RETHINKING WALKBLE CITY IN POST-CORONA ERA

A REVIEW OF WALKABILITY MEASURES

Xinrui Zheng
Master program in policy and planning science, University of Tsukuba
Mamoru Amemiya
Faculty of Engineering, Information and Systems, University of Tsukuba

INTRODUCTION

The COVID-19 outbreak has significantly accelerated the pace of adoption of digital transformation, including the transition toward working from home. Further, it has increased online shopping, online education, and so on. As more people move out of cities into suburban areas due to these remote activities, it is necessary to consider ways to create walkable neighborhoods in suburban areas.
In this study, we focused on a walking type of recreational walking, which is thought to hold physical and mental health benefits and help people stay fit and active even as they work from home, to answer the following questions:

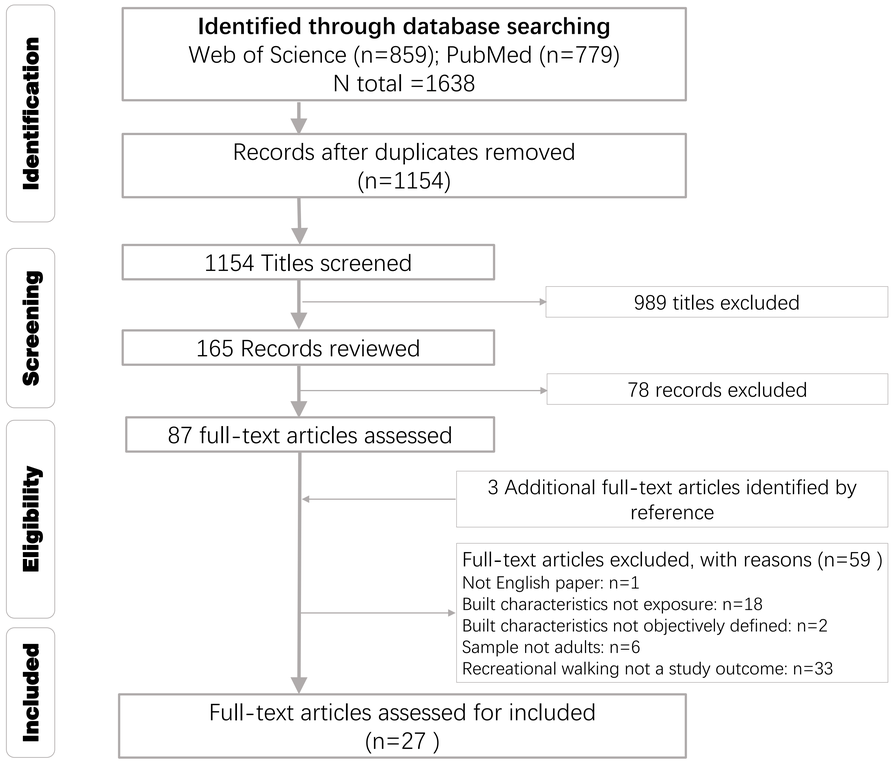
- Do the present concept of walkability (density, mixture and accessibility) also important to recreational walking?
- Are there any potential environmental factors affecting recreational walking in the post-corona-19 era that have not been widely recognized?

Based on a systematic review, we examined different walkability measures from the urban morphology perspective of density, mixed land use, and accessibility, as well as the associations with recreational walking behavior. We concluded that there is a need to update the concept of walkability in the post-corona era.

METHODOLOGY

Keyword: ("**walkability**" or "**walkable environment**" or "**land use mix**" or "**functional mix**" or "**density**" or "**street connectivity**") and ("**walk**" or "**walking**" or "**physical activity**" or "**pedestrian**") and ("**leisure**" or "**recreation**")

A systematic search was conducted using the Web of Science and PubMed electronic databases. Studies published from 2000 to March 2021 estimating associations between three key dimensions of urban morphological conditions (density, mixture, and accessibility) at the neighborhood level and in home-based recreational walking among adults were reviewed.



RESULT & DISCUSSION

This is a review of relationship between objective measures of the neighborhood environment and recreational walking. Twenty-eight quantitative studies focusing on adults' recreational walking were reviewed for three specific dimensions of objective measures of the neighborhood environment, density (**n=26 studies**), mixture (**n= 14 studies**) and accessibility **(n=22 studies**).
Of the **377 estimated associations** between environmental characteristics and recreational walking, only **64 (17.0%) were positive**, **24 (6.4%) were negative**, **and 289 (76.7%) were null**.

No	Index	Description	Association +	Association n.s.	Association -	Subjects in the post-corona era
1	**DENSITY**					
1	Residential Density	Examined in 59 associations calculated by ratio of dwelling units to residential area, residential land area ratio, population density and number of households	12	44	3	**SUBJECTS** The examined studies were predominantly based on an urban environment and regarded residential and functional density as critical elements. Fewer studies included in our review captured landscape density relative to the functional destination density. This might be due to the gaps in evidence that regarding suburban areas.
2	Landscape Density	Examined in 53 associations calculated by area ratio/presence of green spaces, water spaces, water ways and monuments	16	17	6	
3	Functional density	Examined in 39 associations calculated by NDAI, employees density, number/density of various types of functional destinations/destinations/POI, building density; address density,	5	44	4	
4	Commercial Density	Examined in 28 associations calculated by commercial land use /gross floor area ratio number of commercial destination, number/density of commercial destinations and retail employment density	1	26	1	**FUTURE** Nine studies examined associations between landscape density and recreational walking and obtain higher ratio of positive results than other index. We assume that in the post-corona era, studies into these associations could help determine whether improving the suburban-landscape (such as, agricultural land use and artificially vegetated areas) density would promote recreational walking.
5	Park/POS Density	Examined in 28 associations calculated by presence/distance/size of parks	5	19	3	
6	Service Density	Examined in 15 associations calculated by number/density/presence of various types of facilities, institutional/ social land use area ratio	2	12	1	
			41	162	18	
2	**MIXITURE**					
1	Functional evenness	Examined in 37 associations calculated by the entropy index using the land use area from different land use types categorized by functional use.	6	31	0	**SUBJECTS** Our review findings suggest that the association between functional land use area evenness and recreational walking was not significant. This might be due to the neglect of **spatial distribution** and the importance of **landscape mix** in recreational walking.
2	Functional types	Examined in 1 association calculated by the total number of land use types categorized by functional uses	0	1	0	**FUTURE** No studies included in this review examined associations between spatial mix and recreational walking in the post-corona era. However, studies on these associations could help determine whether concerning more about **mixture of landscape** would enhance the ability of neighborhoods to support recreational walking.
3	Landscape evenness	Examined in 1 association calculated by the entropy index using the land use area from different land use types categorized by landscape types.	1	0	0	
			7	32	0	
3	**ACCESSIBILITY**					
1	Intersection density	Examined in 85 associations calculated by the ratio of >=3-way/4-way intersections number to total studied area, link node ratio.	13	70	4	**SUBJECTS** Consistently with findings from other reviews, a distinct association was found between access-related environment and recreational walking. We assume that the overall connectivity might fail to reflect good access to recreational walking destinations.
2	Street length	Examined in 13 associations calculated by streets/sidewalks/path/cycleway length	2	10	1	
3	Transit density	Examined in 12 associations calculated by the number/density of bus stops/transit stops/train stations, and distance to train station	0	11	1	**FUTURE** Even though no positive results obtained by the associations between transit density and recreational walking, we think that a highly developed transit system would be necessary to create a walkable suburban neighborhood.
4	Block size	Examined in 2 associations calculated by the block size or average census block area	0	1	0	
5	Street width	Examined in 1 associations calculated by the width of streets	0	1	0	
			19	97	7	

CONCLUSION

In this review, we summarized the recent English-speaking literature on the association between urban morphology-related neighborhood environment attributes and recreational walking. Overall, the evidence indicates a distinct association between neighborhood environment and recreational walking.

We think that future studies could help determine whether improving the landscape-related elements would promote recreational walking and help to update the concept of walkability from the proxy of urbanity to a new alternative one.

REFERENCE

Cerin, E., Leslie, E., Owen, N., & Bauman, A. (2007). Applying GIS in Physical Activity Research: Community 'Walkability' and Walking Behaviors. In A. Lai, PC and Mak (Ed.), GIS FOR HEALTH AND THE ENVIRONMENT: DEVELOPMENT IN THE ASIA-PACIFIC REGION (pp. 72–89). Croucher Fdn; PSDAS; Univ Hong Kong, Dept Geog; Geog Sci & Nat Resources Res Chinese Acad Sci. https://doi.org/10.1007/978-3-540-71318-0_6
Chaix, B., Simon, C., Charreire, H., Thomas, F., Kestens, Y., Karusisi, N., Vallée, J., Oppert, J. M., Weber, C., & Pannier, B. (2014). The environmental correlates of overall and neighborhood based recreational walking (a cross-sectional analysis of the RECORD Study). In Int J Behav Nutr Phys Act (Vol. 11, Issue 1, p. 20). https://doi.org/10.1186/1479-5868-11-20
Christian, H. E., Bull, F. C., Middleton, N. J., Knuiman, M. W., Divitini, M. L., Hooper, P., Amarasinghe, A., & Giles-Corti, B. (2011). How important is the land use mix measure in understanding walking behaviour? Results from the RESIDE study. The International Journal of Behavioral Nutrition and Physical Activity, 8, 55. https://doi.org/10.1186/1479-5868-8-55
Christian, H., Knuiman, M., Divitini, M., Foster, S., Hooper, P., Boruff, B., Bull, F., & Giles-Corti, B. (2017). A Longitudinal Analysis of the Influence of the Neighborhood Environment on Recreational Walking within the Neighborhood: Results from RESIDE. In Environ Health Perspect (Vol. 125, Issue 7, p. 77009). https://doi.org/10.1289/ehp823
Feuillet, T., Commenges, H., Menai, M., Salze, P., Perchoux, C., Reuillon, R., Kesse-Guyot, E., Enaux, C., Nazare, J. A., Hercberg, S., Simon, C., Charreire, H., & Oppert, J. M. (2018). A massive geographically weighted regression model of walking-environment relationships. In Journal of Transport Geography (Vol. 68, pp. 118–129). https://doi.org/10.1016/j.jtrangeo.2018.03.002
Forsyth, A., Hearst, M., Oakes, J. M., & Schmitz, K. H. (2008). Design and destinations: Factors influencing walking and total physical activity. In Urban Studies (Vol. 45, Issue 9, pp. 1973–1996). https://doi.org/10.1177/0042098008093386
Forsyth, A., Oakes, J. M., Schmitz, K. H., & Hearst, M. (2007). Does residential density increase walking and other physical activity? In Urban Studies (Vol. 44, Issue 4, pp. 679–697). https://doi.org/10.1080/00420980601184729
Gao, J., Kamphuis, C. B. M., Helbich, M., & Ettema, D. (2020). What is 'neighborhood walkability'? How the built environment differently correlates with walking for different purposes and with walking on weekdays and weekends. Journal of Transport Geography, 88, 102860. https://doi.org/10.1016/j.jtrangeo.2020.102860
Kondo, K., Lee, J. S., Kawakubo, K., Kataoka, Y., Asami, Y., Mori, K., Umezaki, M., Yamauchi, T., Takagi, H., Sunagawa, H., & Akabayashi, A. (2009). Association between daily physical activity and neighborhood environments. In Environmental Health and Preventive Medicine (Vol. 14, Issue 3, pp. 196–206). https://doi.org/10.1007/s12199-009-0081-1
Koohsari, M. J., Badland, H., Mavoa, S., Villanueva, K., Francis, J., Hooper, P., Owen, N., & Giles-Corti, B. (2018). Are public open space attributes associated with walking and depression? In Cities (Vol. 74, pp. 119–125). https://doi.org/10.1016/j.cities.2017.11.011
Lu, Y., Xiao, Y., & Ye, Y. (2017). Urban density, diversity and design: Is more always better for walking? A study from Hong Kong. PREVENTIVE MEDICINE, 103(S), S99–S103. https://doi.org/10.1016/j.ypmed.2016.08.042
Mavoa, S., Bagheri, N., Koohsari, M. J., Kaczynski, A. T., Lamb, K. E., Oka, K., O'Sullivan, D., & Witten, K. (2019). How Do Neighbourhood Definitions Influence the Associations between Built Environment and Physical Activity? INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH, 16(9). https://doi.org/10.3390/ijerph16091501
McCormack, G. R. (2017). Neighbourhood built environment characteristics associated with different types of physical activity in Canadian adults. HEALTH PROMOTION AND CHRONIC DISEASE PREVENTION IN CANADA-RESEARCH POLICY AND PRACTICE, 37(6), 175–185. https://doi.org/10.24095/hpcdp.37.6.01
McCormack, G. R., Koohsari, M. J., Turley, L., Nakaya, T., Shibata, A., Ishii, K., Yasunaga, A., & Oka, K. (2021). Evidence for urban design and public health policy and practice: Space syntax metrics and neighborhood walking. HEALTH & PLACE, 67. https://doi.org/10.1016/j.healthplace.2019.102277
Nehme, E. K., Oluyomi, A. O., Calise, T. V., & Kohl, H. W. (2016). Environmental Correlates of Recreational Walking in the Neighborhood. In American Journal of Health Promotion (Vol. 30, Issue 3, pp. 139–148). https://doi.org/10.4278/ajhp.130531-QUAN-281
Oakes, J. M., Forsyth, A., & Schmitz, K. H. (2007). The effects of neighborhood density and street connectivity on walking behavior: The Twin Cities walking study. In Epidemiol Perspect Innov (Vol. 4, p. 16). https://doi.org/10.1186/1742-5573-4-16
Oliver, L. N., Schuurman, N., & Hall, A. W. (2007). Comparing circular and network buffers to examine the influence of land use on walking for leisure and errands. International Journal of Health Geographics, 6(1), 41. https://doi.org/10.1186/1476-072x-6-41
Oliver, L., Schuurman, N., Hall, A., & Hayes, M. (2011). Assessing the influence of the built environment on physical activity for utility and recreation in suburban metro Vancouver. BMC PUBLIC HEALTH, 11. https://doi.org/10.1186/1471-2458-11-959
Perchoux, C., Kestens, Y., Brondeel, R., & Chaix, B. (2015). Accounting for the daily locations visited in the study of the built environment correlates of recreational walking (the RECORD Cohort Study). In Prev Med (Vol. 81, pp. 142–149). https://doi.org/10.1016/j.ypmed.2015.08.010
Saelens, B. E., Sallis, J. F., Frank, L. D., Cain, K. L., Conway, T. L., Chapman, J. E., Slymen, D. J., & Kerr, J. (2012). Neighborhood Environment and Psychosocial Correlates of Adults' Physical Activity. MEDICINE AND SCIENCE IN SPORTS AND EXERCISE, 44(4), 637–646. https://doi.org/10.1249/MSS.0b013e318237fe18
Sallis, J. F., Cerin, E., Kerr, J., Adams, M. A., Sugiyama, T., Christiansen, L. B., Schipperijn, J., Davey, R., Salvo, D., Frank, L. D., De Bourdeaudhuij, I., & Owen, N. (2020). Built Environment, Physical Activity, and Obesity: Findings from the International Physical Activity and Environment Network (IPEN) Adult Study. In Fielding, JE (Ed.), ANNUAL REVIEW OF PUBLIC HEALTH, VOL 41 (Vol. 41, pp. 119–139). https://doi.org/10.1146/annurev-publhealth-040218-043657
Sugiyama, T, Paquet, C., Howard, N. J., Coffee, N. T., Taylor, A. W., Adams, R. J., & Daniel, M. (2014). Public open spaces and walking for recreation: Moderation by attributes of pedestrian environments. In Preventive Medicine (Vol. 62, pp. 25–29). https://doi.org/10.1016/j.ypmed.2014.01.030
Sugiyama, Takemi, Howard, N. J., Paquet, C., Coffee, N. T., Taylor, A. W., & Daniel, M. (2015). Do Relationships Between Environmental Attributes and Recreational Walking Vary According to Area-Level Socioeconomic Status? JOURNAL OF URBAN HEALTH-BULLETIN OF THE NEW YORK ACADEMY OF MEDICINE, 92(2), 253–264. https://doi.org/10.1007/s11524-014-9932-1
van Wijk, D. C., Groeniger, J. O., van Lenthe, F. J., & Kamphuis, C. B. M. (2017). The role of the built environment in explaining educational inequalities in walking and cycling among adults in the Netherlands. INTERNATIONAL JOURNAL OF HEALTH GEOGRAPHICS, 16. https://doi.org/10.1186/s12942-017-0083-y
Wang, Z., Ettema, D., & Helbich, M. (2021). Objective environmental exposures correlate differently with recreational and transportation walking: A cross-sectional national study in the Netherlands. In Environ Res (Vol. 194, p. 110591). https://doi.org/10.1016/j.envres.2020.110591
Witten, K., Blakely, T., Bagheri, N., Badland, H., Ivory, V., Pearce, J., Mavoa, S., Hinckson, E., & Schofield, G. (2012). Neighborhood Built Environment and Transport and Leisure Physical Activity: Findings Using Objective Exposure and Outcome Measures in New Zealand. ENVIRONMENTAL HEALTH PERSPECTIVES, 120(7), 971–977. https://doi.org/10.1289/ehp.1104584
Zhao, L. Z., Shen, Z. J., Zhang, Y. J., & Ma, Y. (2019). The Impact of the Community Built Environment on the Walking Times of Residents in a Community in the Downtown Area of Fuzhou. In Sustainability (Vol. 11, Issue 3, p. 11). https://doi.org/10.3390/su11030691