leisure-time cycling and sports among the general adult population. We found that various self-reported neighbourhood safety indicators were positively associated with leisure-time cycling and sports (chapters 2 to 4). Prior research on this topic is somewhat inconsistent. Regarding leisure-time cycling, a Dutch study found no associations with personal safety indicators, but they did find associations with traffic safety [50]. Studies from Australia and the UK found some evidence of associations with crime safety and social order, but no evidence of associations with traffic safety [36,37]. Regarding leisure-time sports, prior Dutch research also found positive associations with general neighbourhood safety [51,52]. Studies from other countries found no evidence of a safety-sports association [53,54].

Interestingly, we found that associations of neighbourhood safety with leisure-time sports differed according to the sports location (chapter 3). Neighbourhood safety was positively associated with sports at indoor sports clubs, but not associated with sports at outdoor sports clubs or on streets. In line with suggestions made elsewhere [52], this implies that neighbourhood safety may not only be important during the exercise itself, but also during the journey to reach the sports facilities. A third of the Dutch adults use their bicycle to reach sports facilities, which makes them more vulnerable to crime and other safety problems [55]. Indoor sports clubs were by far the most popular location to practice sports in the Netherlands (chapter 3), which explains why we also found neighbourhood safety to be associated with overall sports participation (chapter 4).

We found that leisure-time cycling and sports were not only associated with levels of neighbourhood safety, but also with changes in neighbourhood safety over time, though these latter associations were substantially weaker (chapter 4). This is

consistent with earlier research on associations of overall PA with neighbourhood safety levels and changes therein [56,57]. Our results imply that part of the relation of neighbourhood safety with leisure-time cycling and especially sports may not be truly causal and may be due to residential self-selection bias. Nonetheless, neighbourhood safety appeared to be related with leisure-time cycling and somewhat with leisure-time sports beyond residential self-selection. Though more robust studies are needed to rule out other possible biases, we believe that there is at least some evidence to suggest that neighbourhood safety may have a positive impact on leisure-time cycling and sports.

To what extent and how are ABIs like the Dutch District Approach able to influence LTPA among adults in deprived areas?

There is evidence to suggest that ABIs like the District Approach can stimulate LTPA among adults in deprived areas, primarily by increasing levels of leisure-time walking. Results of our quasi-experimental evaluation showed that the District Approach was associated with increases in leisure-time walking in the most deprived areas of the Netherlands (chapter 7). There were no indications of an impact on leisure-time cycling or sports. Few other ABIs have been scientifically evaluated for their impact on PA. In England, deprived areas that were targeted by the ABI New Deal for Communities (NDC) saw no improvements in general PA levels [58,59]. Results of our study indicate that the use of such general PA outcomes may obscure effects visible for more purpose- and type-specific PA outcomes.

There may be several possible explanations as to why the District Approach appeared to have an impact on leisure-time walking, but not on leisure-time cycling and sports in deprived areas. First, leisure-time cycling and sports may be more likely to be influenced by characteristics of areas that have not been targeted by the District Approach, as these activities are likely to exceed neighbourhood boundaries. Second, leisure-time cycling and sports may be more likely to be influenced by factors that have not been addressed by the District Approach. For example, a large part of the population in deprived areas is of non-Dutch origin, who are less used to cycling or may not even know how to cycle.

Our realist synthesis of 13 peer-reviewed studies revealed three potential pathways by which ABIs like the District Approach might stimulate leisure-time walking in deprived areas (chapter 8). First, our realist review suggested that by improving the neighbourhood infrastructure, ABIs might make it more convenient for adults to use existing walking facilities in deprived areas (e.g. sidewalks, trails, and parks). This pathway received only limited support from evaluations of the District Approach and other ABIs. Only a limited number of deprived areas that were targeted by the District

Approach made investments in infrastructure [60]. The share of infrastructural investments as part of other ABIs like the NDC and the SRB are unknown.

The two other pathways received more support from evaluations of the District Approach and other ABIs. First, our realist review suggested that by reducing the amount of safety problems in the area and by improving the physical neighbourhood design, ABIs might reduce adults' fear to use existing walking facilities in deprived areas (chapter 8). There was some evidence to suggest that the District Approach was able to do so. Nearly all deprived target areas invested in neighbourhood safety at an intermediate or large scale [60]. We found that the District Approach was associated with a small reduction in levels of criminal victimization in deprived areas, though not with changes in perceptions of general safety, physical order, or social order (chapter 5). Another Dutch study found no indications of an impact of the District Approach on self-reported neighbourhood safety [11]. They may have underestimated the impact of the District Approach because they only made comparisons with similarly deprived areas, which may have experienced spill-over effects of the District Approach or may have received interventions of their own. Moreover, we found that the District Approach did appear to have a positive impact on safety perceptions, but only in areas that took on a wider neighbourhood improvement approach and that were densely populated (chapter 6). Given the large variation in programme content and area characteristics across the deprived target areas, some target areas may have seen improvements in safety perceptions and hence in fear and levels of walking, but this may have been overshadowed by a lack of changes in others [60]. Evaluations of ABIs other than the District Approach also provided some evidence to support the pathway of fear. The English NDC was associated with reductions in criminal victimization and improvements in perceptions of lawlessness and dereliction in deprived target areas [61]. There were no indications of changes in fear of crime or safety concerns. The English Single Regeneration Budget (SRB) was associated with a small reduction in safety concerns, though there were no indications of changes in crime, vandalism, problems with dogs, and litter [62].

Second, our realist review suggested that by improving neighbourhood aesthetics, ABIs might make walking more relaxing and stress releasing (chapter 8). There was inconsistent evidence whether the District Approach was able to do so. Two third of the deprived target areas invested in green on an intermediate or large scale [60]. They aimed to increase the amount and quality of green to be active in as well as that of green to look at. Unexpectedly, areas that invested in green did not see larger improvements in leisure-time walking than those without green investments [63]. However, the impact of green interventions on leisure-time walking may be more complicated to measure than that. Our realist review pointed out that green will not provide relaxation and stress release if not well maintained or not properly landscaped (chapter 8). Moreover, green space may attract youth gangs and drug

dealers, causing adults to be fearful (chapter 8). Therefore, a better way to explore the amount of support for the pathway of relaxation and stress release may be to look at changes in the appreciation of green space. Evaluations of ABIs other than the District Approach have done so and provided some evidence to support the pathway of relaxation. The SRB was associated with a slight increase in the appreciation of open space in deprived target areas, while the rest of England showed large decreases in appreciation [62].

IMPLICATIONS

For practice

Results of this thesis indicate that LTPA among adults in deprived areas can successfully be promoted by means of ABIs like the Dutch District Approach that aim to improve socio-economic as well as environmental conditions in these areas. These initiatives appeared to be able to stimulate leisure-time walking among adults within a relatively short period of time of only 3.5 years.

The multidisciplinary nature of ABIs like the District Approach seemed to be the key to success. Our literature review revealed that adults in deprived areas encountered many problems that kept them from walking in leisure time. Most of these problems were related to the quality of existing leisure-time walking facilities (e.g. sidewalks, trails, parks), rather than the quantity of these facilities or the amount of social stimuli to use them. Results of our thesis indicated that ABIs like the District Approach are able to promote leisure-time walking in deprived areas by making existing walking facilities less frightening and more relaxing, thereby increasing their quality. ABIs may do so by tackling various safety problems, improving the physical neighbourhood design, and improving neighbourhood aesthetics.

Multidisciplinary approaches can be hard to organise and maintain as many different organisations are involved that all have different interests. Based on our realist evaluation, we advise organisations that are involved in such a multidisciplinary approach to arrange periodic meetings, develop clear plans of actions, and appoint a coordinator to organise and keep track of the process. These actions may facilitate role alignment, communication, and leadership among the various organisations and hence increase the efficiency and effectiveness of their approach.

Results of this thesis indicated that perceptions of neighbourhood features like safety may be more difficult to change than actual neighbourhood features. Some interventions may successfully tackle actual neighbourhood safety problems but may have a negative impact on perceptions of neighbourhood safety. For example,

increased police surveillance may reduce levels of crime but may at the same time give off a signal to the residents that their neighbourhood is unsafe. Moreover, improvements in actual neighbourhood safety may not translate into improved perceptions of neighbourhood safety in certain types of areas, such as areas that are not very densely populated, so residents are less likely to be exposed to neighbourhood improvements. Practitioners need to be aware of such processes when implementing interventions.

For research

An extensive body of cross-sectional research has explored associations of neighbourhood safety with LTPA. Because of their ease to acquire large study populations, they are very much suited to answer specific research questions. In this thesis, we have successfully applied this study design to shed more light onto the role of specific neighbourhood safety problems in specific LTPA behaviours for specific population groups. This thesis highlights several questions that have not been answered yet and may very well be addressed in future cross-sectional research. Research may explore whether safety-LTPA associations differ between deprived and non-deprived neighbourhoods, whether there is a threshold level of neighbourhood safety after which it has an impact on LTPA, and what neighbourhood size is most appropriate to assess safety-LTPA associations. Research is advised to use specific LTPA outcomes, as our results indicate that neighbourhood safety may be differently related to leisure-time walking, cycling, and sports. Research is also advised to take into account neighbourhood factors other than safety to limit the possibility of residual neighbourhood-level confounding.

While cross-sectional studies may be valuable to explore new areas of interest, they are unable to make causal inferences. We have found evidence to suggest that cross-sectional studies are prone to residential self-selection bias (chapter 4). To acquire more robust evidence on the causality of neighbourhood-LTPA relations, it may be useful to perform quasi-experimental studies that look at changes in LTPA following an environmental modification. Only few quasi-experimental studies have been performed to explore the impact of large-scale ABIs on LTPA. A larger amount of studies with a longer follow-up time are needed to acquire more robust evidence. Research on the impact of ABIs on LTPA is advised to use type-specific LTPA measures, as we found the impact of the District Approach to differ by type of LTPA. Moreover, LTPA measures should make reference to where the activity has taken place, to make more accurate estimates of the impact of ABIs on LTPA. In addition, more research is needed to explore the underlying pathways by which ABIs may influence LTPA, by evaluating its impact on neighbourhood safety, aesthetics and pedestrian infrastructure. Finally, future studies should use longitudinal, individual-level data to deal with the possible bias caused by selective migration.

A disadvantage of quasi-experimental studies like the one we performed with the District Approach is that they are unable to shed light on the impact of ABIs in specific areas. Results of our thesis indicate that the impact of ABIs may be restricted to certain areas. By only looking at outcomes at the programme level, studies may underestimate the impact of ABIs. Besides the need to focus on specific areas, there is also a need to focus on specific interventions. Quasi-experimental studies like ours provide limited insight into what interventions are able to produce positive changes and which are not. Therefore, research is advised to combine quasi-experimental studies with case studies that focus on specific areas and specific interventions.

Moreover, quasi-experimental studies and case studies are advised to be accompanied with realist studies to uncover how ABIs in general and specific interventions in particular are able to produce change. We gained insight into the pathways by which ABIs can stimulate leisure-time walking in deprived areas. Additional research is needed to explore why ABIs may be unable to stimulate leisure-time cycling or sports. Moreover, realist studies may be useful to uncover the conditions under which ABIs do and don't work. This may help gain more insight into why ABIs and specific interventions work in one area, but not in the other. We explored these issues for one specific safety intervention implemented in one specific city, but additional research is needed on the contextual factors that influence the success of other specific interventions and of ABIs as a whole.

OVERALL CONCLUSIONS

Two main conclusions arose from this thesis. First, though residential self-selection seemed to explain a substantial part of the relation between neighbourhood safety and LTPA, we found evidence to suggest that good neighbourhood safety may promote leisure-time cycling and sports in the general adult population. There were no indications of an impact of neighbourhood safety on leisure-time walking among the general adults population. However, among adults in deprived areas, we did find evidence to suggest that good neighbourhood safety may promote leisure-time walking. Alternative explanations such as residual neighbourhood-level confounding should be ruled out to provide more robust evidence on the causality of these relations.

Second, we found evidence to suggest that ABIs that aim to improve socio-economic as well as environmental condition in deprived areas may promote LTPA among adults in deprived areas, primarily by increasing the amount of adults that walk in leisure time. ABIs appear to be able to increase leisure-time walking by means of investments meant to make existing walking facilities less frightening, more convenient, and more

relaxing. Results emphasize the need for large-scale, multidisciplinary approaches to solve neighbourhood problems and hence improve LTPA in deprived areas.

REFERENCES

1. Humpel N, Owen N, Leslie E, Mashall AL, Bauman AE, Sallis JF. Associations of location and perceived environmental attributes with walking in neighborhoods. *Am J Health Promot* 2004;18:239-242.
2. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking. Review and research agenda. *Am J Prev Med* 2004;27:67-76.
3. Giles-Corti B, Timperio A, Bull F, Pikora T. Understanding physical activity environmental correlates: increased specificity for ecological models. *Exerc Sport Sci Rev* 2005;33:175-181.
4. Foster S, Giles-Corti B. The built environment, neighborhood crime and constrained physical activity: an exploration of inconsistent findings. *Prev Med* 2008;47:241-251.
5. Handy S, Cao X, Mokhtarian PL. Self-selection in the relationship between the built environment and walking: empirical evidence from Northern California. *J Am Plan Ass* 2006;72:55-74.
6. Cao X, Mokhtarian PL, Handy SL. Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. *Transport Rev* 2009;29:359-395.
7. van Dyck D, Cardon G, Deforche B, Giles-Corti B, Sallis JF, Owen N, et al. Environmental and psychosocial correlates of accelerometer-assessed and self-reported physical activity in Belgian adults. *Int J Behav Med* 2011;18:235-245.
8. McGormack GR, Shiell A. In search of causality: a systematic review of the relationship between the built environment and physical activity among adults. *I J Behav Nutr Phys Act* 2011;8.
9. Sugiyama T, Neuhaus M, Cole R, Giles-Corti B, Owen N. Destination and route attributes associated with adults' walking: a review. *Med Sci Sports Exerc* 2012;44:1275-1286.
10. Mokhtarian PL, Cao X. Examining the impacts of residential self-selection on travel behaviour: a focus on methodologies. *Transport Rev* 2008;42:204-228.
11. Permentier M, Kullberg J, van Noije L. *Werk aan de wijk. Een quasi-experimentele evaluatie van het krachtwijkenbeleid*. Den Haag: Sociaal en Cultureel Planbureau, 2013.
12. Beatty C, Lawless P, Pearson S, Wilson I. *Residential mobility and outcome change in deprived areas: evidence from the New Deal for Communities Programme*. West Yorkshire: Department of Communities and Local Government, 2009.
13. Pearson S, Lawless P. Population mobility in regeneration areas: trends, drivers, and implications; evidence from England's New Deal for Communities Programme. *Environ Plann A* 2012;44:2023-2039.
14. Petticrew M, Cummins S, Ferrell C, Findlay A, Higgins C, Hoy C, et al. Natural experiments: an underused tool for public health. *Public Health* 2005;119:751-757.
15. Craig P, Cooper C, Gunnell D, Haw S, Lawson K, Macintyre S, et al. Using natural experiments to evaluate population health interventions: new Medical Research Council guidance. *J Epidemiol Community Health* 2012, 66;1182-1186.

16. Dishman RK, Washburn RA, Schoeller DA. Measurement of physical activity. *Quest* 2001;53:295-309.
17. Prince SA, Adamo KB, Hamel ME, Hardt J, Gorber SC, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *I J Behav Nutr Phys Act* 2008;5:56.
18. Wendel-Vos W, Droomers M, Kremers S, Brug J, van Lenthe F. Potential environmental determinants of physical activity in adults: a systematic review. *Obes Rev* 2007;8:425-40.
19. Saelens BE, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc* 2008;40:550-566.
20. van Holle V, Deforche B, van Cauwenberg J, Goubert L, Maes L, van de Weghe N, et al. Relationship between the physical environment and different domains of physical activity in European adults: a systematic review. *BMC Public Health*, 2012;12:807.
21. Krosnick JA. Survey Research. *Annu Rev Psychol* 1999;50:537-567.
22. Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *Br J Sports Med* 2003;37:197-206.
23. Wilson DK, Kirtland KA, Ainsworth BE, Addy CL. Socioeconomic status and perceptions of access and safety for physical activity. *Ann Behav Med* 2004;28:20-8.
24. McGinn AP, Evenson KR, Herrin AH, Huston SL, Rodriguez DA. Exploring associations between physical activity and perceived and objective measures of the built environment. *J Urban Health* 2007;84:162-184.
25. Ball K, Jeffery RW, Crawford DA, Roberts RJ, Salmon J, Timperio AF. Mismatch between perceived and objective measures of physical activity environments. *Prev Med* 2008;47:294-298.
26. Gebel K, Bauman A, Owen N. Correlates of non-concordance between perceived and objective measures of walkability. *Annals of Behav Med* 2009;37:228-238.
27. Gebel K, Bauman AE, Sugiyama T, Owen N. Mismatch between perceived and objectively assessed neighbourhood walkability attributes: prospective relationships with walking and weight gain. *Health Place* 2011;17:519-524.
28. Humpel N, Marshall AL, Leslie E, Bauman A, Owen N. Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Ann Behav Med* 2004;27:60-67.
29. Bevolking en huishoudens; viercijferige postcode [homepage on the internet]. Den Haag: Centraal Bureau voor de Statistiek; c2012. [updated 2013 January 21; cited 2014 July 26]. Available from <http://statline.cbs.nl/StatWeb/>
30. Kerncijfers wijken en buurten [homepage on the internet]. Den Haag: Centraal Bureau voor de Statistiek; c2009-2012 [updated 2014 April 11; cited 2014 July 26]. Available from <http://statline.cbs.nl/StatWeb/>
31. Wallmann B, Buksch J, Froboese I. The association between physical activity and perceived environment in German adults. *Eur J Public Health* 2012;22:502-508.
32. French S, Wood L, Foster SA, Giles-Corti B, Frank L, Learnihan V. Sense of community and its association with the neighborhood built environment. *Environ Behav* 2014;46:677-697.
33. van Dyck D, Veitch J, de Bourdeaudhuij I, Thornton L, Bali K. Environmental perceptions as mediators of the relationship between the objective built environment and walking among socio-economically disadvantaged women. *I J Behav Nutr Phys Act* 2013;10:108.

34. Bracy NL, Millstein RA, Carlson JA, Conway TL, Sallis JF, Saelens BE, et al. Is the relationship between the built environment and physical activity moderated by perceptions of crime and safety? *I J Behav Nutr Phys Act* 2014;11:24.
35. Hallal PC, Reis RS, Parra DC, Hoehner C, Brownson RC, Simões EJ. Association between perceived environmental attributes and physical activity among adults in Recife, Brazil. *J Phys Act Health* 2010;7:213-222.
36. Beenackers MA, Foster S, Kamphuis CBM, Titze S, Divitine M, Knuiman M, et al. Taking up cycling after residential relocation: built environmental factors. *Am J Prev Med* 2012;42:610-615.
37. Adams EJ, Goodman A, Sahlqvist S, Bull FC, Ogilvie D. Correlates of walking and cycling for transport and recreation: factor structure, reliability and behavioural associations of the perceptions of the environment in the neighbourhood scale (PENS). *I J Behav Nutr Phys Act* 2013;10:87.
38. Beenackers MA, Kamphuis CBM, Mackenbach JP, Burdorf A, van Lenthe FJ. Why some walk and others don't: exploring interactions of perceived safety and social neighborhood factors with psychosocial cognitions. *Health Educ Res* 2013;28:220-233.
39. Caspi CE, Kawachi I, Subramanian SV, Tucker-Seeley R, Sorensen G. The social environment and walking behavior among low-income housing residents. *Soc Sci Med* 2013;76-84.
40. van Dijk J, van Kestern J, Smit P. *Criminal victimization in international perspective: key findings from the 2004-2005 ICVS and EU ICS*. Meppel: Boom Juridische uitgevers, 2007.
41. Mason P, Kearns A, Bond L. Neighbourhood walking and regeneration in deprived communities. *Health Place* 17:727-737.
42. Mason P, Kearns A, Livingston M. "Safe Going": the influence of crime rates and perceived crime and safety on walking in deprived neighbourhoods. *Soc Sci Med* 2013;91:15-24.
43. Chandola T. The fear of crime and area differences in health. *Health & Place* 2001;7:105-116.
44. Steptoe A, Feldman PJ. Neighborhood problems as sources of chronic stress: development of a measure of neighborhood problems, and associations with socioeconomic status and health. *Ann Behav Med* 2001;23:177-185.
45. Giles-Corti B, Donovan RJ. Socioeconomic differences in recreational physical activity levels and real and perceived access to a supportive physical environment. *Prev Med* 2002;35:601-11.
46. Loukaitou-Sideris A, Eck JE. Crime prevention and active living. *Am J Health Promot* 2007;21:380-389.
47. Kavanagh AM, Goller JL, King T, Jolley D, Crawford D, Turrell G. Urban area disadvantage and physical activity: a multilevel study in Melbourne, Australia. *J Epidemiol Community Health* 2005;59:934-940.
48. Do DP, Finch BK. The link between neighborhood poverty and health: context or composition? *Am J Epidemiol* 2008;168:611-619.
49. Skogan WG, Maxfield MG. *Coping with crime. Individual and neighbourhood reactions*. London: Sage Publications, 1981.
50. Kamphuis CBM, Giskes K, Kavanagh AM, Thornton LE, Thomas LR, van Lenthe FJ, et al. Area variation in recreational cycling in Melbourne: a compositional or contextual effect? *J Epidemiol Community Health* 2008;62:890-898.

51. Kamphuis CBM, van Lenthe FJ, Giskes K, Huisman M, Brug J, Mackenbach JP. Socioeconomic status, environmental and individual factors, and sports participation. *Med Sci Sports Exerc* 2008;40:71-81.
52. Beenackers MA, Kamphuis CBM, Burdorf A, Mackenbach JP, van Lenthe FJ. Sports participation, perceived neighbourhood safety, and individual cognitions: how do they interact? *IJ Behav Nutr Phys Act* 2011;8:76.
53. Poortinga W. Perceptions of the environment, physical activity, and obesity. *Soc Sci Med* 2006;63:2835-2846.
54. van Dyck D, Cardon G, Deforche B, Giles-Corti B, Sallis JF, Owen N, et al. Environmental and psychosocial correlates of accelerometer-assessed and self-reported physical activity in Belgian adults. *Int J Behav Med* 2011;18:235-245.
55. Breedveld K, Tiessen-Raaphorst A. *Rapportage sport 2006*. Den Haag : Sociaal en Cultureel Planbureau, 2006.
56. Jongeneel-Grimen B, Busschers W, Droomers M, van Oers HAM, Stronks K, Kunst AE. Change in neighborhood traffic safety: does it matter in terms of physical activity? *Plos One* 2013;8:e62525
57. Jongeneel-Grimen B, Droomers M, van Oers HAM, Stronks K, Kunst AE. The relationship between physical activity and het living environment: a multi-level analyses focusing on changes over time in environmental factors. *Health Place* 2014;26:149-160.
58. Batty E, Beatty C, Foden M, Lawless P, Pearson S, Wilson I. *The New Deal for Communities Experience: a final assessment. Communities and local governments*. West Yorkshire: Department of Communities and Local Government, 2010.
59. Lawless P, Foden M, Wilson I, Beatty C. Understanding area-based regeneration: the New Deal for Communities Programme in England. *Urban Stud* 2010;47:257-275.
60. Droomers M, Harting J, Jongeneel-Grimen B, Rutten L, van Kats J, Stronks K. Area-based interventions to ameliorate deprived Dutch neighborhoods in practice: does the Dutch District Approach address the social determinants of health to such an extent that future health impacts may be expected? *Prev Med* 2014;61:122-127.
61. Lawless P. Understanding the scale and nature of outcome change in area-regeneration programmes: evidence from the New Deal for Communities programme in England. *Environ Plann C* 2011;29:520-532.
62. Rhodes J, Tyler P, Brennan A. Assessing the effect of area based initiatives on local area outcomes: some thoughts based on the national evaluation of the Single Regeneration Budget in England. *Urban Stud* 2005;42:1919-1946.
63. Droomers M, Jongeneel-Grimen B, Kramer D, de Vries S, Kremers SPJ, Bruggink JW, et al. The impact of intervening in green space in deprived Dutch neighborhoods on physical activity and general health. Results from the quasi-experimental URBAN40 study. [submitted for publication].

Summary

SUMMARY

Physical inactivity is an important risk factor for many major chronic diseases. In developed countries, leisure-time physical activity (LTPA) has become increasingly more important to maintain good health, as technological advancements have reduced the amount of physical effort needed for transport and labour. However, only 39% of the adult European population engage in some or a lot of LTPA. Numbers are even lower among adults living in deprived areas. Understanding why some adults do and others do not engage in LTPA is essential for the development of effective public health interventions.

Social-ecological models posit that research and practice should not only focus on personal determinants of LTPA, but also on environmental determinants. There is profound evidence for the role of neighbourhood aesthetics, pedestrian infrastructure, and leisure-time facilities in LTPA. However, the role of other neighbourhood factors remains unclear, such as that of neighbourhood safety.

In the past two decades, numerous area-based initiatives (ABIs) have been implemented across western-Europe with the aim to improve the living conditions in deprived areas. In 2008, the so called District Approach was implemented in the 40 most deprived areas of the Netherlands (hereafter called deprived target districts). There is limited evidence on whether and how these initiatives can improve neighbourhood safety and LTPA in deprived areas.

To address these knowledge gaps, this thesis posed three research questions:

1. To what extent are general neighbourhood safety and specific safety problems associated with leisure-time walking, cycling, and sports in Dutch adults?
2. To what extent and how is the District Approach associated with changes in general neighbourhood safety and in specific safety problems as reported by adult residents of the deprived target districts?
3. To what extent and how is the District Approach associated with changes in leisure-time walking, cycling, and sports among adult residents of the deprived target districts?

Part I of this thesis consisted of chapters 2 to 4 and displayed associations of neighbourhood safety with LTPA among Dutch adults. **Chapter 2** reported on associations of self-reported physical order, social order, crime safety, and traffic safety with leisure-time walking and cycling. None of the safety indicators was associated with leisure-time walking among adults in general. However, general safety was negatively associated with leisure-time walking among younger men, older men, and lower educated adults. All safety indicators were associated with leisure-time

cycling. These associations were strongest for general safety and among older women. These results suggest that improved neighbourhood safety may not stimulate leisure-time walking, but that it may stimulate leisure-time cycling, especially among older women and when improving multiple safety aspects simultaneously.

Chapter 3 reported on associations of self-reported neighbourhood social safety (a composite measure of social order and crime safety) with leisure-time sports at various locations. Indoor sports clubs were the most popular location to practice sports. More positive perceptions of social safety were associated with higher odds of sports at indoor sports clubs, but not with sports at outdoor sports clubs or sports on streets. These results imply that improved neighbourhood safety can enhance sports participation, primarily through the enhancement of sports at indoor sports clubs.

Chapter 4 described associations of levels of self-reported neighbourhood safety as well as *changes* in self-reported neighbourhood safety over time with leisure-time walking, cycling, and sports. Leisure-time walking was negatively associated with levels of social order and non-victimization, but not with levels of general safety and physical order. Similar results were obtained when looking at changes in the safety indicators over time. Leisure-time cycling was positively associated with levels of all four neighbourhood safety indicators as well as with changes therein over time, though these latter associations were weaker. Leisure-time sports was positively associated with levels of all four neighbourhood safety indicators, but only with changes in social order and non-victimization over time. These results show that leisure-time cycling and sports are less strongly related with changes in neighbourhood safety than with levels of neighbourhood safety. This implies that at least part of the relation is not truly causal, and might be explained by other processes such as residential self-selection.

Part II of this thesis consisted of chapters 5 and 6 and displayed to what extent and how the Dutch District Approach was associated with changes in neighbourhood safety as reported by adults living in deprived target districts. **Chapter 5** described the results of a quasi-experimental study in which we explored to what extent the District Approach was associated with changes in trends of general safety, physical order, social order, and non-victimization in deprived target districts. The implementation of the District Approach was associated with a somewhat more positive change in non-victimization trend in deprived target districts than in control areas. These results were statistically significant in women, older adults, and lower educated adults only. There were no between-district differences in trend changes of the other safety indicators. These results imply that the Dutch District Approach was able to reduce levels of criminal victimization, especially among more vulnerable and exposed groups. However, it seemed unable to improve perceptions of neighbourhood safety in deprived areas.

Chapter 6 presented the results of a realist evaluation in which we explored how safety perceptions were influenced by a neighbour nuisance intervention that was implemented in four deprived districts in the city of Arnhem. The intervention produced change at three different levels. At the organizational level, the coordinated partnership strategy resulted in a more efficient approach of nuisance households because of increased role alignment, communication, and leadership. At the level of nuisance households, the joint assistance and enforcement strategy resulted in less neighbor nuisance because of the removal of the various underlying reasons for nuisance. At the district levels, the intervention resulted in improved perceptions of neighbourhood safety because of improved perceptions of social control, but this effect was only visible in one of the four districts. Key district level conditions for change included a wider neighbourhood renewal approach, central location, and dense population. These results suggest that in certain conditions, area-based safety interventions like the one in Arnhem have the potential to tackle specific safety problems and hence improve area-level safety perceptions.

Part III of this thesis consisted of chapters 7 and 8 and displayed to what extent and how the Dutch District Approach was associated with changes in LTPA among adults in deprived target districts. **Chapter 7** described the results of a quasi-experimental study in which we assessed to what extent the District Approach was associated with changes in leisure-time walking, cycling, and sports in deprived target districts. The implementation of the District Approach was associated with a more positive change in leisure-time walking trend in deprived target districts than in control groups. There were no between-district differences in trend changes of leisure-time cycling and sports. None of the results differed by intensity of environmental interventions. These results imply that the Dutch District Approach has been able to stimulate leisure-time walking in deprived target areas, but not leisure-time cycling or sports.

Chapter 8 presented the results of a realist review in which we explored how ABIs like the Dutch District Approach might stimulate leisure-time walking in deprived areas. A synthesis of evidence from 13 peer-reviewed articles indicated that ABIs may stimulate walking in deprived areas in three main ways. First, by tackling safety problems and improving physical neighbourhood design, adults may be less fearful to use existing walking facilities (e.g. parks, sidewalks). Second, by improving neighbourhood aesthetics, walking may be more relaxing and stress releasing. Third, by improving neighbourhood infrastructure, existing walking facilities may be more convenient to use. Three additional, less well supported pathways were identified. First, by improving the amount of walking facilities, there may be more settings for walking. Second, by improving social capital, adults may have more opportunities for social interaction while walking. Third, by improving social capital, adults may have more social support for walking. These results imply that ABIs have the ability to

stimulate leisure-time walking in deprived areas by making existing walking facilities less frightening, more convenient, and more relaxing.

Chapter 9 summarized the main findings of this thesis and discussed them in light of various methodological considerations and previous research. Furthermore, implications for practice and research were described. Two main conclusions arose from this thesis.

First, though residential self-selection seemed to explain a substantial part of the relation between neighbourhood safety and LTPA, we found evidence to suggest that safe neighbourhoods may promote leisure-time cycling and sports in the general adult population. Neighbourhood safety did not appear to have an effect on leisure-time walking among the general adult population, but there were indications of a positive effect among adults in deprived areas. More robust studies are needed to provide stronger evidence on the causality of these relations.

Second, ABIs like the Dutch District Approach that aim to improve socio-economic as well as environmental conditions in deprived areas may promote LTPA among adults in these areas, primarily by stimulating them to walk in leisure time. There was evidence to suggest that ABIs may promote leisure-time walking in deprived areas because they make existing walking facilities less frightening, more convenient, and more relaxing. Results emphasize the need for large-scale and multidisciplinary approaches to solve neighbourhood problems and stimulate LTPA in deprived areas.

Samenvatting

SAMENVATTING

Lichamelijke inactiviteit is een belangrijke risicofactor voor veel chronische aandoeningen. In ontwikkelde landen hebben technologische ontwikkelingen ervoor gezorgd dat er steeds minder lichamelijke inspanning nodig is voor transport en arbeid. Daardoor is lichamelijke activiteit in de vrije tijd steeds belangrijker geworden voor het behoud van een goede gezondheid. Echter, slechts 39% van de Europese volwassenen is enigszins of heel lichamelijk actief in de vrije tijd. Dit percentage is nog lager onder volwassenen die in achterstandswijken wonen. Om mensen te stimuleren om meer lichamelijk actief te zijn in hun vrije tijd is het belangrijk om te begrijpen waarom sommige volwassenen wel lichamelijk actief zijn en anderen niet.

Sociaal-ecologische modellen stellen dat onderzoek en praktijk zich niet alleen zouden moeten richten op persoonlijke determinanten van lichamelijke activiteit in de vrije tijd, maar ook op omgevingsdeterminanten. Er is sterk bewijs dat lichamelijke activiteit in de vrije tijd is geassocieerd met de esthetiek van de buurt, de voetgangerinfrastructuur en de recreatieve faciliteiten in de buurt. Echter, de rol van andere buurtkenmerken blijft onduidelijk, zoals dat van buurtveiligheid.

In de afgelopen twee eeuwen zijn diverse buurtvernieuwingsinitiatieven ingevoerd door heel West-Europa die tot doel hebben om de leefomstandigheden in achterstandswijken te verbeteren. In 2008 werd de zogeheten Wijkenaanpak ingevoerd in de 40 meest achtergestelde buurten in Nederland (hierna aandachtswijken genoemd). Het is onduidelijk of en hoe dit soort initiatieven in staat zijn om de buurtveiligheid en lichamelijke activiteit in achterstandswijken te verbeteren.

Om deze kenniskloof te dichten, stonden in dit proefschrift drie onderzoeksvragen centraal:

1. In welke mate zijn algemene buurtveiligheid en specifieke veiligheidsproblemen geassocieerd met het recreatieve wandel-, fiets-, en sportgedrag van Nederlandse volwassenen?
2. In welke mate en hoe ging de Wijkenaanpak gepaard met veranderingen in algemene buurtveiligheid en specifieke veiligheidsproblemen zoals gerapporteerd door volwassen inwoners van de aandachtswijken?
3. In welke mate en hoe ging de Wijkenaanpak gepaard met veranderingen in het recreatieve wandel-, fiets-, en sportgedrag van volwassen inwoners van de aandachtswijken?

Deel I van dit proefschrift bestond uit hoofdstuk 2 tot 4 en beschreef de relaties tussen buurtveiligheid en lichamelijke activiteit in de vrije tijd onder Nederlandse

volwassenen. **Hoofdstuk 2** liet zien in welke mate zelfgerapporteerde algemene buurtveiligheid, fysieke orde, sociale orde, misdaad en verkeersveiligheid waren geassocieerd met wandelen en fietsen in de vrije tijd. Geen van de veiligheidsindicatoren was geassocieerd met het recreatieve wandelgedrag van de algemene volwassen bevolking. Echter, algemene buurtveiligheid was negatief geassocieerd met het recreatieve wandelgedrag van jonge mannen, oude mannen en lager opgeleide volwassenen. Alle veiligheidsindicatoren waren positief geassocieerd met recreatief fietsen. Deze relaties waren het sterkst voor algemene buurtveiligheid en bij oudere vrouwen. Deze resultaten suggereren dat betere buurtveiligheid er niet toe leidt dat meer volwassenen gaan wandelen in hun vrije tijd, maar wel dat ze meer gaan fietsen. Dit laatste geldt vooral voor oudere vrouwen en wanneer men zich richt op het verbeteren van meerdere veiligheidsaspecten tegelijk.

Hoofdstuk 3 beschreef de relatie tussen zelfgerapporteerde sociale buurtveiligheid (een samengestelde maat van sociale wanorde en misdaad) en recreatief sporten op verschillende locaties. Overdekte sportclubs waren de meest populaire locatie voor sportbeoefening. Positievare percepties van sociale buurtveiligheid waren geassocieerd met een grotere kans om aan zandsport te doen, maar was niet geassocieerd met veldsport of straatsport. Deze resultaten wijzen erop dat betere buurtveiligheid ertoe leidt dat meer volwassenen gaan sporten in hun vrije tijd, vooral door de positieve invloed op zandsport.

Hoofdstuk 4 liet zien in hoeverre de mate van zelfgerapporteerde buurtveiligheid alsook *veranderingen* in zelfgerapporteerde buurtveiligheid over de tijd waren geassocieerd met wandelen, fietsen, en sporten in de vrije tijd. Recreatief wandelen hing negatief samen met de mate van sociale orde en slachtofferschap, maar niet met de mate van algemene buurtveiligheid en fysieke orde. Vergelijkbare resultaten werden verkregen wanneer we keken naar veranderingen in buurtveiligheid over de tijd. Recreatief fietsen hing positief samen met de mate van alle vier de veiligheidsindicatoren, alsook met veranderingen daarin over de tijd, hoewel deze laatste relaties zwakker waren. Recreatief sporten hing positief samen met de mate van alle vier de veiligheidsindicatoren, maar alleen met veranderingen in sociale orde en slachtofferschap over de tijd. De resultaten laten zien dat recreatief fietsen en sporten minder sterk samen hangt met veranderingen in buurtveiligheid over de tijd dan met de mate van buurtveiligheid. Dit wijst erop dat de relatie voor een deel niet causaal is en verklaard lijkt te worden door andere processen, zoals woonplaatsvoorkeuren.

Deel II van dit proefschrift bestond uit hoofdstuk 5 en 6 en beschreef in hoeverre en hoe de Wijkenaanpak was geassocieerd met veranderingen in buurtveiligheid zoals gerapporteerd door volwassenen inwoners van de aandachtswijken. **Hoofdstuk 5** beschreef de resultaten van een quasi-experimentele studie waarin we onderzochten

in hoeverre de Wijkenaanpak was geassocieerd met veranderingen in algemene buurtveiligheid, fysieke orde, sociale orde en slachtofferschap in de aandachtswijken. De invoering van de Wijkenaanpak was geassocieerd met een iets grotere afname in het aantal slachtoffers van criminaliteit in de aandachtswijken dan in de controlewijken. Deze resultaten waren alleen statistisch significant bij vrouwen, ouderen en lager opgeleide volwassenen. De overige veiligheidsindicatoren ontwikkelden zich niet anders in de aandachtswijken dan in de controlewijken. Deze resultaten suggereren dat de Wijkenaanpak heeft geleid tot een daling in het aantal slachtoffers van criminaliteit in achterstandswijken, vooral onder meer kwetsbare en blootgestelde groepen. Het lijkt echter niet te hebben geleid tot een beter gevoel van buurtveiligheid in achterstandswijken.

Hoofdstuk 6 beschreef de resultaten van een zogeheten “realist evaluation” waarin we onderzochten hoe veiligheidsgevoelens werden beïnvloed door een burenoverlastinterventie die was ingevoerd in vier Arnhemse achterstandswijken. De interventie zorgde voor veranderingen op drie verschillende niveaus. Op organisatieniveau leidde een strategie van gecoördineerde samenwerking tot een efficiëntere aanpak van overlasthuishoudens doordat er sprake was van meer afstemming, communicatie en leiderschap. Op het niveau van de probleemhuishoudens leidde een strategie van zorg en handhaving tot minder burenoverlast doordat de diverse onderliggende redenen voor overlast werden aangepakt. Op wijkniveau leidde de interventie tot betere gevoelens van buurtveiligheid doordat de gevoelens van sociale controle verbeterden, maar dit effect was alleen zichtbaar in één van de vier wijken. Belangrijke voorwaarden voor verbeteringen op wijkniveau waren een bredere wijkvernieuwingsaanpak, centrale ligging, en hoge bevolkingsdichtheid. Deze resultaten suggereren dat buurtgerichte veiligheidsinterventies zoals die in Arnhem, onder bepaalde condities in staat zijn om veiligheidsproblemen op te lossen en daarmee de waargenomen buurtveiligheid te verbeteren.

Deel III van dit proefschrift bestond uit hoofdstuk 7 en 8 en beschreef in hoeverre en hoe de Wijkenaanpak was geassocieerd met veranderingen in het recreatieve lichamelijke activiteitsgedrag van volwassen inwoners van de aandachtswijken. **Hoofdstuk 7** beschreef de resultaten van een quasi-experimentele studie waarin we onderzochten in hoeverre de Wijkenaanpak gepaard ging met veranderingen in het aantal volwassen inwoners van de aandachtswijken dat wandelt, fietst of sport in hun vrije tijd. Het aantal wandelaars nam sterker toe in de aandachtswijken dan in de controlewijken. Het aantal fietsers en sporters ontwikkelde zich niet anders in de aandachtswijken dan in controlewijken. De intensiteit waarmee de aandachtswijken in hadden gezet op het verbeteren van de leefomgeving had geen invloed op de resultaten. Deze resultaten suggereren dat de Wijkenaanpak ertoe heeft geleid dat

meer volwassen inwoners van aandachtswijken zijn gaan wandelen in hun vrije tijd, maar niet meer zijn gaat fietsen of sporten.

Hoofdstuk 8 beschreef de resultaten van een zogeheten “realist review” waarin we onderzochten hoe wijkvernieuwingsinitiatieven zoals de Wijkenaanpak ervoor kunnen zorgen dat volwassenen in achterstandswijken meer gaan wandelen in hun vrije tijd. Een synthese van bewijs uit 13 wetenschappelijke artikelen wees uit dat volwassenen in achterstandswijken kunnen worden gestimuleerd om te gaan wandelen in hun vrije tijd door 1) veiligheidsproblemen op te lossen en de inrichting van de buurt zodanig te verbeteren dat volwassenen minder bang zijn om bestaande wandelfaciliteiten (bijv. park of stoep) te gebruiken, 2) de esthetiek van de buurt zodanig te verbeteren dat wandelen meer ontspannend is, 3) de infrastructuur van de buurt zodanig te verbeteren dat bestaande wandelfaciliteiten gebruiksvriendelijker zijn. Daarnaast vonden we gering bewijs dat volwassenen in achterstandswijken meer gaan wandelen door 1) het aantal wandelfaciliteiten zodanig te vergroten dat er meer settings zijn om te wandelen, 2) het sociaal kapitaal in de buurt zodanig te vergroten dat er meer sociale interactie is tijdens het wandelen, 3) het sociaal kapitaal in de buurt zodanig te vergroten dat er meer sociale steun is om te wandelen. Deze resultaten suggereren dat wijkvernieuwingsinitiatieven volwassenen in achterstandswijken kunnen stimuleren om meer te wandelen in hun vrije tijd door bestaande wandelfaciliteiten minder eng, meer gebruiksvriendelijk, en meer ontspannend te maken.

In **hoofdstuk 9** werden de belangrijkste resultaten van dit proefschrift samengevat en bediscussieerd in relatie tot diverse methodologische kwesties en eerder onderzoek. Daarnaast werden de implicaties voor praktijk en onderzoek besproken. Op basis van dit proefschrift kwamen wij tot twee hoofdconclusies.

Allereerst, ondanks het feit dat woonplaatsvoorkeuren een substantieel deel van de relatie tussen buurtveiligheid en recreatieve lichamelijke activiteit lijken te verklaren, vonden we aanwijzingen dat betere buurtveiligheid ertoe kan leiden dat meer volwassenen gaan fietsen en sporten in hun vrije tijd. Buurtveiligheid leek geen effect te hebben op het recreatieve wandelgedrag van volwassenen in het algemeen, maar leek wel een positief effect te hebben onder volwassenen in achterstandswijken. Meer robuuste studies zijn nodig om sterker bewijs te leveren voor de causaliteit van deze relaties.

Ten tweede lijken buurtvernieuwingsinitiatieven zoals de Wijkenaanpak in staat te zijn om volwassen inwoners van achterstandswijken te stimuleren om meer lichamelijk actief te zijn in hun vrije tijd, vooral door hen te stimuleren om meer te wandelen. Deze initiatieven lijken recreatief wandelgedrag te kunnen stimuleren doordat ze bestaande wandelfaciliteiten in achterstandswijken minder eng, meer

gebruiksvriendelijk en meer ontspannend maken. Deze resultaten benadrukken het belang van een grootschalige en multidisciplinaire aanpak om buurtproblemen in achterstandswijken op te lossen en daarmee lichamelijke activiteit te stimuleren.

Dankwoord

DANKWOORD

Na drie jaar is het moment daar: mijn proefschrift is af! Hoewel enkel mijn naam op de omslag pronkt, had dit proefschrift nooit bestaan zonder de hulp van vele anderen. In dit hoofdstuk wil ik graag mijn dank aan hen betuigen.

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About the author

ABOUT THE AUTHOR

Daniëlle Kramer was born on 21 April 1988 in Amsterdam. She grew up in Mijdrecht, where she completed her secondary education at the Veenlanden College in 2006. In that same year, she started the Bachelor of Communication Sciences at the VU University in Amsterdam. During this Bachelor, she got interested in the field of health communication and promotion. After obtaining her Bachelor's degree in 2009, she studied a semester abroad at San Diego State University in San Diego, America. Her main subject was Public Health. After returning home at the end of 2009, she completed a short track of the Premaster of Health Sciences at the VU University in Amsterdam. In 2010, she enrolled in the Master of Health Sciences at the VU University, with a specialisation in Prevention and Public Health. She graduated cum laude in 2011.



As part of the Master of Health Sciences, Daniëlle completed a research internship at the Department of Public Health at the Academic Medical Centre, University of Amsterdam (AMC-UvA). She wrote a thesis about the relation of neighbourhood safety with leisure-time walking and cycling among Dutch adults (see chapter 2 of this thesis). In January 2012, Daniëlle returned to the Department of Public Health of the AMC-UvA and started working as a junior researcher. In July 2014, she finished the work that underlies this thesis.

In August 2014, Daniëlle started working as an Epidemiologist at the Department of Prevention, Advise and Crisis at the Municipal Health Services (GGD) Kennemerland in Hoofddorp.

List of publications

LIST OF PUBLICATIONS

Articles included in this thesis

Kramer D, Maas J, Wingen M, Kunst AE. Neighbourhood safety and leisure-time physical activity among Dutch adults: a multilevel perspective. *I J Behav Nutr Phys Act* 2013;10:11.

Kramer D, Stronks K, Maas J, Wingen M, Kunst AE. Social neighborhood environment and sports participation among Dutch adults: does sports location matter? *Scand J Med Sci Sports* 2014. [Epub ahead of print].

Kramer D, Droomers M, Jongeneel-Grimen B, Wingen M, Stronks K, Kunst AE. The impact of area-based initiatives on physical activity trends in deprived areas; a quasi-experimental evaluation of the Dutch District Approach. *I J Behav Nutr Phys Act* 2014;11:36.

Kramer D, Jongeneel-Grimen B, Stronks K, Droomers M, Kunst AE. Are area-based initiatives able to improve area safety in deprived areas? A quasi-experimental evaluation of the Dutch District Approach. [submitted for publication].

Kramer D, Harting J, Kunst AE. Understanding the impact of area-based interventions on area safety in deprived areas: realist evaluation of a neighbour nuisance intervention in Arnhem, the Netherlands. [submitted for publication].

Kramer D, Jongeneel-Grimen B, Stronks K, Bruggink JW, Kunst AE. Associations of changes in neighbourhood safety with leisure-time physical activity: evidence for the role of residential self-selection. [submitted for publication].

Kramer D, Lakerveld J, Stronks K, Kunst AE. Uncovering how area-based initiatives may stimulate leisure-time walking among adults in deprived areas: a realist review. [submitted for publication].

Articles not included in this thesis

Williams G, Mans DRA, Garssen J, Visser O, **Kramer D**, Kunst AE. Cancer incidence and mortality of Surinamese migrants in the Netherlands: in-between Surinamese and Dutch levels? *Cancer Cause Control* 2013;24:1375-1383.

Stronks K, Droomers M, Jongeneel-Grimen B, **Kramer D**, Hoefnagels C, Bruggink JW, van Oers JAM, Kunst AE. Een betere wijk, een betere gezondheid? Ontwikkelingen in

de gezondheid van bewoners van aandachtswijken tussen 2004-2011. [submitted for publication].

Droomers M, Jongeneel-Grimen B, **Kramer D**, de Vries S, Kremers SPJ, Bruggink JW, van Oers JAM, Kunst AE, Stronks K. The impact of intervening in green space in deprived Dutch neighborhoods on physical activity and general health. Results from the quasi-experimental URBAN40 study. [submitted for publication].

Jongeneel-Grimen B, Droomers M, **Kramer D**, Bruggink JW, van Oers JAM, Stronks K, Kunst AE. The impact of a Dutch area-based initiative on mental health trends: a quasi-experimental study. [submitted for publication].

Jongeneel-Grimen B, **Kramer D**, Droomers M, Bruggink JW, van Oers JAM, Stronks K, Kunst AE. The mental health impact of changes in neighbourhood safety. [submitted for publication].

Portfolio

PORTFOLIO

Name PhD candidate: Daniëlle Kramer
 PhD period: January 2012 – July 2014
 Name PhD supervisors: Prof. dr. K. Stronks
 Prof. dr. A.E. Kunst

| | Year | Workload (ECTS) ¹ |
|--|------|------------------------------|
| Courses, master classes, and trainings | | |
| Master class “Evaluation of public health interventions in real-life settings”, organised by University of Wageningen, Wageningen, the Netherlands | 2013 | 1 |
| Training “Realist review”, organised by SOPHIE, Barcelona, Spain | 2013 | 1 |
| Courses “Primary and secondary prevention research” and “Social epidemiology” as part of the Erasmus Summer Programme, organised by Erasmus MC, Rotterdam, The Netherlands | 2012 | 1.2 |
| Course “Career development”, organised by AMC Graduate School, Amsterdam, The Netherlands | 2014 | 1 |
| Seminars | | |
| “Beweegvriendelijke wijken”, organised by CEPHIR, Rotterdam, The Netherlands | 2013 | 0.1 |
| “Preventief verbinden”, organised by Academische Werkplaats SARPHATI, Amsterdam, the Netherlands | 2013 | 0.2 |
| “Social Mobility and Health Impacts of Urban Regeneration in Times of Crisis”, organised by TU Delft, Delft, the Netherlands | 2014 | 0.2 |
| “Overlast- en zorgoverleg in Arnhemse wijken; leerpunten voor succes”, Arnhem, The Netherlands + oral presentation | 2014 | 0.6 |
| (International) Conferences | | |
| Nederlands Congres voor de Volksgezondheid (NCVGZ), Amsterdam, The Netherlands | 2011 | 0.25 |
| Nederlands Congres voor de Volksgezondheid (NCVGZ), Amsterdam, The Netherlands + oral presentation | 2012 | 0.75 |

| | | |
|--|---------------|-----|
| HEPA Europe 4th conference, Helsinki, Finland + poster presentation | 2013 | 1 |
| ISBNPA conference, San Diego, United States of America + oral presentation | 2014 | 1.9 |
| Project meetings | | |
| Kick-off meeting SOPHIE, Brussels, Belgium | 2012 | 0.9 |
| Steering committee meeting SOPHIE, Barcelona, Spain | 2012 | 0.6 |
| Partnership meeting URBAN40, Amsterdam, The Netherlands + oral presentation | 2012 | 0.6 |
| Steering committee and advisory board meeting SOPHIE, Amsterdam, The Netherlands + oral presentation | 2013 | 1.2 |
| Partnership meeting URBAN40, Amsterdam, The Netherlands + oral presentation | 2013 | 0.6 |
| Teaching | | |
| Teaching workgroup "diagnostics of public health" to medical students of the AMC | 2012- 2014 | 0.7 |
| Assessing papers written by medical students of the AMC Honours Programme | 2012- 2014 | 0.4 |
| Peer reviewing | | |
| Preventive medicine | 2013 | 0.2 |
| Medicine & Science in Sports & Exercise | 2013 | 0.2 |
| American Journal of Public Health | 2013 | 0.1 |
| International Journal of Behavioral Nutrition and Physical Activity | 2013- 2014 | 0.1 |
| ¹ 1 ECTS = 28 hours. | | |