Gender differences in cycling patterns and attitudes towards cycling in a sample of European regular cyclists

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Abstract

Previous research has shown that men cycle more than women and women tent to report less favourable perceptions and attitudes towards cycling than men. Gender differences in perceptions and attitudes towards cycling may be influenced by such difference in bicycle use. Attitudinal differences concerning cycling between male and female may be the consequence and not only the cause of gender imbalance in bicycle use. To our knowledge, no previous research has focused on gender differences in perceptions and attitudes towards cycling involving a sample with gender balance in bicycle use (e.g. regular cyclists). In our study, we investigated gender differences in attitudes towards cycling and towards cycling infrastructure, purpose of cycling, risk perception, and exposure to severe crashes in a large sample of regular cyclists. Following a cross-sectional design, we collected data from 2417 participants from Hungary, Italy, Spain, Sweden, Netherlands, and United Kingdom. A survey was administered to an online panel of respondents. Gender differences in attitudes towards cycling were small in terms of effect size or non-significant, with women having more positive attitudes in personal benefits rather than mobility benefits. Women reported gender-stereotyped reasons for cycling more than men, except for social activities. Also, women showed higher discomfort than men cycling in mixed traffic and higher risk perception than men. Furthermore, men reported higher exposure to severe crashes than women. We contend that bicycle use and gender role (i.e. society's shared beliefs concerning a range of attitudes, norms, and behaviours that are generally considered appropriate or desirable for individuals based on their actual or perceived sex) can affect differences between male and female cyclists in perceptions, attitudes towards cycling, and cycling behaviours.

Keywords: cycling; gender; attitudes; bicycle; crashes; risk perception

1. Introduction

There is growing evidence that health benefits of cycling are not evenly distributed across different sections of the population because cycling is strongly linked to socio-economic factors (Heinen et al., 2010), including gender differences. Although gender differences in cycling appear to be context specific (e.g. high-cycling countries of Europe and Asia), several studies revealed that, in general, men cycle more than women (e.g. Garrard et al., 2012, Heesch et al., 2012, Moudon et al., 2005, Pucher et al., 2011, Pucher et al., 1999, Ryley, 2006, Twaddle et al., 2010, Wittmann et al., 2015). Several – related – explanations have been advanced to account for the gap between men and women in bicycle use. First, men tend to report less barriers or constraints to cycling and more positive attitudes to cycling compared to women (e.g. Akar et al., 2013, Dickinson et al., 2003, Emond et al., 2009, Garrard et al., 2012). Second, compared to men, women are more likely to report different attitudes towards cycling infrastructure and environments (e.g. a preference for slower traffic streets and segregation from motor traffic) and report higher risk perception of cycling (Aldred et al., 2016, Beecham and Wood, 2014, Frings et al., 2012, Garrard et al., 2012, Griffin and Haworth, 2015, Heesch et al., 2012, Krizek et al., 2005). Third, culturally specific factors such as the cycling culture (Aldred et al., 2016) and the gender inequality (Prati, 2017) have been proposed to explain these gender differences.

In the present study, we argued that gender differences in attitudes towards cycling may be associated with bicycle use. According to self-perception theory (Bem, 1967), cycling behaviour may influence attitudes towards cycling. Indeed, self-perception theory asserts that people tend to develop their attitudes by inferring them from observations of their own behaviour. For instance, men may be less likely to report negative attitudes towards cycling because they cycle more than women. Consequently, one's attitudes towards cycling may be influenced by the need to justify one's mobility behaviour. To our knowledge, no studies have been conducted to determine whether gender balance in cycling behaviour is associated with gender balance in perceptions and attitudes towards cycling, but indirect preliminary evidence can be found in a previous study involving a

sample of members of a community cycling organization (Heesch et al., 2012). Specifically, Heesch et al. (2012) found that women belonging to a community cycling organization were more likely to report positive attitudes towards cycling than their male counterparts who did not belong to any cycling organization. However, since identification may affect our attitudes (e.g. Bonaiuto et al., 1996, Martin and Epitropaki, 2001, Prati et al., 2017a, Van Dick et al., 2007, Van Knippenberg and Van Schie, 2000), it is not clear whether this difference in positive attitudes was due to cycling behaviour or due to identification with the organization.

The initial aim of this study was to examine gender differences in positive attitudes towards cycling in a population of regular cyclists (i.e. cyclists who cycle at least once a month) irrespective of their membership of an organization. Unlike findings of previous studies (e.g. Akar et al., 2013, Dickinson et al., 2003, Emond et al., 2009, Garrard et al., 2012), we would expect gender differences in positive attitudes towards cycling to be small or non-existent (Hypothesis 1). In addition, following the same reasoning, the differences in risk perception of cycling (Aldred et al., 2016, Beecham and Wood, 2014, Frings et al., 2012, Garrard et al., 2012, Griffin and Haworth, 2015, Heesch et al., 2012, Krizek et al., 2005) and attitudes towards cycling infrastructure and environments (Beecham and Wood, 2014, Garrard et al., 2012, Krizek et al., 2005) between male and female cyclists are expected to be small or non-existent in a sample of regular cyclists (Hypothesis 2 and 3, respectively).

The second aim of the study was to investigate gender differences in bicycle use in a population of regular cyclists. According to a social constructionist view of gender (Beall, 1993, West and Zimmerman, 1987), we should expect gender differences in cycling patterns based on socially constructed views of masculinity and femininity. Gender inequality was found to affect women's bicycle use (Prati, 2017). Specifically, the traditional sexual division of labour (e.g. gender gaps in time spent on caring activities and housework) may explain why women tend to use the bicycle for non-commuting trips such as taking children to or from school and carrying shopping by bicycle (Garrard et al., 2012). Thus, considering the gender role, we should expect

gender differences in terms of the purposes of cycling, such as female cyclists being more likely to use the bicycle for travelling with children and going for shopping compared to their male counterparts (Hypothesis 4). Likewise, competitive cycling and sport in general, has patriarchal characteristics in Western countries (e.g. Adams et al., 2010, Bryson, 1987, Connell, 1995, Dunning, 1986, Koivula, 1999, Wellard, 2002). In fact, most of famous cycling competitions such as Tour de France or Giro d'Italia are reserved exclusively for males. Even though there are some women's famous cycling road races (e.g. UCI Road World Championships Women's road race), identification with the masculine image of cycling may lead to gender differences in sport participation for training and leisure purposes and, specifically, to an under representation of women among sport and recreational cyclists. Therefore, we expect that male cyclists are more likely to use bicycle for recreation or training purposes than female cyclists (Hypothesis 5). Also, a previous study involving regular cyclists showed that commuting cycling (travelling to/from work) is more frequent among male cyclists than female cyclists (de Geus et al., 2014). Due to the traditional sexual division of labour, women's travel behaviour is more likely to include trip chaining — i.e., pick up children from school, do the grocery shopping (e.g., Garrard et al., 2012) — and this may create an additional barrier to commuter cycling. Thus, we hypothesise that bicycle use for work trips are more frequent among male cyclists than female cyclists (Hypothesis 6).

Finally, the third aim of the study was to investigate gender differences in cycling injuries. Past research suggests that male cyclists have a higher likelihood of suffering severe injuries than female cyclists (Bíl et al., 2010, Eluru et al., 2008, Marín Puchades et al., 2017, Prati et al., 2017b). However, there is little evidence that the likelihood of suffering severe injuries is higher among men than women when considering a sample of regular cyclists. We argue that gender difference in the likelihood of suffering severe injuries is only marginally related to bicycle use because it mainly depends on gender differences in skills, risk perception, attitudes towards road safety and risky driving behaviours (Cobey et al., 2013, Cordellieri et al., 2016, Johnson et al., 2011, Schantz, 2017,

Useche et al., 2018). Hence, in this sample of regular cyclists, we expect to find a higher exposure to severe accidents among male cyclists than among female cyclists (Hypothesis 7).

European countries differ in terms of topography, psychosocial factors, politics, economy, bicycle culture, and road infrastructures. To account for these differences, we included the role of countries in our analyses. The effect of country was estimated in an exploratory way. Therefore, we did not raise any hypothesis about what we could find, but simply intended to explore and determine the potential effect of the geographical context on gender differences.

2. Materials and Methods

2.1 Procedure

Ethical approval for the study was obtained from the Institute for Transport Studies of the University of Leeds. The survey was administered to an 'online panel' of respondents in six countries (Hungary, Italy, Spain, Sweden, Netherlands, United Kingdom) who had previously agreed to take part in data collection. These panels consist of a database of individuals who have agreed to participate in surveys and are a commonly used tool in market research to access and collect data on particular consumer groups. As such these panels contain detailed socio-demographic data to enable recruitment to particular needs and quotas. For example, to be included in our dataset, all respondents had to make, on average, at least 1 cycle trip per month with minimum quotas of 50% regular cyclists, 30% females and 10% over the age of 50. In this way we ensure segmentation over these dimensions yield sufficient group sizes for robust statistical analysis.

A pilot version of the questionnaire was written in English and administered to 60 participants, 30 in the Netherlands and 30 in the United Kingdom. After examination of the pilot questionnaire data, the questionnaire was updated with new wording of questions which produced anomalous replies. Then, the finalised version of the questionnaire was translated, sense checked by native speakers, before being uploaded to a customised online survey platform, and administered to 2417 participants. Data from participants who responded with the same values within a scale or who

completed the questionnaire in a time shorter than a pre-established limit was eliminated, leaving a sample of 2397 participants included in the analysis.

2.2 Measures

Participants filled out a web-based questionnaire with sets of scale and multiple-choice questions. The questionnaire contained questions on demographic information such as age, gender, student status, working status, having children under 12 years of age in household, and nationality. Other areas included information about cycling frequency, attitudes towards cycling, perceived safety when cycling, cycling infrastructure and the cycling environment.

Cycling frequency. To measure cycling frequency, the participants responded to the item "How many months a year do you normally cycle?", prompting them to think only about these months. This allowed us to account for local geographical differences in terms of weather limitations for bicycle use. To measure the second item, "In general, during these months, how often do you cycle?", participants were asked to respond using a five-point scale ranging from 1 (*daily*) to 5 (*less than once per month*). We calculated the yearly trip values by multiplying the number of months by the number of trips per months.

Attitudes towards cycling. Participants' attitudes towards cycling were evaluated with 14 questions, each one evaluating a specific attitude. Included were questions such as "How far do you agree that you cycle because it is pleasant?", "How far do you agree that you cycle because it is physically relaxing?" or "How far do you agree that you cycle because of the environmental benefits?". For each question, responses ranged from 1 (*completely disagree*) to 5 (completely agree). We developed this measure based on a review of the literature, pilot testing of draft items, and refinement of the instrument. We did exploratory factor analysis to investigate the dimensions of positive attitudes towards cycling, using principal axis factoring followed by quartimin rotation. Parallel analysis indicated a two-factor solution. A total of 51.7% variance was explained by exploratory factor analysis. The variance explained by each factor of the rotated two-factor solutions was, respectively, 41.6% and 10.1%. Absolute factor loadings greater than 0.40 were

considered salient (the factor loadings along with the items are reported in Appendix, Table 1.A). One item (i.e., "How far do you agree that you cycle because it offers privacy?") was dropped because of its low factor loading on both factors. The first factor was about the benefits of cycling for the person and his or her environment. We labelled this factor as "Personal benefits". We labelled the second factor "Benefits of cycling as a mean of transport" because the questions refer to the positive aspects of using cycling as a mean of transport in everyday life. Cronbach's alpha for the two factors was .85 and .87. respectively.

Comparative risk perception. A single 5-point scale item was designed to evaluate participants' perception of their safety when cycling in comparison with other bicycle users. Previous research has shown that people tend to underestimate their own risk levels (Caponecchia, 2010), this phenomenon is known as optimism bias. To reduce this effect, we asked the participants to assess their risk levels in relation to the reference group of cyclists of the same age and sex with the question, "Compared to other bicycle riders of my age and sex, my risk of being involved in a traffic accident is…". Options available were 1 (*much smaller)*, 2 (*a little* smaller), 3 (*virtually the same*), 4 (*a little* higher), and 5 (*much higher)*.

Rating of the cycling infrastructure. Two 5-point scale items were designed to evaluate participants' attitudes towards cycling infrastructure and environment, namely "How would you rate the cycling infrastructure in terms of the level of provision of cycling infrastructure?" and "How would you rate the cycling infrastructure in terms of the quality of the cycling infrastructure?". Responses for each question ranged from 1 (*excellent*) to 5 (*very poor*). Correlation between the two items was .87, so a single variable was calculated.

Perceived discomfort on different types of roads. We asked participants the following question "How comfortable would you be to cycle in the following scenarios?" (1) A path separated from the street: (2) a two lane (one in each direction) residential commercial shopping street, with traffic speeds of 30 miles an hour, on street parking and no bike lane: (3) a two lane (one in each direction) residential commercial shopping street, with traffic speeds of 30 miles an hour, on street parking and

a stripped bicycle lane: (4) a major urban or suburban street with 4 lanes (2 each direction), on street parking, traffic speeds of 30 KM an hour and no bike lane: (5) a major urban or suburban street with 4 lanes (2 each direction), on street parking, traffic speeds of 30 KM an hour and a stripped bike lane: and (6) a major urban or suburban street with 4 lanes (2 each direction), on street parking, traffic speeds of 30 miles an hour and a bike lane separated from traffic by parked car or a kerb. Response options ranged from 1 (*very comfortable*) to 5 (*very uncomfortable*). We did a factor analysis of the six items measuring the level of discomfort on different types of cycling infrastructure. We employed principal axis factoring followed by quartimin rotation. Parallel analysis indicated a two-factor solution. Exploratory factor analysis explained 53.9% of variance (two factors of 36.0% and 17.9%). Considering salient absolute factor loadings greater than 0.40, the first factor included the two scenarios without a bike lane ("Discomfort without bike lane"), while the second factor comprised the remaining four scenarios that involved a bike lane ("Discomfort with bike lane"). Reliability of the two factors was satisfactory: $r = .69$ (first factor) and $\alpha = .82$ (second factor).

The purpose of cycling (commuting trips, sport, leisure). A multiple-choice question was designed to investigate eight reasons behind participants' use of bicycle. "Why do you make these cycle journeys?": commute/travel to or from work, travel to or from college/university, taking children to or from school, for business trips, shopping/entertainment, personal business (e.g. health appointment), visiting family/friends, leisure/training (e.g. a ride in the country side)." Participants were allowed to select more than one of the alternatives if they applied. For the current analyses, all positive responses for each purpose of cycling were recoded as 1, while non-responses were recoded as "0" and considered as if bicycle were not used for that purpose.

Exposure to severe crashes. To obtain a measure of exposure to severe crashes we used two questions: "In the past 2 years whilst cycling, have you had an accident so severe that you had to see a doctor or were taken to a hospital?" with the options 1 (*No*), 2 (*Yes, I had to see my doctor but did not need to go to hospital*), 3 (*Yes, I had to visit a hospital as an outpatient), and 4 (Yes, I had to stay*

in hospital overnight), and "In the past 2 years whilst cycling, have you had an accident whereby your bike was damaged?" with options 1 (*No*), 2 (*Once*), 3 (*Twice*), and 4 (*More often*).

2.3 Statistical Analysis

We conducted the analyses using SPSS v.25. In our analyses, we controlled for the effect of cycling frequency and socio-demographic variables (i.e. age, student status, working status, having children under 12 years of age in household and nationality). To investigate the influence of gender on attitudes towards cycling, comparative risk perception, evaluation of cycling infrastructure and cycling environment, and perceived discomfort on different types of roads we used multivariate analysis of variance (MANOVA). MANOVA is designed to investigate the effect of independent variables on several continuous dependent variables simultaneously. As a test of the multivariate effects, we chose Pillai's criterion because of its advantage in terms of robustness (Tabachnick and Fidell, 2013). As adjustment for post hoc pairwise comparisons, we used a Sidak correction, which is similar to the Bonferroni correction but has the advantage of being less conservative. To investigate the influence of gender on purposes of cycling, we used multiple logistic regression analysis. Finally, we used ordinal regression analysis to examine the effect of gender on previous involvement in bicycle accidents.

3. Results

A total of 2389 participants completed the questionnaire. Of these, 1171 (49%) were male, 1210 (50.6%) were female and 8 (0.3%) identified themselves as transgender. Given that the sample of transgender participants was too small to be comparable with the other two categories, it was not included in the subsequent analyses. The age of the participants ranged from 18 to 86 years. The mean for female was 40.6 (SD = 13.70), the mean for male was 44.9 (SD = 14.62), whereas the general mean value was 42.75 (SD = 14.34). With regards to 'frequency of cycling', 365 (15.3%) participants cycled 1-3 times a month, 707 (29.7%) cycled 1-2 days a week, 872 (36.6%) 3 or more days a week, and the remaining 437 (18.4%) participants cycled daily.

Table 1 displays results of multivariate and univariate analyses of variance for perceptions and attitudes towards cycling. Using Pillai's trace, there was a significant effect of gender and country, while the interaction between country and gender was not significant, $F(6, 2364) = 1.07$, $\eta^2 = .00$. Separate univariate ANOVAs for gender revealed non-significant effects of Mobility benefits (Hypothesis 1), Discomfort with bike lane, and Rating of the cycling infrastructure (Hypothesis 3). In addition, separate univariate ANOVAs showed significant effects of Personal benefits (Hypothesis 1), Discomfort without bike lane (Hypothesis 3), and Risk perception (Hypothesis 2). Post-hoc pairwise comparisons revealed that:

- female cyclists were more likely to report Personal benefits compared to male cyclists, $p < .001$;
- female cyclists reported higher scores on Discomfort without a bike lane compared to male cyclists, $p < .001$;
- female cyclists reported higher Risk perception compared to male cyclists, $p = .001$.

The scores on Mobility and Personal benefits were higher among Spanish and Italian participants, while were lower among Dutch participants. Hungarian participants reported the highest score on perceived discomfort on roads without bike lanes, while participants from UK reported the lowest score. Perceived discomfort on roads with bike lanes was highest among Dutch and Hungarian participants, while participants from the other countries reported substantially similar scores. Italian participants reported the worse rating of the cycling infrastructure, while the rating of the quality and quantity of the cycling infrastructure was best among Dutch participants. Finally, Hungarian participants reported lowest scores on risk perception, participants from the other countries reported substantially similar scores.

Table 1

Multivariate and Univariate Analyses of Variance for Perceptions and Attitudes Towards Cycling

		ANOVA $F(1, 2359)$					
Variable	MANOVA $F(6, 2364)$, η^2	Mobility benefits	Personal benefits	Discomfort without bike lane	Discomfort with bike lane	Rating of the cycling infrastructure[1]	Risk perception
Gender	16.21***, $\eta^2 = .04$	$F = 0.33$	$F = 26.35$***	$F = 60.61$***	$F = 2.51$	$F = 3.31$	$F = 10.26$***
Men *M* (SE)		3.14 (0.04)	4.04[a] (0.03)	3.27[a] (0.05)	1.92[a] (0.03)	2.75[a] (0.05)	2.74[a] (0.04)
Women *M* (SE)		3.16 (0.04)	4.18[b] (0.03)	3.60[b] (0.05)	1.88[a] (0.03)	2.82[a] (0.05)	2.84[b] (0.04)
Country	33.42***, $\eta^2 = .08$	$F = 37.67$***	$F = 49.87$***	$F = 23.22$***	$F = 54.49$***	$F = 69.79$***	$F = 11.92$***
UK *M* (SE)		3.17[a] (0.05)	4.09[a] (0.04)	3.04[a] (0.06)	1.82[a] (0.04)	2.66[a] (0.06)	2.81[ab] (0.05)
Netherlands *M* (SE)		2.82[b] (0.05)	3.78[b] (0.04)	3.50[b] (0.07)	2.21[b] (0.04)	2.16[b] (0.06)	2.87[a] (0.05)
Spain *M* (SE)		3.62[c] (0.05)	4.35[c] (0.04)	3.26[c] (0.06)	1.71[ac] (0.04)	2.96[c] (0.06)	2.92[ac] (0.05)
Hungary *M* (SE)		3.00[d] (0.05)	4.04[a] (0.04)	3.74[d] (0.07)	2.15[b] (0.04)	3.07[c] (0.06)	2.57[d] (0.05)
Italy *M* (SE)		3.30[a] (0.05)	4.34[c] (0.04)	3.53[b] (0.06)	1.69[c] (0.04)	3.31[d] (0.06)	2.86[ac] (0.05)
Sweden *M* (SE)		3.01[ad] (0.05)	4.08[a] (0.04)	3.51[b] (0.06)	1.80[ac] (0.04)	2.54[a] (0.06)	2.69[bd] (0.05)

Note. Multivariate *F* ratios were generated from Pillai's statistic. ANOVA = univariate analysis of variance. MANOVA = multivariate analysis of variance. * $p < .05$. ** $p < .01$. *** $p < .001$. Means in a column sharing the same superscript are not significantly different from each other according to post-hoc tests. [1] Higher scores correspond to a worse rating of the cycling infrastructure. Analyses were controlled for the effect of age, cycling frequency, working status, student status, and having children in household on the outcome.

Table 2

Multiple Logistic Regression Analyses (Odds Ratio) Predicting Eight Purposes of Cycling from Gender among Six European Countries

Variable	Commute/travel to or from work	Travel to or from college/ university	Taking children	Business trips	Shopping-entertainment	Personal business	Visiting family/friends	Leisure-training
UK	0.55*	0.89	0.92	0.54	0.95	0.63	1.53	1.05
Netherlands	1.07	0.61	2.14*	0.54	2.15*	1.88*	1.28	0.55*
Spain	0.67	2.37	1.60	4.22	1.35	1.21	0.87	1.00
Hungary	1.12	1.80	1.73	—[a]	1.39	1.46	1.26	1.21
Italy	1.07	0.94	1.76	1.03	1.35	1.24	1.20	0.63
Sweden	0.86	1.11	0.60	1.64	0.80	0.86	0.99	1.35

Note. * $p < .05$. P-values are for odds ratio. Gender was coded as 1 (male) or 2 (female). [a] few participants reported using bicycle for that purpose and, therefore, it was not possible to calculate reliable estimates. Analyses were controlled for the effect of age, cycling frequency, working status, student status, and having children in household on the outcome.

Table 2 shows the results of multiple logistic regression analyses, predicting eight purposes of cycling from gender, cycling frequency and socio-demographic variables. Female cyclists from the Netherlands were more likely to use the bicycle for taking children, for shopping-entertainment, and for personal business (Hypothesis 4). Male cyclists from UK were more likely commute/travel to or from work (Hypothesis 6). In addition, male cyclists from the Netherlands were more likely to use the bicycle for leisure-training (Hypothesis 5).

Using ordinal regression and controlling for cycling frequency socio-demographic variables, we found that, compared to female cyclists, male cyclists were more likely to report (1) having had an accident so severe that they had to see a doctor or were taken to a hospital, $b = 0.48$ (95% CI = 0.18, 0.79), $SE = 0.16$, $p = .002$, and (2) having had an accident were their bike was damaged, $b = 0.33$ (95% CI = 0.21, 0.45), $SE = 0.06$, $p < .001$, confirming Hypothesis 7. The test of parallel lines revealed that in both ordinal regression analyses the assumption that the parameters are the same for all categories were reasonable, $\chi^2(22) = 30.09$, $p = .116$ and $\chi^2(22) = 19.90$, $p = .589$, respectively. We repeated both ordinal regression analyses to test potential interaction between gender and countries. All the interactions effects were not significant, indicating the relationship between gender and having had an accident did not significantly vary by country.

4. Discussion

The main aim of this study was to assess gender differences in attitudes towards cycling, bicycle use and cycling injuries in a population of regular cyclists. We performed this investigation in six different European countries with diverse cycling cultures to cover more varied social environments.

In line with our expectations, gender differences in attitudes towards cycling were small in terms of effect size (albeit significant) or non-existent in our sample of regular cyclists. While we did not observe significant gender differences in perception of mobility benefits of cycling, we found gender differences in personal benefits of cycling; females perceived more than males that

cycling is a practical and convenient transport mode. Even though previous studies have suggested that male cyclists tend to perceive fewer barriers or constraints to cycling and more positive attitudes to cycling compared to women (e.g. Akar et al., 2013, Dickinson et al., 2003, Emond et al., 2009, Garrard et al., 2012), it should be borne in mind that the samples used were indicative of the general population (ad most previous studies have done). In these studies, it is conceivable that the results were influenced by the male-group's higher probability of contacting more regular cyclists than their female counterparts. In line with self-perception theory (Bem, 1967), when considering only regular cyclists, these differences and constraints not only decrease or even disappear, but it would also appear that women perceive greater personal benefits when cycling compared to male cyclists.

Results did not show gender differences in the evaluation of the cycling infrastructure; however, female cyclists perceived higher levels of discomfort than males on roads without bicycle lanes. This finding confirms previous work that has shown that female cyclists are more likely to express concerns about safety issues in cycling in mixed traffic compared to male cyclists (Aldred et al., 2016, Beecham and Wood, 2014, Garrard et al., 2012, Heesch et al., 2012, Krizek et al., 2005). In addition, our results showed that females reported higher levels of risk perception of cycling than males, as shown by previous research (Aldred et al., 2016, Beecham and Wood, 2014, Frings et al., 2012, Garrard et al., 2012, Griffin and Haworth, 2015, Heesch et al., 2012, Krizek et al., 2005). Given higher perceptions of risk of cycling among regular female cyclists, we conclude that these findings are not specific to cycling but may be function of gender differences in risk perception in different domains. Previous research on risk perception suggests that males and females perceive risks differently (e.g. DeJoy, 1992, Flynn et al., 1994, Gustafson, 1998). Gustafson (1998) suggests that the traditional social roles of females, as care providers and nurturers, explain the differences in risk perception, causing women to perceive more risks to health and safety than men. Men, on the other hand, traditionally cover the role of income earners and hence tend to perceive higher level of economic risks than women, while their perceptions of risk to health and

safety are lower. Flynn et al. (1994) identified the tendency of males to perceive lower risk than females across different types of hazards and noticed that Caucasian males in Unites States showed significantly lower risk perception than non-white males and females (regardless of ethnicity). This phenomenon is also known as white male effect and in general its explanation lies in the privileged position of this particular demographic group in society. Finucane et al. (2000) adduce white males' socio-economic resources, sense of control, and cultural worldviews as underlying factors of white male effect. In later studies, however, the validity of white male effect was cast in doubt suggesting that in countries with higher gender equality (e.g. Sweden) there is no significant difference between men and women in risk perception (Olofsson and Rashid, 2011).

Regarding bicycle use, Dutch female cyclists were more likely to use the bicycle for shopping or entertainment, personal business, and taking children to or from school and less likely to cycle for recreation or sport compared to the male counterparts. This finding suggests that Dutch women act in accordance with their traditional gender role (Beall, 1993, Garrard et al., 2012, West and Zimmerman, 1987) when it comes to bicycle use, focusing more on care for household and offspring. However, the most interesting finding was that there were not such gender differences in cycle use in other countries. We hypothesise that the influence of traditional gender role norms was observed in the Netherlands probably because Dutch regular cyclists resemble more the Dutch general population, while regular cyclists in the other countries may belong to subcultures that appear to be less affected by traditional gender role norms.

The fact that female cyclists were not more likely to use the bicycle for visiting family and friends than males seems to be an exception to traditional gender roles. This result suggests that social activities are neither typically female nor male and therefore are not part of roles attributed to gender. We did not, however, find differences in the use of bicycle for going to or from university or work (except for United Kingdom). A previous study showed that male cyclists are more likely to use the bicycle for the work trips (de Geus et al., 2014). The findings of the present study suggest

that this difference may reflect less bicycle use among women. Indeed, when considering regular cyclists, this difference disappears, at least in most countries.

Furthermore, we did not find gender differences in cycling for recreation or sport (except for the Netherlands). While cycling as a sport might be more popular among males than among females, among female regular cyclists, recreation or sport cycling is as frequent as among male regular cyclists. In addition, there is a wide range of recreational cycling including those cyclists who just go out for a slow-paced ride around a park. Regular bicycle use could be a means to reduce the patriarchal characteristics of recreation or sport cycling in Western countries (e.g. Adams et al., 2010, Bryson, 1987, Connell, 1995, Dunning, 1986, Koivula, 1999, Wellard, 2002). Additionally, it could be that women are more and more interested in cycling in terms of recreation or sport for its health benefits such as weight management, smoking cessation as well as because it reduces levels of depression and stress and relieves symptoms of premenstrual syndrome (Garrard, 2003). An example of that is the indoor-cycling (i.e. spinning) which is very popular form exercise among women (Szabo et al., 2015). Indeed, in the present study, women were more likely to endorse the view that cycling conveys benefits for the person.

In line with previous research (Bíl et al., 2010, Eluru et al., 2008, Marín Puchades et al., 2017, Prati et al., 2017b), the findings of the present study suggest that gender differences in the likelihood of being involved in bicycle crashes remain among regular cyclists. Researchers have examined different variables to explain gender difference in the likelihood of being involved in bicycle crashes such as speeding, risk perception, attitudes towards road safety, risky driving behaviours, knowledge and skills (Cobey et al., 2013, Cordellieri et al., 2016, Johnson et al., 2011, Schantz, 2017, Useche et al., 2018).

Gender differences in perceptions and attitudes towards cycling were found to be similar across the six European countries. We did find, however, differences in perceptions and attitudes towards cycling between countries. Results showed that scores on mobility and personal benefits of cycling were lower among Dutch cyclists. While this could be considered counterintuitive, it is

possible to argue that in the Netherlands many people opt to use the bicycle mostly because (1) cycling is part of the Dutch national identity, (2) of many formal and informal social norms present in the Netherlands, and (3) of the quality and provisions of bicycle infrastructure (e.g. Haustein and Nielsen, 2016, Kuipers, 2012, Pucher and Buehler, 2008). Thus, Dutch cyclists may cycle for other reasons than for environmental or personal benefits. Indeed, our results showed that, compared to Dutch cyclists, Italian and Spanish cyclists tend to report higher values for personal benefits and mobility benefits of cycling, while lower ratings on infrastructure quality and provisions. Thus, it seems likely that environmental or personal benefits are more valued among regular cyclists in emerging cycling countries such as Italy than in established cycling country such as the Netherlands because they tend to lack other motivational forces such as quality and provisions of bicycle infrastructure or pro-bicycle social norms.

In the present study, Hungarian cyclists reported the highest scores on perceived discomfort both for cycling on road with and without cycling lanes, as well as reporting the lowest risk perception related to cycling. There is evidence that in recent years many investments have been made to improve cycling network and infrastructure in Hungary's major cities such as Budapest and Debrecen (e.g. Kerényi and Bencze-Kovács, 2012, Kosztin et al., 2017). Haustein and Nielsen (2016) attributed the large share of practical cyclists found in Hungary to such investments. Our study may suggest that those efforts mainly affected cyclists' risk perception, while not having a considerable impact on cycling comfort in general. The lowest discomfort ratings were reported by cyclists from the United Kingdom and this may be connected to the unprecedent investment in cycling in the last decade as part of the National Cycling Cities and Towns Programme (Chatterjee et al., 2013). Future studies could test this argument further comparing different interventions and type of infrastructure provided in Hungary and U.K. in order to shed light if and which element has a greater impact on cyclist's comfort.

The contribution of the present study should be considered in the light of its limitations. The cross-sectional design of the study limits the causal inferences that can be made. Concerning the

sample, the applicability to some segments of the population was limited by the requirement for e-mail and Internet access. In addition, the generalizability of the findings is limited because the study population is self-selective (i.e. online panel). Finally, the survey data are based on self-reported information and, therefore, are open to recall bias and reporting errors.

4.1 Conclusions and Implications

The findings of the present study suggest that gender differences in attitudes towards cycling tend to disappear when considering regular cyclists. Therefore, it is not only that women are less likely to use bicycles than men because they have different attitudes towards cycling, but also that women exhibit different attitudes towards cycling because they are less likely to use bicycles. This is in line with the assumptions of self-perception theory (Bem, 1967). That is, people tend to use their own behaviour as a source of evidence for their beliefs and attitudes. This is, of course, our interpretation based on the empirical findings presented here: we acknowledge that there may be a two-way relationship between behaviours and attitudes. We would like to highlight that participants for this study were selected because of their bicycle use, not their perceptions or attitudes towards cycling. This study findings provide some insights for interventions aimed at promoting cycling and increasing cycling behaviours among women. In addition to focusing on the promotion of positive attitudes towards cycling, practitioners could also focus on increasing cycling behaviours. For instance, practitioners can promote special occasions or circumstances for cycling to demonstrate the positive aspects of cycling (e.g. the personal benefits of cycling). In addition, given that women perceive higher discomfort in mixed traffic, provision of cycling infrastructure (e.g. cycling paths separated from other road traffic) should be increased to increase the comfort of female cyclists. We argue that the development of bicycle paths separated from the rest of the traffic can foster higher gender balance in bicycle use. More important, we believe that female input and consultation should be considered in the design of transport infrastructure to ensure gender balance in bicycle use. Finally, results from the study confirm the paradox that male cyclists report lower risk perception of cycling and higher likelihood of having a bicycle crash than female cyclists. This pattern of findings

highlights the need of intervention aimed at increasing risk perception among male cyclists. Social marketing efforts may be not only an effective means to promote gender equality in cycling (e.g. focusing on challenging traditional gender roles) but also to strengthen safety and injury prevention for male cyclists.

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