

Article

Why Don't People Ride Bicycles in High-Income Developing Countries, and Can Bike-Sharing Be the Solution? The Case of Qatar

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Abstract: Although cycling is increasing in developed regions, such as Europe and North America, high-income developing countries in the Arabian Gulf region still have low cycling activities. Limited research has investigated the barriers to cycling in these countries. In this study, the barriers and motivators in Qatar, a high-income developing country, were investigated. Respondents were asked to report their bicycle usage during the last 12 months. The results indicated that approximately 15% used a bicycle during this period, but only 1.7% bicycled for transportation purposes. The analysis revealed the different barriers to cycling and their relative strengths. The study also compared the perceived challenges of cycling between males and females. The questionnaire results indicated that both groups considered the issues related to the weather conditions, bicycle ownership, lack of paths or connections, and driver behavior as important barriers to cycling. However, the female participants identified clothing, parental consent, and cultural and societal pressure as far more important. When asked about motivators for cycling, the results revealed that improving intersections, adding additional infrastructure facilities, planting trees for shading, affordable bicycles, and campaigns targeting potential cyclists and drivers are needed in order to increase cycling. To better understand how bike-sharing will be perceived if implemented in the future, the feedback was obtained from the participants, and their opinions indicated that there is a great deal of acceptance for this type of service. The outcome of this study can be of benefit to public agencies in developing countries that have the goal of increasing cycling use among their populations.

Keywords: biking; cycling; barriers; motivators; developing countries; active transportation

1. Introduction

Cycling is a physical activity suitable for all age groups. Several advantages are linked to it in terms of better health, less pollution, and less traffic congestion. Many countries have implemented policies aimed at cycling and raising awareness about its importance. Moreover, many studies have focused on identifying factors affecting the adoption of cycling as a mode of transportation. The main goal is to find ways to change non-users' behavior. Non-users have beliefs, assumptions, perceptions, and expectations that affect their decisions regarding cycling. These beliefs differ from one region to another.

High-income developing countries are known for their limited adoption of cycling compared to bike-friendly countries in different areas of the world. These countries deal with various challenges to promoting cycling, including but not limited to a negligible cycling culture and a car-oriented culture characterized by aggressive driving [1,2]. Given that some of these countries lack a cycling culture, it is necessary to identify the infrastructure and programs needed to increase the cycling modal share. To that end, it is important to find the key factors affecting the adoption of cycling in order to develop

effective policies. To date, few studies have been conducted in high-income developing countries. Most relevant studies have focused on barriers and motivators of cycling in developed countries, such as those in Europe and North America.

Qatar, a high-income developing country in the Arabian Gulf region, was used as a case study in this research. The country is aiming for a paradigm shift after enormous investment in walking and cycling infrastructure [3,4]. In recent years, there has been a clearly positive change, with an emphasis on establishing a comprehensive bicycle network. However, although bike lanes are available, usage remains low, and innovative strategies will be required in order to increase it. The purpose of this study was to determine the cycling modal share in Qatar for the first time, understand the barriers and motivators of cycling in the country, compare the perceived barriers and motivators between the male and the female population, and investigate attitudes about the introduction of bike-sharing in this type of environment.

2. Literature Review

2.1. Barriers to Cycling

The benefits of active transportation, especially cycling, are well known. Increasing the number of cyclists in any country could help to reduce obesity and improve physical and mental health [5,6]. However, behavior change is a complicated process. The first step is to identify barriers to cycling. In this context, barriers are defined as factors that discourage people who are capable of cycling from doing so. Many studies have investigated these barriers using different methods, such as questionnaires, observations, and field measurements [7–9].

Barriers can be grouped under four general categories: demographic, environmental, infrastructure-related, and traffic-related factors. In regard to demographic barriers, different studies have reported mixed results concerning age and income levels [10–12]. In terms of gender, females have been found to be less likely to use a bicycle than males [13]. Studies have also shown that not having access to a car and owning a bicycle have a positive impact on bicycle use [14,15].

Regarding environmental barriers, weather, built environment, and topographies have been found to affect cycling decisions [10,16]. Unusual weather conditions have been found to negatively impact bicycle use [10,17]. Similarly, steep gradients have a negative impact [18]. Furthermore, the urban design of a neighborhood affects bicycle use. Dense urban areas are considered to provide favorable conditions [19].

Many studies have focused on infrastructure barriers. A lack of bike lanes has been reported as one of the main barriers. Conversely, the existence of a bicycle network promotes bicycle use [9,20]. Moreover, its quality and proper design, including connectivity, have a positive impact [21]. Safe and proper parking areas for bicycles and end-of-trip facilities, such as showers and dressing rooms, also have a positive effect [20]. Regarding traffic-related barriers, many people perceive using a bicycle and interacting with vehicles as often dangerous. This barrier can either be assessed by actual measurements, such as speed measurements and crash rate estimations, or by evaluating the population's risk perception [22,23].

2.2. Motivators for Cycling

Research has identified several motivators for cycling. A study conducted in South Africa suggested various motivators, such as advertising the benefits of cycling, educating the public about road safety, training people in cycling, providing affordable bicycles, and improving the safety of the cycling environment [24]. A study conducted in Melbourne, Australia, also made various recommendations, including campaigns emphasizing the benefits of cycling, training programs to improve cycling skills and increase safety, and events aimed at offering individuals incentives to cycle more [25].

A similar study in New South Wales, Australia, emphasized the need to improve safety by providing designated bike lanes and facilities at workplaces and recommended promoting the benefits of cycling and providing financial rewards through marketing activities [26]. In London, UK, a study underlined the need to complete the bicycle network by identifying priority routes for its completion. To overcome the enforcement, parking, and facility barriers, it recommended increasing the number of parking spots for bicycles, including at subway stations and major transportation hubs, and developing a database of bicycle stand locations. To overcome the safety barrier, it suggested launching campaigns to increase safety awareness among cyclists and drivers. To overcome the information and education barriers, it recommended providing cyclists with information about cycling routes and parking at all subway stations [27].

2.3. Bike-Sharing as a Solution

One of the potential solutions to low cycling rates is bike-sharing programs. These programs provide bicycles in key locations of a city, which the public can rent for short periods and then return to the same or any other docking station in the network. Recently, systems without docking stations, which offer users more freedom, have encouraged more people to use these programs [28]. Programs can vary depending on many factors, such as rental time allowed, operating hours, and cost of the service. Bike-sharing is typically presented as an ideal solution for congested metropolitan environments [29,30] and is less often tested in medium-sized or smaller cities [31,32].

Some cities, such as Hangzhou in China, Tokyo in Japan, and Bogota in Colombia, have successfully introduced bike-sharing programs in their transportation networks. Others, such as Seattle in the USA, Melbourne in Australia, and Madrid in Spain, have been less successful [12–14]. Therefore, it is important to understand the population's perception of using this type of service prior to its implementation.

Despite their increasing popularity in cities across Europe, North America, and elsewhere, bike-sharing programs are uncommon and of limited scope in developing countries. Moreover, there is limited research in countries with low cycling rates, especially high-income developing countries. These countries typically have sizeable numbers of potential cyclists. This study is among the first to investigate the likelihood of using bike-sharing services in the Persian Gulf countries.

3. Methods

3.1. Case Study

Qatar, a country in the Arabian Gulf region with about three million inhabitants, is used as a case study for this investigation. The country is considered one of the six high-income Gulf countries that form the Gulf Cooperative Council. These countries include Qatar, Bahrain, Kuwait, Oman, Saudi Arabia, and the United Arab Emirates. They are classified as developing countries, according to the United Nations. However, the gross domestic product per capita in this region is one of the highest in the world. These countries have unique socio-cultural, economic, weather, religion, and geographical characteristics. The six countries have a desert climate, characterized by mild and pleasant winters followed by extremely hot and humid summers.

The six countries host a significant proportion of expatriates who come from various parts of the world. They have different backgrounds, cultures, and training. This combination creates heterogeneous traffic composition and adverse traffic conditions, which affects traffic safety in this region. Furthermore, this region suffers from the excessive use of personal vehicles as the main mode of transportation.

The Arabian Gulf countries invest heavily in bicycle facilities, but the effect of these infrastructures on the cycling rates for the population in general and according to gender is still not measured. This study is one of the first attempts to measure the perception of cycling in this region, where perceptions differ widely from developing countries.

3.2. Bicycle Network in the City of Doha

Most of the streets in the city of Doha are almost flat, providing good conditions for cycling. The country's policy is to provide bike lanes on all new roads. However, some old roads still lack bike lanes and proper parking places for bicycles. Over the last decade, the country has invested billions of dollars into improving the infrastructure in the country, including separated bike lanes on all new roads (see Figure 1). At the same time, no cycling promotion campaigns were conducted during this time period. Moreover, there is no information regarding the percentage of people cycling in the country. The most common type of bike lanes used in Qatar is a separate paved two-way path that is usually provided on both sides of the road. One of the most important goals of the country is completing a high quality, well-connected cycling network and facilities in order to increase the likelihood of successfully inducing cycling, as proven in previous research [10,33–36].



Figure 1. Sample bike lanes in Doha, Qatar.

The bicycle network in the city of Doha was designed with the goal of making Qatar one of the premier cycling communities in the world. The city network contains approximately 540 km of designated bike lanes and connects all the major commercial, employment, education, and recreational destinations within the city. The network provides access to all areas of the city, linking schools, parks, stadiums, metro and bus stations, and all major destinations within the city. It also forms a continuous, interconnected grid, with no gaps in facilities. Cyclists are able to ride from one end of the city to the other while remaining on a designated bike lane. The network provides coverage of most areas of the city at a distance of one kilometer. This means that any person would be able to ride a bicycle out their front door, and within one kilometer be cycling on a designated bike lane. In addition, the network includes 258 km of off-street bicycle highways that link the city of Doha to the three nearby cities, Al Khor, Al Wakra, and Al Wukair. This system of bicycle highways generally follows the major cross-country vehicle road routes, being constructed within the roadway right-of-way.

3.3. Gender and Attitudes Toward Cycling

In general, male cyclists are substantially more likely than females to cycle in countries with low cycling rates [13]. In Australia and North America, this pattern of gender difference in cycling rates has been associated with the risks linked to relatively poor cycling infrastructure, policies, and regulations [37,38]. Gender differences in cycling are not known in the Arabian Gulf region. Investigating the existence of gender differences in the region and the causes for these variations is necessary for the increase of cycling use in this region. Therefore, it was important to investigate gender similarities, differences, and perceptions as part of this study.

3.4. Questionnaire Design

A questionnaire survey was designed to include respondents' socio-demographic information, current mobility patterns, cycling usage, barriers towards cycling, ways to promote cycling, and willingness to use a bike-sharing program in the future. The participants were categorized into three groups. The first group was identified as "cannot use a bicycle" based on answering "yes" to any of the following statements: "I do not know how to ride a bicycle" or "I have health issues that prevent me from using a bicycle".

The second group was identified as "can use a bicycle" and consisted of people that can use a bicycle. This group was divided into two groups: non-users (did not use a bicycle in the last 12 months) and users (used a bicycle at least once in the last 12 months). The third group was composed of people who did not complete the survey.

The non-users were asked to rate different questions regarding the reasons why people do not ride a bicycle, what could encourage them to bicycle, and what their perception would be towards bike-sharing if offered at a reasonable price.

3.5. Sample Description

The survey was conducted online and collected 868 responses. Out of the 868 responses, 77 (8.9%) did not complete the survey, and 102 (11.7%) cannot use a bicycle either because they do not know how to ride a bicycle or have a health condition that prevents them from cycling. Out of the remaining 689 respondents, 103 (14.9%) used a bicycle during the last 12 months, and 586 (85.1%) did not use a bicycle during the last 12 months, as indicated in Figure 2.

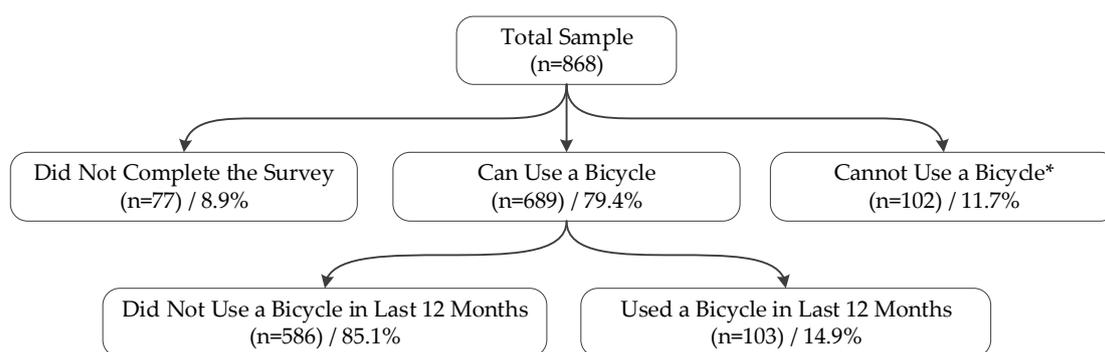


Figure 2. Sample Distribution. Note: * Do not know how to ride a bicycle or have health issues.

3.6. Modal Share

In countries with limited cycling activities, there is a high percentage of the population who selects other modes of commuting. When asked about the most frequent mode of transport they use on a typical day, 568 (82.4%) respondents mentioned private cars, and only eight (1.2%) respondents mentioned cycling. The summary of the results is shown in Figure 3. It is clear from the responses of the participants that the level of private car use is extremely high, surpassing and threatening the use of all other modes. The mode choice in developing countries has shifted to private cars due to rapid

urbanization and economic growth. These results were expected, since Qatar has an exceptionally high rate of private vehicle ownership, which can be explained by the high income in the country, as one of the oil-rich countries in the region.

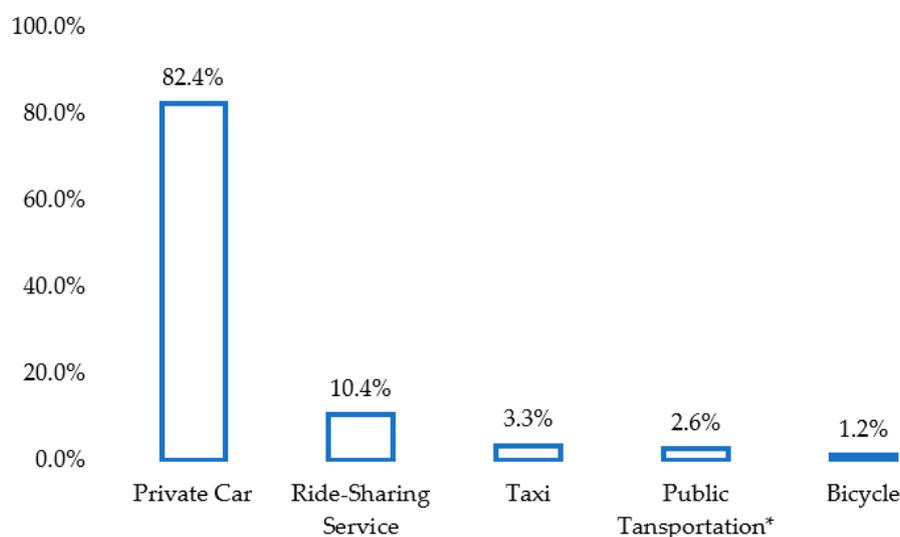


Figure 3. Transport Modal Share. Note: *At the time of the survey, the public bus service was the only active public transportation service in the country.

3.7. Users Versus Non-Users

Basic descriptive statistics for the users and non-users are shown in Table 1. The participants are listed in terms of gender, age, nationality, marital status, monthly income, education level, bicycle ownership (yes/no), vehicle ownership (yes/no), exercise (yes/no), health conditions, weekly vehicle usage, and bike lane availability. A Chi-square test was used to investigate whether socio-demographic and other characteristics are significantly different across groups. The test indicates which specific groups were different. The results indicated that nationality, bicycle ownership, vehicle ownership, exercise, health conditions, and vehicle weekly usage were significant. However, there is no significant difference between the remaining groups.

From the 689 non-users, 73.0% of the participants were categorized as male, and 27.0% were classified as female. This difference can be explained by the imbalanced population in Qatar (which is 75.5% male and 24.5% female) [38]. The bicycle use was almost the same for male (14.9%) and female (15.1%) respondents. Participants were asked to enter their age. The age was then coded into four categories (25 or less, 26–40, 41–55, and 55 or more). There was no statistically significant difference between the user and the non-user groups according to age. The highest percentage of users were among the 41–55 group (18.7%).

The Qatari participants in this study represent 22.4% of the total, whereas Qataris represent 14.3% of the population [39]. The oversampling is needed to ensure that there are enough Qatari participants in the sample in order to report more reliable results for this group. The sample shows that the non-Qatari group cycles the least. Only 13.1% of the non-Qataris used a bicycle during the last 12 months compared to 20.5% of the Qatari sample.

A high percentage of the participants were single (67.9%). This group had the highest use rate (16.0%) compared to the other groups. It is often difficult to get information on people's income, as some participants can consider it inappropriate and may not tell the truth. A high percentage of the respondents (44.4%) had low income (10,000 Qatar Riyal or less). About three-quarters of the respondents have an income of 20,000 Qatari Riyal or less. Surprisingly, the higher-income group (30,000 or more) had the highest use rate (19.4%).

Table 1. Characteristics of the user and non-user groups.

		Non-User		User		Total	χ^2	P	
		n	% Within Row	n	% Within Row	n	% Within Column		
Gender	Male	428	85.1	75	14.9	503	73.0	0.002	0.963
	Female	158	84.9	28	15.1	186	27.0		
Age	25 or Less	154	86.0	25	14.0	179	26.0	2.740	0.434
	26–40	284	86.6	44	13.4	328	47.6		
	41–55	139	81.3	32	18.7	171	24.8		
Nationality	55 or More	9	81.8	2	18.2	11	1.6		
	Qatari	136	79.5	35	20.5	171	24.8	5.448	0.020
Marital Status	Non-Qatari	450	86.9	68	13.1	518	75.2		
	Single	393	84.0	75	16.0	468	67.9	1.360	0.507
	Married	181	87.4	26	12.6	207	30.0		
Monthly Income	Other	12	85.7	2	14.3	14	2.0		
	10,000 or Less	266	86.9	40	13.1	306	44.4	2.095	0.553
	10,001 to 20,000	180	84.5	33	15.5	213	30.9		
Education Level	20,001 to 30,000	90	83.3	18	16.7	108	15.7		
	30,001 or More	50	80.6	12	19.4	62	9.0		
	Less than High School	1	33.3	2	66.7	3	0.4	6.856	0.077
Bicycle Ownership	High School	81	87.1	12	12.9	93	13.5		
	College	444	84.7	80	15.3	524	76.1		
	Higher Education	60	87.0	9	13.0	69	10.0		
Vehicle Ownership	No	557	90.4	59	9.6	616	89.4	131.928	<0.001
	Yes	29	39.7	44	60.3	73	10.6		
Exercise	No	91	76.5	28	23.5	119	17.3	8.329	0.004
	Yes	495	86.8	75	13.2	570	82.7		
Health Conditions	No	283	91.9	25	8.1	308	44.7	20.450	<0.001
	Yes	303	79.5	78	20.5	381	55.3		
	Excellent	153	80.1	38	19.9	191	27.7	6.325	0.042
Vehicle Weekly Use	Very good	260	85.5	44	14.5	304	44.1		
	Good	173	89.2	21	10.8	194	28.2		
	No Vehicle	91	76.5	28	23.5	119	17.3	10.245	0.017
Bike Lane Availability	Rarely	11	100.0	0	0.0	11	1.6		
	Few Times a Week	88	84.6	16	15.4	104	15.1		
	Daily	396	87.0	59	13.0	455	66.0		
Total	Not on any roads	212	86.5	33	13.5	245	35.6	1.833	0.400
	Some roads	332	84.9	59	15.1	391	56.7		
	Many roads	42	79.2	11	20.8	53	7.7		
Total		586	85.1	103	14.9	689	100.0		

The level of education among the participants is high, with only three participants with education less than high school. The results showed that the rate for participants with a college degree (15.3%) was the highest. The access to a car was high in the sample (82.7%). As expected, lower access to a car was strongly associated with a higher rate of bicycle use. Similarly, high bicycle ownership was strongly associated with high bicycle use, as expected [40].

The participants who are used to exercise had a much higher use rate (20.5%) compared to participants who do not exercise (8.1%). Moreover, participants with better health conditions had a much higher use rate. The participants who use their vehicles daily were less likely to use a bicycle compared to participants who use their vehicles a few times a week. The participants were asked if bike lanes are available in their neighborhoods. Participants with a high presence of bike lanes were found to ride a bicycle more than participants with low or no bike lanes in their neighborhood.

4. Results

4.1. Barriers to Cycling

The participants responded to different questions based on their current experience. The focus of this section of the analysis is the non-user participants (586 respondents) who were capable of using a bicycle but decided not to in the last 12 months. This group was asked to rate 14 barriers. The respondents were requested to rate the relevance of each barrier using a scale of 1 (strongly disagree)

to 5 (strongly agree). The mean score for all barriers was calculated, and the barriers were sorted from high to low, as indicated in Figure 4.

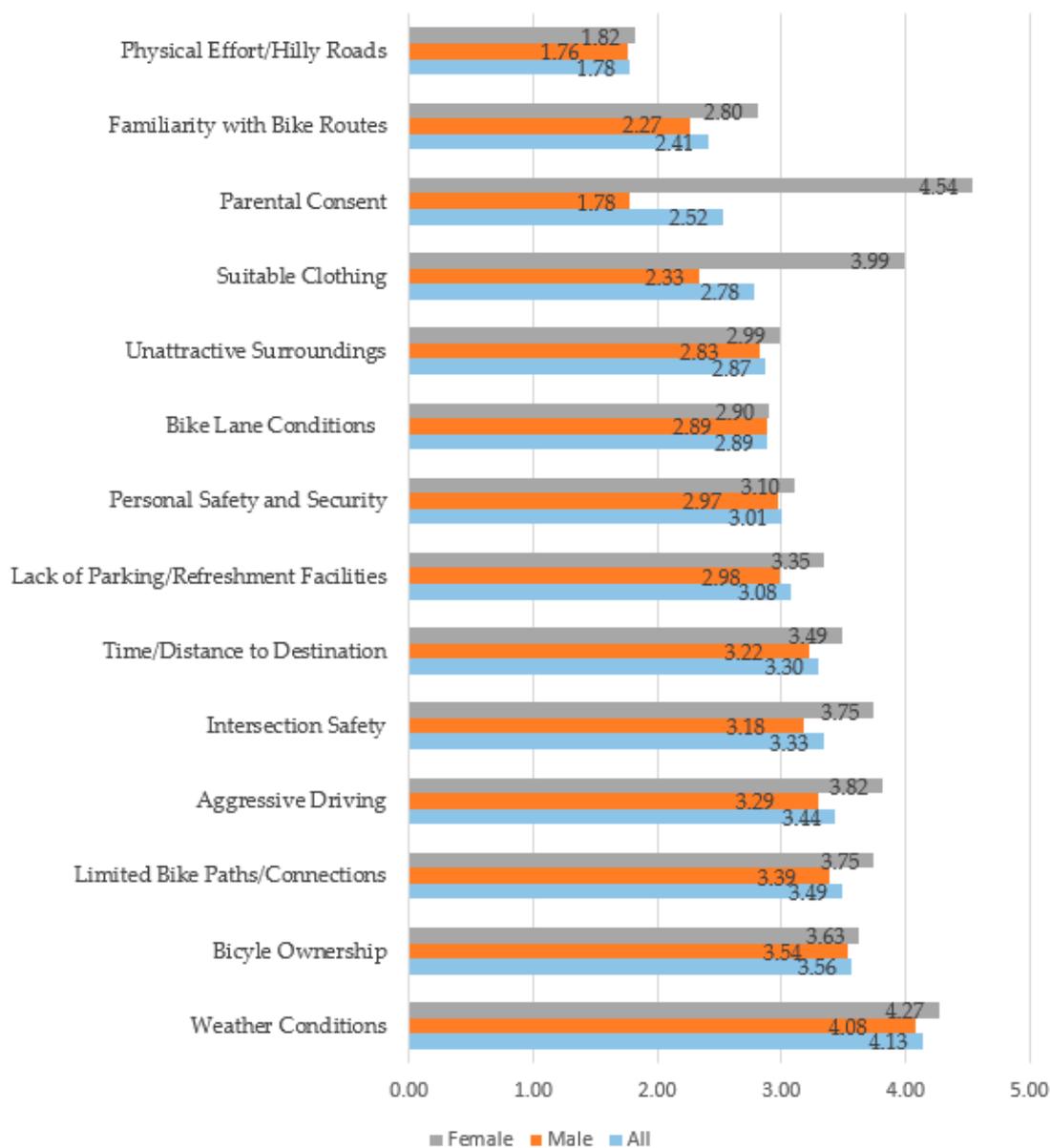


Figure 4. Barriers to cycling.

The first and highest reason given for not cycling was the weather conditions, with a score of 4.13. The high temperature in this region significantly restricts the opportunities for full usage times during the day. It also influences the types of facilities and services planned for and placed along the path. Furthermore, the intense heat in the Qatari summer months is well-known for its potential to cause physical harm to human beings and affect physical activity levels [41,42]. A reasonable objective would be to find cooling methods to reduce temperatures. Previous studies indicated that weather conditions, including rain, heat, wind, and humidity, can affect bicycle ridership [43,44]. The second reason was bicycle ownership, with a score of 3.56. Bicycle ownership has a positive effect on cycling [10,40,44]. According to the survey results, only 4.9% of the non-users own a bicycle. There is a need to identify methods to increase the number of persons owning bicycles in the country.

The third reason was limited bike paths and connections, with a score of 3.49, which is an indication that there is a need to construct more bike lanes. The availability of bike lanes encourages bicycle

use [9,20,26,27]. The fourth reason was aggressive driving, with a score of 3.44. The result indicates the concerns regarding the behavior of drivers, which is a common concern in previous studies [20,45,46]. Cyclists are vulnerable in traffic, so the success of the bicycle path strongly depends on providing a safe cycling environment. Safety is a major concern for non-users in Doha. Car traffic in Doha is relatively unstructured, with high speeds and frequent lane changes, which is dangerous for cyclists. However, there are locations where the bicycle infrastructure meets the car infrastructure, specifically where the bicycle path is routed through residential areas. At these locations, the law should assist in protecting cyclists against motorized traffic.

The fifth reason was intersection safety, with a score of 3.33. This concern makes sense since one of the most common locations of crashes involving bicycles is intersections. Usually, at these locations, cyclists experience interference from a car when crossing the intersection. In this case, different issues can happen, such as drivers not staying in their lanes or drivers cutting off cyclists.

The sixth reason was not being able to use a bicycle due to destinations being too far, with a score of 3.3. This is definitely a concern in the city of Doha. However, with the start of the new metro service, this issue may be alleviated in the future. The seventh reason was the lack of parking and refreshment facilities, with a score of 3.08. The availability of safe parking is considered an important factor for cyclists [20]. While there are no major differences between male (2.98) and female (3.35) participants, the female participants consider this barrier more important. The eighth reason was personal safety and security, with a score of 3.01. The ninth reason was bike lane conditions, with a score of 2.89. This barrier is related to issues such as darkness, debris in paths, dirty or littered areas, and path surface conditions. The tenth barrier was unattractive surroundings, with a score of only 2.87.

The eleventh barrier was suitable clothing, with a score of 2.78. It is difficult to ride a bicycle if not properly dressed for the ride. Not having the right combination of clothing can be a barrier to having good riding experiences. There were also interesting differences in the responses of the male and female participants. The male participants did not consider this barrier important (2.33). However, the female participants (3.99) seem to be more concerned about this barrier. This difference could be due to the traditional clothing used in the region, as the Qatari female nationals mostly wear a long black cloak called an "abbayah" that is worn over their clothing, which is probably difficult to wear while riding a bicycle.

The twelfth barrier was parental consent, with a score of 2.52. It is necessary for some non-users to obtain the consent of their parents in order to participate in any cycling activity. Some parents consider cycling a hazardous activity, which may result in serious or fatal injury and refusal for parents to give consent to their child. The female participants consider this barrier far more important (4.57) compared to the male participants (1.78). This may be due to barriers related to social, cultural, behavioral, or lifestyle issues. Studies show that obesity is much higher for females in all Arab countries compared to males, which is a great concern from a health perspective [47,48]. In general, the factors contributing to the physical inactivity among Arab women were identified as fatigue and tiredness, lack of time, lack of social support, traditional roles for women, availability of domestic help by maids, lack of facilities for undertaking physical activities, and weather conditions [49]. However, these factors need to be assessed further to identify their relative significance and association for contributing to physical inactivity.

The thirteenth barrier was the unfamiliarity with bike routes, with a score of 2.41. This barrier investigates whether the respondents had no awareness of the bicycle network or feel that this issue can affect their bicycle usage. It should be noted that no sources are currently available to provide information regarding the bicycle network in Qatar. The last barrier was the amount of effort needed for cycling and the presence of hilly roads, with a score of only 1.78. Some studies identified factors such as the amount of effort expended by the cyclist as a factor that can affect the use of bicycles [50]. Furthermore, geographical barriers such as hilly distances are usually identified as inconvenient for bicycle use. This barrier had the lowest score among all barriers. The participants did not seem to have major concerns regarding these two issues.

In order to allow the participants to provide their opinion regarding the barriers beyond the items provided in the questionnaire, their feedback was obtained through an open-ended question. Several mentioned barriers were similar to the structured survey questions. Some of the common barriers to cycling were related to aggressive driving. Answers such as “having to deal with aggressive car drivers”, “people drive at a high speed and do not respect pedestrians or people riding a bicycle”, and “people feel unsafe riding, especially if they have their kids with them” were mentioned. Weather conditions were mentioned frequently. Answers such as “harsh weather” and “very hot weather” were mentioned. Some participants mentioned the inadequacy of the cycle road network, the lack of coolers to drink from, the lack of repair facilities, and the lack of ability to carry heavy things.

However, somewhat surprisingly, the most common barrier listed was the influence of societal perceptions on the non-users in general, and especially for females. This barrier was not listed in the structured questions. For example, answers for barriers included: “society’s perspective of a female riding a bicycle will not be positive”; “it is not in my culture to use a bicycle”; “unfortunately, our society considers anyone not using a private vehicle to be from a lower class”; “I do not ride a bicycle because I do not see any females riding a bicycle on the street”; “it is not accepted by the society, and therefore I do not do it”; “the lack of suitable places for a girl with a veil to ride a bicycle, because I cannot drive it in public and open places”; “the society is not used to seeing a female riding a bicycle and I will look weird”; “society is not accustomed to the idea of a male or female student driving a bicycle, which would seem strange”; “society rejects the idea of a veiled girl riding a bicycle”; “in general, adults do not use bicycles in our society”; “this is not a thing that is acceptable in our society”; “the cultural perspective of seeing a woman riding a bicycle”; “it is very odd to see a girl riding a bicycle and that is why I would never do it”; “it is not socially accepted in Qatar, but I do it only if I am visiting another country”; and “in the local culture, bicycles are used by children or men only”. One answer was as simple as “because I am a girl”.

4.2. Potential Motivators

After seeking the rating of the barriers, the participants were asked to rate 10 different motivators following the same approach. The results are shown in Figure 5. The first and most important motivator is improving intersections to handle cycling, with a score of 4.26. This motivator was more important for the participants than adding additional bike lanes, which is surprising. Solutions such as the grade-separated crossing of major roads, raised platforms for at-grade crossings with minor roads and driveways, and wide medians, which allow cyclists to cross in two stages, should be considered.

The second important motivator for cycling was the inadequacy of the cycle road network and the need to add more bike lanes, with a score of 4.19. The third motivator was related to the need for proper bicycle parking and refreshment facilities, with a score of 4.15. Adding these types of facilities might increase bicycle commuting rates. Proper bicycle parking facilities should be provided in the key areas within the bicycle network. The bicycle racks should provide an acceptable level of security. There is also a need for refreshment opportunities and the opportunity to store or lock up one’s bicycle not far from the path. Access to drinking water at regular intervals could be useful and should be considered as part of the network.

The fourth barrier was planting trees or adding canopies for shade, with a score of 4.13. In general, some barriers to walking and cycling are difficult to completely eliminate, such as bad weather. The approximate temperature through the year in Qatar ranges from 11 to 43 °C, with an annual average of 28.3 °C. For approximately half the total time each year, the temperature in Doha is a good and healthy temperature for cycling. A reasonable objective of providing a cooling method to reduce the temperature in the remaining part of the year would provide a comfortable and safe cycling environment. Weather conditions could be improved by building shelters that give pedestrians and cyclists protection from bad weather. Therefore, planting trees or adding canopies in order to provide shade would be successful, especially if possibly supported by an active cooling system. To achieve

temperature reduction, there are a number of ways of cooling the bike lanes, such as evaporative and radiant cooling.

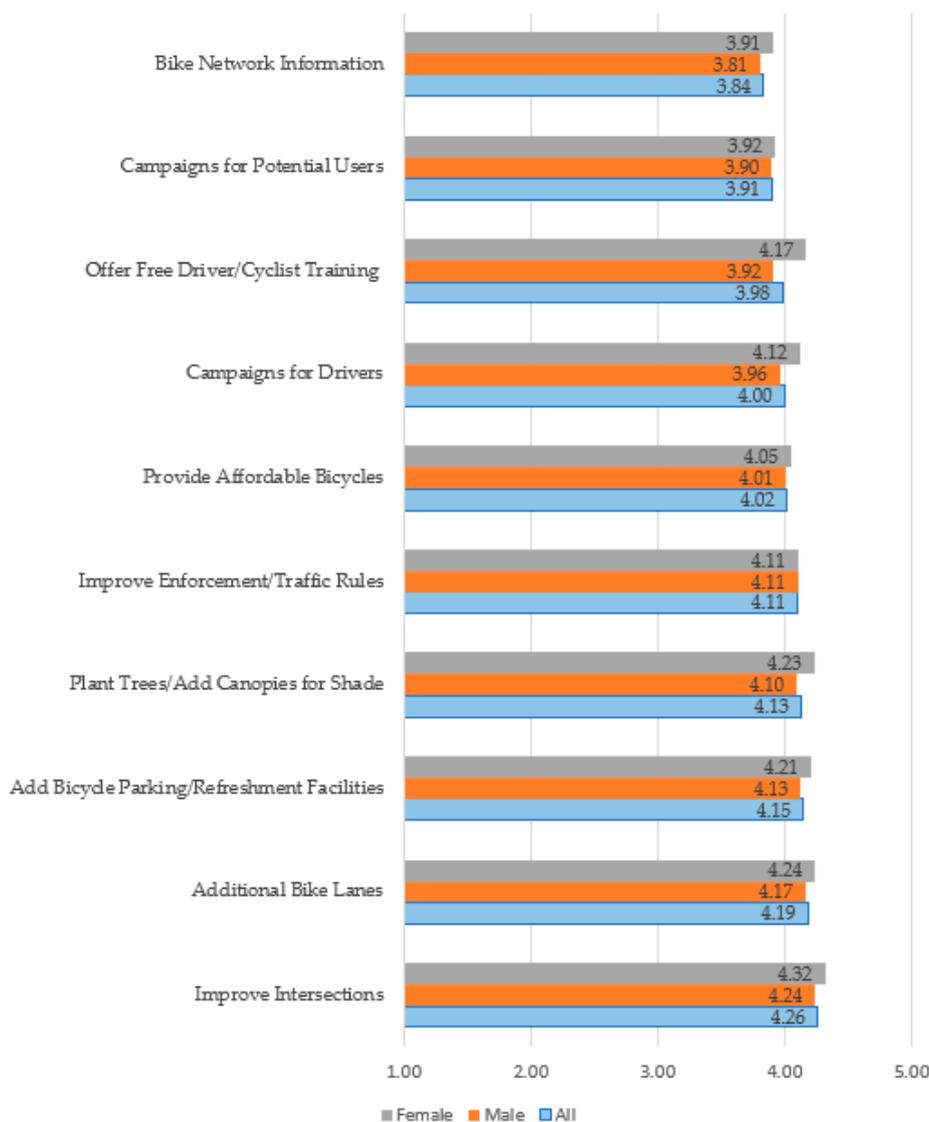


Figure 5. Motivators for cycling.

The fifth motivator was to improve enforcement and traffic rules, with a score of 4.11. The goal is to regulate the way people use the road and interact with bicycle riders. The participants rated this motivator highly, raising a particular concern that the current traffic law is not well enforced to guarantee the safety of the cyclists. Furthermore, to provide better protection for cyclists, it is recommended to strengthen the traffic laws with additions and amendments. The sixth motivator was to provide affordable bicycles, with a score of 4.02. According to the characteristics of the participants, there is a significant relationship between the number of users and bicycle ownership. Perhaps offering affordable bicycles will result in higher bicycle ownership, which in turn will increase the number of users. The seventh motivator was to develop campaigns for drivers, with a score of 4.00. Given the concerns regarding sharing the roadway with aggressive drivers, one of the potential solutions was to develop campaigns to educate drivers on how to deal with cyclists. These types of campaigns are important from a safety perspective, at least until drivers become more accustomed to cyclists.

The eighth motivator was related to offering free driver and cyclist training on using bicycles, bike lanes, and interacting with bicycles and vehicles on the road, with a score of 3.98. The idea is to

teach cyclists and drivers on how to use the road safely together. It has been noted from the results of the barriers that intersection safety was a major concern. It seems that people feel they are in danger once they leave the bike lane and interact with vehicles. Increasing bicycle education can lead to better confidence in dealing with these situations, increasing the usage of bike lanes. Providing this type of training for drivers and cyclists could decrease common errors and improve their cycling experience. They could also encourage novice cyclists to learn cycling rules.

The ninth motivator was to provide campaigns for potential users, with a score of 3.91. There are a number of internationally proven techniques for encouraging and changing travel behavior. Most involve a form of individualized marketing, where the transport choices are presented to the citizen in the form of advertisements, posters, or events to convey a message. The purpose of these campaigns is to influence a specific target group's attitudes and behavior. In the area of cycling, this method can be used to encourage and reach out to potential users and their families.

The last motivator was to provide bicycle network information to current and potential users, with a score of 3.84. One of the most important tools for promoting cycling and increasing usage is the publication of a bicycle network map. Most modern cities have these maps, which show both existing and planned routes, with additional relevant information such as locations of bicycle shops, cafes, public facilities (libraries, government offices, etc.), and sporting facilities. An application could also be useful to provide advanced mapping on handheld electronic devices.

In order to allow the participants to provide their opinion regarding the potential solutions beyond the items provided in the questionnaire, their feedback was obtained through an open-ended question. Several potential solutions were mentioned, similar to the solutions mentioned in structured survey questions. Several comments were related to the infrastructure, including the need for more bike lanes, the need for connected bike lanes, and decreasing the number of intersections, such as: "need more bike lanes to reach areas of interest"; "if I want to go to the nearby mall, there are some bike lanes, but then they stop"; "make continuous bike lanes to reach malls, major supermarkets, and children's daycare"; "need more uninterrupted bike lanes"; "make bike lanes suitable to ride with my kids"; "fewer intersections"; "decrease the number of the intersections that a cyclist has to cross"; "provide more parking"; and "offer showers and restrooms".

As expected, participants mentioned recommendations related to general campaigns, such as: "have campaigns to highlight the importance of cycling for the body and mind"; "encourage children to ride bicycles at a young age, so it becomes common later on"; "highlight the benefits of cycling on health and the environment"; and "campaigns to educate people on the importance of cycling". Some participants mentioned specific types of campaigns, including campaigns related to schools, such as "spreading the culture of bicycles as a means of transportation between school students". They also mentioned campaigns related to women, focused on finding ways for women to ride bicycles in a conservative way, either by designing special clothing or covering the bicycles, such as: "make covered bicycles for females"; "encourage the society to accept such ideas; my parents are even worried to let me drive"; "community awareness to encourage more women to ride bicycles"; "raising community awareness regarding women cycling"; and "awareness of the society about the importance of cycling for women".

Additional solutions were presented regarding providing awareness, such as: "need school to provide training to people in public streets"; "create bicycle competitions, whether racing or otherwise"; "create a bicycle center to support potential users"; "initiate bicycle clubs to provide training and improve the knowledge and skills for people interested"; and "develop government programs such as bicycle day to increase public awareness".

Some comments focused on providing affordable bicycles, maintenance options, and cheap accessories, such as: "decrease the prices of bicycles through promotions", "make car rack to mount bicycles cheap or free to encourage people to take their bicycles to nice places to ride", and "increase the number of stores that cater to cyclists".

Bike rental was also mentioned in several comments, such as: “I hope that bicycles are rented in various places for the purpose of enjoyment and exercise”, “maybe offering a bicycle for free in public places for few months will encourage people using them”, and “have bike lanes and free bicycles in parks for the people to practice and get used to cycling”.

4.3. Perception of Bike-Sharing

In this section of the questionnaire, the bike-sharing concept was explained to the participants before answering any questions. Pictures were also provided for clarification, and the participants were asked if they would be willing to use the program if it becomes available in the future. The results showed that a high percentage of the participants (77.8%) would be willing to use the program if implemented. Therefore, the concept of bike-sharing could be successful if implemented in the future and should be tested on a small scale for a start. A Chi-square test was used to investigate whether socio-demographic and other characteristics are significantly different across groups. The test allows the determination of which specific groups were different. The results indicated that age, nationality, and education levels were significant, as shown in Table 2. However, there is no significant difference between the remaining groups.

Table 2. Characteristics of the potential bike-sharing user and non-user groups.

		Will Not Use		Potential User		Total	χ^2	<i>P</i>
		n	% Within Row	n	% Within Row	n	% Within Column	-
Gender	Male	92	21.5	336	78.5	428	73.0	0.436
	Female	38	24.1	120	75.9	158	27.0	-
Age	25 or Less	29	18.8	125	81.2	154	26.3	16.125
	26–40	55	19.4	229	80.6	284	48.5	-
	41–55	40	28.8	99	71.2	139	23.7	-
Nationality	55 or More	6	66.7	3	33.3	9	1.5	-
	Qatari	44	32.4	92	67.6	136	23.2	10.608
Marital Status	Non-Qatari	86	19.1	364	80.9	450	76.8	-
	Single	76	19.3	317	80.7	393	67.1	5.664
	Married	51	28.2	130	71.8	181	30.9	-
Monthly Income	Other	3	25.0	9	75.0	12	2.0	-
	10,000 or Less	50	18.8	216	81.2	266	45.4	6.404
	10,001 to 20,000	40	22.2	140	77.8	180	30.7	-
	20,001 to 30,000	23	25.6	67	74.4	90	15.4	-
Education Level	30,001 or More	17	34.0	33	66.0	50	8.5	-
	Less than High School	0	0.0	1	100.0	1	0.2	8.589
	High School	28	34.6	53	65.4	81	13.8	-
	College	90	20.3	354	79.7	444	75.8	-
Bicycle Ownership	Higher Education	12	20.0	48	80.0	60	10.2	-
	No	125	22.4	432	77.6	557	95.1	0.432
Vehicle Ownership	Yes	5	17.2	24	82.8	29	4.9	-
	No	15	16.5	76	83.5	91	15.5	2.028
Exercise	Yes	115	23.2	380	76.8	495	84.5	-
	No	72	23.8	231	76.2	303	51.7	0.907
Health Conditions	Yes	58	20.5	225	79.5	283	48.3	-
	Excellent	37	24.2	116	75.8	153	26.1	1.787
	Very good	51	19.6	209	80.4	260	44.4	-
Weekly Use	Good	42	24.3	131	75.7	173	29.5	-
	No Vehicle	15	16.5	76	83.5	91	15.5	3.666
	Rarely	3	27.3	8	72.7	11	1.9	-
Bike Lanes Availability	Few Times a Week	16	18.2	72	81.8	88	15.0	-
	Daily	96	24.2	300	75.8	396	67.6	-
	Not on any roads	53	25.0	159	75.0	212	36.2	1.81
Total	Some roads	67	20.2	265	79.8	332	56.7	-
	Many roads	10	23.8	32	76.2	42	7.2	-
Total		130	22.2	456	77.8	586	100.0	-

Slightly more male participants (78.5%) are willing to use services compared to female participants (75.9%). The proposed service is more popular with younger, single, lower-income, and non-Qatari

participants. It is also more popular with higher-education participants. Furthermore, the percentage of potential users with no access to a private car was higher than participants with access to a car.

To allow the participants to provide their opinion regarding the bike-sharing system beyond the yes/no question, their feedback was obtained through an open-ended question. Many participants mentioned that this is a great idea. Some participants made some recommendations for the services, such as: “provide a variety of bicycle sizes”, “have bicycles that are suitable for tall and over-sized people”, “provide seats for children so that parents can ride with their children”, “have bicycle baskets to be able to carry groceries”, “include bicycles that can be folded to be carried in private cars”, “make it possible to also rent car mounts”, “a good location for this service would be around malls”, “this service should be offered in universities and colleges for students to move around campus”, and “provide bicycle repair services to fix the bicycle if something goes wrong while using it”.

5. Conclusions

Despite the increasing public interest in cycling worldwide, the high-income developing countries in the Gulf region, namely Qatar, Bahrain, Kuwait, Oman, Saudi Arabia, and the United Arab Emirates, still have low cycling rates and, in many cases, limited cycling infrastructure. Few studies have investigated the factors related to this problem in these countries. This study investigated the barriers and challenges to cycling in Qatar and identified solutions to help decision-makers and planners launch programs aimed at increasing cycling rates. The number of people that used a bicycle over a period of 12 months prior to the study was less than 15%, and the cycling modal share was much lower (1.7%). The study also revealed a heavy use of private cars (82.4%), which has a detrimental effect on all other modes, including walking and cycling. Contrary to findings of research in countries with low cycling rates [13], this study found no significant difference in the cycling rate between males and females.

5.1. Barriers

The top five barriers identified by the participants were, in the order listed, weather conditions, bicycle ownership, limited bike paths, aggressive driving, and intersection safety. Most of these results are similar to previous findings in countries both with much higher [51–53] and with low cycling maturity levels [8,54,55].

The most cited reasons for male participants matched the overall reasons, except for the fifth reason, which was distance and time to get to a destination instead of intersection safety. The barriers identified by female participants, however, were not similar. The top barriers were parental consent, weather conditions, suitable clothing, aggressive driving, and intersection safety. Self-image and social norms seem to be an important issue. Previous studies investigated the role of the public image of cycling as a barrier. However, most of these studies were conducted in countries with much higher cycling rates. The studies have recognized that self-image and social norms also play a role [7,50]. Finally, the analysis of open-ended responses verified the importance of bicycle lanes. It also revealed additional factors, such as the importance of improved interactions between cyclists and drivers.

5.2. Motivators

The top motivators for cycling were mostly related to infrastructure and facilities. The list included improving safety at intersections, adding more bike lanes, providing more bicycle parking and refreshment facilities, planting trees for shade, and improving traffic rules and their enforcement. These motivators correspond to the barriers cited by non-users.

Participants also recommended general campaigns for cyclists and drivers, especially for children and women. The latter was a common recommendation among many female participants. Other solutions included offering awareness seminars, establishing providing cycling lessons, organizing cycling competitions, forming bicycle clubs, and launching government programs. Some comments were related to providing affordable bicycles, maintenance options, and cheap accessories, and

increasing the number of stores that cater to cyclists. These results are consistent with previous research [54]. Bike-sharing was also recommended as a solution.

5.3. Bike-Sharing

This study was among the first to investigate the possible success of bike-sharing services in high-income developing countries in the Gulf region. The findings can help policy makers and transportation providers to introduce and manage these schemes more effectively. Participants indicated a great deal of acceptance for this type of service. Moreover, the study found no difference in acceptance rates between male and female participants. These results suggest that bike-sharing services can be successful. Therefore, authorities should explore available options, testing them on a small scale at first.

5.4. Limitations

Identifying the factors influencing people's decision to cycle is a complex process. As in any questionnaire-based study, participants rank barriers and solutions; however, life circumstances and personal behavior play a major role in their actual reasons for not using a bicycle and their willingness to change their behavior. Moreover, there is a possibility that non-users may not accurately perceive the barriers for cycling, and consequently, may misidentify the proper motivators for cycling [52]. Identifying barriers and solutions is a good start; however, what happens in reality once some of these solutions are implemented does not necessarily guarantee that people will start to cycle more.

5.5. Future Work

The barriers and motivators of cycling can change over time. They can also change due to major events, such as the introduction of a new public transportation service or a major increase in gas prices. For example, the completion of the metro network currently in progress in the city of Doha may also be the catalyst for a first generation of cyclists. This type of service can encourage people to ride bicycles to metro stations, thus making cycling part of their commute. Furthermore, it is expected that the cycling rate will increase with the completion of the bicycle network. With all these changes and the implementation of policies to promote cycling, the barriers and motivators may change. Therefore, additional studies should be conducted in the future to reevaluate these factors.

It is also important to monitor and identify the problems that might be encountered once a reasonable number of people have taken up cycling. It would also be particularly interesting to investigate issues after the completion of the infrastructure network and the implementation of a bike-sharing system to assess their impact.

Future studies can also include research into raising public awareness to increase the adoption of cycling. This could include assessing tailored programs and policies, which can be applied to different segments of the population in order to educate people and raise awareness about the benefits of cycling at the individual and family levels. Monitoring characteristics before and after implementation is another area for future research.

Finally, the findings of this research will be helpful in identifying the barriers and challenges to cycling in Qatar. The study can aid in developing strategies for promoting cycling in Qatar and similar developing countries, thus contributing to promoting a healthier lifestyle.

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