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1 **Abstract**

2 **Background:** In most countries women cycle less than men. This is despite the clear environmental  
3 and health benefits of active commuting. Feminist critiques suggest this gender gap reflects societal  
4 roles and values, yet there has been little empirical research on the differences in men’s and  
5 women’s cycling in the context of total travel.

6 **Methods:** Regression analyses were used to explore the travel mode and distance travelled of  
7 49,965 participants in the nationally representative, continuous, cross-sectional New Zealand  
8 Household Travel Survey (2002 to 2014). Regular cyclists were people who cycled at least 10 days in  
9 the preceding month. We reported results by gender and cyclist status.

10 **Results:** Car was the dominant mode of travel for all groups. While fewer women regularly cycled  
11 (2%) compared to men (5%), women travelled less each day (12-17% less distance) and were more  
12 likely to use public transport and walk than men. These gender patterns were broadly replicated in  
13 people who were regular cyclists. Women made 17-47% more motorised trips of less than 5km than  
14 men each day. Overall half of regular cyclists achieved 600 METS or above per week through travel  
15 related physical activity, compared to 11-15% of non-regular cyclists. Even after full model  
16 adjustment men had more than twice the odds (OR 2.58 (95%CI:2.29 - 2.92)) of cycling compared to  
17 women.

18 **Conclusions:** Men are more likely to cycle than women in NZ and cyclists get more physical activity.  
19 Nonetheless, analysis across all travel (irrespective of regularity of cycling status) suggests that  
20 women use more diverse travel modes and generate lower greenhouse gas emissions than men.  
21 Better consideration of the social processes shaping travel is needed to create policy, institutions,  
22 programmes and infrastructure that achieve the long term goals of the transport system, such as  
23 increasing cycling and reducing greenhouse gas emissions.

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## 27 1. Introduction

28

29 There are a myriad of health, environmental and city liveability reasons to increase cycling for urban  
30 transport (Giles-Corti et al., 2016; Stevenson et al., 2016; Watts et al., 2017). Globally, many cities  
31 are investing in infrastructure, programmes and policies to increase cycling, with modest levels of  
32 success in some cases (Crane et al., 2017; Dill et al., 2014; Goodman et al., 2014; Heinen et al., 2015;  
33 Keall et al., 2015). In jurisdictions with a low overall prevalence of cycling, including New Zealand,  
34 one of the universal findings is a disproportionately low number of women cycling, with usually only  
35 20-30% of cyclists being female (Garrard et al., 2012; Shaw et al., 2016). Low levels of cycling  
36 amongst women are not inevitable: in countries with higher levels of cycling, such as the  
37 Netherlands, women comprise about half of cyclists (Garrard et al., 2012; Pucher and Buehler, 2008).  
38 However in these low prevalence locations, pro-cycling policies, infrastructure and programmes  
39 appear to have had limited success to date in increasing the proportion of women cyclists (Aldred et  
40 al., 2016; Goodman and Cheshire, 2014; Ogilvie and Goodman, 2012; Pucher et al., 2011).

41

42 One body of research examining these variations in cycling focuses on how gender differences in  
43 factors such as risk perception, infrastructure preferences, cultural identities and trip purpose  
44 impact on the desire and ability of women to cycle (Aldred et al., 2017; Garrard et al., 2012; Heesch  
45 et al., 2012; Ravensbergen et al., 2019; Steinbach et al., 2011; Sullivan and O'Fallon, 2006). For  
46 example systematic reviews show that, compared to men, women report greater safety concerns  
47 related to cycling and stronger preferences for separated cycle infrastructure (Aldred et al., 2017;  
48 Ravensbergen et al., 2019). This approach tends to focus on cycling and cyclists, in particular  
49 underrepresented cyclists, and quantitatively or qualitatively examine the factors that impact on  
50 cycling (or lack thereof). One criticism of this approach is that it doesn't offer an obvious rationale  
51 for why many of these factors do not affect women in high cycling prevalence jurisdictions, not what  
52 the reasons underpinning the female/male differences are (Garrard et al., 2012; Ravensbergen et al.,  
53 2019).

54

55 Feminist explanations suggest a slightly different perspective with which to view gender differences  
56 in cycling (Connell, 2012; Heise et al., 2019). Law argued that gender is integral to understanding the  
57 social relations and structures that influence daily mobility through gendered patterns of activity and  
58 differential access to time, money and resources. These forces ultimately produce a range of  
59 observable variations in gender-related travel perceptions, experiences and behaviour (Law, 1999).  
60 In support of this hypothesis a range of gender differences in overall travel (not just cycling) have

61 been reported in a number of countries, for example women take fewer trips, travel less distances  
62 and for a shorter time as well as having different reasons for trips and use of travel modes (Hanson,  
63 2010; Kronsell et al., 2016; Lee et al., 2018; Miralles-Guasch et al., 2016; Taylor et al., 2015).

64

65 In light of these different perspectives, in this analysis we sought to understand differences in cycling  
66 by gender in New Zealand in the context of wider differences in mobility by gender. Specifically, we  
67 aimed to answer the questions:

- 68 • How do the individual and household characteristics of women who currently cycle for transport  
69 differ from women who do not cycle? How do these findings differ for men?
- 70 • What are the patterns of travel for female cyclists and non-cyclists? How do these findings differ  
71 for men?
- 72 • Do any personal, sociodemographic and household factors explain the difference in cycling  
73 between women and men?
- 74 • What are the socio-demographic and household predictors of female cycling? How do these  
75 differ for men?

## 76 **2. Methods**

77

### 78 2.1 Study context

79

80 New Zealand is a car dominated society, with the highest levels of per capita car ownership in the  
81 OECD (OECD, 2017). Transport planning has traditionally been car-centric, and this has led to a  
82 decline in travel by all modes other than private cars (Imran and Pearce, 2015; Shaw et al., 2016).

83 New Zealand has comparatively high levels of gender equality; at the end of the data period used in  
84 this study it ranked 13<sup>th</sup> in the Global Gender Gap Index. However economic equality remains an  
85 area of concern, e.g. in 2014 New Zealand women earned an estimated 61% of the male wage  
86 (World Economic Forum, 2014). These comparatively high levels of gender equality in combination  
87 with a highly car dominated transport system make New Zealand an interesting setting to examine  
88 gender differences in travel patterns.

89

### 90 2.2 Study design and population

91

92 We obtained anonymised data for this secondary analysis of the New Zealand Household Travel  
93 Survey (NZHTS) from the Ministry of Transport under their data sharing protocols. The NZHTS is a

94 continuous, nationally representative cross-sectional survey undertaken to provide ongoing  
95 surveillance of household travel patterns.

96  
97 The NZHTS survey stratifies the country into geographic regions. A random sample of meshblocks  
98 from within these geographic units is then selected, roughly proportional to the population in the  
99 geographic area. Meshblocks are the smallest geographic unit for which statistical data are collected  
100 and processed in New Zealand, each one contains between 60 and 110 people. Within each  
101 meshblock all addresses are listed randomly and then every seventh address selected for  
102 participation. Each household is sent a letter and visited up to four times to maximise participation.  
103 Over a seven to eight-year period all addresses within a specific meshblock are invited to participate.  
104 When all addresses in a specific meshblock have been exhausted, another meshblock within the  
105 region is selected. The survey doubled in size between 2007/2008 and 2008/2009 from 2200 to 4600  
106 households being invited to participate. All eligible household members (household members or  
107 visitors present during the survey period) are invited to participate in the survey. Participation in the  
108 survey is estimated at 70% by the Ministry of Transport. Further details on the NZHTS sampling and  
109 protocols for the 2003-2014 time period is available from the Ministry of Transport (Ministry of  
110 Transport, 2018).

111  
112 All participants of the NZHTS between 2003 and 2014 who were eligible to be in the survey, had  
113 complete responses and were over the age of 18 were included in the population for this analysis.  
114 The survey methodology changed substantially in 2015 and again in 2018, so to ensure consistency  
115 only the earlier time period (2003-2014) was used in this analysis.

### 116 117 2.3 Data and variables

118  
119 Data were collected through face-to-face interviews with participants. Between 2002-2014 each  
120 participant was randomly assigned two contiguous days of the week in which travel information was  
121 recorded in a travel diary- an even spread of days of the week was maintained. Subsequent to the  
122 travel diary days a follow-up interview occurred to elicit further personal and household information  
123 and to ensure the travel diary was complete (using a memory jogger).

124  
125 The survey collected information on cycling in two different ways. Firstly, participants were asked  
126 about cycling participation in the last year and, if they had cycled in the last month for any reason,  
127 frequency (1-4 days, 5-9 days, 10-19 days or 20+ days). Secondly, all trips undertaken during the

128 two-day travel diary had a mode (e.g. car, bus, walking etc) coded, so people who took trips by bike  
129 were identified. In this analysis, we defined a regular cyclist as anyone who cycled ten or more days  
130 in the preceding month, in order to capture individuals who regularly cycle but happened not to  
131 during their two-day travel diary.

132

133 Gender was self-assigned either male or female (between 2002-2014 no other gender option was  
134 permitted). Information was collected during the interviews or derived on other relevant variables,  
135 including; age (grouped into 18-29, 30-44, 45-59, 60-74, 75+); personal income (collected in bins);  
136 NZDep (an area based deprivation measure); self-assigned total ethnicity (Māori, Pacific, Asian, NZ  
137 European, other - 4% of people self-identify with more than one ethnicity); employment status (full  
138 time, part time, looking for work, student, homemaker, beneficiary, retire and other); whether the  
139 person has multiple jobs; car driving license (yes/no); lifetime driving experience (self-reported  
140 kilometres driven – nil, less than 20000km, over 20000 km); household size (grouped into 1-2  
141 people, 3-5 people and 6+); rurality; household car access (nil, 1 car, 2 or more cars); and working  
142 bikes in household (nil, 1 bike, 2 or more bikes).

143

144 Information was collected on the purpose (i.e. going to work, home, social visits etc), destination,  
145 mode, and duration of each trip taken during the travel diary. Trip distance was estimated by the  
146 Ministry of Transport by calculating the fastest route between the map coordinates of the origin and  
147 destination addresses provided by the respondents (via any intermediate address if relevant).

148

149 Transport related physical activity metabolic equivalents (METS) were calculated by multiplying the  
150 daily time spent in minutes for walking and cycling by 3.5 and 4.0 respectively, consistent with  
151 published values for walking for transport and cycling to and from work and analysis of the average  
152 speed of travel for those modes in the NZHTS (Ainsworth et al., 2011; Mizdrak et al., 2018). (One  
153 MET is considered equivalent to the resting metabolic rate, and MET values express intensity levels  
154 as multiples of the resting metabolic rate). A weekly MET value was then calculated and a binary  
155 variable of under or over 600METs/week was created; this is the approximate MET equivalent to the  
156 World Health Organization recommendations for minimum weekly physical activity for good health  
157 (Kyu et al., 2016; World Health Organization, 2010).

158

159 2.4 Analysis

160

161 We produced basic tabulations of person, household and travel characteristics of female cyclists and  
162 non-cyclists and male cyclists and non-cyclists. As interpreting travel patterns for each mode is quite  
163 complex we created a number of policy-relevant summary indicators. For example the proportion of  
164 trips under 5km taken by car (i.e. in theory able to be cycled), and proportion of people who  
165 achieved over 600METs from walking and cycling for transport. Analysis took into account how many  
166 days of the travel diary were completed (about 16% of the participants in the analysis only filled in  
167 one day of the two-day diary). We undertook logistic regression to identify sociodemographic and  
168 household associations between gender and cycling. Covariates that might plausibly act as  
169 confounders between the exposure (gender) and outcome (cycling) were examined. We then looked  
170 at the independent associations of sociodemographic and household factors separately by gender,  
171 hypothesising that given the different gender roles in society these associations might be different  
172 for women and men.

173

174 All analyses were undertaken using Stata 15.1. The data were weighted with survey weights  
175 calculated and provided by the Ministry of Transport to weight the sample to represent the entire  
176 New Zealand population. The confidence intervals and statistical tests will be slightly conservative  
177 (overstating the variance) because the software used did not account for post-stratification used in  
178 the travel survey estimates.(Ministry of Transport, 2017)

179

### 180 **3. Results**

181

182 Figure 1 shows the dataset for analysis and final participants. Overall two percent of women and five  
183 percent of men over the age of 18 were classified as regular cyclists using the definition of having  
184 cycled 10 more days in the preceding month. Over 94% of survey participants individuals took one or  
185 more trips by any mode during the two day travel diary period.

186

#### 187 **Figure 1 Participants of household travel survey 2003-2014 for analysis**

188 Unweighted numbers reported in this figure (remainder of results use survey weights).

189

190 Table 1 shows the personal and household characteristics of the participants by cyclist status and  
191 gender (information about cycling during each survey year and frequency over the preceding year  
192 can be found in the supplementary information). Regular cyclists were more likely to be in the 30-44  
193 age group and less likely to be in older age groups. Men overall were more likely to hold a drivers  
194 licence than women, but male regular cyclists were less likely (90.2%) to hold a drivers licence than

195 male non-regular cyclists (94.2%). For women this was reversed; women regular cyclists were more  
196 likely to hold a drivers licence (92%) than non-regular cyclists (86%).

197

198 **Table 1 Personal and household characteristics by cyclist status and gender**

199 Regular cyclist: cycled 10 or more days in the last month. \*Individuals can identify with more than one category so no p  
200 values possible and only row percent.

201

202 Table 2 looks at the travel characteristics of regular cyclists and non-regular cyclists by gender. Men  
203 took overall fewer trips compared to women (e.g. non-regular cyclists mean daily trips 4.63  
204 95%CI:4.57 - 4.70 for male cf. 4.90 95%CI:4.84-4.95 female) but travelled further (e.g. non-regular  
205 men cyclists 46 km/day 95%CI:45 – 47 cf. women 38 km/day 95%CI:37-39).

206

207 We found regular cyclists, irrespective of gender, took more trips and travelled for a longer time but  
208 about the same distance as non-regular cyclists. For example, female regular cyclists took a mean  
209 5.66 (95%CI:5.38 - 5.94) trips daily by all modes and travelled 39km (95%CI: 35-44) compared to non-  
210 regular cyclists who took 4.90 (95%CI:4.84 - 4.95) trips for 38km (95%CI:37 - 39).

211

212 Regular cyclists (male and female) walked more than non-regular cyclists (trips, time and distance in  
213 these modes are all greater for regular cyclists). The number of PT trips was low for both men and  
214 women. Male regular cyclists and non-regular cyclists took the same number of PT trips (0.08  
215 trips/day) however women non-regular cyclists took more PT trips than regular cyclists (0.10  
216 95%CI:0.09-0.11 cf. 0.06 95%CI:0.03-0.08). Further information on public transport use in the  
217 previous month and year by cyclist status and gender is available in the supplementary information.  
218 Finally, the majority of trips taken, time spent travelling and distance travelled by both genders  
219 irrespective of cyclist status, was in a private motor vehicle. Proportionately fewer of the total km  
220 travelled by regular cyclists was in private motor vehicle (e.g. 33 out of 39km/day (85%) for women  
221 regular cyclists compared to 36 out of 38 km/day (95%) for non-regular cyclists)

222

223 **Table 2 Daily travel characteristics by cyclist status and gender**

224 These mean figures include people who did not travel during the two day travel diary.

225

226 Figures 2 and 3 show the six most common trip purposes by cyclist status (relevant table in the  
227 supplementary information). Overall these showed similar levels of trips with the purpose of  
228 accompanying people, shopping and social visits irrespective of cyclist status. Regular cyclists were  
229 more likely to take trips with the purpose of recreation (0.68 95%CI: 0.56-0.80) than non-regular

230 cyclists (0.26 95%CI 0.25-0.27). In general men took fewer trips accompanying other people and  
231 fewer shopping trips, irrespective of cyclist status.

232

233 **Figure 2 Daily trips by trip purpose taken by women by cyclist status (six most common purposes)**

234 Mean number of trips and 95% confidence intervals

235

236 **Figure 3 Daily trips by trip purpose taken by men by cyclist status (six most common purposes)**

237 Mean number of trips and 95% confidence intervals

238

239 Figures 4 and 5 show some summary indicators of travel by gender (relevant table in the  
240 supplementary information). Figure 4 shows that among non-regular cyclists 11% of women and  
241 15% of men achieved 600 METs/week from transport related walking and cycling. For regular cyclists  
242 this increased to around half. Figure 5 shows mean trips taken per person, and, irrespective of  
243 gender, regular cyclists took over double the number of trips by walking, cycling or PT compared to  
244 non-regular cyclists. However women took more 'replaceable' trips of 5km or less in a private  
245 vehicle (mean of 2.4/day irrespective of cyclists status) than men. Men took less of these replaceable  
246 trips overall, and male regular cyclists took 21% less than non-regular cyclists.

247

248 **Figure 4 Percentage of people taking any trips by sustainable modes and achieving 600METs  
249 transport related physical activity per week, by gender and cyclist status.**

250 All differences between regular cyclists and non-regular cyclists significant at <0.0001. Any cycling and walking trips  
251 indicator = any trip taken by any of those modes within the travel diary period. Over 600 METs/week indicator = achieved  
252 over 600 METs/week from cycling and walking trips.

253

254 **Figure 5 Mean daily potentially replaceable trips and trips by sustainable modes, by gender and  
255 cyclist status.**

256 PT: public transport. Means and 95% confidence intervals presented.

257

258 Table 3 shows the results of regression analysis looking at the association between gender and  
259 cycling. Men had an odds ratio of 2.51 (95%CI: 2.24 - 2.81) of being a regular cyclist compared to  
260 women. This association was unchanged even after progressive adjustment for the  
261 sociodemographic, household and transport access factors that were theorised to potentially act as  
262 confounders in the association.

263

264 **Table 3 Modelling of association between gender and cyclist status**

265 \* All models adjusted for survey year. Reference group: women.

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Table 4 shows the regression results examining the socio-demographic and household determinants of cycling compared to not cycling by gender. After adjusting for the other household and socio-demographic factors in the table most other ethnic groups were less likely to cycle than NZ European, although some of the confidence intervals include one (even with 12 years data there were few non NZ European female cyclists). There were no clear associations by income for women. Women who had larger household sizes and children in the households were much less likely to cycle than women who don't. For example women with any children in the household under 18 were 60% less likely to be regular cyclists compared to those without children (OR 0.43 95%CI: 0.31 - 0.58). There was a linear association between cycling and household car access; the more cars in the household the less likely cycling was. Most findings were similar for men; although while Pacific and Asian men were less likely to cycle than NZ European (e.g. Pacific men OR 0.42 (95% CI: 0.25 - 0.72)), Māori men had about the same chance of being regular cyclists after adjusting for other covariates (OR 0.97 (95%CI: 0.75 - 1.25)).

**Table 4 Socio-demographic and household determinants of cycling compared to not cycling by gender**

\*Adjusted for all other variables in table and survey year. **Bold results:** 95%CI exclude the null.

**4. Discussion**

4.1 Key findings

The majority of travel (trips taken, time spent and distance travelled) was by private vehicle for all groups, however, despite this, we found distinct and complex patterns in travel by gender and cyclist status in NZ adults. Women took more trips, but travelled 12-17% fewer kilometres per day, and were more likely to walk and use PT than men. Thus women overall had a more diverse and lower greenhouse gas emission travel profile than men. Women undertook more potentially replaceable trips per day (car trips less than 5km) than men (female regular cyclists and non-regular cyclists both took more replaceable trips than men). For both men and women regular cyclists were much more likely to achieve 600METs per week from transport-related cycling and walking than non-regular cyclists. Even after full model adjustment for household and sociodemographic factors men were still over twice as likely to cycle as women.

## 300 4.2 Strengths and Weaknesses

301

302 A strength of this study is the data, which comes from a nationally representative cross sectional  
303 survey of household travel in New Zealand with 12 years of standardised data collection.

304

305 This research was interested in utility/transport cycling rather than recreational cycling since the  
306 former is more likely to substitute for travel by car, with consequent social and environmental  
307 benefits. We initially explored three different definitions of a regular cyclist; one or more cycling trip  
308 in the two day travel diary, cycling for any reason 10 or more days in the last month (implying this is  
309 a regular activity) or any cycling for any reason in the last month. The three definitions resulted in  
310 an overall prevalence of regular cyclists amongst women of 1.7%, 2.2% and 9.1% and men 3.9%,  
311 5.3%, and 17.2% respectively. We also examined a definition of cycling 5 or more days in the last  
312 month but there was some evidence that this may have lowered the specificity of the exposure  
313 measure by recruiting in more recreational only cyclists (see Table 6 in supplementary material). We  
314 chose the definition of cycling 10 or more days in the last month for this analysis. We felt this  
315 approach achieved a compromise between only using people who took a cycling trip in the two day  
316 travel diary (resulting in a selected group may not have represented the overall travel patterns of all  
317 cyclists) or using those who cycled less than 10 days a month (which may have inflated our exposure  
318 measure to include people who took infrequent recreational cycling trips). Our exposure group may  
319 include some people who exclusively cycle for recreational reasons, however these are likely to be  
320 relatively few – only 1% of individuals who cycled during the travel diary period (i.e. people who we  
321 know the purpose of every trip including cycle trips) did so exclusively for recreational reasons. We  
322 also acknowledge that the boundary between these activities is not always straight forward (Handy  
323 et al., 2014), and the focus on utility transport has limitations (Aldred, 2015). We conducted  
324 sensitivity analyses using these different definitions (data not presented). Defining a cyclists as  
325 someone who has done any cycling in the last month showed, unsurprisingly, that the cyclist group  
326 was identical to the non-cyclist group of the relevant gender (i.e. if a person only cycles once a  
327 month then the remainder of their trips will look the identical to the remainder of the same  
328 gendered population). Using the definition of a cyclist only being someone who took a cycling trip  
329 during the travel diary period resulted in findings largely similar to what we have presented but  
330 slightly more exaggerated in terms of the difference (i.e. even fewer kilometres travelled by car).  
331 Better elucidation of cycling patterns and reasons in national surveys would be helpful to construct  
332 analyses such as this.

333

334 As with all analyses using routinely collected data we were limited to the variables collected, which  
335 in some cases were not optimal (e.g. limited socioeconomic variables, family type was determined  
336 by 'interviewer observation' rather than directly asked). The cross-sectional nature of the survey also  
337 means that it is difficult to pinpoint cause and effect. For example, the association between  
338 increased car access and reduced cycling may mean either being without a car results in more  
339 cycling or being less likely to cycle leads to greater likelihood of buying a car.

340

#### 341 4.3 Policy and practice implications

342

343 This paper provides further evidence for gender differences in cycling being a social process which is  
344 just one illustration of a variety of gendered travel patterns and behaviours (Law, 1999). One of the  
345 most striking findings in this paper is that overall differences in travel between genders are largely  
346 maintained even when men and women are regular cyclists. That is, the 'travel profiles' of both men  
347 and women regular cyclists look more like their gender compatriots than each other (i.e. women  
348 regular cyclists take more trips but travel the same distance as women non-regular cyclists; the same  
349 applies to men). These similarities are only revealed because we framed the analysis around overall  
350 travel patterns by gender, rather than just looking at differences amongst men and women who  
351 cycle.

352

353 Commonly cited explanations for gender differences in (all) travel, including cycling, include women  
354 working closer to the family home, having more household responsibilities or having less access to  
355 the family vehicle (Hanson, 2010). However, international studies suggest that these explanations  
356 are not always supported by evidence (Hanson, 2010; Kavanagh and Bentley, 2008; Kronsell et al.,  
357 2016; Miralles-Guasch et al., 2016). For example, one Spanish study showed that even for the same  
358 trip purpose women and men will use different modes (Miralles-Guasch et al., 2016). In this study  
359 we also found differences in mode for trips for the same purpose by gender. For example shopping  
360 trips undertaken by men in NZ are much more likely to be done using a car than those by women  
361 (unpublished results). A US study by Taylor et al explored possible reasons for why women  
362 undertake more household serving trips than men (i.e. travel other than commuting). These  
363 included time-use related reasons (i.e. the perception that women have more time because they are  
364 more likely to have part-time paid work), microeconomic (i.e. women earn less than men) and  
365 gender socialisation (i.e. implicit gender beliefs about who should do specific tasks in the  
366 household). Gender socialisation that fitted best with these findings, as even in households where  
367 women were better educated, worked more and earned more than their male partners, they still

368 undertook about 50% more household serving trips (Taylor et al., 2015). We need to use the  
369 available NZHTS data to further examine differences by gender in overall travel.

370

371 What do these findings mean for policy to increase women's cycling? The combination of an existing  
372 propensity towards low greenhouse gas emission travel modes, evidence from countries with high  
373 overall cycling levels that women take half (or more) of the trips by bike *and* the number of trips  
374 women take in NZ that are potentially amendable to mode swapping suggests there is significant  
375 potential for supporting increased cycling among women, who already have more flexible and lower  
376 carbon travel. The travel patterns and reasons for travel that we observed in this study suggest  
377 specific changes in cycling infrastructure to women to undertake relatively short trips to their  
378 required destinations (home/shops) and to travel safely in the company of others. These would likely  
379 require whole street/suburb changes rather than a network approach of the provision of cycle lanes  
380 on busy streets leading into the central city. These are changes that require a much greater  
381 emphasis on what is local to where people live, to facilitate activities that can be regarded as  
382 mundane. These types of policies work to enable mode change within established variations in travel  
383 by gender; and implicitly normalise these gender variations in travel. An additional approach would  
384 be policies that aim to disrupt the processes that structure social relations and institutions that  
385 ultimately result in the observable gender differences in travel (Law, 1999).

386

387 While most of the discussion is centred on women, it is just as relevant to consider how gender  
388 processes play out in men's travel. Despite men cycling more than women, men travel further each  
389 day and take the majority of trips by car, meaning their travel profile is more greenhouse gas  
390 emission intensive. Even men who regularly cycle still travel further by private vehicle than female  
391 non-regular cyclists. In addition, there are other stark examples of gender inequities in transport  
392 outcomes e.g. New Zealand men are much more likely to be hospitalised or killed as a result of road  
393 traffic injury than women (Hosking et al., 2013). Men's travel is perceived as less complex than  
394 women's due to less unpaid work-related travel, hence, in theory, it should be more amenable to  
395 mode change. Policies need to focus on how to get more men, for example, using public transport  
396 for their routine commuting.

397

398 Finally, we need policies to challenge the social processes that underpin the gender differences in  
399 travel. Like other gender related social processes, gendered perceptions of travel start early in life  
400 (Baslington, 2008). Gender equity policies that aim to break down traditional roles and  
401 responsibilities of men and women may be useful to help ameliorate some of the current gender

402 differences in travel. However these need to be done in tandem with environmental transport  
403 policies as international literature suggests that as women moved into the labour force women's  
404 travel became more like men's, rather than vice versa, meaning car travel increased(Susilo et al.,  
405 2018).

406

## 407 5. Conclusion

408

409 Cycling provides just one example of wider differences in travel patterns by gender in NZ. To achieve  
410 a low greenhouse gas emission land transport system, of which cycling is an important part, more  
411 attention needs to be paid in transport research, policy, institutional structures, planning and  
412 programmes to understanding and modifying the social processes impacting on travel.

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420 **References**

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