TITLE

Urban form and psychosocial factors: do they interact for leisure-time walking?

Short title: Urban form and walking

AUTHORS

Mariëlle A. Beenackers, PhD[1][*]

Carlijn B.M. Kamphuis, PhD[1]

Richard G. Prins, PhD[1]

Johan P. Mackenbach, MD, PhD[1]

Alex Burdorf, PhD[1]

Frank J. van Lenthe, PhD[1]

[1] Department of Public Health, Erasmus University Medical Center, Rotterdam, The Netherlands

[*] Corresponding author: Department of Public Health, Erasmus University Medical Center,

Rotterdam; PO Box 2040, 3000 CA Rotterdam, The Netherlands, Tel: +31-10-7043502, Fax:

+31-10-7038474, Email: m.beenackers@erasmusmc.nl

CONFLICT OF INTEREST

The authors declare there is no conflict of interest.

FUNDING

ABSTRACT

Introduction: This cross-sectional study uses an adaptation of a social-ecological model on the hierarchy of walking needs to explore direct associations and interactions of urban form characteristics and individual psychosocial factors for leisure-time walking.

Methods: Questionnaire data (n=736) from adults (25-74 years) and systematic field observations within 14 neighborhoods in Eindhoven (the Netherlands) were used. Multilevel logistic regression models were used to relate the urban form characteristics (accessibility, safety, comfort, pleasurability), and individual psychosocial factors (attitude, self-efficacy, social influence, intention) to two definitions of leisure-time walking, i.e. any leisure-time walking and sufficient leisure time walking according to the Dutch physical activity norm, and to explore their interactions.

Results:

Leisure-time walking was associated with psychosocial factors but not with characteristics of the urban environment. For sufficient leisure-time walking, interactions between attitude and several urban form characteristics were found that indicated that positive urban form characteristics contributed towards leisure-time walking only in residents with a less positive attitude towards physical activity. In contrast, living in a neighborhood that was accessible for walking was stronger associated with leisure-time walking among residents who experienced a positive social influence to engage in physical activity compared with those who reported less social influence.

Conclusion: This study showed some evidence for an interaction between the neighborhood environment and individual psychosocial factors in explaining leisure-time walking. The specific

mechanism of interaction may depend on the specific combination of psychosocial factor and environmental factor. The lack of association between urban form and leisure-time walking could be partly due to the little variation in urban form characteristics between neighborhoods.

INTRODUCTION

Paragraph #1: Physical inactivity is a major health concern in developed countries (4, 7, 8, 41). Leisure-time walking is promising as a focus for public health interventions to increase physical activity, since it is possible for the majority of the population, it does not require any financial means, and it can be continued into old age. Increasing walking in the population can therefore comprise a substantial public health gain (27).

Paragraph #2: Leisure-time walking is determined both by individual factors (e.g. attitudes or self-efficacy) and environmental factors (e.g. neighborhood aesthetics) (20, 26, 31, 32, 35, 44). Studies on environmental and individual determinants of walking pose at least two challenges (18). Firstly, not all environmental determinants may be equally important in the decision process underlying walking. While it seems not plausible that all neighborhood factors bear the same impact on the decision to walk, this relative importance has been studied rarely (16). This information is important to design neighborhoods that facilitate leisure-time walking. Secondly, the way in which environmental and individual factors interplay in determining walking is still poorly understood. Despite recognition of the social-ecological nature of walking (33), only few have studied the interplay between environmental and individual factors. In recent studies on interactions between environmental factors and individual psychosocial factors in leisure-time walking Carlson et al (5), Van Dyck et al (38) and Ding et al (13) found interactions in which a positive neighborhood environment contributed more to walking in persons with more negative psychosocial factors towards walking. Rhodes et al (30) on the other hand found a more synergistic relation between land-use mix and intention for walking, whereby the association between intention and walking was stronger in those perceiving closer access to recreation

facilities. Cerin et al (9) also studied leisure-time walking and did not find any interactions between neighborhood environment factors and self-efficacy or enjoyment. So far, the evidence on neighborhood-psychosocial interactions is emerging but still scarce and does not show a consistent pattern.

Paragraph #3: Alfonzo (2) described a framework on the hierarchy of walking needs that could provide guidance in addressing these two important challenges. Firstly, it proposes a hierarchy of urban form characteristics that are expected to influence walking behavior. The levels in the hierarchy are antecedents of each other so that a lower level need should be satisfactorily fulfilled before a higher order level is considered. Secondly, it places this hierarchy in a social-ecological perspective that provides concrete hypotheses on how the association between these urban form characteristics and walking could be influenced by individual factors.

Paragraph #4: The framework departs from the idea that walking is an individual choice, and identifies five levels of factors potentially and hierarchically involved in the walking decision-making process (see Figure 1). The most fundamental level within this "hierarchy of walking needs" is the ability of people to walk, labeled *feasibility*. The other four levels within the hierarchy relate to the urban form and are labeled, in order of importance, *accessibility*, *safety*, *comfort*, and *pleasurability*. The core assumption of the hierarchical structure is that higher order needs will not typically be considered if more basic needs have not yet been satisfied. The hierarchy also implies that the probability to walk will increase if more levels within the hierarchy are fulfilled. In addition however, what is considered satisfactory and how many levels need to be satisfactory to engage in walking is supposed to be moderated by individual

factors, e. g. psychosocial factors such as attitudes or self-efficacy. Alfonzo hypothesizes that when a person has less favorable psychosocial factors towards walking (e.g. is less motivated to walk), more levels within the hierarchy would need to be satisfactory to decide to walk.

<<< FIGURE 1 HERE >>>

Paragraph #5: The aim of this study is to explore how urban form characteristics and individual psychosocial factors are associated with leisure-time walking and to explore neighborhood-psychosocial interactions for leisure-time walking, following Alfonzo's framework on the hierarchy of walking needs.

METHODS

Design and data collection

Paragraph #6: This cross-sectional study used questionnaire data on potential individual correlates of walking that were collected as part of the fourth wave (October 2004) of the Dutch GLOBE study in a stratified sample of the adult population of the city of Eindhoven and its surrounding municipalities (N=6,377; response 64.4%). More detailed information on the objectives, study design, and data collection of the GLOBE study can be found elsewhere (25, 39, 40). In February 2006, objective neighborhood data were collected in 14 neighborhoods in the city of Eindhoven. To maximize variability in neighborhood characteristics, the data was collected in seven of the most deprived and seven of the most affluent neighborhoods, in which 814 study participants resided. Neighborhood socioeconomic status (SES) was based on the NIVEL (Netherlands institute for health services research) deprivation index which is calculated

from the proportion of economically non-active, average income per income earner, proximity index, and the proportion of residents from non-Western origin (37). The neighborhood was defined as the smallest geographical unit in the Netherlands created for statistical and administrative purposes. These neighborhoods have on average 2000 residents and vary in size between 0.5 and 1.0 km^2. Respondents for whom information on walking behavior was missing (n=37) or for whom more than a quarter of the values on the individual variables used in the analyses were missing (n=41) were omitted from the analyses. Thus, a total of 736 respondents were included, (mean number of respondents per neighborhood n=53, ranging from 20 to 95). Under the Dutch law for medical-scientific research (WMO), ethical approval of this type of non-invasive survey research is not required. The participants were not asked to actively sign an informed consent form but the background and objectives of the study were communicated on the first page of the questionnaire and in the accompanying invitation letter. Completion of the questionnaire was voluntary. The use of personal data in the GLOBE study is in compliance with the Dutch Personal Data Protection Act and the Municipal Database Act, and has been registered with the Dutch Data Protection Authority (number 1248943).

Measures

Leisure-time walking

Paragraph #7: Leisure-time walking was assessed by the SQUASH (Short Questionnaire to Assess Health-enhancing physical activity), a validated Dutch questionnaire that measures several specific types of physical activity, including leisure-time walking (43). Because of the skewed distribution of walking, the variable was dichotomized in two outcomes. The first dichotomous measure (labeled 'any leisure-time walking') indicated any participation in leisure-

time walking in a usual week: 'yes, does walk during leisure-time (1)', versus 'no, does not walk at all during leisure-time (0)'. The second dichotomous outcome (labeled 'sufficient leisure-time walking') indicated whether someone walked sufficiently to reach the Dutch physical activity norm (23) of at least 5 days a week for at least 30 minutes a day. This outcome measure was coded as 'yes, walks 5 days or more a week for at least 30 minutes a day (1)' and 'no, does not walk, or walks less than 5 days a week for at least 30 minutes a day (0).

Individual psychosocial factors

Paragraph #8: Individual psychosocial factors were based on theories such as the Theory of Planned Behavior (TPB) (1),the Social Cognitive Theory (SCT) (3), and the Attitude, Social Influence, self-Efficacy (ASE) model (11, 24). The latter model integrates concepts of both the TPB and the SCT. Attitude (eleven items, Cronbach's alpha=0.79), self-efficacy (two items, Cronbach's alpha=0.80), and intention (one item) towards sufficient physical activity were measured on a five-point ordinal scale, and social influence on sufficient physical activity (three items referring to social norms, social support and modeling, Cronbach's alpha=0.72) was measured on a three-point ordinal scale. They were all formulated towards 'sufficient physical activity in line with recommended levels'. An overview of the items can be found in Supplemental Digital Content 1. For all psychosocial factors (except intention) a mean score was calculated. A higher score on each scale represented a more positive psychosocial factor towards physical activity.

Feasibility

Paragraph #9: Feasibility, the bottom layer of Alfonzo's hierarchy of walking and an individual indicator of whether someone is able to walk or not, was operationalized using the question 'Are

you able to walk for 400 meters at once, without stopping (if necessary with a walking aid)?'. Respondents who indicated they were able with no or little difficulty were coded as 'walking is feasible'. Respondents who indicated that they were not able or with great difficulty were coded as 'walking is not feasible'.

Urban form

Paragraph #10: Information about the four 'urban form' levels of the hierarchy of walking needs (accessibility, safety, comfort, and pleasurability) was obtained by field observations in February 2006. An environmental audit tool, which was based on other instruments (6, 10, 29, 42, 46), was used for this purpose. Its development has been described in more detail elsewhere (21, 22). Briefly, for each neighborhood, 10% of the total number of streets in the neighborhood was randomly selected, with a minimum of three streets per neighborhood. It resulted in a total of 75 audited streets. Inter-rater reliability was moderate to good (34) ranging from 67% to 97% with a mean of 78%. The scores on the street level items were aggregated to obtain the scores per neighborhood for each item.

Paragraph #11: The first urban form level, *accessibility*, is defined by Alfonzo to reflect "the pattern, quantity, quality, variety and proximity of activities present, as well as the connectivity between the uses"(2, 19). Accessibility in terms of access to facilities is not strongly associated with leisure-time walking (19, 31). There is stronger evidence for the association between walking infrastructure and leisure-time walking (31). Therefore, *accessibility* was operationalized in this study by two items measuring the presence and the quality of the available sidewalks (Cronbach's alpha=0.57). The second urban form level, *safety*, defined by Alfonzo as whether a person feels safe from the threat of crime (2), was operationalized by eight items that

indicated either presence of incivilities or disorder (the presence of graffiti, litter on the streets, signs of alcohol or drugs) or physical features that would provide surveillance of the street (houses for sale, empty houses, street lighting, the height of fences, and the visibility of the street from surrounding houses) (Cronbach's alpha=0.73). These items are thought to influence safety from crime or fear of crime (15, 45). The third urban form level, *comfort*, was defined by Alfonzo as the "level of ease, convenience, and contentment' of a person and includes traffic safety (2). Because of lack of information on other comfort elements such as benches and canopies, *comfort* was operationalized as traffic safety by four items (the presence of traffic signs, crossovers, and speed bumps and whether traffic was through traffic or only destination traffic) (Cronbach's alpha=0.72). The final urban form level, *pleasurability*, was defined by Alfonzo as "the level of appeal that a setting provides with respect to a person's walking experience"(2). It was operationalized by six items on the aesthetics of the neighborhood (maintenance of best building, maintenance of worst buildings, whether there are gardens with all houses, maintenance of the best maintained gardens, green diversity, and green maintenance) (Cronbach's alpha=0.86) (28). More details on the items used to construct the urban form level scales can be found in Supplemental Digital Content 2).

Hierarchy score

Paragraph #12: To test whether the urban form levels were ordered hierarchically, as the theoretical model suggests, a hierarchy score was constructed. First, all urban form characteristics were dichotomized (1=highest three quartiles, 0=lowest quartile). These dichotomies were used to construct the hierarchy score that runs from 0 (none of the urban form levels within the highest three quartiles) to 4 (all urban form levels within the highest three quartiles). A neighborhood could only proceed to a higher hierarchy score when all lower level

urban form levels were also 'high' (within the highest three quartiles). For example, a hierarchy score of '2' would indicate that the lowest two levels (accessibility and safety) received as score 'high" and that the third level (comfort) in the neighborhood would have a 'low' score. A score of 2 does not give information on the highest level in the hierarchy (pleasurability). Neighborhoods with the same hierarchy level score are allowed to vary with respect to the higher order urban form levels. The sensitivity of the definition of the hierarchy score was investigated by using different cut-off values (tertile, median). The results remained similar..

Demographics

Paragraph #13: Potential confounders included were gender, age, country of origin (the Netherlands, other country), and educational level ((1) no education or primary education; (2) lower professional and intermediate general education; (3) intermediate professional and higher general education; (4) higher professional education and university; or (5) missing). Educational level was included as an indicator for socio-economic status (SES) and has proven to be a good measure for SES in the Netherlands (36).

Statistical analyses

Paragraph #14: In the included sample (n=736), there were a total of 4% missing values varying from less than 1% to 10% for each variable. Since complete case analyses would result in a loss of 27% of the cases, these missing values were imputed using the EM method (12) from PASW version 18.0. All individual level variables described in the method section (individual psychosocial factors, demographics, feasibility, and leisure-time walking) were used in the imputation model.

Paragraph #15: First, characteristics of the sample of residents of the deprived and affluent neighborhoods were described by neighborhood SES. Secondly, the estimates (0-1) of the urban form characteristics and percentage of walking were calculated in each of the included neighborhoods. Subsequently, multilevel logistic regressions models were used to relate the psychosocial factors, the urban form characteristics, and the hierarchy score to both measures of leisure-time walking. Separate models were used to test the associations of each of the ten included variables with each of the two outcome measures. All models accounted for the hierarchical structure of the data by allowing intercepts to vary across neighborhoods. The adjusted models were adjusted for age, gender, educational level, country of origin, and feasibility of walking. Interactions of individual psychosocial factors with urban form characteristics or with the hierarchy score were tested in separate models, by adding the interaction term between a certain psychosocial factor and urban form characteristics to the adjusted model with the same psychosocial factor and urban form characteristic. A total of 20 interaction models were tested (four psychosocial factors times five urban form characteristics (four levels + the hierarchy score)). For the interaction of an psychosocial factor and the hierarchy score, dummy variables were created to study the interaction. To facilitate interpretation of the interactions, the psychosocial factors and the urban form characteristics were standardized (mean= 0, standard deviation=1). Significance throughout this study was interpreted using the 95% confidence interval (CI). All analyses were carried out in STATA 12.

RESULTS

Paragraph #16: Table 1 shows the characteristics of the total sample and according to neighborhood SES. A total of 63.7% of the sample participated in any leisure-time walking and 20.8% walked sufficiently during leisure-time to reach the Dutch physical activity norm of at

least 5 days a week for at least 30 minutes a day. The large majority was able to walk for 400 meters without stopping (94.3%). In the low SES neighborhoods, a higher percentage of people were unable to walk (7.8%) as compared with the high SES neighborhoods. All urban form characteristics were more positive in the high SES neighborhoods although only 'pleasurability' was significantly different between the low and the high SES neighborhoods. Residents in high SES neighborhoods reported more positive psychosocial factors towards sufficient physical activity than those residing in low SES neighborhoods.

<<< TABLE 1 HERE >>>

Paragraph #17: Table 2 shows the estimates of urban form characteristics and percentage of walking in each of the included neighborhoods. With few exceptions, all neighborhood scores for accessibility, safety, and comfort were well above 0.5 on our score from 0 to 1 (median 0.74-0.75). Pleasurability showed most diversity with almost half of the neighborhoods scoring below 0.5 (median 0.51, IQR 0.37-0.60).

<<< TABLE 2 HERE >>>

<<< TABLE 3 HERE >>>

Paragraph #18: Table 3 shows the crude and adjusted results of the multilevel logistic regression models for any leisure-time walking and for sufficient leisure-time walking. After adjustment for demographic covariates and feasibility of walking, self-efficacy (OR 1.23, 95%CI 1.04-1.46) and

intention (OR 1.31, 95%CI 1.12-1.54) were positively associated with any leisure-time walking. These associations were stronger for sufficient leisure-time walking as outcome (self-efficacy: OR 1.65, 95%CI 1.32-2.07, intention: OR 1.48, 95%CI 1.20-1.82). Also a more positive attitude (OR 1.37, 95%CI 1.13-1.66) and more encouraging perceived social influence towards PA (OR 1.24, 95%CI 1.03-1.51) were significantly associated with sufficient leisure-time walking. The separate urban form characteristics were not associated with the walking measures, and neither was the constructed hierarchy score.

Paragraph #19: Two interactions of urban form characteristics with individual psychosocial factors were observed for sufficient leisure-time walking. The association between accessibility and sufficient leisure-time walking was more positive in those who perceived more encouraging social influence towards PA (OR 1.20, 95%CI 1.00-1.43; figure 2). The association between comfort and sufficient leisure-time walking was more positive for those with a less positive attitude towards physical activity (OR 0.81, 95%CI 0.66-0.99; figure 3). Additionally, borderline significant (p<.10) interactions were found between attitude and the other urban form characteristics (attitude*accessibility: OR 0.84, 95%CI 0.69-1.02, attitude*safety: OR 0.83, 95%CI 0.69-1.00, attitude*pleasurability: OR 0.85, 95%CI 0.70-1.02). Although not reaching statistical significance, these interactions were in the same direction: the association between the urban form characteristic and sufficient leisure-time walking became more positive when the psychosocial factor towards physical activity was less positive. With regard to any leisure-time walking, no significant interactions between urban form characteristics and psychosocial factors or between the hierarchy score and psychosocial factors were found. Detailed results from the

multilevel regression models that included the interaction terms can be found in Supplemental Digital Content 3.

<<< FIGURE 2 HERE >>>

<<< FIGURE 3 HERE >>>

DISCUSSION

Paragraph #20: This study applied a hierarchical social-ecological perspective to leisure-time walking (2) and found that positive urban form characteristics contributed towards leisure-time walking more in residents with a less positive attitude towards physical activity. In contrast, living in a neighborhood that was accessible for walking was stronger associated with leisure-time walking among residents who experienced a more positive social influence to engage in physical activity compared with those who reported less social influence. No evidence for an urban form hierarchy was found.

Paragraph #21: The results partly support the proposed idea that psychosocial factors may moderate the association between urban form and leisure-time walking in such a way that the urban form lay-out is less important among those with more positive psychosocial factors. We found several interactions in this direction between attitude and urban form characteristics for sufficient leisure-time walking. Of the few studies that are more or less comparable to our study the results of Ding et al (13) also indicate that the association between neighborhood factors and leisure-time walking is stronger in those with unfavorable psychosocial factors, which is in line with our results for the interaction with attitude. Similarly, Carlson and colleagues found that the presence of walking facilities was only associated with more leisure-time walking when self-

efficacy was low (5).In contrast, we found a stronger association between urban accessibility and sufficient leisure-time walking among those with more supportive social influences for physical activity, which is in line with most other interactions found by Carlson and colleagues although these interactions were for other PA outcomes than leisure-time walking (5). To conclude, our study is in concordance with the results from Ding et al and Carlson et al and provides evidence for interactions as proposed by the model (i.e. that the environment is less important for physical activity among those with more positive psychosocial factors). However, it also provides evidence for interactions in the other direction (i.e. that the environment is more important among those with positive psychosocial factors) indicating that both mechanisms may be at play, depending on the specific combination of psychosocial factor and environmental factor. For our second outcome, any leisure-time walking, no significant interactions were found, which could imply that interactions between individual and neighborhood factors are not so important for any leisure-time walking, but do matter and should be further explored for public health relevant outcomes like sufficient leisure-time walking.

Paragraph #22: The results did not confirm the idea proposed in Alfonzo's model (2) that urban form characteristics would follow a hierarchy in their association with leisure-time walking, as in the first place, no associations between urban form characteristics and leisure-time walking were found. A possible explanation could be that, despite our efforts to maximize variability, the urban form characteristics did not vary much across deprived and affluent neighborhoods and were generally favorable. This low variability in neighborhood design may be typical for Dutch urban areas. The Netherlands is a very dense country with very good walking and cycling infrastructure and a flat topography. Because of these favorable environmental conditions, small

differences between neighborhoods may hamper finding any associations between objective environmental factors and walking behavior. As this situation seems rather specific to the Netherlands, studies in regions with less favorable neighborhood designs and more variation between neighborhoods should be conducted to test the proposed hierarchy.

Study limitations and strengths

Paragraph #23: The results of this study should be interpreted considering some limitations. First, the cross-sectional design impairs conclusions about causality for both the direct associations as the interactions. Second, the questions regarding the individual psychosocial factors were formulated towards 'sufficient physical activity' instead of walking. This has possibly underestimated the association with leisure-time walking. Third, the neighborhood observations took place well over a year after the postal survey. The urban innovation plans from the city of Eindhoven revealed no large urban renovations in the included neighborhoods within the time frame of the study, which strengthens our assumption that the neighborhoods have been comparable at these time points. However, some items in the safety and pleasurability scales are more transient features of the neighborhood environment, such as litter, graffiti, and maintenance of gardens, which could have resulted in some mismatch between environment and behavior. Lastly, physical activity behavior was self-reported, and we did not collect information on walking for transport, which restricted our analyses to leisure-time walking. Although this does not limit the interpretation of our results for leisure-time walking, it would be interesting to study this theoretical model with respect to walking for transport as well in future studies. Additionally, the self-report measure did not include a question on *where* the leisure-time walking took place. This limits the interpretation of the results, since those who reported to walk

could have walked most often elsewhere and, therefore, less susceptible to be influences by the urban form of their neighborhood.

Paragraph #24: The objective assessment of neighborhood factors is considered a major strength of this study since it warranted the absence of same-source bias and reporting bias that can arise when people who walk more in their neighborhood are more aware of their neighborhood. The instrument was based on previous instruments (6, 10, 29, 42, 46) and showed adequate inter-rater reliability and internal consistent reliability. However, construct validity of the used environmental audit is unknown and it is likely that not all relevant elements of each of the hierarchy levels were included in our operationalization. Other elements of the neighbourhood environment that were not operationalized could also be important for leisure-time walking. Another strength was the selection of both deprived and affluent neighborhoods that aimed to optimize the variability of the neighborhood factors. Previous studies show that neighborhoods with lower SES have less favorable neighborhood characteristics compared with neighborhoods with a higher socioeconomic status (14, 17), although this was not found in the city of Eindhoven. Because of the focus of this paper on between-neighborhood variability, the within neighborhood variability was not considered. If neighborhood characteristics are measured on a more individual or street level, this could increase variation and therefore understanding of individual behavior. However, it is also important to understand the between neighborhood variation, as policies are mainly based on between neighborhood variances. Therefore, increasing variability by including different cities or even different countries may provide useful entry points for policies and interventions.

Conclusion

Paragraph #25: To conclude, this study provided some evidence for interactions between the neighborhood environment and individual psychosocial factors in the decision making process for leisure-time walking. The study provided some evidence for a mechanism in which the benefits of a favorable neighborhood environment for leisure-time walking are larger for those who are less motivated to walk but also for a mechanism in which a positive physical neighborhood environment and a positive psychosocial factor can reinforce each other. The specific mechanism may depend on the specific combination of psychosocial factor and environmental factor. The lack of direct association between urban form and leisure-time walking may be partly due to little variation in urban form characteristics between neighborhoods. This study should be replicated in other countries to gain more insight in the interplay between individual and neighborhood factors for walking, and to test whether neighborhood factors act upon walking behavior following the hierarchical structure as specified by Alfonzo (2).

ACKNOWLEDGEMENTS

REFERENCES

1   Ajzen I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* 1991;50(2):179-211.

2   Alfonzo MA. To Walk or Not to Walk? The Hierarchy of Walking Needs. *Environment and Behavior*. 2005;37(6):808-36.

3   Bandura A. *Social foundations of thought and action: A social cognitive theory*. Prentice Hall, Englewood Cliffs, NJ; 1986, 617 p.

4   Bauman AE. Updating the evidence that physical activity is good for health: an epidemiological review 2000–2003. *J. Sci. Med. Sport*. 2004;7(1, Supplement 1):6-19.

5   Carlson JA, Sallis JF, Conway TL, Saelens BE, Frank LD, Kerr J, Cain KL, and King AC. Interactions between psychosocial and built environment factors in explaining older adults' physical activity. *Prev. Med.* 2012;54(1):68-73.

6   Caughy MO, O'Campo PJ, and Patterson J. A brief observational measure for urban neighborhoods. *Health Place*. 2001;7(3):225-36.

7   Centers for Disease Control and Prevention. *Physical activity and health: a report of the Surgeon General*. Washington DC: U.S. Department of Health and Human services; 1996, 278 p.

8   Centers for Disease Control and Prevention. Physical activity and fitness. National Health Interview Survey (NHIS) [Internet]. 2008 [cited 2011 April 29]. Available from: http://wonder.cdc.gov/data2010/.

9   Cerin E, Vandelanotte C, Leslie E, and Merom D. Recreational facilities and leisure-time physical activity: An analysis of moderators and self-efficacy as a mediator. *Health Psychol.* 2008;27(2 Suppl):26-35.

10   Day K, Boarnet M, Alfonzo M, and Forsyth A. The Irvine–Minnesota Inventory to Measure Built Environments: Development. *Am. J. Prev. Med.* 2006;30(2):144-52.

11   de Vries H, Dijkstra M, and Kuhlman P. Self-efficacy: the third factor besides attitude and subjective norm as a predictor of behavioural intentions. *Health Educ. Res.* 1988;3(3):273-82.

12   Dempster AP, Laird NM, and Rubin DB. Maximum likelihood from incomplete data via the EM algorithm. *J Roy Stat Soc B Met.* 1977;39(1):1-38.

13   Ding D, Sallis JF, Conway TL, Saelens BE, Frank LD, Cain KL, and Slymen DJ. Interactive effects of built environment and psychosocial attributes on physical activity: a test of ecological models. *Ann. Behav. Med.* 2012;44(3):365-74.

14   Estabrooks PA, Lee RE, and Gyurcsik NC. Resources for physical activity participation: does availability and accessibility differ by neighborhood socioeconomic status? *Ann. Behav. Med.* 2003;25(2):100-4.

15   Foster S, Giles-Corti B, and Knuiman M. Neighbourhood design and fear of crime: a social-ecological examination of the correlates of residents' fear in new suburban housing developments. *Health Place*. 2010;16(6):1156-65.

16   Frank LD, Kerr J, Sallis JF, Miles R, and Chapman J. A hierarchy of sociodemographic and environmental correlates of walking and obesity. *Prev. Med.* 2008;47(2):172-8.

17   Franzini L, Taylor W, Elliott MN, Cuccaro P, Tortolero SR, Janice Gilliland M, Grunbaum J, and Schuster MA. Neighborhood characteristics favorable to outdoor physical activity: disparities by socioeconomic and racial/ethnic composition. *Health Place*. 2010;16(2):267-74.

18   Giles-Corti B, Timperio A, Bull F, and Pikora T. Understanding physical activity environmental correlates: increased specificity for ecological models. *Exerc. Sport Sci. Rev.* 2005;33(4):175-81.

19   Handy SL. Understanding the Link Between Urban Form and Nonwork Travel Behavior. *Journal of Planning Education and Research*. 1996;15(3):183-98.

20   Humpel N, Owen N, and Leslie E. Environmental factors associated with adults' participation in physical activity: a review. *Am. J. Prev. Med.* 2002;22(3):188-99.

21   Kamphuis CBM. Explaining socioeconomic inequalities in health behaviours - the role of environmental factors. Rotterdam: Erasmus University Medical Centre; 2008. 290 p.

22   Kamphuis CBM, Mackenbach JP, Giskes K, Huisman M, Brug J, and van Lenthe FJ. Why do poor people perceive poor neighbourhoods? The role of objective neighbourhood features and psychosocial factors. *Health Place*. 2010;16(4):744-54.

23   Kemper HCG, Ooijendijk WTM, and Stiggelbout M. Consensus about the Dutch recommendation for physical activity to promote health [Consensus over de Nederlandse Norm voor Gezond Bewegen]. *Tijdschrift voor Gezondheidswetenschappen*. 2000;78:180-3.

24   Kok G, de Vries H, Mudde AN, and Strecher VJ. Planned health education and the role of self-efficacy: Dutch research. *Health Educ. Res.* 1991;6(2):231-8.

25   Mackenbach JP, van de Mheen H, and Stronks K. A prospective cohort study investigating the explanation of socio-economic inequalities in health in the Netherlands. *Soc. Sci. Med.* 1994;38(2):299-308.

26   Owen N, Humpel N, Leslie E, Bauman A, and Sallis JF. Understanding environmental influences on walking: Review and research agenda. *Am. J. Prev. Med.* 2004;27(1):67-76.

27   Physical Activity Guidelines Advisory Committee. *Physical activity guidelines advisory committee report, 2008*. Washington, DC: U.S. Department of Health and Human Services; 2008, 683 p.

28   Pikora T, Giles-Corti B, Bull F, Jamrozik K, and Donovan R. Developing a framework for assessment of the environmental determinants of walking and cycling. *Soc. Sci. Med.* 2003;56(8):1693-703.

29   Pikora TJ, Bull FC, Jamrozik K, Knuiman M, Giles-Corti B, and Donovan RJ. Developing a reliable audit instrument to measure the physical environment for physical activity. *Am. J. Prev. Med.* 2002;23(3):187-94.

30   Rhodes RE, Brown SG, and McIntyre CA. Integrating the perceived neighborhood environment and the theory of planned behavior when predicting walking in a Canadian adult sample. *Am. J. Health Promot.* 2006;21(2):110-8.

31   Saelens BE, and Handy SL. Built environment correlates of walking: a review. *Med. Sci. Sports Exerc.* 2008;40(7 Suppl):S550-66.

32   Saelens BE, Sallis JF, and Frank LD. Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Ann. Behav. Med.* 2003;25(2):80-91.

33   Sallis JF, and Owen N. Ecological Models of Health Behavior. In: K Glanz, BK Rimer and FM Lewis editors. *Health Behavior and Health Educaton. Theory, Research, and Practice*. San Fransisco: Jossey-Bass; 2002, pp. 462-84.

34   Stemler SE. A comparison of consensus, consistency, and measurement approaches to estimating interrater reliability. Practical Assessment, Research & Evaluation [Internet]. 2004 [cited 2012 May 21];9(4). Available from: http://pareonline.net/getvn.asp?v=9&n=4.

35   Trost SG, Owen N, Bauman AE, Sallis JF, and Brown W. Correlates of adults' participation in physical activity: review and update. *Med. Sci. Sports Exerc.* 2002;34(12):1996-2001.

36   van Berkel-van Schaik AB, and Tax B. *Towards a standard operationalisation of socioeconomic status for epidemiological and socio-medical research [Naar een standaardoperationalisatie van sociaal-economische status voor epidemiologisch en sociaal-medisch onderzoek]*. Rijswijk: Ministerie van Welzijn, Volksgezondheid en Cultuur1990. 129 p. Available from: Ministerie van Welzijn, Volksgezondheid en Cultuur.

37   van der Velden J, Rash P, and Reijneveld SA. Identification of deprived areas. A system for the distribution of extra resources to general practitioners [Identificatie van achterstandsgebieden. Een systematiek voor de verdeling van extra middelen aan huisartsen]. *Ned. Tijdschr. Geneeskd.* 1997;141(14):693-7.

38   Van Dyck D, Deforche B, Cardon G, and De Bourdeaudhuij I. Neighbourhood walkability and its particular importance for adults with a preference for passive transport. *Health Place*. 2009;15(2):496-504.

39   van Lenthe FJ, Kamphuis CB, Beenackers MA, Jansen T, Looman CW, Nusselder WJ, and Mackenbach JP. Cohort Profile: Understanding socioeconomic inequalities in health and health behaviours: The GLOBE study. *Int. J. Epidemiol.* 2013.

40   van Lenthe FJ, Schrijvers CTM, Droomers M, Joung IMA, Louwman MJ, and Mackenbach JP. Investigating explanations of socio-economic inequalities in health: the Dutch GLOBE study. *Eur. J. Public Health*. 2004;14(1):63-70.

41   Warburton DE, Nicol CW, and Bredin SS. Health benefits of physical activity: the evidence. *Can. Med. Assoc. J.* 2006;174(6):801-9.

42   Weich S, Burton E, Blanchard M, Prince M, Sproston K, and Erens B. Measuring the built environment: validity of a site survey instrument for use in urban settings. *Health Place*. 2001;7(4):283-92.

43   Wendel-Vos GCW, Schuit AJ, Saris WHM, and Kromhout D. Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. *J. Clin. Epidemiol.* 2003;56(12):1163-69.

44   Wendel-Vos W, Droomers M, Kremers S, Brug J, and van Lenthe F. Potential environmental determinants of physical activity in adults: a systematic review. *Obes. Rev.* 2007;8(5):425-40.

45   Wood L, Shannon T, Bulsara M, Pikora T, McCormack G, and Giles-Corti B. The anatomy of the safe and social suburb: an exploratory study of the built environment, social capital and residents' perceptions of safety. *Health Place*. 2008;14(1):15-31.

46   Zenk SN, Schulz AJ, Mentz G, House JS, Gravlee CC, Miranda PY, Miller P, and Kannan S. Inter-rater and test–retest reliability: Methods and results for the neighborhood observational checklist. *Health Place*. 2007;13(2):452-65.

APPENDICES

Supplemental Digital Content 1:   Table S1: Measurement of individual psychosocial factors in the Dutch GLOBE postal survey 2004

Supplemental Digital Content 2:   Table S2: Measurement and inter-rater reliability of urban form characteristics in the 2006 neighborhood observations in the Dutch GLOBE study.

Supplemental Digital Content 3:   Table S3-A: Associations of <u>any leisure-time walking</u> with urban form characteristics, psychosocial factors and their interaction.

Table S3-B: Associations of <u>sufficient leisure-time walking</u> with urban form characteristics, psychosocial factors and their interaction.

LIST OF FIGURE CAPTIONS

Figure 1:   Hierarchy of walking needs (adaptation from Alfonzo (2005))

Figure 2:   Simple slopes for the interaction between neighborhood accessibility and social

influence in explaining sufficient leisure-time walking.

Note: The odds ratio (OR) for an interaction term can be interpreted as a

multiplicative factor. To obtain the OR for 'accessibility' in each of the categories of

'social influence' we multiplied the OR of the interaction term with the OR of social

influence in the reference category (mean).

Figure 3:   Simple slopes for the interaction between neighborhood comfort and attitude in

explaining sufficient leisure-time walking.

Note: The odds ratio (OR) for an interaction term can be interpreted as a

multiplicative factor. To obtain the OR for 'comfort' in each of the categories of

'attitude' we multiplied the OR of the interaction term with the OR of attitude in the

reference category (mean).

Table 1: Characteristics of the GLOBE study according to neighborhood SES (n=736).

Characteristics	Total (n=736) %	7 low SES neighborhoods (n=345) %	7 high SES neighborhoods (n=391) %	p-value
Neighborhood SES				
Low	46.9%	100%		
High	53.1%		100%	
Any leisure-time walking				
No	36.3%	37.4%	35.3%	
Yes	63.7%	62.6%	64.7%	.555 [b]
Sufficient leisure-time walking [a]				
No	79.2%	77.1%	81.1%	
Yes	20.8%	22.9%	18.9%	.185 [b]
Gender				
Male	46.7%	44.6%	48.6%	
Female	53.3%	55.4%	51.4%	.283 [b]
Age				
mean (sd)	*55 (15)*	*59 (16)*	*52 (14)*	**.000** [c]
25-34	10.7%	9.9%	11.5%	
35-44	19.6%	14.5%	24.0%	
45-54	16.3%	10.4%	21.5%	
55-64	22.3%	21.7%	22.8%	
65-75	20.5%	26.4%	15.4%	
75+	10.6%	17.1%	4.9%	
Education				
1 Low	9.9%	16.2%	4.4%	

2	35.5%	43.8%	28.1%	
3	21.7%	13.9%	28.6%	
4 High	26.6%	18.0%	34.3%	
missing	*6.3%*	*8.1%*	*4.6%*	**.000** [b]
Country of origin				
Netherlands	91.6%	91.6%	91.6%	
Other	8.4%	8.4%	8.4%	.987 [b]
Feasibility of walking				
Able to walk 400m	94.3%	92.2%	96.2%	
Not able to walk 400m	5.7%	7.8%	3.8%	**.020** [b]
Psychosocial factors	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	
Attitude (1-5)	3.71 (0.57)	3.59 (0.59)	3.81 (0.53)	**<.000** [c]
Self-efficacy (1-5)	3.70 (0.98)	3.53 (1.06)	3.85 (0.87)	**<.000** [c]
Social influence (1-3)	2.32 (0.59)	2.26 (0.59)	2.37 (0.59)	**.013** [c]
Intention (1-5)	3.94 (1.13)	3.74 (1.21)	4.12 (1.02)	**<.000** [c]
Urban form characteristics				
Accessibility (0-1)	0.72 (0.19)	0.67 (0.05)	0.76 (0.25)	.468 [d]
Safety (0-1)	0.77 (0.10)	0.70 (0.05)	0.83 (0.10)	.070 [d]
Comfort (0-1)	0.72 (0.16)	0.65 (0.18)	0.77 (0.13)	.641 [d]
Pleasurability (0-1)	0.54 (0.19)	0.42 (0.12)	0.64 (0.19)	**.041** [d]

[a] Five or more days a week for at least 30 minutes of physical activity a day.

[b] p-value calculated by means of chi-square, using the individual as the level of measurement.

[c] p-value calculated by an independent t-test, using the individual as the level of measurement.

[d] p-value calculated by an independent t-test, using the neighborhoods as the level of measurement.

Table 2: Urban form characteristics and leisure-time walking in 14 neighborhoods, stratified by socio-economic status.

Neighborhood	n [a]	Accessibility (0-1)	Safety (0-1)	Comfort (0-1)	Pleasurability (0-1)	Hierarchy score [b] (0-4)	Any leisure-time walking (% yes)	Sufficient leisure-time walking [c] (% yes)
High SES neighborhoods						Mean: 2.29		
Achtse Barrier – Guntselaer	71	0.25	0.85	0.75	0.61	0	57.8	19.7
Achtse Barrier – Spaaihoef	64	0.90	0.88	0.95	0.67	4	53.1	20.3
Eliasterrein – Vonderkwartier	47	0.80	0.66	0.90	0.26	1	76.6	14.9
Blixembosch-Oost	93	1.00	0.94	0.78	0.88	4	66.7	24.7
Gijzenrooi	37	0.78	0.88	0.75	0.77	4	78.4	16.2
Heesterakker	49	0.80	0.75	0.55	0.53	2	63.3	12.2
Irisbuurt	30	0.80	0.68	0.60	0.51	1	66.7	16.7
Low SES neighborhoods						Mean: 1.86		
Blaarthem	41	0.70	0.63	0.80	0.26	1	61.0	9.7
Hagenkamp	37	0.70	0.78	0.65	0.58	4	64.9	18.9
Kronehoef	64	0.70	0.73	0.35	0.50	2	54.7	15.6
Sintenbuurt	23	0.70	0.70	0.85	0.37	3	47.8	4.4
Tivoli	20	0.80	0.73	1.00	0.13	3	60.0	40.0

Vlokhoven	65	0.60	0.75	0.60	0.38	0	64.6	27.7
Woenselse Heide	95	0.64	0.66	0.71	0.48	0	70.5	32.6
Neighborhood median (IQR)		0.74 (0.70-0.80)	0.74 (0.68-0.83)	0.75 (0.61-0.84)	0.51 (0.37-0.60)			

a. Number of surveyed residents in each neighborhood

b. Interpretation of hierarchy level scores:

- *0*: neighborhood does not have a high level for 'accessibility' (and the level of other characteristics varies);

- *1:* neighborhood has a high level for 'accessibility', but not for 'safety' (and the level of 'comfort' and 'pleasurability' varies);

- *2*: neighborhood has a high level for 'accessibility' and 'safety', but not for 'comfort' (and the level of 'pleasurability' varies);

- *3:* neighborhood has a high level for 'accessibility', 'safety' and 'comfort', but not for 'pleasurability;

- *4:* neighborhood has a high level for all four neighborhood characteristics.

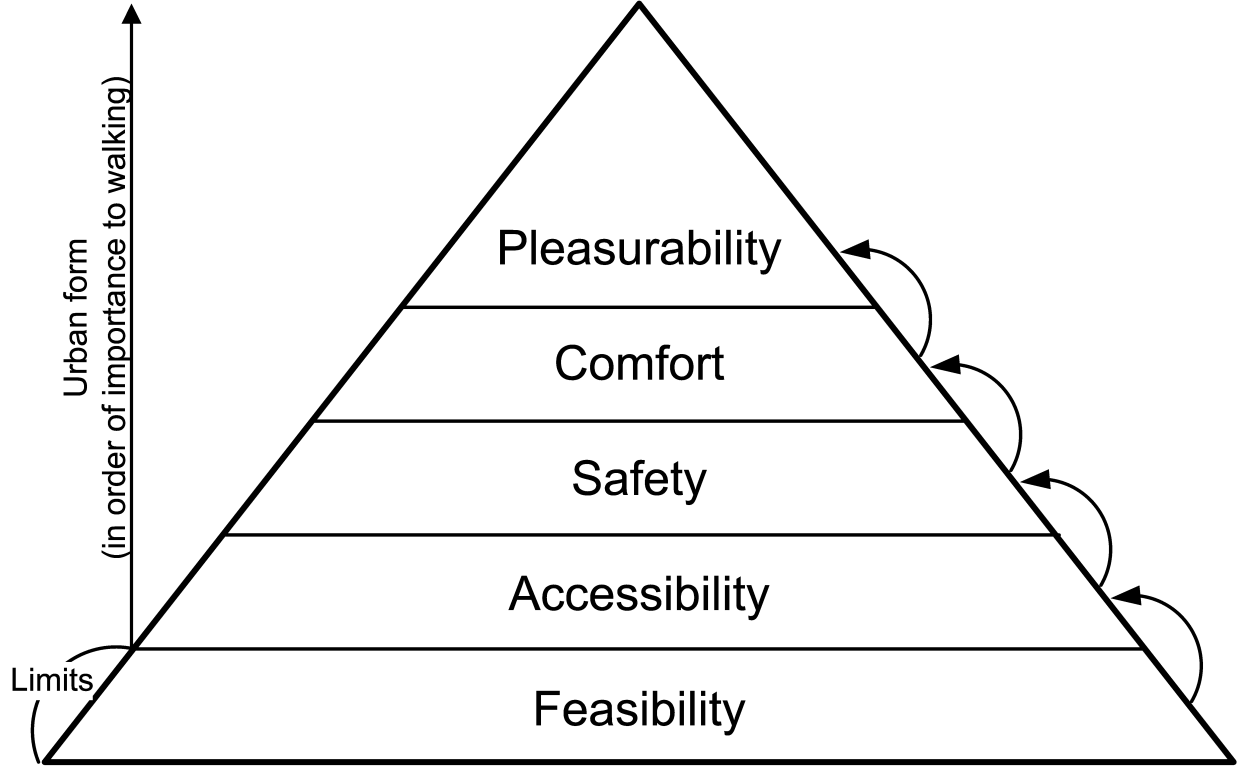- *Note: a high level is defined as a value within the top three quartiles.*

c. Five or more days a week with at least 30 minutes of physical activity a day.

Table 3: Crude and adjusted odds ratios (OR) for sufficient leisure-time walking [a] and any leisure-time walking (n=736).
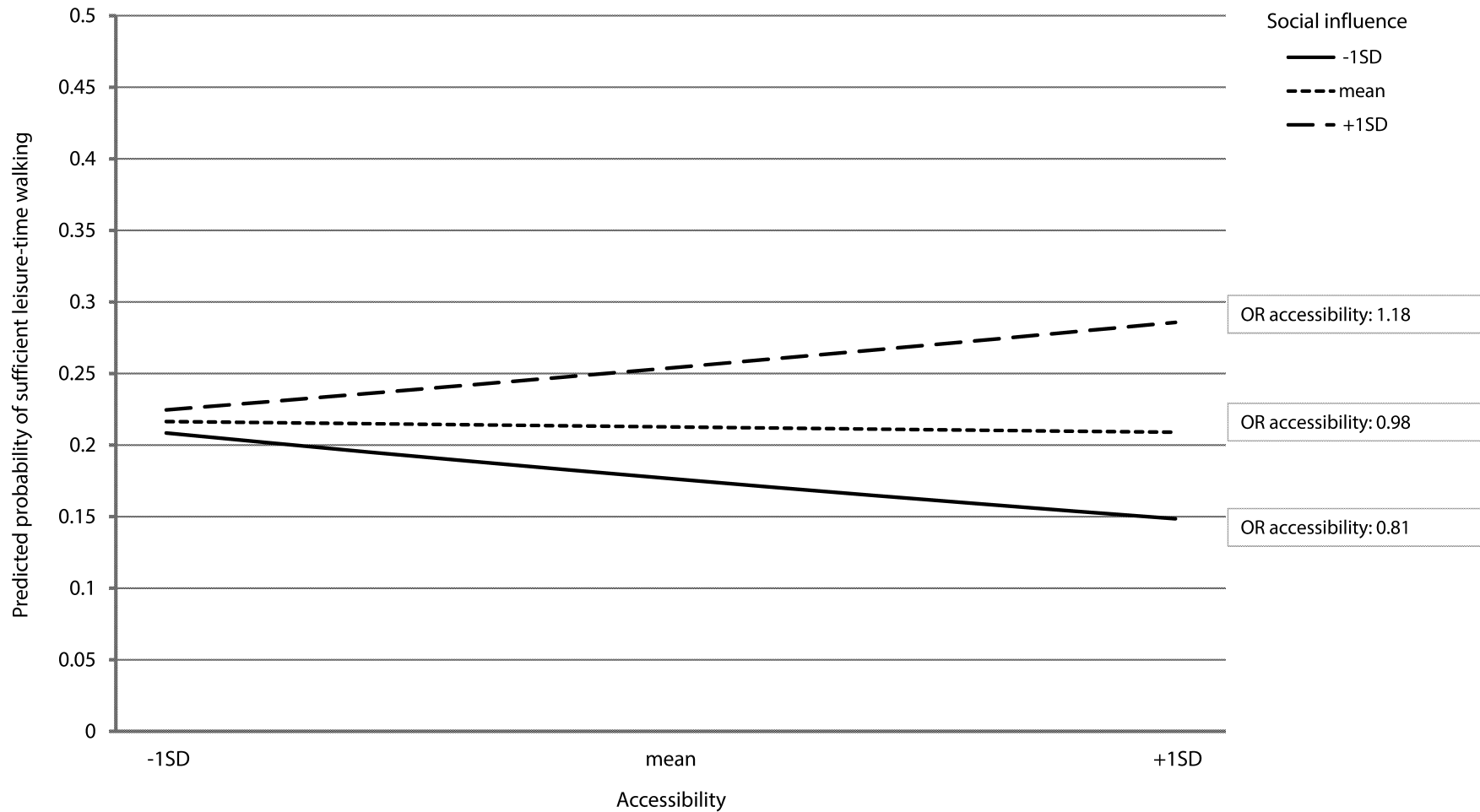
Predictors	Any leisure-time walking				Sufficient leisure-time walking [a]			
	Crude		Adjusted [b]		Crude		Adjusted [b]	
	OR	95% CI [c]	OR	95% CI [c]	OR	95% CI [c]	OR	95% CI [c]
Individual level								
Feasibility								
Not able to walk for 400m (able=ref.)	**0.30**	**0.15-0.57***	**0.27**	**0.14-0.53***	0.72	0.31-1.68	0.62	0.26-1.47
Psychosocial factors								
Attitude [d]	**1.19**	**1.02-1.39***	1.13	0.97-1.33	**1.33**	**1.11-1.61***	**1.37**	**1.13-1.66***
Self-efficacy [d]	**1.31**	**1.13-1.53***	**1.23**	**1.04-1.46***	**1.56**	**1.26-1.92***	**1.65**	**1.32-2.08***
Social influence [d]	1.14	0.98-1.32	1.16	0.99-1.36	**1.23**	**1.02-1.49***	**1.24**	**1.03-1.51***
Intention [d]	**1.34**	**1.15-1.56***	**1.31**	**1.12-1.54***	**1.41**	**1.15-1.73***	**1.48**	**1.20-1.82***
Neighborhood level								
Urban form								
Accessibility [d]	1.06	0.89-1.27	1.05	0.88-1.25	0.99	0.75-1.30	1.01	0.77-1.32
Safety [d]	0.96	0.80-1.14	0.94	0.79-1.11	1.08	0.82-1.42	1.10	0.84-1.44
Comfort [d]	1.03	0.87-1.22	1.03	0.87-1.22	1.08	0.84-1.40	1.11	0.87-1.42
Pleasurability [d]	1.01	0.85-1.21	0.99	0.83-1.18	1.02	0.79-1.31	1.03	0.80-1.33
Hierarchy level score								
4	1.00		1.00		1.00		1.00	
3	0.63	0.32-1.23	0.67	0.34-1.32	0.98	0.44-2.19	0.98	0.43-2.23
2	0.77	0.48-1.24	0.78	0.49-1.26	0.61	0.33-1.13	0.58	0.31-1.09
1	1.20	0.74-1.95	1.16	0.72-1.88	0.58	0.32-1.08	0.59	0.32-1.10
0	1.02	0.68-1.51	1.06	0.71-1.57	1.39	0.91-2.14	1.33	0.85-2.07

a. Five or more days a week with at least 30 minutes of physical activity a day.

b. Adjusted models were adjusted for feasibility (being able to walk for at least 400m), age, gender, educational level, and ethnicity.

c. * = p<.050, ** = p<.010, *** = p<.001

d. All individual psychosocial factors and urban form characteristics were standardized for ease of interpretation (mean=0, standard deviation=1).

Pleasurability

Comfort

Safety

Accessibility

Feasibility

Limits

Urban form
(in order of importance to walking)

Hierarchy of walking needs
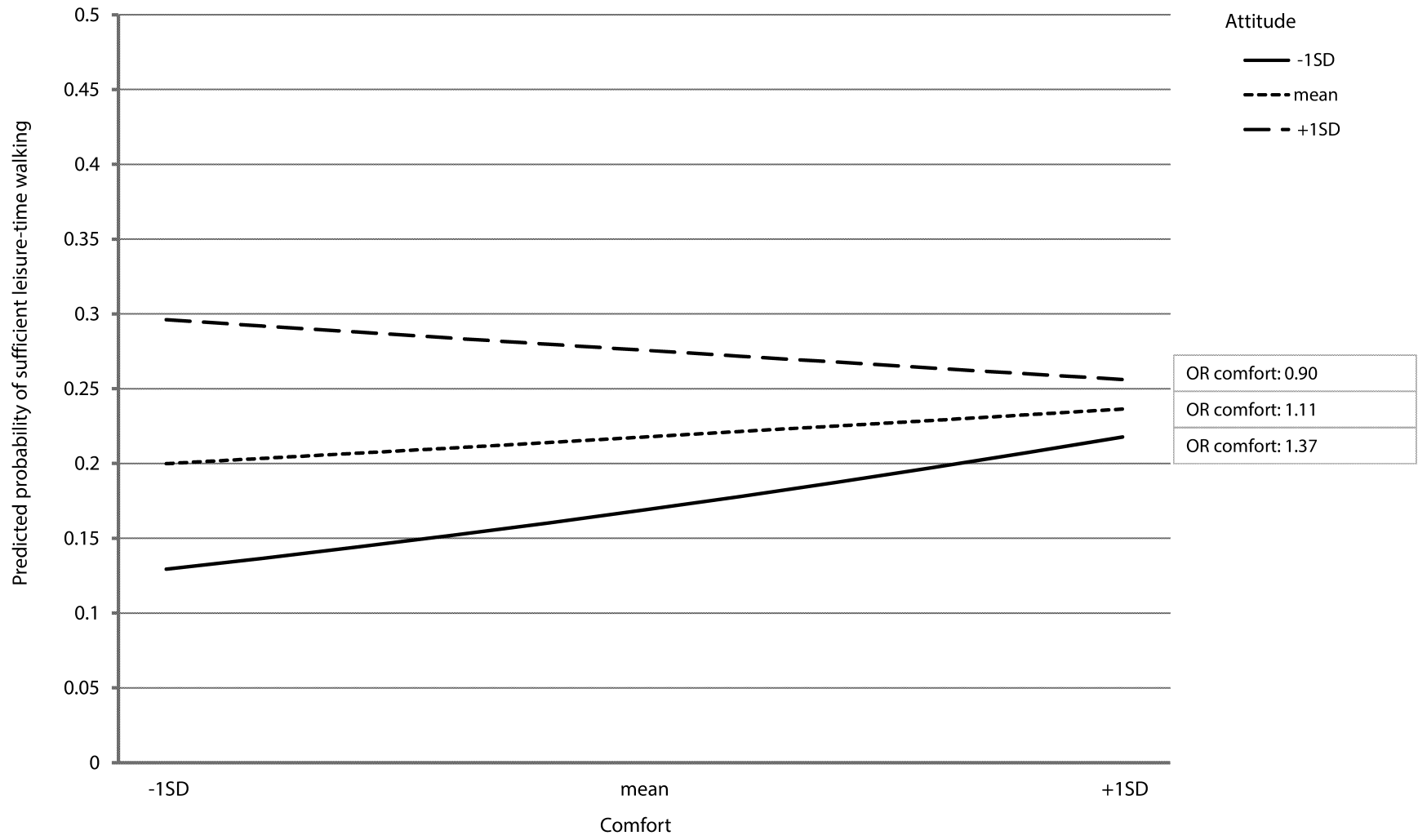
SUPPLEMENTAL DIGITAL CONTENT 1

Table S1: Measurement of psychosocial factors in the Dutch GLOBE postal survey 2004

Variable	Item	Response categories
Attitude	Negative outcome expectancy of PA[a]: It requires too much time	(1)Very important ••• (5)Not important at all
	Negative outcome expectancy of PA: It requires too much discipline	(1)Very important ••• (5)Not important at all
	Negative outcome expectancy of PA: It requires too much energy	(1)Very important ••• (5)Not important at all
	Negative outcome expectancy of PA: I am afraid to get injured	(1)Very important ••• (5)Not important at all
	Negative outcome expectancy of PA: I feel uncomfortable when exercising	(1)Very important ••• (5)Not important at all
	Positive outcome expectancy of PA: It makes me feel less stressed	(1)Not important at all ••• (5)Very important
	Positive outcome expectancy of PA: It gets me into a good mood	(1)Not important at all ••• (5)Very important
	Positive outcome expectancy of PA: I like being active	(1)Not important at all ••• (5)Very important
	Positive outcome expectancy of PA: I am more confident with my body	(1)Not important at all ••• (5)Very important
	Positive outcome expectancy of PA: It is good for fitness/condition	(1)Not important at all ••• (5)Very important
	Positive outcome expectancy of PA: I feel energized	(1)Not important at all ••• (5)Very important
Social influence	Most people who are important to me think I should be sufficiently physically active [b]	(1)No, not true • (3)Yes, true
	Most people who are important to me stimulate me to be sufficiently physically active	(1)No, not true • (3)Yes, true
	Most people who are important to me are sufficiently physically active	(1)No, not true • (3)Yes, true
Self-efficacy	Do you think it is easy or difficult to be sufficiently physically active?	(1)Very difficult ••• 5)Very easy
	How sure are you that you can be sufficiently physically active?	(1)Not sure at all ••• (5)Very sure
Intention	Do you plan to be sufficiently physically active?	(1)No, for sure not ••• (5)Yes, for sure

[a] PA=physical activity
[b] Sufficient physical activity was defined in the questionnaire as being active for at least half an hour a day

SUPPLEMENTAL DIGITAL CONTENT 2

Table S2: Measurement and inter-rater reliability of urban form characteristics in the 2006 neighborhood observations in the Dutch GLOBE study.

Urban form characteristics	Inter-rater reliability
Accessibility (α=.57)	
*(Mean score goes from 0-1 with a **higher** score meaning better accessibility.)*	
Availability of a sidewalk (1=yes, 0=no)	0.97
Quality of sidewalk (1=good, 0=reasonable to bad)	0.70
Safety (α=.73)	
*(Mean score goes from 0-1 with a **higher** score meaning a safer neighborhood.)*	
Graffiti (1= no, nothing, 0=yes, little to much)	0.70
Litter on the streets (1=no, little to nothing, 0=yes, some to much)	0.67
Houses for sale (1=yes, one or more, 0=no)	0.80
Empty houses (1=yes, one or more, 0=no)	0.70
Height of fences (1=higher than eye level, 0=lower than eye level)	0.73
Visibility of the street from surrounding houses (1=<½of street is visible ,0=>½ street is visible)	0.73
Street lighting (1=one side of the street or less, 0=both sides of the street)	0.83
Signs of alcohol/drugs (1=yes, 0=no)	0.83
Comfort (α=.72)	
*(Mean score goes from 0-1 with a **higher** score meaning a more comfortable neighborhood.)*	
Traffic (1=only destination traffic, 0=through traffic or through traffic and destination traffic)	0.80
Crossovers present (1=no, 0=yes)	0.93
Traffic signs (1=no, 0=yes)	0.67
Traffic control devices (speed bumps) (1=yes, 0=no)	0.87
Pleasurability (α=.86)	
*(Mean score goes from 0-1 with a **higher** score meaning a more pleasurable neighborhood.)*	
Maintenance of best buildings (1=good, 0=reasonable to bad)	0.67
Maintenance of worst buildings (1=good, 0=reasonable to bad)	0.67
Gardens present with all houses (1=yes, with all houses, 0=no)	0.87
Maintenance of best maintained gardens (1=good, 0=reasonable to bad)	0.80
Green diversity (1=more than 2 different types of green, 0=none or only one type of green)	0.83
Green maintenance (1=good, 0=reasonable to bad)	0.80

SUPPLEMENTAL DIGITAL CONTENT 3

Table S3-A: Associations of <u>any leisure-time walking</u> with urban form characteristics, psychosocial factors and their interaction (n=736)[a,b,c].

	Attitude (AT)			Self-Efficacy (SE)			Social Influence (SI)			Intention (INT)		
		OR	95%CI		OR	95%CI		OR	95%CI		OR	95%CI
Accessibility (L1)	L1	1.05	0.88-1.25	L1	1.05	0.88-1.24	L1	1.04	0.87-1.24	L1	1.05	0.88-1.25
	AT	1.14	0.97-1.33	SE	**1.22**	**1.03-1.45**	SI	1.17	1.00-1.36	INT	**1.31**	**1.11-1.54**
	L1 *AT	1.00	0.85-1.17	L1 * SE	0.98	0.84-1.14	L1 * SI	1.11	0.95-1.28	L1 * INT	0.97	0.83-1.14
Safety (L2)	L2	0.93	0.78-1.10	L2	0.94	0.79-1.11	L2	0.92	0.78-1.09	L2	0.92	0.77-1.08
	AT	1.14	0.97-1.34	SE	**1.23**	**1.04-1.46**	SI	1.17	1.00-1.36	INT	**1.32**	**1.13-1.55**
	L2 * AT	1.13	0.97-1.33	L2 * SE	1.05	0.89-1.24	L2 * SI	1.05	0.91-1.23	L2 * INT	1.14	0.96-1.35
Comfort (L3)	L3	1.02	0.86-1.21	L3	1.01	0.85-1.20	L3	1.03	0.86-1.23	L3	1.02	0.85-1.21
	AT	1.13	0.96-1.33	SE	**1.23**	**1.04-1.46**	SI	1.16	0.99-1.36	INT	**1.32**	**1.12-1.56**
	L3 * AT	0.98	0.84-1.14	L3 * SE	1.03	0.88-1.20	L3 * SI	1.06	0.90-1.24	L3 * INT	1.07	0.91-1.24
Pleasurability (L4)	L4	0.98	0.82-1.17	L4	0.99	0.83-1.18	L4	0.97	0.81-1.16	L4	0.97	0.82-1.16
	AT	1.14	0.97-1.33	SE	**1.23**	**1.04-1.46**	SI	1.16	0.99-1.36	INT	**1.31**	**1.12-1.54**
	L4 * AT	1.13	0.96-1.32	L4 * SE	1.00	0.85-1.17	L4 * SI	1.08	0.93-1.26	L4 * INT	1.01	0.85-1.20
Hierarchy score (H0-H4)	H4	1.00		H4	1.00		H4	1.00		H4	1.00	
	H3	0.58	0.29-1.19	H3	0.66	0.33-1.30	H3	0.68	0.34-1.35	H3	0.68	0.34-1.37
	H2	0.79	0.49-1.28	H2	0.79	0.49-1.28	H2	0.79	0.49-1.27	H2	0.82	0.51-1.33
	H1	1.19	0.73-1.92	H1	1.15	0.71-1.87	H1	1.20	0.74-1.94	H1	1.19	0.73-1.92
	H0	1.06	0.71-1.58	H0	1.05	0.70-1.56	H0	1.10	0.74-1.64	H0	1.06	0.71-1.57
	AT	1.23	0.93-1.62	SE	1.22	0.91-1.64	SI	**1.36**	**1.03-1.79**	INT	1.30	0.98-1.72
	H4 * AT	1.00	(p=0.1507)[d]	H4 * SE	1.00	(p=0.9842)[d]	H4 * SI	1.00	(p=0.3984)[d]	H4 * INT	1.00	(p=1.000)[d]
	H3 * AT	0.52	0.24-1.12	H3 * SE	1.05	0.52-2.14	H3 * SI	0.75	0.36-1.57	H3 * INT	1.01	0.49-2.10
	H2 * AT	1.01	0.63-1.62	H2 * SE	1.07	0.67-1.73	H2 * SI	0.62	0.38-1.01	H2 * INT	1.01	0.63-1.63
	H1 * AT	0.65	0.39-1.06	H1 * SE	0.91	0.55-1.51	H1 * SI	0.82	0.50-1.34	H1 * INT	1.00	0.59-1.72
	H0 * AT	1.04	0.70-1.54	H0 * SE	1.02	0.69-1.50	H0 * SI	0.89	0.60-1.30	H0 * INT	1.01	0.69-1.48

a. All multilevel models are adjusted for feasibility (being able to walk for at least 400m), age, gender, educational level, and ethnicity.
b. Bold printed results are significant ($p<0.05$)
c. All individual psychosocial factors and urban form characteristics were standardized for ease of interpretation (mean=0, standard deviation=1).
d. p-value resulting from the likelihood-ratio test of the model without the interaction nested in the model with the interaction.
Note: We want to acknowledge Ding et al (2012) for the idea of how to present many interaction results compactly into one table.

Table S3-B: Associations of <u>sufficient leisure-time walking</u>* with urban form characteristics, psychosocial factors and their interaction (n=736)[a,b,c]

	Attitude (AT)			Self-Efficacy (SE)			Social Influence (SI)			Intention (INT)		
		OR	95%CI		OR	95%CI		OR	95%CI		OR	95%CI
Accessibility (L1)	L1	1.08	0.81-1.43	L1	1.01	0.77-1.33	L1	0.98	0.75-1.28	L1	0.99	0.76-1.28
	AT	**1.38**	**1.14-1.68**	SE	**1.65**	**1.32-2.08**	SI	**1.26**	**1.04-1.53**	INT	**1.50**	**1.21-1.85**
	L1 *AT	0.84	0.69-1.02	L1 * SE	0.99	0.80-1.21	L1 * SI	**1.20**	**1.00-1.43**	L1 * INT	1.08	0.89-1.32
Safety (L2)	L2	1.13	0.86-1.49	L2	1.13	0.86-1.49	L2	1.06	0.81-1.40	L2	1.08	0.83-1.41
	AT	**1.38**	**1.14-1.68**	SE	**1.66**	**1.32-2.08**	SI	**1.24**	**1.02-1.50**	INT	**1.47**	**1.20-1.81**
	L2 * AT	0.83	0.69-1.00	L2 * SE	0.94	0.75-1.17	L2 * SI	1.07	0.89-1.30	L2 * INT	0.94	0.76-1.16
Comfort (L3)	L3	1.11	0.86-1.43	L3	1.07	0.83-1.38	L3	1.10	0.85-1.41	L3	1.09	0.85-1.39
	AT	**1.37**	**1.13-1.66**	SE	**1.65**	**1.31-2.07**	SI	**1.24**	**1.02-1.50**	INT	**1.47**	**1.19-1.81**
	L3 * AT	**0.81**	**0.66-0.99**	L3 * SE	0.99	0.80-1.21	L3 * SI	1.08	0.88-1.32	L3 * INT	0.93	0.75-1.15
Pleasurability (L4)	L4	1.02	0.78-1.34	L4	1.07	0.82-1.40	L4	1.01	0.78-1.30	L4	1.02	0.79-1.31
	AT	**1.39**	**1.14-1.69**	SE	**1.65**	**1.32-2.07**	SI	**1.24**	**1.02-1.51**	INT	**1.48**	**1.20-1.82**
	L4 * AT	0.85	0.70-1.02	L4 * SE	0.87	0.70-1.08	L4 * SI	1.01	0.84-1.22	L4 * INT	0.96	0.77-1.19
Hierarchy score (H0-H4)	H4	1.00		H4	1.00		H4	1.00		H4	1.00	
	H3	1.04	0.45-2.39	H3	0.52	0.14-1.86	H3	0.91	0.36-2.31	H3	1.04	0.45-2.43
	H2	**0.48**	**0.24-0.97**	H2	0.48	0.24-1.00	H2	0.65	0.34-1.23	H2	0.57	0.28-1.13
	H1	0.57	0.30-1.08	H1	0.55	0.28-1.07	H1	0.65	0.34-1.22	H1	0.54	0.27-1.08
	H0	1.27	0.81-1.98	H0	1.28	0.81-2.01	H0	1.48	0.93-2.35	H0	1.38	0.87-2.17
	AT	1.09	0.80-1.49	SE	1.41	0.98-2.03	SI	**1.59**	**1.11-2.29**	INT	**1.47**	**1.01-2.13**
	H4 * AT	1.00	*(p=0.2688)[d]*	H4 * SE	1.00	*(p=0.0609)[d]*	H4 * SI	1.00	*(p=0.2113)[d]*	H4 * INT	1.00	*(p=0.1341)[d]*
	H3 * AT	1.39	0.56-3.45	H3 * SE	**5.25**	**1.13-24.48**	H3 * SI	1.52	0.51-4.48	H3 * INT	1.32	0.49-3.58
	H2 * AT	**2.05**	**1.06-3.97**	H2 * SE	1.81	0.82-4.01	H2 * SI	0.64	0.33-1.22	H2 * INT	1.61	0.72-3.58
	H1 * AT	1.24	0.65-2.35	H1 * SE	1.08	0.52-2.23	H1 * SI	0.64	0.33-1.23	H1 * INT	1.67	0.74-3.78
	H0 * AT	1.31	0.85-2.02	H0 * SE	1.05	0.65-1.68	H0 * SI	0.67	0.42-1.06	H0 * INT	0.79	0.50-1.25

*.   Sufficient =five or more days a week with at least 30 minutes of physical activity a day.
a.   All multilevel models are adjusted for feasibility (being able to walk for at least 400m), age, gender, educational level, and ethnicity.
b.   Bold printed results are significant (p<0.05)
c.   All individual psychosocial factors and urban form characteristics were standardized for ease of interpretation (mean=0, standard deviation=1).
d.   p-value resulting from the likelihood-ratio test of the model without the interaction nested in the model with the interaction.
Note: We want to acknowledge Ding et al (2012) for the idea of how to present many interaction results compactly into one table.

Reference:
Ding D, Sallis JF, Conway TL, Saelens BE, Frank LD, Cain KL, and Slymen DJ. Interactive effects of built environment and psychosocial attributes on physical activity: a test of ecological models. *Ann. Behav. Med.* 2012;44(3):365-74.