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## Promoting cycling activities in the State of Qatar: Challenges and potential treatments

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### Abstract

In the last few decades, cycling has received an increased attention due to its health, social, and economical benefits. Many countries are adopting different policies to encourage cycling as a daily mode of transport. In this paper, the main barriers and motivators to cycling and their relation to demographic factors were investigated. In addition, main trip purposes of cycling and the effect of seasonal variation on trips duration were studied in the State of Qatar. Data was obtained through questionnaire by interviewing 272 respondents. Descriptive statistics and correlations were conducted to investigate the causal relationships. Most of the respondents reported that they cycle for exercise/leisure purpose. Due to weather conditions, cyclists are willing to cycle more in the winter season compared to summer for all trip purposes. Results also revealed a significant relation between different barriers/motivators and demographic factors such as gender, age and ethnicity. The results of this study could be beneficial to policymakers in identifying the main barriers and motivators for the public in order to promote cycling.

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### 1. Introduction

In the past few decades, many countries have started to promote cycling as a smart and green mode of transportation. Cycling has received increasing attention due to its environmental, social and health benefits around the globe. Some of the benefits of cycling include improving health, reducing fuel consumption and emissions, cost effective and in

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some cases enjoyable social activity [1-3]. In addition, cycling is a low-cost mode of transport compared to the other modes and it could help in reducing the number of motorized vehicles on roads and alternatively improving traffic flow efficiency [4].

In general, most of the factors affecting cycling activities fall under two main groups i.e., socio-demographic factors and choice related factors [5]. Socio-demographic factors include gender, age, income level, occupational status, availability of bicycle/vehicle, and ethnicity. On the other hand, choice related factors include trip factors (i.e., journey duration and trip purpose), environmental factors (i.e., weather condition, topography, and urban form), structural factors (i.e., bicycle network, safe parking, and additional facilities), and subjective factors (i.e., perception of risk).

Useche et al. [6] investigated the factors that encourage or discourage the use of bicycles through questionnaire survey data collected from 1064 cyclist respondents. Among the different encouraging factors, the factor “physical health and fitness” was ranked first followed by the “contribution to environment sustainability” and “time saving”. On the other hand, “perceived crash risk”, “safety issues” and “adverse weather conditions” were the highest ranked factors for discouraging cycling activities among the respondents. Another study by Fishman et al. [7] in Australia studied the main barriers to cycling. The study found that safety factors represented by the lack of cycling infrastructure and drivers’ behavior were the two major barriers for cycling. In the United States, Fowler et al. [8] studied the correlation between barriers to cycling and gender, and ridership status using an online questionnaire with a total sample of 1334 respondents. Results showed that weather conditions and safety issues were the main barriers for cyclists and non-cyclists, respectively, for both males and females. A significant variation in the weather condition would result in a reduction of using bicycles by 30% and 47% [9, 10].

Cycling infrastructure also plays important role in encouraging people to cycle more. According to Handy et al. [11] cycling infrastructure could encourage all types of cyclist users. This includes people who cycle for transportation and non-transportation purposes [12]. Hunter et al. [13] found that when cycle lanes are provided, drivers’ and cyclists’ level of comfort increases. This is mainly because drivers feel that cyclists will stay on their designated lane and cyclists feel that drivers will not drive into the cycle lane. In Portland city, Oregon, a study was conducted by random phone surveys that found positive relations between the availability of cycle tracks/lanes with the number of cycling trips as well as with the desire to cycle more [14]. The findings also indicated that better street connectivity could lead to more cycling activities, especially for the utilitarian trips. In addition, among the different demographic factors, males and respondents aged less than 55 years were found to be more likely to cycle compared to females and respondents aged 55 years and more [14].

Other factors in the literature such as providing showers, lockers, and bicycle parking facilities at the destination locations were found to have significant impacts on attracting people to cycle [15, 16]. Cultural norms could also affect cycling activities, for instance, in some cultures owing a bicycle means not having enough money to afford a vehicle [11]. Interestingly, it is also reported in the literature that in general, car ownership has a negative correlation with cycling and bicycle ownership [10, 16].

A recent study in the State of Qatar surveying 868 respondents (of which 103 were cyclists) found that heat, lack of the cycle path connections and the network cohesion were the main barriers to cycling activities [17]. Moreover, subjective risk due to the aggressive driving behavior in Qatar was also considered as a barrier to cycling by the respondents. Constructing more cycle lanes/paths with shading and improving intersection safety were highly ranked among the different motivators. The study did not include the relation between barriers/motivators with demographic factors such as age and ethnicity. Therefore, in this study, we try to focus on analyzing these types of relations. The state of Qatar is a unique case in terms of the diverse population composed of various ethnicities and cultural backgrounds [18, 19]. Therefore, it is crucial to identify different factors (i.e., barriers and motivators) considering different demographics that could contribute to improve cycling activities in countries having such heterogeneous populations.

The main objective of this paper is to study cycling activities and the main barriers/motivators in the State of Qatar taking into consideration different demographic factors. To achieve the study objective, the following research questions are generated:

- What are the different trip purposes in the State of Qatar considering different demographic factors?
- What are the key reasons that discourage the public from cycling?
- What are the different treatments that would encourage the public to cycle more often?

## 2. Methodology

### 2.1. Questionnaire development

The purpose of the questionnaire was to study cycling and the main barriers/motivators to cycling in the State of Qatar. The questionnaire consisted of three main sections as follow; the first section composed of six different socio-demographic related questions such as gender, age, ethnicity, occupational status and monthly income. The second section included three main questions targeting how frequent respondents cycle for different trip purposes were included. In addition, questions about the duration that the respondent would cycle in summer and winter seasons were asked in this section. The third section targeted the main barriers, which could affect or prevent the respondent from cycling activities. This included 12 different barriers such as heat, limited cycle lanes, dangerous driving behavior, etc. The next section comprised of questions related to the main motivators, which could encourage the respondents to cycle more often. Fourteen different treatments were introduced that can be divided into two main types, safety-related and infrastructure-related treatments.

The questionnaire was designed and collected by the Ministry of Transport (MOT) in the State of Qatar. The data collection method was carried out via interviewing the respondents in different locations of Doha city where cycling activities are more common. A total of 274 respondents were interviewed, of which 2 people could not complete the questionnaire.

### 2.2. Sample description

The total sample composed of 272 respondents. Out of the total sample, 79% were males while 21% were females. According to the Planning and Statistics Authority in the State of Qatar, females comprise 26.3% while males comprise 73.7% of the total population [20]. Regarding age groups, 26.5% of the respondents were less than 25 years, 43% in the 25-34 years age group, 19.9% in the 35-44 years age group, and 10.7% were more than 44 years old. Among different ethnicities, 25.4% of the respondents were Middle Easterners, 19.9% Eastern Asians, 34.6% Southern Asians, 10.3% Africans, 5.1% Europeans & Australians, and 4.8% Americans. Employed respondents comprise 79.4% of the total sample while 20.6% were unemployed representing students and other categories. Regarding monthly income, most respondents (88.2%) reported a monthly income of less than 15,000 QR (equivalent to approx. 4110 USD by the date), while the rest reported a monthly income of more than 15,000 QR. Out of the total sample, 183 respondents were cyclist and 89 respondents were not cyclists.

### 2.3. Data analysis

In this study, different analyses were conducted to answer the three research questions. This includes descriptive statistics presented by bar charts, box plots, and tables. This was done to show the mean rating of respondents for different questions about trip purposes and the relation between trip purposes with seasonal variation and demographic factors (i.e., gender, age, and ethnicity). In addition, Spearman's correlation was conducted to study the relations between the barriers/motivators to cycling and demographic factors. Fig. 1 shows a descriptive flowchart of the study.

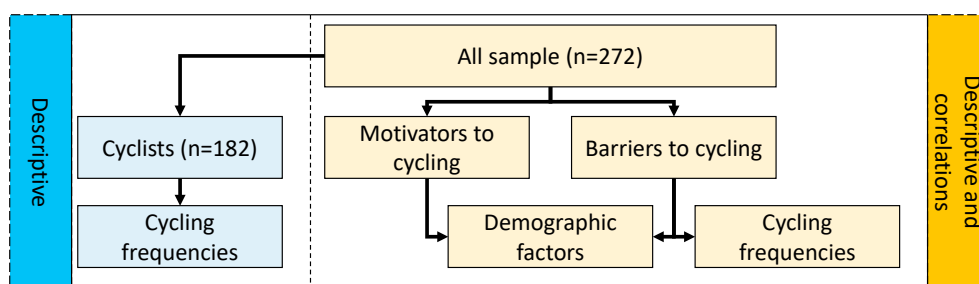


Fig. 1. Flowchart of the study

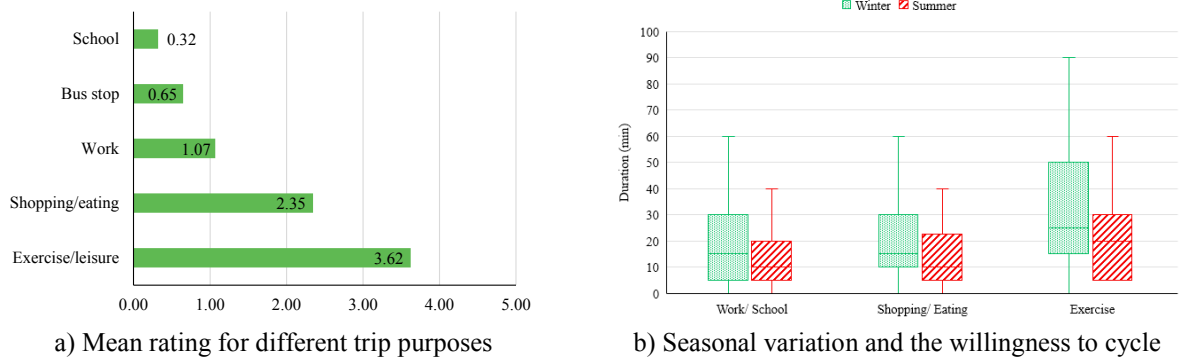


Fig. 2. Descriptive analysis of trip purposes

IBM SPSS Statistics software (version 26) was used for the analyses purposes. For all analyses, a significance value of 0.05 was chosen.

### 3. Results

#### 3.1. Cycling frequency

To answer the first research question about identifying the different trip purposes in the State of Qatar considering different demographic factors, only cyclists (N=183) were considered in this part. Fig. 2(a) presents the descriptive statistics of the mean cycling rating reported for the five different trip purposes. For this regard, the coding for the frequency per trip purposes was (0=never, 1=at least once per year, 2=at least once per month, 3=at least once per week, 4= two to three times per week, 5=daily). The highest cycling trips were reported for exercise/leisure activities with a mean of 3.62/5 (at least once per week) followed by cycling for shopping/eating with a mean score of 2.35/5 (at least once per month). On the other hand, the respondents reported that they cycle less frequently (i.e., once per year/never) to the work (1.07), bus stops (0.65), and school (0.32). As indicated in the results, most of cycling activities in the State of Qatar fall under exercise/leisure purpose.

The analysis was extended to the cycling activities during summer vs. winter seasons. In this regard, Fig. 2(b) exhibits box plots for the duration (in minutes) that the respondents were willing to cycle during summer and winter seasons for different trip purposes. As expected, the respondents reported longer cycling duration in winter compared to summer for all the trip purposes. In line with the earlier results, the duration that cyclists were willing to cycle for exercise/leisure was the highest with a mean of 30 min (ranging between 0 to 90 min) in winter, and a mean of 22 min (ranging between 5 to 60 min) in summer.

To investigate cycling frequency under different demographic factors, Table 1 presents the mean rating of each trip purpose for gender, age, and ethnicity. Based on the table, male cyclists reported more cycling activities than females

Table 1. Trip purposes under demographic factors (N=183)

Variable	Level	Work	School	Bus stop	Shopping/Eating	Exercise/Leisure	Mean Score
Gender	Male	1.17	0.32	0.71	2.35	3.66	1.71
	Female	0.66	0.31	0.40	2.33	3.49	1.44
Age	< 25	0.73	0.65	0.49	2.28	3.37	1.55
	25 - 34	1.17	0.24	0.67	2.49	3.76	1.70
	35 - 44	1.19	0.19	0.58	2.12	3.65	1.55
	>= 45	1.27	0.05	1.00	2.26	3.67	1.83
	Mid_Est	0.61	0.34	0.45	1.85	3.59	1.48
Ethnicity	Est_Asia	0.98	0.40	0.63	2.64	3.95	1.72
	Sth_Asia	1.48	0.06	0.76	2.54	3.66	1.74
	Afrc	0.75	0.58	0.67	2.17	2.42	1.32
	Euro&Aust	0.85	0.77	0.83	2.38	3.46	1.69
	Amer	1.20	0.60	0.50	2.00	3.82	1.91

Ethnicity: Mid\_Est=Middle Easterner; Est\_Asia=Eastern Asian; Sth\_Asia=Southern Asian; Afrc=African; Euro&Aust=European & Australian; Amer=American

for all the trip purposes. For age, old age cyclists had higher mean scores compared to all other age groups. Regarding ethnicity, Americans reported highest mean rating of 1.91/5, while Africans reported the lowest mean score of 1.32/5.

### 3.2. Barriers to cycling

The second research question is about identifying the key barriers that discourage the public from cycling. In this regard, Fig. 3(a) shows the mean rating for each barrier. For this, the coding for each barrier to cycling was (1=not a reason, 2=minor reason, 3=important reason). As expected in Qatar due to the weather condition, “Heat” was reported one of the main barriers to cycling with highest mean rating of 2.78/3. The second highest mean rating was obtained for “Limited cycle lanes” (mean = 2.54/3) followed by poor condition of the available cycle lanes “Cycle lane conditions” (mean = 2.51/3).

Table 2 presents the results from Spearman’s correlation tests conducted to investigate the relationship between the barriers and the different demographic factors. The results revealed that in comparison to males, female respondents showed higher discouragements to cycling activities due to the barriers “Heat” ( $r_{(270)} = .15, p = .016$ ), “Too much to carry”, ( $r_{(270)} = .14, p = .019$ ), and “Bicycle ownership” ( $r_{(270)} = .16, p = .007$ ). When it comes to age of the respondents, the results showed negative correlations with the factors “Heat” ( $r_{(270)} = -.15, p = .016$ ) and “Unsafe intersections” ( $r_{(270)} = -.12, p = .044$ ). This indicates that that younger people showed higher discouragement to cycling activities because of heat and their concerns about intersections safety (due to the lack of signals/priority signs at the cycling crossing locations), compared to elder people. Regarding ethnicity, compared to the other ethnic groups, Middle Easterners were more concerned regarding carrying too much stuff with them ( $r_{(270)} = .12, p = .046$ ). While comparing the East Asians with other ethnic groups, we found that their main concern was the poor condition of the

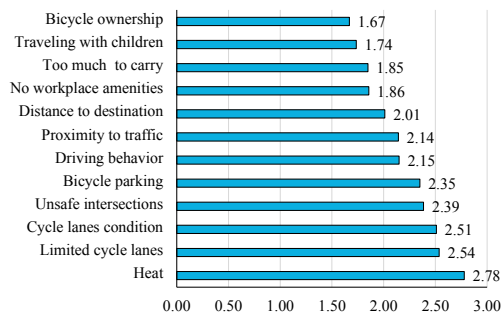
Table 2. Spearman’s correlation between barriers and demographic factors

Barrier	Gender	Age	Ethnicity					
			Mid_Est	Est_Asia	Sth_Asia	Afrc	Euro&Aust	Amer
Heat	.15*	-.15*	.12	-.03	-.14*	.09	.03	-.04
Limited cycle lanes	.11	-.10	.00	.05	-.13*	-.05	.08	.17**
Cycle lane conditions	.11	-.05	-.05	.13*	-.07	-.01	-.04	.08
Unsafe intersections	.11	-.12*	-.04	.03	-.06	.00	.05	.11
Bicycle parking	.05	-.06	-.06	.11	-.03	-.12	.05	.11
Driving behavior	.08	.06	.00	-.15*	-.09	.16*	.12*	.15*
Proximity to traffic	-.06	.01	.07	-.10	-.03	-.01	.10	.02
Distance to destination	-.08	-.03	.09	-.08	.02	-.04	.00	-.04
No workplace amenities	-.09	-.02	.06	-.16**	-.02	.14*	-.07	.08
Too much to carry	.14*	-.02	.12*	-.05	-.10	.05	-.04	.01
Traveling with children	.12	.10	.08	-.15*	.01	.06	-.07	.08
Bicycle ownership	.16**	.09	.03	-.06	-.01	.10	-.09	.03

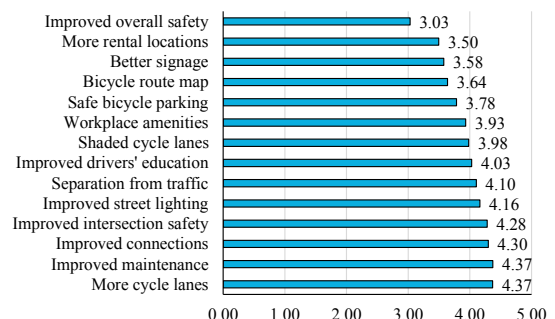
Gender: Male = 0; Female = 1

Age: Low to high

Ethnicity: Mid\_Est=Middle Easterner; Est\_Asia=Eastern Asian; Sth\_Asia=Southern Asian; Afrc=African; Euro&Aust=European & Australian; Amer=American



a) Mean rating for barriers to cycle



b) Mean rating for motivators to cycle

Fig. 3. Mean rating for barriers/motivators to cycle

Table 3. Spearman’s correlation between motivators and demographic factors

Motivator	Gender	Age	Ethnicity					
			Mid_Est	Est_Asia	Sth_Asia	Afrc	Euro&Aust	Amer
More cycle lanes	-.03	-.03	-.03	.05	-.10	.03	.07	.08
Improved maintenance	.04	-.04	-.07	<b>.16**</b>	-.07	-.03	.00	.03
Improved connections	-.04	.09	-.01	.03	-.01	-.03	.03	.00
Improved intersection safety	-.04	.03	.01	.01	-.03	-.07	.06	.07
Improved street lighting	.10	.03	.09	-.02	<b>-.13*</b>	.01	.07	.07
Separation from traffic	<b>-.15*</b>	.05	-.01	-.10	.05	-.01	.09	.00
Improved drivers’ education	.00	.10	.06	-.11	-.04	.05	.06	.04
Shaded cycle lanes	-.07	-.06	-.05	.10	.00	-.03	.03	-.05
Workplace amenities	<b>-.18**</b>	.03	.09	<b>-.13*</b>	.02	.07	-.08	.00
Safe bicycle parking	-.03	-.03	-.10	<b>.13*</b>	.03	-.05	-.02	-.03
Bicycle route map	.03	-.04	.00	<b>.19**</b>	-.08	-.04	-.09	-.02
Better signage	.06	.06	.03	.06	-.06	.04	-.11	.00
More rental locations	.04	-.02	.05	.03	-.12	.03	.01	.06
Improved overall safety	-.05	.02	<b>-.17**</b>	<b>.14*</b>	.03	-.06	-.01	.07

Gender: Male = 0; Female = 1

Age: Low to high

Ethnicity: Mid\_Est=Middle Easterner; Est\_Asia=Eastern Asian; Sth\_Asia=Southern Asian; Afrc=African; Euro&Aust=European & Australian; Amer=American

available cycle lanes ( $r_{(270)} = .13, p = .032$ ). However, driving behavior ( $r_{(270)} = -.15, p = .012$ ) and having children traveling with them ( $r_{(270)} = -.150, p = .014$ ) were the least important barriers to cycling for East Asians compared to other ethnic groups. Interestingly, South Asians showed that heat ( $r_{(270)} = -.14, p = .024$ ) and the limited infrastructure for cycling ( $r_{(270)} = -.13, p = .039$ ) were the least important barriers to them for cycling. Other form that, compared to the other groups, Africans ( $r_{(270)} = .16, p = .011$ ), Europeans & Australians ( $r_{(270)} = .12, p = .049$ ), and Americans ( $r_{(270)} = .15, p = .016$ ) agreed that the aggressive behavior of drivers was a barrier which could prevent them from cycling. In addition, Americans reported higher discouragement to cycle because of the limited cycle lanes ( $r_{(270)} = .17, p = .007$ ).

### 3.3. Motivators to cycling

The third research question focuses on identifying the key motivators that would encourage the public to cycle more often. To address this, Fig. 3(b), shows the mean rating of each motivator. The coding for each motivator to cycling was (1=very unimportant, 2=unimportant, 3=neutral, 4=important, 5=very important). Constructing more cycle lanes and providing better maintenance for cycle lanes received equally the highest rating with a mean value of 4.37/5. Another important motivator with a mean rating of 4.3/5 was to provide better network connections for the cycling infrastructure, followed by improving intersection safety such as providing signals/priority signs at intersections (mean = 4.28/5), improved street lighting at night (mean = 4.16/5), proper separation of the cycling infrastructure from the traffic (mean = 4.1/5), and educate drivers about cyclists rights (mean = 4.03/5).

Spearman’s correlation was conducted to investigate the linkages between the motivating factors and the different demographic factors (see Table 3). Results showed that for gender, proper separation of cycle lanes from traffic ( $r_{(270)} = -.15, p = .014$ ) and providing amenities such as lockers and showers at workplace ( $r_{(270)} = -.18, p = .003$ ) would encourage male respondents to cycle more compared to females. Regarding ethnicity, in comparison to the other ethnic groups, Middle Easterners respondents believe that improving the safety in general does not motivate them to cycle more ( $r_{(270)} = -.17, p = .005$ ). When comparing Eastern Asians to other ethnic groups, results revealed that maintaining cycle lanes in good conditions ( $r_{(270)} = .16, p = .008$ ), providing safe parking locations for bicycles ( $r_{(270)} = .13, p = .03$ ), providing information about the available cycling routes ( $r_{(270)} = .19, p = .002$ ) and improving the overall safety ( $r_{(270)} = .14, p = .022$ ) are all motivators for them to do more cycling. However, results showed that providing workplace amenities was not a motivator for Eastern Asians ( $r_{(270)} = -.13, p = .035$ ). For street lighting at night, Southern Asians think that this does not act as a motivator for cycling ( $r_{(270)} = -.13, p = .028$ ) in comparison to the other groups.

### 3.4. Cycling frequency vs. Barriers

Spearman's correlation was conducted for the total sample (N=272) to investigate the relation between cycling frequencies and the barriers to cycling. For this, the coding for each barrier to cycling was (1=not a reason, 2=minor reason, 3=important reason). Results indicated significant positive correlations between cycling frequency and the barriers "Limited cycle lanes" ( $r_{(270)} = .31, p < .001$ ), "Cycle lanes condition" ( $r_{(270)} = .21, p < .001$ ), "Unsafe intersections" ( $r_{(270)} = .18, p = .003$ ), and "Bicycle parking" ( $r_{(270)} = .22, p < .001$ ). This indicates that these were important barriers for the people having high cycling frequencies. On the other hand, significant negative correlations were found between cycling frequency and the barriers "No workplace amenities" ( $r_{(270)} = -.12, p = .05$ ), "Traveling with children" ( $r_{(270)} = -.21, p < .001$ ), and "Bicycle ownership" ( $r_{(270)} = -.21, p = .001$ ). This indicates that these were important barriers for the people having low cycling frequencies.

## 4. Discussion

The main objective of this paper was to find the main barriers and motivators to cycling activities in the State of Qatar taking into consideration the different demographic characteristics. To achieve the objective, three research questions were formulated. The analysis for the first research question (i.e., what are the different trip purposes in the State of Qatar considering different demographic factors?) showed that in general, most cycling activities in the State of Qatar are for leisure/exercise purpose. The main reason for this finding could be due to the car ownership culture in Qatar [17]. Another reason could be the car dependency, i.e., most of the people favor private vehicles over other modes of transportation for different trip purposes. In this regard, previous research has shown a negative relation between vehicle ownership and bicycle ownership [10, 16]. Considering the demographic characteristics of the respondents, males reported higher cycling activities than females. One of the possible reasons for this could be the cultural norms associated to people in the Arab region. The results are in line with previous studies reporting that females are less likely to cycle compared to males [6, 21, 22]. Other than that, old age groups (i.e.,  $\geq 44$  years) were found to have more cycling activities compared to the other age groups. Results also showed that for all the trip purposes, cyclists ride for longer durations during winter season compared to summer. Summer season in the state of Qatar starts from May until September and is characterized by hot weather (i.e.,  $45^\circ\text{C}$  to  $50^\circ\text{C}$ ) with high humidity [23]. Literature also showed that weather can be a significant factor that affects cycling activities [6, 9, 10]. Interestingly, this was also reflected in the barriers where the respondents reported that heat was the main barrier to cycling.

The second and third research questions addressed the main barriers/motivators and their relation to the different demographic factors. Compared to males, females showed higher discouragement to cycle during the hot weather condition or if they carry stuff with them. This could be due to the differences in the physical abilities of the two groups. In this context, a proper separation of cycle lanes from the motorized traffic and providing them with some amenities at workplaces such as lockers and showers could also encourage males to further increase their cycling activities compared to females. In accordance, different studies have found that providing a safe environment for cyclist would encourage people to do more cycling activities [13, 24].

When it comes to ethnicity of the respondents, Africans, Americans, Europeans and Australians reported aggressive driving behavior as a common barrier to cycling activities. Previous studies have also indicated aggressive driving behavior of drivers in the State of Qatar and that reckless driving was the main cause of road traffic crashes [25-27]. Therefore, proper treatments such as speed calming measures are required to stimulate drivers' traveling speed in the proximity of cycle lanes. Other important barriers were the limited cycling infrastructure and the poor condition of the existing ones. The State of Qatar has built various cycle tracks alongside the main roads at different locations. Nevertheless, based on the results, there is still need to build more cycle track/lanes and properly connect them with the existing ones. This is important to improve safety of both cyclists and drivers as well as to promote cycling activities in the region [28]. Other reasons that protect different groups to do cycling activities included holding and carrying things while riding and lack of amenities such as lockers and showers at workplaces. On the other hand, bicycle parking facilities and availability of maps at different locations were some of the other significant motivators

that could motivate people to cycle. It is vital for policymakers and government agencies to work with employers of different related businesses and institutions to initiate such facilities that could motivate cycling as a mode of transport.

This study was not without limitations. The sample size used in this study was limited and skewed more towards a younger age group. A longitudinal study with larger samples could be designed to further understand the perceptions of people regarding main barriers and motivators.

## 5. Conclusion

In this paper, a questionnaire data of 272 respondents was analyzed to study the cycling activities and the main barriers/motivators to cycling in the State of Qatar. Results revealed that most of the cycling activities are done for the exercise/leisure purposes in the State of Qatar. Males and older people were found to cycle more often compared to the other groups. The study results also identified different barriers and motivators that could motivate certain groups to increase their cycling activities. This include building more cycle lanes/tracks with proper separation from motorized traffic, improving the network connectivity, providing amenities at workplaces for employees, providing cycling routes maps along with the information about parking locations, and educating drivers to respect the right of way of cyclists. The use of cycling as a mean of transportation in the State of Qatar is still very limited. Therefore, policymakers may take the results of this study into consideration to improve cycling as a daily smart and green mode of transportation. Future research can study the change in the cycling activities after implementing some of the motivators. Moreover, future research can include other factors such as economical, sustainability, and cultural factors.

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