

TRANSPORT FINDINGS

Gender, Weather, and Time of Day: Active Travel Observations in Greater Sydney

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Findings

This paper examines how weather and time of day affect the way males and females use walking and cycling infrastructure in Sydney, Australia. Using observational data from three dedicated walking and cycling paths, the results show that more males than females engaged in walking and cycling, with cycling showing a greater gender disparity. While active travel volumes were influenced by weather and time of day, no significant gender differences were observed in how these factors affected the number of active travel users.

1. Questions

Adverse weather conditions deter walking and cycling (Burchfield, Fitzhugh, and Bassett 2012; Guo, Wilson, and Rahbee 2007). Furthermore, the weather-cycling relationship can be moderated by gender (de Kruijf et al. 2021), and day of week / time of day (Singhal, Kamga, and Yazici 2014; Zhao et al. 2018).

In many cities, the provision of infrastructure for active travel (defined here as walking and cycling) is a key component of programs to encourage walking and cycling (Jáuregui et al. 2021; Marshall 2022). There has, however, been a lack of in-depth studies examining the way active transport infrastructure interacts with weather, time of day, and gender, in the context of the uptake of active transport modes in Australia. We address this gap by focusing on specific infrastructure, allowing for a detailed examination of how these factors affect active travel use.

We conducted comprehensive manual observations of active travel behaviours at selected active travel infrastructure interventions in Greater Sydney, Australia. The following research questions are addressed:

- How do weather and time of day affect the behaviour of cyclists and pedestrians at observation sites?
- Is there a gender difference in the usage of active travel infrastructure?

2. Methods

This study is focussed on three selected instances of active travel infrastructure in Greater Sydney ([Table 1](#)). These cases represent three different types of infrastructural interventions: on-road cycleway, off-road shared path; and a bridge that only allows for walking and cycling (on a shared path) and for buses (on a bus lane), but not for car traffic.

Active traffic volume was observed for walking (including people who walk, run, and walk with dogs or prams) and cycling (including people who ride bikes and e-bikes). The traffic count was recorded in both directions, noting gender differences (based on observation, where gender was considered as a binary variable) and weather conditions, including sunny/rainy status. Five observation sessions were conducted at each site: two on weekday mornings, two on weekday afternoons, and one on a Saturday morning. Each session lasted two hours (see [Table 1](#)) and sessions were conducted in late February and March 2024.

Each session involved multiple people positioned at different locations along the infrastructure at the same time. [Figure 1](#) shows photos of the three sites. [Figure 2](#) illustrates the standing locations of observers, which is consistent for every observation session. All observers received standardised training before the observation sessions and were instructed to follow specific guidelines to ensure consistency in data recording. During each session, the fieldwork leader visited all observation sites to verify that observers were adhering to the set standards, ensuring data reliability.

The apparent (“feels like”) temperature (Steadman 1994) was considered in the data analysis. The apparent temperatures during mornings and afternoons were calculated respectively based on the temperature (°C), relative humidity (%) and wind speed (m/s) at 9am and 3pm from the nearest weather stations, drawing data from Australian Government Bureau of Meteorology (2024). Therefore, the apparent temperature is the human perceived temperature, including an adjustment for humidity and wind speed.

Descriptive analysis was conducted. Then, given the over-dispersion of the active travel count data, multivariable negative binomial regression analyses were used to assess the effects of the weather conditions and time of day on active travel counts, stratified by gender and observation sites. All statistical analyses were performed using the software R.

3. Findings

There are slightly more cyclists than pedestrians at Moore Park Road Pop-up Cycleway, and substantially more pedestrians than cyclists using the Shared Path from North Ryde Station to Macquarie Centre, as well as the Bennelong Bridge. Detailed data is provided in Table S1 of the Supplemental

Table 1. Traffic observation sites and observation arrangement

Site name	Moore Park Road pop-up cycleway	Shared Path from North Ryde Station to Macquarie Centre	Bennelong Bridge (Homebush Bay Bridge)
Nature of infrastructure	Two-way cycleway (on the roadway) *The current governmental decision is to retain the cycleway until 2026	Two-way shared path for cyclists and pedestrians (partially on the roadway and partially off the roadway)	Two-way bus lanes & two-way shared path for cyclists and pedestrians * Emergency vehicles are also permitted.
Context of infrastructure	Connecting the Eastern suburbs to Sydney CBD (i.e., Bondi Junction to Surry Hills). The nearby land use is primarily residential and public recreational areas.	An east link to the Macquarie Shopping Centre and the area. It connects three metro stations and services commuters. The nearby land use is primarily mixed use, commercial core, business park, and residential (low and high).	Connecting the suburbs of Rhodes (Canada Bay Council) and Wentworth Point (City of Parramatta Council), providing convenient access to Marina Square, Rhodes train station, and Rhodes Waterside and Rhodes Central. The nearby land use is primarily mixed use, high density residential, local centre, and some public recreation.
Local Government Area	City of Sydney	Ryde	Canada Bay, Paramatta
Month of opening	August 2020	July 2020	May 2016
Length of infrastructure (km)	1.3	2.7	0.3
Number of observers	4	4	2
Observation date	22/02/2024, 02/03/2024, 07/03/2024, 09/03/2024, 13/03/2024, 14/03/2024, 16/03/2024, 21/03/2024, 28/03/2024		
Observation time period	Weekday 1 (morning) Morning peak session: 7:30 am – 9:30 am Morning off-peak session: 10:00 am – 12:00 am Weekday 2 (afternoon) Afternoon peak session: 5:00 pm – 7:00 pm Afternoon off-peak session: 1:30 pm – 3:30pm Saturday Morning 10:00 am -12:00 am		

Information. Generally, more males than females engage in walking and cycling at the observation sites, with the gender imbalance being most pronounced among cyclists—male cyclists outnumber female cyclists by approximately three to one.

Weather effects on gender

The apparent temperature ranges from 10.95 to 29.58 °C, with a median of 23.43 °C during the nine observation days. [Table 2](#) provides a summary of the weather effects on active travel by gender. There are more cyclists and pedestrians on sunny days compared to cloudy or rainy days.



Figure 1. Photos of the three sites.

Source: The authors.

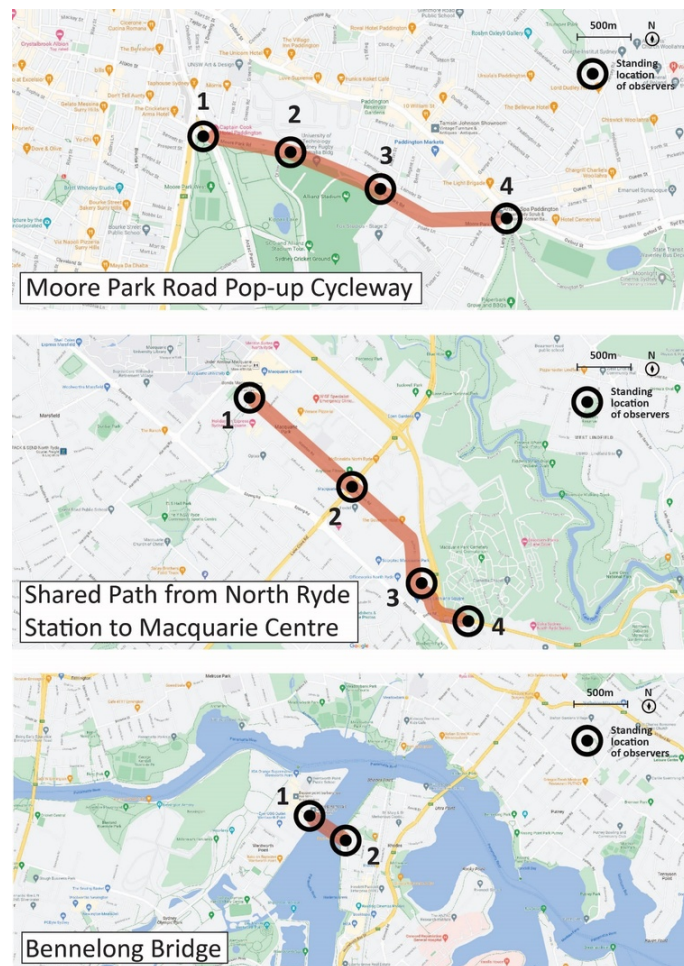


Figure 2. Locations of observers

Source: The authors, based on Google Maps.

Table 2. Data summary of weather effects on gender

Weather	Number of observation entries (each observer in each observation session can only have one entry)	Total cyclist count (%) (64.1% regular bikes, 35.9% e-bikes)		Total pedestrian count (%)	
		Female	Male	Female	Male
Cloudy/ rainy	8	44 (19.3%)	184 (80.7%)	1069 (53.5%)	928 (46.5%)
Sunny	42	634 (21.7%)	2284 (78.3%)	3468 (47.7%)	3803 (52.3%)
Total	50	678	2468	4537	4731

Time of day effects on gender

On weekdays, the number of cyclists and pedestrians is higher during peak hours than during off-peak hours. Detailed data is provided in Table S1 of the Supplemental Information.

Regression analyses are shown in [Table 3](#), and to explore the gender effect, in Tables S2-3 in the Supplemental Information. The number of male and female cyclists decreased significantly with increasing apparent temperature. There are significantly more cyclists on weekday afternoons, particularly during peak hours, compared to mornings or Saturdays. There are more users on Saturdays than weekday morning off-peak hours. More pedestrians are observed during peak hours than off-peak hours on weekday afternoons for both genders.

To enhance the statistical power of the analysis, we combined the data from Moore Park Road Pop-up Cycleway and Shared Path from North Ryde Station to Macquarie Centre, as both represent infrastructure situated along existing roads. In this case, the effect of apparent temperature and time of day on cyclists counts becomes larger and more significant than in the all-site analysis. More cyclists are observed during weekday morning peak hours than morning off-peak hours. The significant associations remain for both genders with stronger effects for females, and more female cyclists are observed during weekday afternoon off-peak hours than morning peak hours.

When combining the data from the Shared Path from North Ryde Station to Macquarie Centre and Bennelong Bridge, which are both shared paths, the effects of apparent temperature and time of day on cyclists also become stronger than in the all-site analysis, with largest effects for females. Markedly more cyclists are observed on weekday afternoons, especially in peak hours for females, followed by Saturdays and weekday mornings. Additionally, there are significantly more pedestrians during weekday afternoon peak hours than weekday off-peak hours, for both females and males. The number of male rather than female pedestrians decreases with increased apparent temperature.

We conducted a formal test (Wald test) to determine whether the coefficients from the two regressions (for males and females) differ significantly. The results indicate no significant difference between genders in the relationship between weather/time of day and the number of active travel users. Detailed data is provided in Table S4-6 of the Supplemental Information.

Overall, the data suggest that people prefer cycling and walking during weekday afternoon peak hours especially at cool temperatures in the summer / autumn season, however cycling appears to be less desirable during weekday morning off-peak hours than it is on Saturdays. Female cyclists seem to be more sensitive to weather variations and time of day than males, while male pedestrians using the Shared Path from North Ryde Station to Macquarie Centre and Bennelong Bridge may be more likely to be affected by apparent temperature than females. However, it should be acknowledged that the small sample size in this study may influence the accuracy of our estimates as indicated by the large confidence intervals.

To summarise, at the observation sites, there are more males than females engaged in walking and cycling. Cyclists exhibited a greater gender difference compared to the number of pedestrians. Weather affects active traffic volume: active travel volumes decrease with increased apparent temperature, and this is particularly significant for cyclists, indicating that cycling is very sensitive to weather conditions. Time of day also affects active traffic volume: afternoon peak hours have more traffic volume than all weekday off-peak hours, indicating that cycling and walking are both sensitive to time of day. Future studies with longer observational duration and multiple sites are needed to confirm these findings.

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Table 3. The effects of weather and time of day on active travel volume

	IRR (95% CI) for cyclist			IRR (95% CI) for pedestrian	
	All sites (n=50)	MP+MQ (n=40)	MQ+BB (n=30)	All sites (n=50)	MQ+BB (n=30)
Weather					
Apparent temperature (per 1 °C increase)	0.92* (0.85, 0.98)	0.88*** (0.82, 0.95)	0.33*** (0.23, 0.49)	1.07 (0.99, 1.16)	0.74 (0.54, 1.02)
Time of day					
Reference: weekday morning peak session					
Weekday morning off-peak session	0.46 (0.19, 1.10)	0.28** (0.11, 0.71)	0.65 (0.25, 1.69)	0.54 (0.20, 1.46)	0.55 (0.25, 1.21)
Weekday afternoon off-peak session	1.51 (0.49, 4.69)	2.48 (0.77, 7.98)	11.90*** (3.19, 44.48)	0.34 (0.09, 1.22)	0.90 (0.30, 2.70)
Weekday afternoon peak session	4.16* (1.34, 12.91)	7.22*** (2.25, 23.17)	28.66*** (7.73, 106.29)	0.95 (0.26, 3.42)	2.52 (0.84, 7.59)
Saturday session	1.40 (0.57, 3.43)	1.11 (0.36, 3.40)	6.61** (2.13, 20.50)	0.69 (0.25, 1.93)	1.11 (0.42, 2.94)
Reference: weekday morning off-peak session					
Weekday afternoon off-peak session	3.29* (1.05, 10.30)	8.89*** (2.70, 29.26)	18.37*** (4.84, 69.68)	0.63 (0.17, 2.26)	1.63 (0.54, 4.92)
Weekday afternoon peak session	9.08*** (2.91, 28.34)	25.88*** (7.88, 84.96)	44.23*** (11.75, 166.53)	1.75 (0.48, 6.32)	4.60** (1.53, 13.83)
Saturday session	3.05* (1.23, 7.54)	3.98* (1.29, 12.34)	10.19*** (3.25, 32.00)	1.28 (0.46, 3.58)	2.03 (0.77, 5.36)
Reference: weekday afternoon off-peak session					
Weekday afternoon peak session	2.76* (1.15, 6.58)	2.91* (1.17, 7.26)	2.41 (0.95, 6.10)	2.80* (1.04, 7.54)	2.81* (1.27, 6.23)
Reference: weekday afternoon peak session					
Saturday session	0.34* (0.11, 0.98)	0.15** (0.04, 0.58)	0.23** (0.08, 0.70)	0.73 (0.22, 2.49)	0.44 (0.17, 1.13)

Notes: IRR, incidence rate ratio. CI, confidence interval. MP, Moore Park Road Pop-up Cycleway. MQ, Shared Path from North Ryde Station to Macquarie Centre. BB, Bennelong Bridge. ***, $p < 0.001$. **, $p < 0.01$. *, $p < 0.05$. Statistically significant results ($p < 0.05$) are shown in **bold**.



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SUPPLEMENTARY MATERIALS

Supplemental Information

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