

Risks for bicycle-related injuries in Al Ain city, United Arab Emirates

An observational study

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Abstract

Traffic-related injuries are a serious health problem. Traffic safety is a priority reflected in the United Nations Sustainable Development Goals. Data on current hazards for bicycle-related injuries from the United Arab Emirates are lacking. The aim of our observational study was to assess the behavior of bicyclists on the roads in Al Ain City, United Arab Emirates and compare our current results with a previous study from 2004.

We adapted and tested a structured data collection form. Different sectors of Al Ain were randomly selected to cover the whole city during different times. Bicyclists were observed without direct contact.

Out of 1129 bicyclists, 97.6% were males and 13.2% children. 39.4% were cycling on main roads with high-density traffic, 33.1% were cycling against the traffic, 39.3% were cycling at night, and 96.8% of them were not using lights. Only 2.1% of the bicyclists used helmets. A higher proportion of female than male cyclists used helmets (25.9% vs 1.5%; $P < .001$, Fisher exact test). There was an increase in cycling with the traffic ($P < .001$) and in use of helmets ($P < .025$) compared with the previous study.

Unsafe practices of bicyclists and low use of helmets despite legislation persist in Al Ain. There is a need to raise bicycle safety awareness and improve enforcement of bicycle helmet legislation. This should be directed toward expatriate workers, children, parents, and maids. Environmental changes, namely building separate bicycle lanes, can increase safety for cycling.

Abbreviations: GHP = gross domestic product, IBM-SPSS = statistical package for the social sciences from international business machine corporation, IL = Illinois, P = P value, UAE = United Arab Emirates, USA = United States of America.

Keywords: bicycle injuries, children, helmet legislation, helmet use, traffic safety, UAE

1. Introduction

Traffic-related injuries are a major public health problem worldwide. Annually, 1.35 million people are killed and

50 million seriously injured because of road traffic collisions.^[1] In 2010, the United Nations declared a Decade of Action for Road Safety. One of the Sustainable Development Goals (11.2) specifically requires countries to assure access to safe, affordable, and sustainable transport systems.^[1] In the United Arab Emirates (UAE) traffic-related mortality decreased from 37.1 per 100,000 in 2007 to 4.5 per 100,000 in 2019 following focussed and sustained governmental efforts.^[2,3] However, the mortality rate is still higher than in countries with similar gross domestic product and sociodemographic indicators.^[4] Data from the Global Burden of Disease study has shown that death rate of cycling-related injuries in the UAE has increased from 0.33 per 100,000 in 2009 to 0.7 in 2019.^[5]

Bicycling is re-emerging as a popular healthy mode of urban transportation. It is a cheap, environmentally friendly, and healthy transportation method yet it brings its own hazards. Furthermore, electrical bicycles, which can be located and hired through internet programs, are becoming more popular.^[6] Unsafe bicycle riding behaviors include not wearing helmets, cycling in motor vehicle lanes, against the traffic flow and in pedestrian sidewalks, crossing and running red lights, carrying extra passengers, and using mobile phones or eating while riding.^[6-10]

In a study on patients who required hospitalization following bicycle-related injuries in Al Ain City,^[11] 56.2% of cyclists had collided with a moving vehicle, 73.9% had head and face injuries, and overall mortality was 1.5%. None of these patients had been wearing a helmet.

Many countries have been successful in promoting bicycle safety by a combination of environmental changes (such as

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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building separate bicycle lanes), raising traffic safety awareness, and promotion/enforcement of bicycle helmet use. Helmets are efficient in preventing head and brain injuries.^[12–16] A meta-analysis based on 40 studies from 1989 to 2016 showed that bicycle helmets reduce head injury by 51%, serious head injury by 69% and fatal head injury by 65%.^[17] Nevertheless, they offer less protection to the face, and their protection effects differ between adults and children because of differences in crash type and mechanism.^[13] Children have smaller bodies, use smaller bicycles, and usually cycle in less dangerous environments.^[13] Unhelmeted cyclists are more often under the influence of alcohol, cycling without light, and involved in single bicycle crashes.^[18]

Compliance with bicycle helmet legislation varies depending on awareness and legislation enforcement.^[19–21] Some authors argue that any decrease in bicycle-related injuries results from more than mere compliance with helmet regulations, and that those who use helmets may also have concomitant safer riding habits.^[19]

UAE is a Middle-Eastern country undergoing rapid economic growth characterized by construction of high-speed roads and increasing numbers of cars. There are some efforts to build separate bicycle lanes as a component of support for sport and recreational activities but not as an important component of transportation safety.^[22] The economic growth necessitated an influx of foreign workers, who currently form the majority of the population (89%).^[23] Many of these workers have low incomes and some use cycling as an affordable means of transportation.^[24] Al Ain City is located in Abu Dhabi Emirate. It has a population of 740,000.^[25] Although the city has a modern network of roads, it lacks separate bicycle lanes. Accordingly, bicyclists are at high risk of collision with cars. Risk of collision increases at night when bicyclists are hardly visible if they do not use bicycle lamps or reflective clothing.

UAE legislation from 1995 mandates use of helmets for all bicyclists.^[26] Bicycles should be equipped with a front lamp and a red rear light and a reflector at the back. Bicyclists are prohibited from cycling on pavements and against the traffic. A previous observational study in Al Ain reported that, despite legislation, only 0.5% of bicyclists used helmets; many of them rode against the traffic; and they also did not use lights at night.^[20] As recent research data are lacking in this area, we aimed to observe the behaviour of bicyclists on the roads of Al Ain City and to compare changes with an earlier study, to assess the risks for bicycle-related injuries and recommend improvements for bicycle safety.

2. Methods

This is a cross-sectional study using direct observation of the behaviors of bicyclists in Al Ain City during one month (June 7–July 6) in 2018. We decided to use direct observation of bicyclists to collect our data instead of using self-reported questionnaires as we believe that the former is more objective than the latter. In self-reported questionnaires participants tend to report desirable behaviors and there is also a risk of recall bias. Similar challenges were reported in online surveys, which are biased by nonrandom selection of participants and deficient self-report recall.^[7] We updated the structured data collection form from the 2004 study^[20] and piloted the new form. Variables collected included demography, time of observation (day of the week, time of the day), type of bicycle, area of Al Ain and type of road where cycling was observed, direction of cycling (against or with traffic),

use of lights at night, and use of bicycle helmet. Nationality was divided into 2 categories (UAE national, expatriate). The nationality was reported based on clothing as UAE nationals and expatriates habitually dress differently. We used 2 age groups: children, 18 years old or less; and adults, older than 18 years, as judged by the observers. Al Ain City was divided into 29 sectors using Google Maps. A matrix with different sectors and timings was used to randomly select sectors to cover the whole city at different times (day of the week, time during the day). Investigators drove through the city in teams of 2, with one of them putting the observed information into the data collection form. Bicyclists were observed without direct contact or interview. Data were entered into an Excel sheet. After quality check, we analyzed the data using the Statistical Package for the Social Sciences (IBM-SPSS version 23.0, Chicago, IL). Fisher's exact test was used to compare categorical data of 2 or more independent groups. A *P* value of less than .05 was accepted as significant. Ethical approval for this study was obtained from the UAE University Social Sciences Ethics Committee (ERS_2018_5778, 14.10.2018).

3. Results

We randomly observed 1129 bicyclists. 97.6% (n=1102) were males, 86.8% (n=980) adults, and 92.4% (n=1043) expatriates (Table 1). The majority of cyclists (93%; n=1050) were riding 2-wheeled bicycles, 4.2% (n=47) 3-wheeled cycles, and 2.8% (n=32) sport bicycles. 52.1% (n=588) were riding in industrial areas and 47.9% (n=541) in residential areas. 39.4% (n=445) were cycling on main roads with capacity for heavy traffic (roads with

Table 1

Bicyclists by demographic variables, types of road, direction of driving, light, and helmet use (n=1129).

Variable	n	%
Gender		
Male	1102	97.6
Female	27	2.4
Age group		
0–18	149	13.2
>18	980	86.8
Nationality		
UAE	86	7.6
Expatriate	1043	92.4
Type of the road		
Main road with 3 lanes	168	14.9
Main road with 2 lanes	277	24.5
Smaller road at residential area	350	31.0
Pedestrian sidewalk	236	20.9
Others	98	8.7
Direction of driving*		
With traffic	532	66.9
Against traffic	263	33.1
Light use†		
Yes	14	3.2
No	430	96.8
Helmet use		
Yes	24	2.1
No	1105	97.9

UAE=United Arab Emirates.

* Cyclists on roads.

† Four hundred forty-four bicyclists were observed for light use at night.

Table 2
Bicyclists by age and type of road cycling (n=1129).

Age	Total	Main road with 3 lanes (n=168) n (%)	Main road with 2 lanes (n=277) n (%)	Residential road (n=350) n (%)	Sidewalk (n=236) n (%)	Pedestrian crossing (n=79) n (%)	Other (n=19) n (%)	P value
Child (≤18 yrs)	149 (13.2)	16 (10.7)	62 (41.6)	50 (33.6)	20 (13.4)	0	1 (0.7)	<.001
Adult (>18 yrs)	980 (86.8)	152 (15.5)	215 (21.9)	300 (30.6)	216 (22)	79 (8.1)	18 (1.8)	

2 carriageways of 2 or 3 lanes each), 31% (n=350) on residential roads, 20.9% (n=236) on pedestrian sidewalks, and 8.8% (n=98) in other areas, such as pedestrian crossings or parking areas. 33.1% (n=263) of bicyclists were riding against the traffic (Table 1).

52.3% (n=78) of children (≤18 years old) were cycling on main roads with 2 or 3 lanes per carriageway with a high density of traffic (Table 2).

The majority of bicyclists were cycling during the day (6 AM–6 PM) (n=701; 62%) and at weekends (Fridays and Saturdays in the UAE) (39.3%; n=443) (Fig. 1). 129 (30.1%) of cyclists rode on the main roads at night (Table 3). Of those cycling at night (from 6 PM–6 AM; n=428), 96.7% (n=414) were not using lights.

Only 2.1% (n=24) of the bicyclists used helmets (Table 4). Helmet use among females and UAE nationals was significantly higher compared with males and non-UAE nationals (25.9% compared with 1.5%; $P < .001$, Fisher exact test; and 12.8% compared with 1.2%; $P < .001$, Fisher exact test, respectively) (Table 4). Helmet use was significantly higher among bicyclists riding in residential areas compared with industrial areas (3.9% vs 0.5%; $P < .001$, Fisher’s exact test).

In comparison with the previous study,^[20] we observed a higher proportion of UAE nationals ($P < .001$), females ($P = .011$), and children ($P < .001$) using bicycles. In our study, more

bicyclists were riding with the traffic ($P < .001$) and their use of helmets had significantly increased ($P = 0.025$) (Table 5).

4. Discussion

The majority of bicyclists in our study were non-local (expatriate) adult males. The unsafe cycling practices observed in our previous study still persist. Almost one-third of the cyclists were riding against the traffic or on sidewalks. The majority of those cycling at night did not use lights.^[20] Use of bicycle helmets was extremely low. The majority of children were cycling on major roads.

The preponderance of male bicyclists has been described before.^[20] Compared with 2004, there was an increase in females riding bicycles. A recent study reported an increase in the proportion of injured females and UAE nationals admitted to the main trauma center in our city.^[27] Females previously stayed at home, taking care of their children and households. Alongside the rapid economic development of the local community, the education level of females has increased, and the majority are currently employed. This is associated with increased driving as well as activities outside the home in general.^[27,28]

Many of the expatriate male workers use bicycles as an affordable mode of transportation to/from work. As there is no

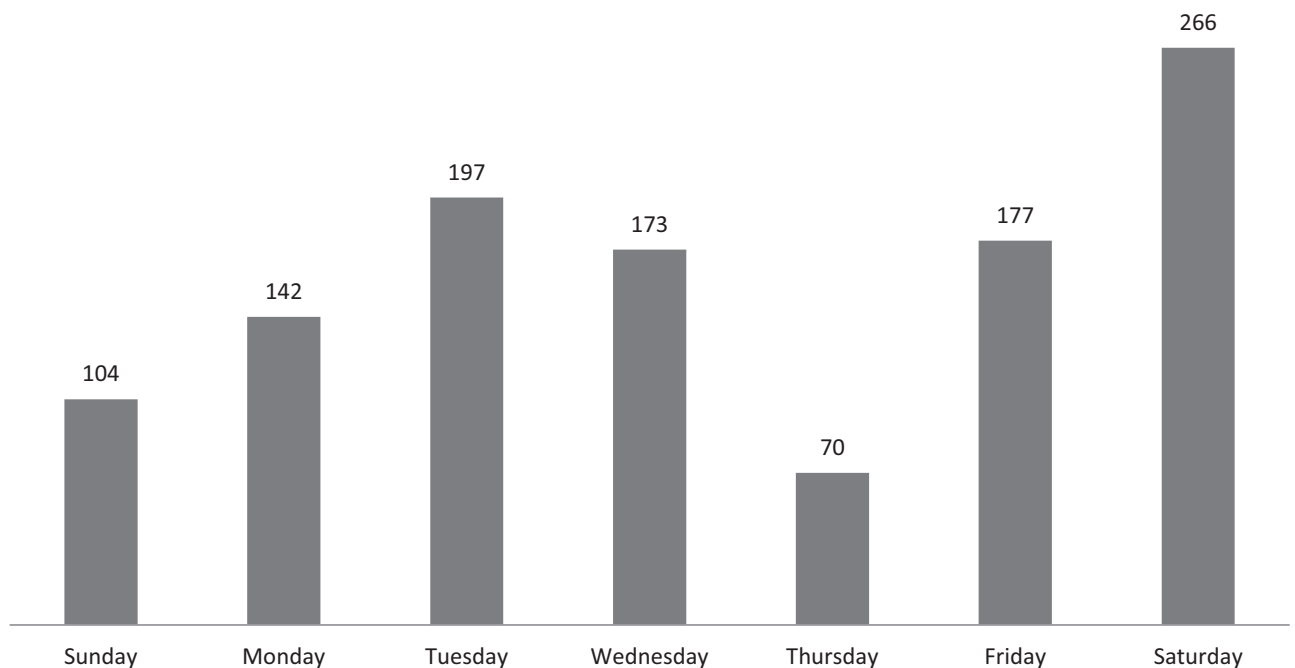


Figure 1. Observations of bicyclists by the day of the week (n=1043).

Table 3**Bicyclists by time of the day and type of road cycling (n = 1129).**

Type of road	Total n (%)	6 AM–6 PM n (%)	6 PM–6 AM n (%)
Main road with 3 lanes	168 (14.9)	113 (16.1)	55 (12.9)
Main road with 2 lanes	277 (24.5)	203 (29)	74 (17.3)
Residential road	350 (31)	229 (32.7)	121 (28.3)
Pedestrian sidewalk	236 (20.9)	103 (14.7)	133 (31.1)
Pedestrian crossing	79 (7)	42 (6)	37 (8.6)
Others	19 (1.7)	11 (1.6)	8 (1.9)

Table 4**Demographic variables of bicyclists by the helmet use (n = 1129).**

	n	Helmet use (n = 24) n (%)	No use (n = 1105) n (%)	P value
Age				
Child (≤ 18 yrs)	149	2 (1.3)	147 (98.7)	.478
Adult (> 18 yrs)	980	22 (2.2)	958 (97.8)	
Gender				
Male	1102	17 (1.5)	1085 (98.5)	<.001
Female	27	7 (25.9)	20 (74.1)	
Nationality				
UAE national	86	11 (12.8)	75 (87.2)	<.001
Expatriate	1043	13 (1.2)	1030 (98.8)	

Table 5**Comparison between the current study with a similar study of 2004.**

Variable	Old study		New study		P value
	No	%	No	%	
Sex					
Male	413	99.5	1102	97.6	.011
Female	2	0.5	27	2.4	
Nationality					
UAE	8	1.9	86	7.6	<.001
Non-UAE	407	98.1	1043	92.4	
Age					
Child	12	2.9	149	13.2	<.001
Adult	403	97.1	980	86.8	
Direction of riding					
With traffic	223	53.7	532	66.9	<.001
Against traffic	192	46.3	263	33.1	
Light use at night					
Used	2	1.1	14	3.2	.17
Not used	177	99.5	430	96.8	
Helmet					
Used	2	0.5	24	2.1	.025
Not used	413	99.5	1105	97.9	

proper traffic safety or cycling training, bicyclists continue unsafe practices. The recent Traffic Law requires bicycles to be equipped with proper front and rear lights.^[26] Nevertheless, many bicyclists ride at night without lights. This can be explained either by bicyclists' overconfidence in the safety of roads and their personal skills or by the fact that the main roads in Al Ain are well

lit. Bicyclists do not realize that riding without lights is very risky, especially on the smaller side roads at night, when unlit bicycles cannot be seen easily by car drivers. Our previous study on bicycle-related injuries requiring hospitalization in Al Ain City showed that most injuries to bicyclists occurred after dark when workers were returning home after their shifts.^[11]

In the current study, there were relatively few sport bicyclists. Such bicyclists usually have their bicycles in better technical condition and use helmets. Despite the growing popularity of sports cycling among UAE nationals and more affluent expatriates for fitness or recreation, the exceptionally hot weather in our setting discourages sport cycling during the day or in the summer. The increased number of UAE nationals among bicyclists compared with 2004 is nevertheless possibly due to the increased popularity of sports cycling.

Bicycle collisions with cars may lead to serious injury or death.^[29] Riding on roads with heavy traffic can substantially increase this risk as it may lead to high energy trauma.^[12,30] It was previously reported that most of the hospitalized injured bicyclists (81.5%) in Al Ain City were injured on the main roads by collisions with moving vehicles.^[11] In our present study, 39% of bicyclists were riding on main roads. Al Ain has a network of main roads which are dual carriageways with 2 or 3 lanes in each direction. Even within the city, drivers may easily reach speeds of up to 100 km/h. There is no separation between cars and bicycles, and there are no specific lanes for bicyclists.

A high proportion of the bicyclists in our study were riding against traffic (33%), which is higher than those reported in China (14%)^[6] and United States (7%)^[8]. Cycling against traffic is extremely dangerous because bicycle-motor vehicle collisions increase bicycle-related deaths.^[30,31] This highlights the need for strong enforcement of traffic safety legislation and raising safety awareness in high risk groups.^[6]

We are concerned that children are currently riding on main roads without helmets in our city. We conducted a prospective study on bicycle-related injuries in Al Ain on patients who were treated at the Emergency Department of Al Ain Hospital from October 2001 to January 2003. This study found that the majority of injured patients were children less than 16 years old.^[32] Families in the UAE tend to have many children, which may limit direct supervision. Parents ask older siblings or maids to supervise children.^[33] Children are often inexperienced bicyclists; they play in the residential areas in proximity to driveways, they love to explore their surroundings, but lack awareness of any risks, and they are more prone to injuries.^[32,34]

Head injury is the most common cause of disability and death among bicyclists.^[14,29,32] In a study on hospitalized bicycle-related injuries from Al Ain City, the proportion of head injuries was almost double (49%) compared with the proportion in studies where a high level of helmet compliance of 50% to 65% was reported.^[12,31] Numerous studies have evaluated the impact of bicycle helmets on head and brain injuries.^[12–15] A Cochrane Review has shown that helmet use reduces the risk of head injury by 85% and brain injury by 88%.^[15] Proper education campaigns alongside helmet use legislation significantly decrease bicycle-related head injuries.^[21] The introduction of helmet legislation in Canada increased helmet compliance from 38% in 1996 to 75% in 1997.^[35] On the other hand, reports from Canada and Australia showed that helmet legislation increased helmet use but may discourage people from cycling, which may have a negative effect on health.^[21,35] To avoid this effect, proper awareness campaigns are needed.^[20]

Despite the UAE Traffic Law No 91 from 1995, which requires that all bicyclists use helmets, the observed helmet use in Al Ain City was extremely low and had increased only slightly compared with 2004 (2.1% compared with 0.5%).^[26] Low helmet compliance was reported from China (2.4%)^[7] (Wu 2019) and France (2%).^[36] Cyclists often consider helmets uncomfort-

able, unattractive, annoying, and increase body heat.^[37–39] Recently, novel helmet fashionable designs that are more comfortable and having better ventilation were introduced.^[38]

In our local context, enforcement of legislation and awareness about the usefulness of bicycle helmets is low. Particular barriers to helmet use include the high temperatures during summer in addition to the cost, especially for workers with low salaries.^[11] In the UAE, there is also a high turnover in the expatriate workforce. Furthermore, expatriate workers have diverse educational, cultural, and socioeconomic backgrounds and speak various languages. These aspects need to be considered in the design of tailored multilingual health promotion campaigns. It is important to have a safe cycling environment including proper road infrastructure with designated bicycle lanes and traffic lights.^[38] This can decrease bicycle crashes by up to 60%.^[40]

4.1. Limitations of the study

There are certain limitations to our study. The study design used only direct observations without contact with bicyclists based on surface validity, so information on age and nationality, which depended on the general appearance and clothing, may not be completely accurate despite the usual clear differences between UAE nationals and expatriates in their dress and appearance. The study was conducted as a specific time-limited research project in Al Ain City, so it may not be generalizable to the whole of the UAE. As the same sectors in Al Ain City were used during different days and times of the day, there was a possibility that some cyclists were observed more than once. Furthermore, the study was conducted during the summer, and many families travel for holidays overseas to avoid the hot temperatures. Accordingly, sport cyclists with better safety behavior may be underrepresented in our study. It would be useful to have more specific details, such as the purpose of the cycling (commuting to/from work vs leisure/sport), cycling under the influence of drugs or alcohol, and supervision of children. Self-reported questionnaires are, of course, useful for the collection of such data in cross-sectional studies from a random population-based sample. Nevertheless, these questionnaires usually report desirable behaviors, and there is the risk of recall bias which limits their objectivity.^[7] Other new methods of observation of bicyclists, as yet not used in the UAE context, include monitoring by moving aerial cameras, video-based observation, or black spot identification.^[6,41,42] However, such approaches would have the same limitations as our current methods. We do not have access to detailed traffic injury police data, accordingly, we were unable to assess the relationship between cycling-related injuries and unsafe cycling behaviors. Despite these limitations, we think that the current study clearly documents the safety risks of cycling in Al Ain City, especially the lack of helmet and light use in our population.

5. Conclusions

Unsafe behavior of bicyclists in Al Ain City persists, with low use of helmets and frequent bicycle riding at night without proper lights. There is a need for the consistent and continuous raising of awareness about safe cycling habits, including the use of lights at night, riding in the direction of the traffic on the correct side of the road, and use of bicycle helmets. Awareness campaigns should also focus on children, schools, parents, and maids to increase the

cycling safety of children.^[43] The economic barriers to the purchase of proper helmets can be overcome by governmental or employer subsidies or discounts. The traffic safety legislation should be properly enforced. Environmental changes to separate vehicles from cyclists by building bicycle lanes can reduce the risk of collisions.^[44] Our future research should further explore the impact of unsafe cycling on injury patterns and outcomes in our setting.

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