Australasian Transport Research Forum 2024 Proceedings
27-29 November, Melbourne, Australia
Publication website: https://australasiantransportresearchforum.org.au/

Associations of utilitarian cycling with destinations and street connectivity assessed within multiple buffers

Firas Mohamed[1,2], Manoj Chandrabose[1,3], Neville Owen[1,3], Takemi Sugiyama[1,3]

[1]Centre for Urban Transitions, Swinburne University of Technology, Melbourne, Australia

[2] Department of Mathematical Sciences, South Eastern University of Sri Lanka, Sammanthurai, Sri Lanka

[3] Baker Heart and Diabetes Institute, Melbourne, Australia

Email for correspondence (presenting author): fmohamed@swin.edu.au

1 Introduction

Cycling is an accessible mode of transportation with multiple health and environmental benefits (Brand et al., 2021; Götschi et al., 2016; Lee and March, 2010; Ma et al., 2021). However, the mode share of cycling in Australia is less than 2% (Goel et al., 2022). Creating cycling-supportive built environments may help promote cycling (Christiansen et al., 2016; Gao et al., 2018; Koohsari et al., 2020). Understanding neighbourhood built environmental features that encourage cycling behaviour is important for this.

A review on this topic found that environmental correlates of cycling vary based on its purpose, such as utilitarian (e.g., shopping and errands), commuting, or recreational activities (Yang et al., 2019). Therefore, in order to develop strategies for promoting cycling, it might be better to focus on different purposes. Our study focuses on utilitarian cycling. The review found that the availability of destinations and street connectivity in the neighbourhoods are consistently associated with residents' cycling behaviour (Yang et al., 2019).

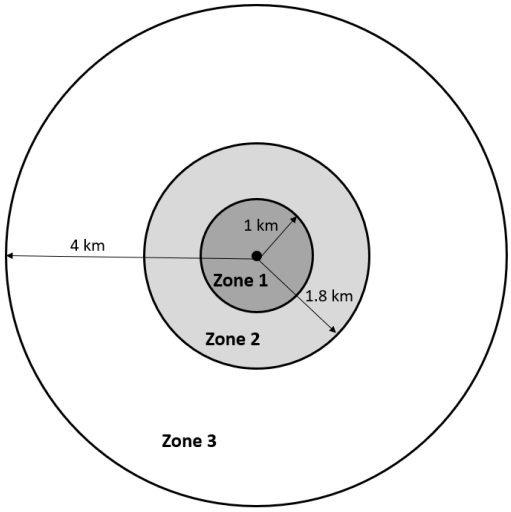
However, there is no clear guidance on the appropriate spatial scales for measuring these attributes, with studies using varying distance buffers without empirical support (Beenackers et al., 2012; Ma et al., 2014; Nielsen et al., 2013; Porter et al., 2020). To address this gap, we examined how far people typically cycle for utilitarian purposes, and based on it, defined multiple buffer sizes, and measured destination availability and street connectivity within those buffers to determine the most suitable spatial scale for these attributes associated with utilitarian cycling.

2 Methodology

Household travel survey data collected in Victoria, Australia (2012–20) were used (Ipsos Social Research Institute, 2017). We calculated cycling mode share for home-based utilitarian trips in 1,105 SA1s (Statistical Area Level 1), which contained 43,965 eligible adult participants. Our analysis of cycling distance found that the 20th, 50th, and 80th percentiles of utilitarian cycling trip distances were 1 km, 1.8 km, and 4 km, respectively. Using these values, we defined three non-overlapping concentric circular buffers from the gravity centre of each SA1 (Figure 1): 0–1 km (Zone 1); 1–1.8 km (Zone 2); and 1.8–4 km (Zone 3). The density of core destinations (i.e., supermarkets, convenience stores, and train stations) and the density of 4-way (or more) intersections (as a measure of street connectivity) were calculated within each zone. Since the outcome variable, utilitarian cycling mode share, was a nonnegative skewed continuous variable with a high proportion of zero values, a two-part regression modelling approach (Boulton and Williford, 2018) was used to assess its associations with the environmental attributes . The first part was logistic regression models, which examined the associations of environmental attributes with the odds of having utilitarian cycling trips across all SA1s (N=1,105). The second part was linear regression models that examined the associations of environmental attributes with cycling mode share

(%) using only those SA1s with non-zero mode share values (N=209). SA1-level sociodemographic characteristics (mean age, percentage of older adults (≥ 60 years), percentage of men, and Index of Relative Socioeconomic Disadvantage) were considered as potential confounders. Spatial analyses were carried out using ArcGIS Pro 3.2. All statistical analyses were carried out using R version 4.2.0.

Figure 1: Three zones within which environmental attributes were calculated



3 Main findings

Cycling mode share for home-based utilitarian trips ranged from 0 to 26%. Table 1 shows the results of the regression models. The logistic regression model for destination density indicated that higher densities in all three zones were associated with a greater odds of having utilitarian cyclists. However, the logistic regression model for intersection density found a significant association only in Zone 3. The linear regression models for destination and intersection densities found significant associations of a higher density in Zone 2 with a higher percentage of utilitarian cycling mode share. However, a higher intersection density in Zone 1 was associated with a lower percentage of utilitarian cycling mode share

Table 1: Results of two-part regression models examining the associations of utilitarian cycling with destination and intersection densities

	Zone	Logistic regression		Linear regression	
		OR (95% CI)	p-value	β (95% CI)	p-value
Core destination density	1	**1.5 (1.2, 1.8)**	**0.001**	0.4 (-0.2, 0.9)	0.183
	2	**1.3 (1.1, 1.7)**	**0.016**	**0.7 (0.1, 1.3)**	**0.024**
	3	**1.4 (1.1, 1.7)**	**0.004**	0.4 (-0.2, 1.0)	0.185
4-way intersection density	1	1.2 (0.9, 1.6)	0.245	**-0.8 (-1.6, -0.0)**	**0.044**
	2	1.2 (0.8, 1.8)	0.362	**1.4 (0.3, 2.5)**	**0.011**
	3	**1.7 (1.3, 2.3)**	**0.001**	0.4 (-0.5, 1.3)	0.331

ORs correspond to the odds of having a utilitarian cycling trip in an SA1 for each one SD unit higher value in environmental attribute.
βs represent the difference in utilitarian cycling mode share (in SA1s with non-zero mode shares) for each one SD unit higher value in environmental attribute.

Bold coefficients indicate statistical significance.

4 Discussion

We observed that the relationships between utilitarian cycling and the two environmental attributes (destination density and intersection density) varied by the outcome type (categorical or continuous) and across the zones. It can be argued based on the findings and the consideration that destinations within 1 km from home can be accessed by walking (Gunn et al., 2017) that the availability of core destinations and 4-way intersections within 1 to 4 km from home may facilitate bicycle use for utilitarian purposes in Australia. These buffer zone definitions may be used in future research to assess whether it is worth providing additional infrastructure for cycling (e.g., separate bike paths) to further promote bicycle use. An important limitation of this study is that the thresholds (20th percentile, median, and 80th percentile) were chosen based on existing transport studies that investigated walking distances (Millward et al, 2013; Sugiyama et al., 2019). Different thresholds may perform better in identifying associations with destination and intersection densities. Future studies can use suitable investigation methods to determine the optimal threshold values.

5 References

Beenackers, M. A., Foster, S., Kamphuis, C. B. M., Titze, S., Divitini, M., Knuiman, M., van Lenthe, F. J. and Giles-Corti, B., 2012. Taking up cycling after residential relocation: Built environment factors. *American Journal of Preventive Medicine*, *42*(6), pp.610-615. https://doi.org/10.1016/j.amepre.2012.02.021

Boulton, A. J. and Williford, A., 2018. Analyzing skewed continuous outcomes with many zeros: A tutorial for social work and youth prevention science researchers. *Journal of the Society for Social Work & Research*, 9(4), pp.721-740. https://doi.org/10.1086/701235

Brand, C., Dons, E., Anaya-Boig, E., Avila-Palencia, I., Clark, A., de Nazelle, A., . . . Int Panis, L. (2021). The climate change mitigation effects of daily active travel in cities. *Transportation Research Part D: Transport and Environment, 93*, 102764. doi:https://doi.org/10.1016/j.trd.2021.102764

Christiansen, L. B., Cerin, E., Badland, H., Kerr, J., Davey, R., Troelsen, J., Van Dyck, D., Mitáš, J., Schofield, G., Sugiyama, T., Salvo, D., Sarmiento, O. L., Reis, R., Adams, M., Frank, L. and Sallis, J. F., 2016. International comparisons of the associations between objective measures of the built environment and transport-related walking and cycling: IPEN adult study. *Journal of Transport & Health*, *3*(4), pp.467-478. https://doi.org/10.1016/j.jth.2016.02.010

Gao, J., Kamphuis, C. B. M., Dijst, M. and Helbich, M., 2018. The role of the natural and built environment in cycling duration in the Netherlands. *International Journal of Behavioral Nutrition & Physical Activity*, *15*(1). https://doi.org/10.1186/s12966-018-0715-z

Goel, R., Goodman, A., Aldred, R., Nakamura, R., Tatah, L., Garcia, L. M. T., Zapata-Diomedi, B., de Sa, T. H., Tiwari, G. and de Nazelle, A., 2022. Cycling behaviour in 17 countries across 6 continents: Levels of cycling, who cycles, for what purpose, and how far? *Transport Reviews*, *42*(1), pp.58-81. https://doi.org/10.1080/01441647.2021.1915898

Götschi, T., Garrard, J., & Giles-Corti, B. (2016). Cycling as a part of daily life: A review of health perspectives. *Transport reviews, 36*(1), 45-71. doi:https://doi.org/10.1080/01441647.2015.1057877

Gunn, L. D., King, T. L., Mavoa, S., Lamb, K. E., Giles-Corti, B. and Kavanagh, A., 2017. Identifying destination distances that support walking trips in local neighborhoods. *Journal of Transport & Health, 5*, pp.133-141. https://doi.org/10.1016/j.jth.2016.08.009.

Ipsos Social Research Institute., 2017. *VISTA 2015 – 2016 Technical report*. Department of Economic Development, Jobs, Transport and Resources - Victoria.

Koohsari, M. J., Cole, R., Oka, K., Shibata, A., Yasunaga, A., Hanibuchi, T., Owen, N. and

Sugiyama, T., 2020. Associations of built environment attributes with bicycle use for transport. *Environment & Planning B: Urban Analytics & City Science*, *47*(9), pp.1745-1757. https://doi.org/10.1177/2399808319845006

Lee, A., & March, A. (2010). Recognising the economic role of bikes: sharing parking in Lygon Street, Carlton. *Australian Planner, 47*(2), 85-93. doi:10.1080/07293681003767785

Ma, L., Dill, J. and Mohr, C., 2014. The objective versus the perceived environment: What matters for bicycling? *Transportation*, *41*(6), pp.1135-1152. https://doi.org/10.1007/s11116-014-9520-y

Ma, L., Ye, R., & Wang, H. (2021). Exploring the causal effects of bicycling for transportation on mental health. *Transportation Research Part D: Transport and Environment, 93*, 102773. doi:https://doi.org/10.1016/j.trd.2021.102773

Millward, H., Spinney, J. and Scott, D., 2013. Active-transport walking behavior: Destinations, durations, distances. *Journal of Transport Geography*, *28*, pp.101-110. https://doi.org/10.1016/j.jtrangeo.2012.11.012

Nielsen, T. A. S., Olafsson, A. S., Carstensen, T. A. and Skov-Petersen, H., 2013. Environmental correlates of cycling: Evaluating urban form and location effects based on Danish micro-data. *Transportation Research Part D: Transport & Environment*, *22*, pp.40-44. https://doi.org/10.1016/j.trd.2013.02.017

Porter, A. K., Kohl, H. W., Perez, A., Reininger, B., Gabriel, K. P. and Salvo, D., 2020. Bikeability: Assessing the objectively measured environment in relation to recreation and transportation bicycling. *Environment & Behavior*, *52*(8), pp.861-894. https://doi.org/10.1177/0013916518825289

Sugiyama, T., Kubota, A., Sugiyama, M., Cole, R. and Owen, N., 2019. Distances walked to and from local destinations: Age-related variations and implications for determining buffer sizes. *Journal of Transport & Health*, *15*, p.100621. https://doi.org/10.1016/j.jth.2019.100621

Yang, Y., Wu, X., Zhou, P., Gou, Z. and Lu, Y., 2019. Towards a cycling-friendly city: An updated review of the associations between built environment and cycling behaviors (2007–2017). *Journal of Transport & Health*, *14*, p.100613. https://doi.org/10.1016/j.jth.2019.100613