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Riding beyond obstacles: The role of cycling experience in perception of barriers

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Abstract

This study explores the relationship between cycling experience and the perception of physical barriers within the Greater Melbourne. Using a map-based survey, we collected data from 430 cyclists, whose experience ranged from novice to veteran. The survey included sections on sociodemographic background, detailed mapping of cycling experiences and preferences, and perceptions of barriers such as heavy traffic, challenging terrain, and personal safety concerns. Our structural equation modelling analysis reveals that cycling experience significantly influences the perception of these barriers, both directly and through the mediation of general barrier perceptions. Experienced cyclists showed a marked decrease in the perception of specific barriers such as fast traffic, personal safety issues, and inadequate cycling infrastructure. Conversely, novice cyclists displayed heightened sensitivity to these barriers, which negatively impacted their willingness to engage in regular cycling. The analysis also highlighted that sociodemographic factor, particularly gender and education level, significantly affect barrier perceptions. Women and less educated cyclists perceived greater barriers, underscoring the need for targeted community engagement and infrastructural interventions. By enhancing the cycling experience through strategic urban planning and tailored public health initiatives, we can reduce the impact of perceived barriers, thus promoting broader adoption of cycling and supporting more inclusive and sustainable urban transportation.

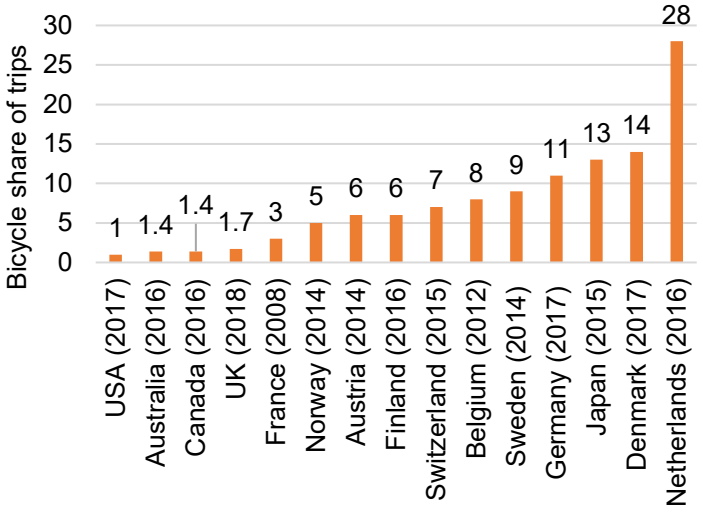
1 Introduction

Cycling is widely recognised for its benefits to public health, environmental sustainability, and economic development (Arellana et al., 2020). The concept of creating cycle-friendly urban environments has gained increasing attention (Lowry et al., 2012, Miller, 2018, van Wee, 2016, Zuo et al., 2018). With the onset of the COVID-19 pandemic, there have been transformative shifts in transportation networks aimed at fostering safer and more sustainable travel practices, including the implementation of 'pop-up' bicycle lanes and the promotion of cycling to accommodate physical distancing (Giles-Corti et al., 2022, Lock, 2020). These changes not only altered travel behaviours—significantly reducing public transport usage while increasing cycling adoption—but also highlighted the need for substantial investment in cycling infrastructure and accessibility (Sung and Monschauer, 2020).

Surveys conducted in Australia and the UK during this period revealed a substantial increase in cycling, indicating not just a change in frequency but also an improvement in cyclists' skills and confidence, particularly among women (Fuller et al., 2021, Morley and Pafka, 2023). These changes underline a societal shift towards viewing cycling as a viable primary mode of transportation, necessitating a serious investment in cycling infrastructure and accessibility (Lock, 2020).

Despite over half of Australian households owning at least one bicycle, the bicycling share of daily trips remains one of the lowest globally, with only 1.1% of workers using bicycles to commute, even though nearly 30% of the working population lives within a 30-minute cycling distance from their workplaces (Pucher, 2020, Both et al., 2022) (see Figure 1). Although major cities in Australia have greatly expanded their overall cycling networks in recent years, cycling participation rates have decreased, particularly amongst the young (Austroads, 2019). This paradox suggests that substantial barriers still deter would-be cyclists, despite the apparent availability of infrastructure.

Figure 1: Bicycling share of daily trips (Pucher, 2020)



Research investigating these barriers has been extensive (Boufous et al., 2021, Aldred et al., 2019, Vietinghoff, 2021). Nevertheless, the modest cycling participation rates in Australian metropolitan areas suggest that significant hurdles continue to deter would-be cyclists (Austroads, 2019). While these barriers are typically characterised as physical obstacles, an emerging inquiry is whether cyclists from varied sociodemographic backgrounds and with disparate levels of cycling experience perceive these barriers uniformly (Heinen et al., 2010).

Van Bekkum and colleagues (2011) identified environmental factors as the primary perceived barriers to bicycle commuting, with significant differences in barrier perception across different demographic groups and stages of behavioural change. For example, individuals at different stages of behaviour change exhibit varied perceptions of cycling obstacles. Those in the precontemplation stage (those who have not yet considered cycling as a viable mode of transport), along with females and administrative or logistical staff members, tend to perceive greater obstacles compared to maintainers (those who have adopted cycling and are sustaining this behaviour), males and academic staff and faculty members. This distinction highlights how perceptual differences can significantly affect overall cycling behaviour and attitudes (Zhao et al., 2018b, Xing et al., 2018). In their study, Zhao et al. primarily focused on satisfaction related to the characteristics of bicycle paths, intersections, traffic facilities, and the personal benefits of cycling. Zhao et al. (2018a) focused on satisfaction with specific bicycle path characteristics, intersection designs, and traffic facilities, as well as the personal benefits of cycling. Xing et al. (2018), on the other hand, concentrated specifically on perceptions related to the characteristics of bike paths.

While this study primarily focuses on the role of infrastructure in enhancing urban cycling experiences, it recognizes the broader ecosystem that supports cycling. Echoing Cooley's (1894) historical perspective, transport systems encompass not just infrastructure but also vehicles, user behaviour and culture, and the regulatory frameworks that facilitate or hinder their operation. The emphasis on infrastructure in this paper is deliberate, aimed at highlighting tangible challenges and opportunities that can be directly influenced through urban planning and policy interventions. Previous studies have contributed valuable insights into specific aspects of cycling infrastructure and the personal benefits of cycling. Building on this foundation, our study extends the scope by examining various factors that may be perceived as barriers to cycling, such as traffic conditions, personal safety concerns, and facility availability. Moreover, this research employs a mixed-methods approach that integrates quantitative data from surveys with qualitative insights to foster a deeper understanding of these barriers and their impact on cycling behaviour.

By focusing on how different barriers are perceived depending on a cyclist's level of experience, this study explores in detail the ways in which individual cycling proficiency can mitigate perceived obstacles. While this study examines the interaction between experience and perception within the context of Melbourne, it should not be considered a reference for broad generalizations to all potential cycling barriers globally.

Building on this foundation, our study hypothesizes that novice cyclists may perceive infrastructure and traffic conditions as more daunting than experienced cyclists, who are likely to navigate these challenges with greater ease and confidence. By exploring how varied levels of cycling experience influence the perception of barriers, our research aims to assess the role of experience in overcoming the challenges faced by cyclists. This insight is pivotal in crafting targeted interventions to boost cycling participation and support more inclusive and sustainable urban transportation solutions.

2 Methods

This exploratory study utilised a cross-sectional design to assess the influence of cycling experience on the perception of cycling barriers among cyclists within Greater Melbourne. The Maptionnaire platform was employed to conduct a map-based survey, offering a dynamic interface for participants to visually identify and describe barriers to cycling on a digital map. This approach provided rich spatial data, allowing for the capture of nuanced, location-specific insights on cycling experiences and perceived barriers. Maptionnaire's interactive functionality facilitated detailed feedback directly from the cyclists' perspectives, enhancing the validity of the data related to environmental and infrastructural barriers. Recruitment was conducted with the cooperation of Bicycle Network, a prominent cycling advocacy group. They assisted in the survey's dissemination by sharing the survey link through their well-established social media channels, thereby enabling access to a broad audience of cyclists within the target demographic. To ensure a more representative sample and mitigate bias towards active cyclists, the survey was also distributed through various other social media platforms and directly to diverse organizations. These organizations included community centres, educational institutions, and workplace groups, whose members range from non-cyclists to occasional riders and daily commuters.

The survey consisted of three main categories: sociodemographic information, mapping of cycling experience and preferences, and the subjective perception of barriers. Sociodemographic data included age, gender, and educational background. Cycling experience was assessed by mapping preferred routes to various destinations, including work, college or university, shops, sports and leisure centres, and other locations. The perception of barriers was measured through a series of questions related to environmental factors and infrastructure.

2.1 Data

Data was collected from a total of 430 cyclists within Greater Melbourne, with route data available for 125 individuals. The analytic sample for this study, which included sociodemographic information, preferences, and attitudes, consisted of 305 participants who were all over 18 years old, meeting the eligibility criteria for the survey. Table 1 presents the descriptive statistics of the variables used in the SEM models.

The average age of respondents is 42.6 years, with a range from 22 to 75 years, encompassing young adults through to seniors, which highlights a broad age diversity important for understanding varied cycling needs across life stages. The sample comprises 63.9% men and 36.1% women, mirroring national trends but also pointing towards the need for targeted gender-specific cycling initiatives. Most respondents are well-educated, with 40.3% holding postgraduate degrees and 30.4% with bachelor's degrees, suggesting a participant group with potentially high expectations of urban cycling infrastructure.

In terms of infrastructure satisfaction, 40.6% of participants are satisfied or very satisfied, contrasting with 39.4% who express some level of disappointment, including 15.1% who are very disappointed. This spread indicates diverse perceptions of cycling infrastructure, which likely influences individual cycling behaviour and preferences.

Regarding cycling experience, most of the participants (53.7%) have more than 10 years of experience, indicative of a seasoned cyclist profile within the study. Additionally, those with 5 to 10 years and less than 5 years of experience make up 27.5% and 18.7% of the sample, respectively. This detailed breakdown allows for a detailed analysis of how varying levels of cycling familiarity affect perceptions of barriers and overall cycling frequency, crucial for designing effective cycling policies.

Table 1: Descriptive statistics for sociodemographic variables

Age	42.6	-	22	75
Gender			0	1
Women	110	36.1	1	1
Men	195	63.9	0	0
Education				
Diploma or under	72	23.6	0	1
Bachelor	93	30.4	0	1
Postgraduate	123	40.3	0	1
Overall satisfaction of infrastructure			1	4
Very disappointed	74	15.1	1	1
Disappointed	57	24.3	2	2
Neutral	61	20.0	3	3
Satisfied/Very satisfied[1]	124	40.6	4	4
Cycling experience				
Less than 5 years	57	18.7	1	1
5 to 10 years	84	27.5	2	2
More than 10 years	168	53.7	3	3

[1] Since the number of respondents who were 'very satisfied' was very limited, this category was combined with 'satisfied' for analysis purposes.

Table 2 presents the percentages of respondents who agreed with various questions about potential barriers to cycling, based on the question: "Are there any specific barriers or challenges that discourage you from cycling more frequently?". The table highlights that concerns about personal safety while cycling and the lack of separated cycling paths or lanes are the most commonly agreed upon barriers, with 52.7% and 58.2% of respondents citing them, respectively. Heavy traffic and congestion are also significant deterrents, with 45.4% of cyclists identifying them as barriers. Fast traffic is a concern for 40.9% of respondents, while adverse weather conditions are noted by 29.1%.

Other barriers such as limited bike parking facilities and insufficient lighting on cycling routes were less frequently identified, agreed upon by 28.2% and 15.4% of respondents, respectively. The least concerning barriers were hilly terrain or challenging topography, and the lack of showers or changing facilities at destinations, noted by only 11.8% and 6.36% of participants, respectively. These statistics underscore the diverse range of physical and environmental challenges that can impact cycling frequency in urban settings.

Table 2: Responses to barriers questions

Heavy_trff	Heavy traffic and congestion	45.4
Fast_trff	Fast traffic	40.9
Bike_parking	Limited bike parking facilities	28.2
Pers_safety	Concerns about personal safety while cycling	52.7
Poor_light	Insufficient lighting on cycling routes	15.4
Sep_path	Lack of separated cycling paths or lanes	58.2
Hilliness	Hilly terrain or challenging topography	11.8
Dest_fas	Lack of showers or changing facilities at destinations	6.36
Weather	Weather conditions (extreme heat, rain, snow)	29.1

2.2 Analysis

Data analysis was conducted using Structural Equation Modelling (SEM), a comprehensive statistical technique ideal for testing complex relationships among observed and latent variables. This method enabled the evaluation of direct and indirect effects within the hypothesised model, providing an understanding of how different factors influence cyclists' perceptions of barriers.

The SEM model was designed to examine the intricate relationships influencing cycling behaviours and barrier perceptions. It included age, gender, and education level as exogenous variables, hypothesized to impact both direct cycling experience and perceptions of barriers. Cycling experience was modelled as a mediator, assessed through the frequency of cycling and commonly used routes, to explore its influence on how cyclists perceive barriers. The construct 'Barrier Perception' served as a latent variable, created from survey responses related to environmental and infrastructural challenges. This latent variable encapsulated the complex nature of perceived barriers, including traffic conditions, safety concerns, and infrastructural adequacies. The measurement model was established to define how these latent constructs were indicated by observed variables, with 'Barrier Perception' specifically indicated by responses to various specific barriers such as heavy traffic, poor lighting, and inadequate cycling lanes. The structural part of the model further explored the relationships between the sociodemographic variables, cycling experience, and 'Barrier Perception'. It specified paths from each exogenous variable to the mediator and from the mediator to the latent variable. Additionally, to assess the direct effects comprehensively, paths were also included directly from the exogenous variables to 'Barrier Perception'. This configuration provided a framework to dissect the various ways demographics, cycling habits, and perceptions interconnect, aiding in understanding and potentially enhancing urban cycling experiences. The analyses explore the role of cycling experience in shaping perceptions of barriers to cycling through two distinct SEM approaches. The first model adopts a direct approach, connecting cycling experience to specific barriers without the mediation of perceived barriers (see Figure 2). This model suggests a correlation where more frequent cycling is associated with a reduced perception of various barriers such as fast traffic, personal safety concerns, and hilly terrain. The second model introduces mediation, indicating that cycling experience may influence perceptions of barriers both directly and indirectly. The indirect influence is posited through the mediating effect of a general reduction in perceived barriers (see Figure 3). This dual approach helps to explore how cycling experience might be related to changes in the perception of barriers. However, it is important to acknowledge that these relationships may not strictly imply causality. The observed associations could also reflect self-selection

biases, where individuals who are less deterred by these barriers may engage more frequently in cycling, or they may develop strategies over time to cope with or overcome these barriers. Further research is needed to untangle these potential influences and better understand the complex interactions between cycling frequency and barrier perception.

Figure 2: SEM structure of the model without mediation effect of cycling experience

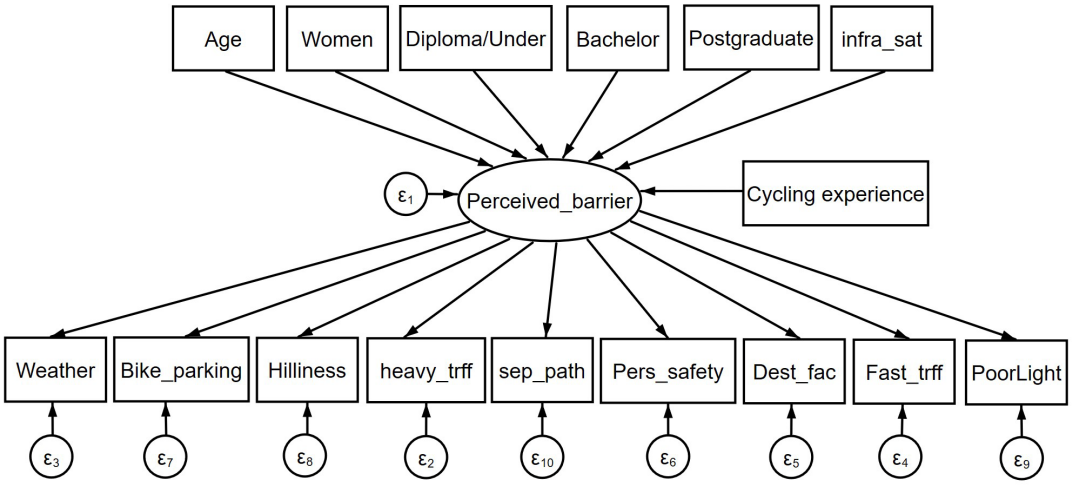
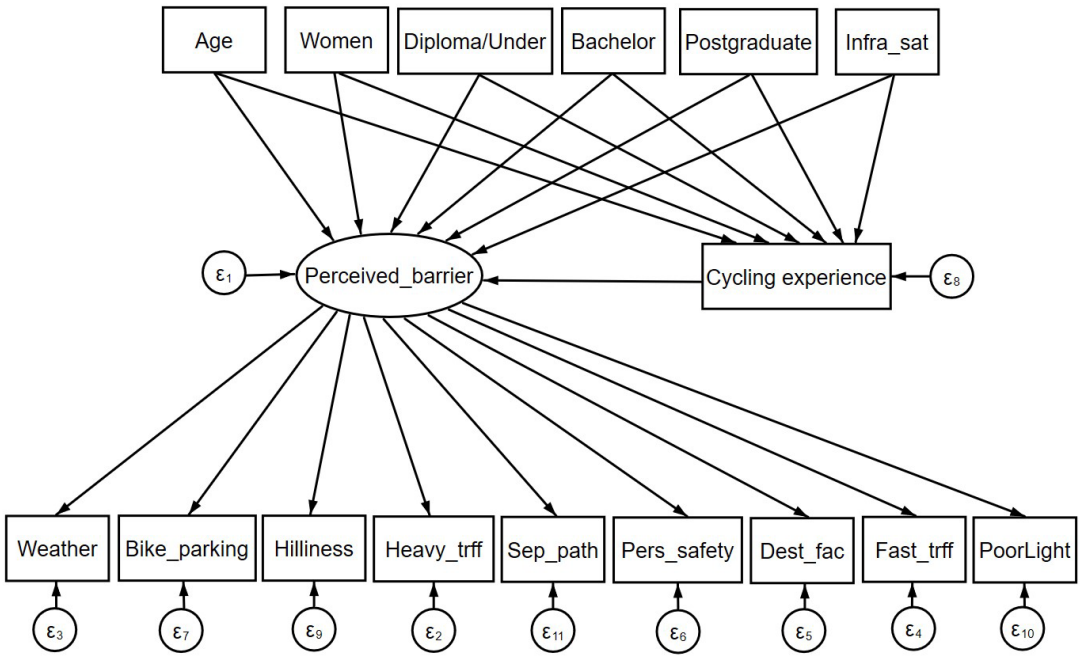


Figure 3: SEM model with mediation effect of cycling experience



3 Results

Table 3 presents the SEM results of the model without mediation effect of cycling experience. The analysis results show how cycling experience and sociodemographic factors influence the perception of various cycling-related barriers without the mediation of general perceived barriers. Notably, cycling experience has a consistently negative effect on overall perceived barriers (Coef. = -0.107, $p < 0.001$), underscoring the hypothesis that more cycling experience is associated with a reduced perception of obstacles. This direct relationship highlights the beneficial effects of familiarity with cycling on the individual's perception of barriers.

Specific barriers such as Fast Traffic, Personal Safety, Bike Parking Availability, Hilly Terrain, Insufficient Light, and Lack of Separated Path also show significant direct negative effects from cycling experience. For instance, the experience reduces the perception of Fast Traffic as a barrier by -0.032 and Personal Safety concerns by -0.117, indicating that experienced cyclists feel more confident and less hindered by these conditions. Similar effects are seen with Hilly Terrain (-0.028), Insufficient Light (-0.057), and Lack of Separated Path (-0.082), where more frequent cycling correlates with a lower perception of these elements as barriers.

In terms of sociodemographic influences, the results suggest mixed impacts on perceived barriers. Age shows a slight negative effect (Coef. = -0.007, $p < 0.001$), implying that older individuals may perceive fewer barriers, possibly due to a more established cycling routine or selective cycling habits. Women, however, are shown to potentially perceive more barriers (Coef. = 0.073, $p = 0.065$), although this effect is marginally significant, indicating a trend that could benefit from further exploration.

Education level also plays a role, albeit inconsistently across different degrees. Those with a Postgraduate degree show a significant negative influence on perceived barriers (Coef. = -0.166, $p = 0.039$), suggesting that higher education levels may equip individuals with better resources or coping strategies for overcoming cycling barriers. Conversely, individuals with a Diploma or Bachelor’s degree do not show significant effects, indicating that the relationship between education and barrier perception might be more complex or influenced by other unaccounted factors. Additionally, the absence of significant effects among those with Diploma or Bachelor’s degrees suggests that the impact of education on barrier perception is not linear and may involve complex interactions with other sociodemographic factors. We acknowledge that our current model might not capture all these complexities, pointing to the need for further research that incorporates a more comprehensive range of sociodemographic variables to fully understand the nuances of this relationship.

Overall infrastructure satisfaction is another significant factor, showing a negative relationship with perceived barriers (Coef. = -0.124, $p < 0.001$). This implies that satisfaction with existing cycling infrastructure significantly reduces the perception of barriers, reinforcing the importance of well-maintained and accessible cycling facilities in promoting cycling activities.

These results elucidate the intricate relationship between cyclists' experience, demographic factors, and infrastructure in shaping their perceptions of barriers. The data specifically highlights how different barriers disproportionately affect cyclist groups based on their level of experience and demographic characteristics. This insight provides a strong foundation for recommending targeted interventions. For instance, enhancing lighting and signage in areas identified as poorly lit could directly reduce safety concerns, a barrier frequently noted by newer cyclists. Additionally, implementing community programs that offer cycling safety workshops tailored to the needs of less experienced cyclists can further alleviate their perceived barriers and encourage more consistent cycling habits. By addressing these specific needs, both infrastructure modifications and community initiatives can effectively enhance the overall cycling experience and make cycling more accessible and safer for all,

particularly focusing on the support needed by less experienced and potentially more vulnerable groups.

Table 3: SEM results of the model without mediation effect of cycling experience

	Coef.	St. E	p<|z|	Coef.	St. E	p<|z|	Coef.	St. E	p<|z|
Perceived barriers									
Cycling experience	-0.107	0.026	0.000	_	_	_	-0.107	0.026	0.000
Age	-0.007	0.002	0.000	_	_	_	-0.007	0.002	0.000
Women	0.073	0.039	0.065	_	_	_	0.073	0.039	0.065
Highest qualification									
Diploma or under	-0.086	0.082	0.290	_	_	_	-0.086	0.082	0.290
Bachelor	-0.164	0.088	0.062	_	_	_	-0.164	0.088	0.062
Postgraduate	-0.166	0.080	0.039	_	_	_	-0.166	0.080	0.039
Overall infra satisfaction	-0.124	0.021	0.000	_	_	_	-0.124	0.021	0.000
Barriers									
Heavy traffic									
Cycling experience	_	_	_	-0.107	0.026	0.000	-0.107	0.026	0.000
Perceived barriers	1.000	(constrained)		_	_	_	1.000	(constrained)	
Weather conditions									
Cycling experience	_	_	_	-0.001	0.011	0.959	-0.001	0.011	0.959
Perceived barriers	0.005	0.103	0.959	_	_	_	0.005	0.103	0.959
Fast traffic									
Cycling experience	_	_	_	-0.032	0.015	0.026	-0.032	0.015	0.026
Perceived barriers	0.302	0.129	0.020	_	_	_	0.302	0.129	0.020
Facilities at destinations									
Cycling experience	_	_	_	-0.026	0.009	0.003	-0.026	0.009	0.003
Perceived barriers	0.239	0.065	0.000	_	_	_	0.239	0.065	0.000
Personal safety									
Cycling experience	_	_	_	-0.117	0.028	0.000	-0.117	0.028	0.000
Perceived barriers	1.095	0.139	0.000	_	_	_	1.095	0.139	0.000
Bike parking availability									
Cycling experience	_	_	_	-0.096	0.024	0.000	-0.096	0.024	0.000
Perceived barriers	0.899	0.127	0.000	_	_	_	0.899	0.127	0.000
Hilly terrain									
Cycling experience	_	_	_	-0.028	0.010	0.004	-0.028	0.010	0.004
Perceived barriers	0.265	0.073	0.000	_	_	_	0.265	0.073	0.000
Insufficient light									
Cycling experience	_	_	_	-0.057	0.015	0.000	-0.057	0.015	0.000
Perceived barriers	0.535	0.096	0.000	_	_	_	0.535	0.096	0.000
Lack of separated path									
Cycling experience				-0.082	0.021	0.000	-0.082	0.021	0.000
Perceived barriers	0.766	0.134	0.000	_	_	_	0.766	0.134	0.000

Note: In the SEM model, education categories are included as dummy variables.

Overall satisfaction with infrastructure and cycling experience were included as an ordered variable, where higher values indicate greater satisfaction/cycling experience.

Table 4 delineates the results from the structural equation modelling (SEM) that incorporates the mediation effect of cycling experience on perceived barriers, examining both direct and indirect impacts. This analysis extends the insights from Table 3 by assessing how cycling experience might influence perceptions of barriers through the intermediary of general barrier perceptions. The model reaffirms the direct negative effect of cycling experience on perceived barriers (Coefficient = -0.107, $p < 0.001$), consistent with previous findings, which

indicates that increased cycling experience significantly reduces perceived obstacles. This underscores the direct relationship between regular cycling and the reduction of barriers.

The investigation of indirect effects reveals minimal mediating impacts for most barriers, suggesting that general perceived barriers do not significantly alter the influence of cycling experience on specific barriers such as Fast Traffic (Coefficient = -0.032, p = 0.026) and Personal Safety (Coefficient = -0.117, p = 0.028). On sociodemographic factors, age shows a slightly negative relationship with perceived barriers (Coefficient = -0.007, p < 0.001), becoming more pronounced when mediated (Indirect Coefficient = -0.003, p = 0.001). Women appear to perceive more barriers (Direct Coefficient = 0.073, p = 0.065), with minimal indirect influence (Indirect Coefficient = 0.025, p = 0.041).

Regarding education, individuals with a Postgraduate degree display a significant negative impact on perceived barriers (Direct Coefficient = -0.166, p = 0.039), slightly mediated by general perceptions (Indirect Coefficient = 0.023, p = 0.339). Similarly, overall infrastructure satisfaction shows a direct negative correlation with perceived barriers (Direct Coefficient = -0.124, p < 0.001), with a small but significant mediated effect through general perceptions (Indirect Coefficient = -0.018, p = 0.007).

These results from Table 4 enhance our understanding of the roles that direct and mediated effects play in shaping cyclists' perceptions of barriers. They highlight the predominance of direct experiences over generalized perceptions in influencing how cyclists view barriers. This detailed insight is crucial for developing targeted interventions that effectively address the specific barriers identified, ensuring strategies are tailored to meet the diverse needs of cyclists based on their experiences and sociodemographic characteristics. This approach not only aids in reducing perceived barriers but also supports the broader goal of promoting cycling as a viable and attractive mode of transportation.

Table 4: SEM results of the model with mediation effect of cycling experience

	Coef.	**St. E**	**p<|z|**	**Coef.**	**St. E**	**p<|z|**	**Coef.**	**St. E**	**p<|z|**
Perceived barriers									
Cycling experience	-0.107	0.026	0.000	_	_	_	-0.107	0.026	0.000
Age	-0.007	0.002	0.000	-0.003	0.001	0.001	-0.009	0.002	0.000
Women	0.073	0.039	0.065	0.029	0.013	0.025	0.102	0.041	0.012
Highest qualification									
Diploma or under	-0.164	0.088	0.062	0.021	0.024	0.383	-0.143	0.090	0.114
Bachelor	-0.086	0.082	0.290	0.044	0.025	0.078	-0.042	0.084	0.615
Postgraduate	-0.166	0.080	0.039	0.022	0.023	0.339	-0.144	0.083	0.082
Overall infra satisfaction	-0.124	0.021	0.000	-0.018	0.007	0.006	-0.142	0.022	0.000

Note: Estimates for 'Barriers' and 'Cycling Experience' are the same as those presented in Table 3; therefore, they are not included in this table.

The overall evidence from both models underscores that cycling experience plays a critical role in how barriers to cycling are perceived. The direct effects in the non-mediation model emphasise that practical experience mitigates perceived difficulties directly linked to specific aspects of cycling, like safety or terrain challenges. Meanwhile, the mediation model highlights that part of the influence of cycling experience on specific barriers operates through a general reduction in barrier perception. This approach suggests that effective cycling interventions should include both broad improvements in cycling infrastructure, such as expanding bike lanes and improving traffic safety measures, as well as specific enhancements tailored to address common concerns. For example, installing better lighting and constructing safer bike lanes are crucial for alleviating the fears of less experienced cyclists and encouraging more frequent cycling.

The findings also point to the importance of considering demographic factors in cycling policy and urban design, acknowledging that different groups may have varying perceptions and needs related to cycling infrastructure.

4 Discussion

While previous studies have explored various aspects of cycling behaviour (Zhao et al., 2018b, Xing et al., 2018), our research quantifies the impact of cycling experience on the perception of barriers in an urban environment. Our study contributes to a deeper understanding of how perceived barriers evolve as individuals gain more cycling proficiency. This perspective is particularly valuable for urban planners and policymakers who seek to tailor interventions to cyclist groups at different stages of experience.

The results underline the critical role of cycling experience in shaping perceptions of barriers, which is consistent with behaviour change theories such as the Theory of Planned Behaviour (Ajzen, 2011). This theory posits that attitudes towards behaviour significantly influence intentions and actual behaviour, suggesting that enhancing positive attitudes towards cycling by reducing perceived barriers could increase cycling adoption.

To address these findings, specific policy interventions are essential. For instance, developing cycling training programs that offer guided rides through various terrains and traffic conditions could enhance novice riders' confidence and skills (Pucher et al., 1999). Incorporating such initiatives into urban planning decisions, with a focus on creating a feedback loop that aligns cyclists' needs with infrastructure developments, supports broader societal goals. These include reducing carbon emissions, improving public health, and alleviating urban congestion, with considerable economic benefits such as decreased healthcare costs and reduced road maintenance expenditures due to less car traffic, as evidenced in previous research (Pucher and Dijkstra, 2003, Monazzam et al., 2021).

The study’s geographical focus on Greater Melbourne means the findings may not fully represent the diverse cycling conditions and cultural attitudes found in different regions. This limitation suggests the need for comparative studies across various cities, and possibly, longitudinal studies to track changes in cycling behaviour and perceptions over time, providing a more nuanced global perspective.

Additionally, the relatively small sample size, while yielding promising results, may affect the generalizability of the findings. Increasing the sample size in future research could provide more robust and widely applicable insights. The survey’s exclusive targeting of adults over 18 years also limits the applicability of results to this demographic, excluding potential insights into the cycling experiences of children and adolescents.

Importantly, the study primarily reflects the experiences of current cyclists, omitting non-cyclists who may face significant barriers to starting cycling. Including non-cyclists in future research could help identify a broader range of barriers and enhance understanding of factors deterring potential cyclists.

The Maptionnaire platform used focuses on geographical barriers and may not capture non-geographical challenges such as mechanical issues with bicycles or the absence of a bicycle. Future research could address this by integrating additional survey questions or employing different data collection methods to capture a wider array of barriers.

Although the study considers age and cycling experience as factors influencing the perception of barriers, it does not explore the interaction between these variables in depth. Future studies should investigate how a cyclist’s age and accumulated experience interact to shape their perceptions and behaviours toward cycling barriers.

Finally, while our analysis suggests that satisfaction with cycling infrastructure is inversely related to the perception of barriers, we recognize the possibility of a bidirectional relationship. This complexity should be explicitly addressed in future research to disentangle

the interdependencies between infrastructure satisfaction and barrier perception, ensuring that interventions are appropriately targeted.

Cultural shifts towards sustainability and active lifestyles can reinforce cycling initiatives, necessitating campaigns that resonate with diverse community values. As recent study by Smith et al. (2020) support, structured cycling initiatives combined with supportive infrastructure can significantly enhance cycling safety and uptake. Furthermore, advancements like e-bikes have broadened cycling's appeal, reduced physical barriers and made it more accessible, underscoring the potential of technology to transform cycling into a mainstream urban transportation option (Plazier et al., 2018).

Engaging in interdisciplinary research will further our understanding of how to integrate these advancements with public needs, ensuring that cycling remains a cornerstone of sustainable urban mobility strategies. This discussion moves beyond the confines of the current study to engage with wider social, cultural, and policy contexts, enhancing both the academic depth and practical relevance of the research.

5 Conclusions

This study has explored how cycling experience influences perceptions of barriers in urban cycling environments, particularly within the Greater Melbourne area. The findings reveal that increased cycling experience significantly diminishes the perception of various barriers, such as heavy traffic, personal safety concerns, and inadequate infrastructure. This supports the behavioural theories suggesting that familiarity and comfort with an activity can greatly reduce perceived obstacles, thereby potentially increasing participation.

The structural equation modelling used in this study indicates that both direct experiences and broader perceptions mediate the relationship between cycling frequency and perceived barriers. Experienced cyclists are less deterred by typical urban cycling challenges, suggesting that interventions to increase regular cycling among novices could be particularly effective. For example, tailored training programs that expose new cyclists to diverse traffic conditions and terrains could help build their confidence and resilience, making cycling a more attractive and feasible mode of transportation.

Moreover, the study highlights the importance of demographic considerations in urban cycling policy. With distinct differences in how barriers are perceived across various demographic groups, urban planners and policymakers must design inclusive cycling infrastructure that caters to the needs of a diverse population. This could involve enhancing the safety features of cycling lanes, increasing the availability of bike parking, and ensuring that cycling routes are well-lit and well-maintained.

In conclusion, by addressing the specific and general barriers to cycling identified in this research, cities can not only improve public health and reduce environmental impact but also promote a more inclusive and sustainable urban mobility framework. Future research should aim to extend these findings to other contexts and explore the longitudinal effects of such interventions, providing a deeper understanding of the dynamics that influence urban cycling across different cultures and cities. This will enable a more tailored approach to cycling advocacy and infrastructure development, ensuring that cycling is accessible and appealing to all potential users.

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