Temporal Distribution Of Quadbike Injuries and Associated Factors, in Dubai, UAE

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Abstract

Quadbikes are all-terrain four-wheeled vehicles used extensively as desert recreational vehicles in Dubai, UAE. Quadbiking, like other outdoor sport, is influenced by ambient temperature in the desert ecosystem. This study assesses the temporal distribution of quadbike injuries in this unique desert ecosystem to identify the population affected and factors associated with injuries in addition to forecasting short term injury trend.

Electronic Patient Care Registration (EPCR) reports of Dubai Ambulance [Dubai Corporation for Ambulatory Services] from January 1, 2017, to March 1, 2021, were used as a data source. Variables were recoded and derived from the case history, time of incident and the clinical impression recorded by medics, following the incidence. IBM SPSS Statistical Package Version. 28.0.0.0 was used for descriptive, bivariate and regression analysis. R software version 4.2.1 helped with the time series analysis.

Two hundred twenty-six injury incidents were reported. The analysis showed that both nationals and non-nationals were equally involved in quadbike crash injuries. Those injured were young riders under 35 years [82.3%] and mostly males [73%]. Most crashes involving injuries were rollovers [73%] and were rarely picked up by ambulance from the desert [7%].

Dubai showed a seasonal distribution of quad bike injuries with peaks in winter and a small spike in June. Diurnal distribution of injuries shows higher frequency during the afternoon-evening hours, with an equal number of injuries occurring in the daytime and nighttime hours. Regression analysis showed native Emirati riders being injured more in winter [aOR=5.148; 95% CI 2.094 – 12.65] and during the night [aOR=3.452; 95% CI 1.822-6.54], when compared to non-national riders. Finally, it seems that, incidents of quadbike injuries, will show slight increasing trend in the next few months.

The distinct seasonal nature of quadbike injuries should direct the attention of concerned authorities to the importance of deploying the emergency and rescue services near desert riding hotspots. The authorities should also target vulnerable Emirati youth and guardians, during the winter season and early summer, for comprehensive injury prevention campaigns supported with close surveillance during night-time riding.

1. Introduction

Quadbikes are all-terrain four-wheeled vehicles used extensively for transportation and recreation on uneven terrain. As with all outdoor sports and activities, quadbike recreational sport is heavily influenced by ambient temperature and season. Seasonal influence is more obvious in the Middle East region, compared to elsewhere, with high temperatures going up to 50 degree Celsius in the summer months. The study was undertaken in the United Arab Emirates (UAE), a federal state, located in the eastern end of the Arabian Gulf and shares borders with Oman and Saudi Arabia. The UAE has an arid desert ecosystem with two seasons, summer and winter and two transitional seasons. The summer season is scorching...
and dry, with the maximum temperature going up to 50 degree Celsius in July and August. The cooler winter months between December and March have a mean temperature of 16 to 24 degrees Celsius (1).

Dubai is known for its tourism and for desert recreational activities. It had an Emirati population of 263,450 and an expatriate resident population of 3,092,450 in 2019 (2). It also had a heavy tourist footfall of 16.73 million visitors the same year, with 41% of tourists opting for desert safari and other desert recreational sports (2).

Quadbiking has been gaining popularity among both, nationals and tourists in recent years, despite its injury risk, which is often ignored. Thus far, only two studies have attempted to quantify the magnitude of quadbike injuries and to identify their risk factors in the Middle East (3, 4). With its unique desert ecosystem and climate profile, it is essential to analyze the temporal trends and the risk factors related to desert recreational sports such as quadbiking in the Middle East.

Spatial and temporal distribution analysis has always been a prominent epidemiological tool to investigate infectious and vector-borne diseases (5–9), chronic diseases and injury (10–15). Temporal distribution and its correlation with environmental and other human risk factors helps detect causality and risk (5, 12, 16, 9). This evidence has influenced intervention design by identifying the population at risk, and associated time-dependent risk factors (17). It also optimizes resources for intervention by scheduling interventions around the most vulnerable periods, vector-population control being a famous example (5, 8, 16, 14). Temporal distribution of health outcomes is an effective surveillance tool to assess the impact of various interventions and prevention programs (18). In addition, it is an effective monitoring tool for evaluating interventions and identifying barriers (6, 7, 19, 20).

This study aims to investigate the characteristics of quadbike riders getting injured in Dubai, and the distribution of injuries across the day and across the year. It attempts to identify populations affected by injuries and the factors associated with seasonal and temporal injuries in Dubai, UAE. It will finally attempt to summarize and forecast future trend and seasonal variations in quadbike crashes and injuries in Dubai, using time series analysis.

2. Material And Methods

2.1 Data Sources and variables

Dubai Corporation for Ambulatory Services (DCAS) Data management team extracted the data for the study from the Dubai Ambulance event sheet, activity sheet and EPCR Admin report between 01 January 2017 to 01 March 2021. Since the cases enrolled were not reported using the ICD-10 AM Injury coding system by etiology, we opted to search cases manually, using the case history. The extracted data was cleaned for duplication. The missing records were validated and de-identified by DCAS staff. The study was approved by the Ethics Review Board of Dubai Corporation for Ambulatory Services (DCAS).
The first author checked the dataset for missing values and duplication and two records were excluded due to misclassification error, as they were unrelated to quadbike injury. Finally, the variables were checked for outliers.

"Quadbike injury cases" are cases reported to DCAS through its emergency call system. DCAS is the only public ambulance service system in the emirate of Dubai. The reported cases were either treated at the scene, where the incidence took place, or onboard the ambulance, and/or dispatched to trauma hospitals in Dubai. The severity of reported injuries, however, was not properly recorded at the data source. In this study, “temporal distribution” of cases refers to “the seasonal distribution” of injury cases across the summer and the winter months of the year as well as “diurnal distribution” of injury cases across daylight and nighttime hours of the day.

The DCAS’ reported variables were limited to the patient demographic characteristics (age, gender, nationality), and time of call, crash mechanism, case history and primary diagnosis and treatment. New variables were included to identify injuries witnessed in winter from the date of injury and the nighttime injuries from the time of the incidence. We classified all cases between October 01 to March 31 as wintertime injuries and the rest as summertime injuries. This classification is intended to classify incidents that took place during the outdoor sports season in winter, among local citizens followed by residents living in the UAE. Incidents that occurred during the civil daylight period (between civil twilight period near sunrise and sunset) were classified as daytime injury. The rest were classified as nighttime injuries. Civil twilight injuries were those occurred just before sunrise and immediately after the sunset. Civil daylight includes the time between sunrise and sunset, including civil twilight period. Despite the sun’s position below the horizon, people experience considerable visibility during civil twilight. Thus, making civil daylight a better representative of visibility-related risk associated with crashes in the desert. The date-specific civil twilight data was extracted from an online repository (21). We created new variables to describe quadbikes’ crash mechanisms and injury outcomes, through searching keywords available from the clinical impressions, chief complaint, and case history notes [supplementary file]. Two independent researchers checked these variables to confirm validity and to identify misclassification errors.

This study considers two sets of outcome variables, namely injuries occurring across different seasons (wintertime and summertime injuries) and injuries occurring across the day (daytime and nighttime injuries). The seasonal and diurnal distribution is recorded across different crash mechanism and injury outcomes in addition to demographic predictors, such as age, gender and nationality.

2.2 Analytical Methods

We used IBM SPSS Statistics Version: 28.0 to analyze the dataset. Descriptive statistics including frequency analysis was used to describe the seasonal and diurnal variations in quadbikes injuries in Dubai. Demographic characteristics of quadbikes casualties, including, age group, gender, nationality, injury characteristics including time of call and time of the incident, season, crash mechanism, and injury outcome - represented as body region involved in injury - were used as factors for temporal distribution.
The chi-square or Fisher’s exact test were used for single factor analysis for categorical variables. Demographic characteristics were used as predictors in univariate and multivariate analysis, based on the literature (22–25). All above mentioned factors were included for logistic regression analysis. Regression coefficients and odds ratio (OR), 95% confidence interval and p-values were calculated for those factors. The goodness of fit of the models were identified using Nagelkerke R Square value, Cox and Snell Square and Hosmer & Lameshow Test-Chi square.

The data used for time series analysis were the monthly injury data over four years period, from January 2017 to February 2022. Time series decomposition of injury data helped breaking down the monthly time series data into trend, seasonal and noise components. In this study, we followed the Seasonal and Trend decomposition (STL) using Loess decomposition approach (26). We followed the Holt-Winter’s Seasonal Method of forecasting for this data as it showed both seasonal pattern and trend (27). R software package “forecast” was used for fitting Exponential Smoothening (ETS) models in time series analysis. The models have error, trend and seasonal components. Each of these components could be distinguished as None(N), Additive (A) of Multiplicative (M) (28). The accuracy of the models were compared.

3. Results

3.1 Data Summaries

A total of 226 riders were reportedly injured in Dubai due to quad bikes riding during the period from January 2017 to February 2021 (DCAS, 2021). Both nationals and non-nationals were involved in quadbike crash injuries in almost equal numbers (Table 1). The majority of casualties were predominantly young riders, under 35 years [82.3%] and were males [73%]. Most of the reported injuries resulted from vehicle rollover [73%]. The most common clinical impression of injury cited by medics was mild skin abrasion and laceration [45%], while 21% of injuries involved the head, neck, and spine (Table 1). Most injuries occurred in the winter months from October to April [82%], almost five times the injuries witnessed in the summer months (Table 1).
### Table 1
Characteristics of Injured Quadbike Riders in Dubai, UAE, 2017–2021

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>%</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–15</td>
<td>56</td>
<td>24.8</td>
<td>(13.5,36.1)</td>
</tr>
<tr>
<td>16–25</td>
<td>83</td>
<td>36.7</td>
<td>(26.4,47.1)</td>
</tr>
<tr>
<td>26–35</td>
<td>47</td>
<td>20.8</td>
<td>(9.2,32.4)</td>
</tr>
<tr>
<td>36–45</td>
<td>31</td>
<td>13.7</td>
<td>(1.6,25.8)</td>
</tr>
<tr>
<td>46–55</td>
<td>6</td>
<td>2.7</td>
<td>(-10.2,15.5)</td>
</tr>
<tr>
<td>55–65</td>
<td>3</td>
<td>1.3</td>
<td>(-11.6,14.3)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>164</td>
<td>72.6</td>
<td>(65.8,79.4)</td>
</tr>
<tr>
<td>Female</td>
<td>62</td>
<td>27.4</td>
<td>(16.3,38.5)</td>
</tr>
<tr>
<td><strong>Nationality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emirati Nationals</td>
<td>112</td>
<td>49.6</td>
<td>(40.3,58.9)</td>
</tr>
<tr>
<td>Non-Nationals</td>
<td>114</td>
<td>50.4</td>
<td>(41.2,59.6)</td>
</tr>
<tr>
<td><strong>Time of the call</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day time</td>
<td>106</td>
<td>46.9</td>
<td>(37.4,56.4)</td>
</tr>
<tr>
<td>Night time</td>
<td>120</td>
<td>53.1</td>
<td>(44.2,62.0)</td>
</tr>
<tr>
<td><strong>Crash Mechanism</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rollover</td>
<td>166</td>
<td>73.5</td>
<td>(66.8,80.2)</td>
</tr>
<tr>
<td>Collision</td>
<td>25</td>
<td>11.1</td>
<td>(-1.2,23.4)</td>
</tr>
<tr>
<td>Burn</td>
<td>2</td>
<td>0.9</td>
<td>(-12.2,14.0)</td>
</tr>
<tr>
<td>Not recorded</td>
<td>33</td>
<td>14.6</td>
<td>(2.6,26.6)</td>
</tr>
<tr>
<td><strong>Season</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter [October 01 to March 31]</td>
<td>186</td>
<td>82.3</td>
<td>(76.8,87.8)</td>
</tr>
<tr>
<td>Summer[April 01 to September 31]</td>
<td>40</td>
<td>17.7</td>
<td>(5.9,29.5)</td>
</tr>
<tr>
<td><strong>Injury- Organ System Involved</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head, Neck, Spine</td>
<td>48</td>
<td>21.2</td>
<td>(9.7,32.8)</td>
</tr>
</tbody>
</table>
3.2 Temporal distribution of quadbike injuries across predictors

The temporal distribution of injuries showed an even distribution of injuries across day and night, but the seasonal distribution was skewed. A higher incidence of quadbike injuries was seen in the winter season across all age groups, especially among riders under 16 years, which is the legally acceptable age for riding adult bikes (Table 2). This four-fold increase of injuries in the wintertime is reflected across gender, crash mechanism and injury outcome (Table 2). The distribution of head, neck and spine injury showed the magnitude of wintertime injuries being three times as much as its summer counterpart.

In contrast to the seasonal distribution described above, the numbers of injuries occurring during daylight and nighttime hours were almost similar (Table 2). The frequency of injury was higher during the nighttime for both, Emirati and non-nationals, but was more prevalent among Emirati nationals (Table 2). Collisions occurred twice as much during the nighttime hours, compared to the daytime. Rollovers and/or burns occurred with the same frequency irrespective of the daylight (Table 2).
Table 2
Temporal Distribution of Quadbike Injuries by Demographic factors, Crash mechanisms and Outcomes.
Dubai, UAE, 2017–2021

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Daytime injuries Numbers (%)</th>
<th>Nighttime injuries Numbers (%)</th>
<th>p value</th>
<th>Winter injuries Numbers (%)</th>
<th>Summer injuries Numbers (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–15</td>
<td>56</td>
<td>25(44.6)</td>
<td>31(55.4)</td>
<td>0.018</td>
<td>47(83.9)</td>
<td>9(16.1)</td>
<td>0.957</td>
</tr>
<tr>
<td>16–25</td>
<td>83</td>
<td>32(38.6)</td>
<td>51(61.4)</td>
<td></td>
<td>67(80.7)</td>
<td>16(19.3)</td>
<td></td>
</tr>
<tr>
<td>26–35</td>
<td>47</td>
<td>20(42.6)</td>
<td>27(57.4)</td>
<td></td>
<td>40(85.1)</td>
<td>7(14.9)</td>
<td></td>
</tr>
<tr>
<td>36–45</td>
<td>31</td>
<td>22(71.0)</td>
<td>9(29.0)</td>
<td></td>
<td>25(80.6)</td>
<td>6(19.3)</td>
<td></td>
</tr>
<tr>
<td>46–55</td>
<td>6</td>
<td>5(83.3)</td>
<td>1(16.7)</td>
<td></td>
<td>5(83.3)</td>
<td>1(16.7)</td>
<td></td>
</tr>
<tr>
<td>55–65</td>
<td>3</td>
<td>2(66.7)</td>
<td>1(33.3)</td>
<td></td>
<td>2(66.7)</td>
<td>1(33.3)</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>164</td>
<td>70(42.7)</td>
<td>94(57.3)</td>
<td>0.039</td>
<td>137(83.5)</td>
<td>27(16.5)</td>
<td>0.429</td>
</tr>
<tr>
<td>Female</td>
<td>62</td>
<td>36(58.1)</td>
<td>26(41.9)</td>
<td></td>
<td>49(79)</td>
<td>13(21)</td>
<td></td>
</tr>
<tr>
<td><strong>Nationality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emirati Nationals</td>
<td>112</td>
<td>38(33.9)</td>
<td>74(66.1)</td>
<td>&lt; 0.001</td>
<td>103(92)</td>
<td>9(8)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Non-Nationals</td>
<td>114</td>
<td>68(59.6)</td>
<td>46(40.4)</td>
<td></td>
<td>83(72.8)</td>
<td>31(27.2)</td>
<td></td>
</tr>
<tr>
<td><strong>Crash Mechanism</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rollover</td>
<td>166</td>
<td>86(51.8)</td>
<td>80(48.2)</td>
<td>0.099</td>
<td>136(81.9)</td>
<td>30(18.1)</td>
<td>0.733</td>
</tr>
<tr>
<td>Collision</td>
<td>25</td>
<td>8(32)</td>
<td>17(68)</td>
<td></td>
<td>22(88)</td>
<td>3(12)</td>
<td></td>
</tr>
<tr>
<td>Unrecorded</td>
<td>33</td>
<td>11(33.6)</td>
<td>22(66.7)</td>
<td></td>
<td>26(78.8)</td>
<td>7(21.2)</td>
<td></td>
</tr>
<tr>
<td>Burn</td>
<td>2</td>
<td>1(50)</td>
<td>1(50)</td>
<td></td>
<td>2(100)</td>
<td>0(0)</td>
<td></td>
</tr>
<tr>
<td><strong>Injury- Organ System Involved</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head, Neck, Spine</td>
<td>48</td>
<td>20(41.7)</td>
<td>28(58.3)</td>
<td>0.027</td>
<td>11(22.9)</td>
<td>37(77.1)</td>
<td>0.673</td>
</tr>
<tr>
<td>Limb and Extremities</td>
<td>71</td>
<td>43(60.6)</td>
<td>28(39.4)</td>
<td></td>
<td>10(14.1)</td>
<td>61(85.9)</td>
<td></td>
</tr>
</tbody>
</table>
### 3.3 Logistic Regression Analysis

While more injuries were found occurring during the winter months, wintertime injuries were comparatively more among nationals, than non-nationals ($p \leq 0.001$). One must note here that non-nationals comprise tourists in addition to UAE expatriate residents. This relationship continued to hold even when tested for confounders (Table 3). The logistic regression analysis was carried out, using the season of injuries as the dependent variable. Wintertime injuries were coded with (1) and were compared to summertime injuries, coded with (0). The demographic factors such as nationality, age group, affected body region and nighttime injuries were used as predictors for the regression model. The analysis showed that ‘nationality’ was significantly associated with wintertime injuries ($p < 0.001$) (Table 3). Emirati nationals had 5.15 times higher odds of getting injured during the winter season compared to non-nationals, after adjusting for confounders.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Chi-square ($p$ value)</th>
<th>Beta ($p$-value)</th>
<th>OR</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emirati National</td>
<td>14.234 ($&lt; 0.001$)</td>
<td>1.639 ($&lt; 0.001$)</td>
<td>5.148</td>
<td>2.094–12.65</td>
</tr>
</tbody>
</table>

The model is adjusted for nationals, nighttime injuries, desert pickup, age, and delay to access. Nagelkerke R Square value of the model = 0.184; Cox & Snell Square = 0.111.

Unlike the seasonal distribution, the numbers of injuries occurring during the daylight and night hours are almost similar. Surprisingly, gender did not influence nighttime injuries when tested using logistic regression. Logistic regression model for diurnal injury distribution had nighttime injuries as outcome variable coded as (1) when compared to daytime injuries, coded as (0). Predictors in the model included age, gender, crash mechanism and affected body region. Age was reclassified into a binary variable with age under 35 years coded as (1) and riders above the age of 35 years were comparators. The age of 35 years was taken as a cutoff when the initial six group age classification was converted into two age group classification. After adjusting for other confounders, riders under 35 years had four times higher odds of getting injured at night when compared to the older riders (Table 4). The crash mechanism did not influence the probability of nighttime injuries when adjusted for confounders such as age, nationality, gender and clinical impression (Table 4).
Another predictor that influenced the probability of nighttime quadbike injuries is the rider’s nationality. Emirati citizens showed 3.45 odds of getting injured at night, compared to non-nationals (reference group). This relationship holds when adjusted for the confounders gender, age, crash mechanism, and affected body region (Table 4).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Chi-square (p value)</th>
<th>Beta (p value)</th>
<th>OR</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emirati National</td>
<td>24.214 (&lt; 0.001)</td>
<td>1.239 (&lt; .001)</td>
<td>3.45</td>
<td>1.822–6.54</td>
</tr>
<tr>
<td>Age &lt; 35</td>
<td>13.791 (&lt; 0.001)</td>
<td>1.485 (0.005)</td>
<td>4.41</td>
<td>1.56–12.487</td>
</tr>
</tbody>
</table>

1. The model is adjusted for Gender, Age, Crash Mechanism, Affected body region. Nagelkerke R Square value of model = 0.291; Cox & Snell Square = 0.218;

### 3.4 Time Series Analysis

Quadbike injuries requiring ambulance support and emergency care have shown a slight downward trend in Dubai during the study period, from January 2017 to February 2021. The year 2019 has shown marked reduction in injury numbers following covid lockdown, Fig. 1. In the last two years, 2020 and 2021, injury pattern seemed to reflect a light increase compared to 2019. The figure also shows a marked seasonal pattern, with more injuries recorded in the cooler winter months, ranging from November to April with noticeable low injuries during the summer months, June-August. Apparently, the magnitude of the seasonal pattern of the data has decreased over the covid 19 period.

To reduce the variability, the series is sqrt-root transformed. The decomposition of the transformed time series, using the Loess decomposition approach (26), into trend, seasonality and noise showed a marked decreasing trend with a clear dip during the middle of 2019 and the beginning of 2020, coinciding with the COVID lockdown period.

We fitted the ETS (Error, Trend and Seasonal components) state-space model to the Dubai quadbike injury data using the ets() function of the R package “forecast”. Each of these components can be characterized as “additive (A)”, “multiplicative (M)”, or “none” (N), (28). Out of several possible models, the ets() automatically chooses the best model based on a certain criterion, e.g., minimizing the Akaike Information Criterion corrected for small sample bias ($\text{AIC}_c$). Models with multiplicative errors are useful when the data are strictly positive as in the current study. The following alternative ETS models are evaluated for the best fit, Table 5. Clearly, an ETS with a additive error, additive trend and additive seasonal components, ETS(A,A,A), provides the best fit to the Dubai quadbike injury data, with a smallest $\text{AIC}_c$ of 190.7, Table 5.
Table 5
Alternative ETS Models with related AICc, Dubai Quadbike Injuries, 2017–2021

<table>
<thead>
<tr>
<th>ETS Model</th>
<th>AICc</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>190.7</td>
</tr>
<tr>
<td>AA_dA</td>
<td>200.0</td>
</tr>
<tr>
<td>MAA</td>
<td>193.0</td>
</tr>
<tr>
<td>MA_dA</td>
<td>196.3</td>
</tr>
<tr>
<td>MAM</td>
<td>193.6</td>
</tr>
<tr>
<td>MA_dM</td>
<td>194.5</td>
</tr>
<tr>
<td>MMM</td>
<td>192.7</td>
</tr>
<tr>
<td>MM_dM</td>
<td>191.7</td>
</tr>
</tbody>
</table>

Note: A_d, M_d implies damped additive and multiplicative trend, respectively.

Figure 3 depicts future prediction of quadbike injuries in Dubai for the next 12 months, starting May 2021. The figure reflects slight decreasing trend and seasonality in quadbike injuries in Dubai. The COVID disruption in the recent past might have attributed to this decline.

4. Discussion

The analysis of quadbike injuries reported by DCAS during 2017–2021 showed that the quadbike injuries were seen among both, among the UAE nationals and non-nationals, with males and younger riders experiencing more injury. There is a marked seasonal distribution, with more injuries occurring during the cooler winter months, with more nationals getting injured in winter. Although injuries were evenly distributed across the latter half of the day, the nighttime injuries occurred more among young riders and Emirati nationals.

The downward trend in injury occurrence from 2017 to 2021 also includes the low tourist seasons observed during the winter lockdowns in Dubai - UAE, when tourist footfall fell from 16.73 million in 2019 to 5 million only, in 2020 (2). This coincided with a similar downward trend of road traffic collisions during the period (29). Even before the lockdown, there was a general decline in the number of quadbike injuries, mirroring the downward trend of motorbike injuries in the UAE (30, 31). UAE has also seen a steady decline in vehicle-related injuries due to the priority given to traffic safety and the strong enforcement of traffic safety laws during the period (31, 32). However, the decline might reflect a global improvement in motorbikes’ safety designs, resulting in a downward trend of quadbike injuries, due to vehicle safety designs (23, 22).
We observed a four-fold increase in injuries in the winter season, compared to summer months. Australian farmers reported a similar four-fold spike in sports injuries (33). The W-shaped seasonal distribution of quadbike-related emergency visits is reciprocal equivalence to the M-shaped seasonal trend observed in Spain, where the ambient temperature is around summer (34). This trend curve supports the assumption that ambient outdoor temperature influences outdoor sports (35, 36). It is far more evident in the Middle East, where the summertime temperature rises to 51 degrees Celsius, thereby driving the population to indoor sports and recreation. Emirati citizens and residents exploit the ambient winter temperatures in the country, with increased outdoor recreational activities and injury rates. A resultant temperature-sensitive increase in emergency admissions due to outdoor recreational sports and bike injuries is reported across the globe (35, 24, 33, 36, 34, 37). Similarly, occupational quadbike injuries among dairy and sheep farmers peaked up in the winter-spring season, coinciding with heightened farming activity in Australia and New Zealand (25).

The winter cool months coincide with the tourist season in the UAE, where popular tourists’ desert recreation sports involve riding quad bikes in unfamiliar terrains. It is generally observed that a higher number of injuries are witnessed among tourists involved in quadbiking, a phenomena which might be attributed to desert recreation sports and also crowding (34). However, the exact reason for the reported increases in injury among tourists involved in quadbike usage will require an in-depth crash investigation to understand the hidden risk factors of the problem. More studies are thus needed to investigate quadbike crash injuries in this desert ecosystem.

Despite the observed equivalent distribution of injuries during the hours with civil daylight and without, we found that Emirati riders are more likely to get injured during the darkness at night, when compared to expatriates and tourists (p ≤ 0.001). Nighttime injuries could equally be attributable to behavioral practices when family members go camping together in the desert, accompanied with quadbikes and off-road vehicles for recreation. It has become increasingly habitual for many families in the UAE to go outing in the desert, especially at the weekends and holidays, during the nighttime in the summer months, with lots of outdoor recreational contests, including quad bikes driving. Evidence elsewhere, have shown increased crash incidence among quadbike and e-bike riders during the evening hours(24, 38, 39). This increased risk of nighttime riding could be effectively mitigated through effective safety legislations, enforcement, awareness campaigns and health education and the enforcement of effective safety measures among riders and tourism companies involved in these tourists activities. Children under 16 years were reportedly more engaged in desert recreational activities at night in the UAE and as such are more exposed to quadbike injuries, as noted by similar studies targeting the pediatric age (40, 41).

Although it is generally known that the risk of collisions could be heightened in desert terrains due to the fact that quad bikes travel over the dune's edge, however, it has been shown that numerous other precipitating factors are also associated with night injuries, including riding in groups (40), low visibility (42, 40), defective headlight(43) and riding on paved roads (44). Nighttime riding is commonly known to be associated with other risky behaviors, such as riding under the influence of alcohol and not wearing helmets (40, 43, 44). In terms of crash mechanisms, although quadbike collisions occur more frequently
at night, however, the difference was not statistically significant when adjusted for age, gender, nationality and injury outcome. In contrast to our findings, Jennissen et al. (2021) reported a lower rate of collisions at night (40).

### 4.1 Limitations

We believe that the accuracy of the forecast was limited by the small size of the data available for the statistical analysis. Despite the known limitations of the small sample size, we also observed a distinct seasonality and downward trending in quad bikes crash injuries in the UAE.

In addition, the only injury outcomes provided in the dataset were the clinical impressions reported by DCAS medics. The original plan was to link the DCAS dataset with that of the trauma hospitals in Dubai. However, our intensive efforts failed to establish a linkage between the two databases. To estimate injury outcomes out of these impressions had to be assessed and evaluated manually to classify them in injury groups. The data did not allow for a proper assessment of the injury severity sustained by motorbike casualties, or to estimate the economic losses relating to these crashes. The absence of ICD-9 or 10 for the etiological code in the DCAS database also posed a difficult challenge in identifying quadbike crashes and the resulting injury severity. This leaves a room for misclassification errors. Moreover, the DCAS medical staff also reported both, the ATV/four wheeled straddle seated vehicles and the side-by-side vehicles [commonly known as buggies in the Middle East] as quad bikes. Thus, the risk factors assessed in this study could further be diluted by a totally different vehicle design and safety features. However, clubbing these different vehicles together to identify the vulnerability of quadbike users to crashes might not help the objective of inferring the possible injury prevention strategies.

The quadbike injury related risk groups other than Emirati nationals are expatriate residents, who are familiar with the desert terrain, and quadbiking tourists, with little or no experience with the desert terrain. In either case, these groups could not be easily differentiated in DCAS database and may require a special injury surveillance system. However, the injury profile of the Emirati/national riders provides an opportunity to analyze and infer the necessary safety strategies.

### 4.2 Policy implications

The seasonal and diurnal trends in quadbike injuries give us an opportunity to predict and prepare for the optimal use of emergency care and rescue services in a desert ecosystem. These findings also help planning for better trauma recovery systems, especially those related to emergency calls. Trauma hospitals close to quadbiking hotspots should prepare to receive larger numbers of casualties during the winter months and a smaller peak in the month of June. Injury prevention messaging and quadbikes safety campaigns, are usually carried out by police authorities at the beginning of the winter season. They may need to be repeated and intensified again before the month of June.

The regression predictive models used in the study helped to identify the best times to target injury affected groups for safety interventions in the population. Traffic control and overcrowding in the desert
during the cooler winter months, especially at night, can also help reducing the risk of exposure to injuries in the season. Nighttime quadbike crash injuries among older youth could also be prevented by encouraging greater supervision by guardians or older rider groups.

5. Conclusion

The study showed a distinct seasonality in quadbike related injuries with five-fold increase in injury frequency during the winter season, and a slight peak during the month of June, each year. Injuries were found mainly occurring during the evening and night hours, with Emirati youths more vulnerable to nighttime injuries. Overall, the study predicted a slight deceasing trend of quadbike injuries in the coming short period. The study calls for adjustments to the timing of safety campaigns targeting quadbike injury prevention, including the dispatch of safety messaging, with a focus on nighttime riding risk, especially among Emirati riders in the region. Additionally, trauma hospitals close to quadbiking hotspots should increase their preparedness to receive larger numbers of casualties during the winter months and also during the month of June.

Declarations

Ethical Approvals and Consent to Participants

The ethical approval for the study was obtained from Dubai Corporation for Ambulance Services Medical Accreditation and Research Division (DC002102). No consent was needed from participants because the data was from anonymous medical records, i.e. solely obtained from participants’ files.

Consent for Publication

Not applicable.

Availability of Data and Material

All data generated and analyzed for this article was included in the supplementary files (attached).

Competing Interests

All authors declared that they have no competing interests.

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Authors Contributions

**Preetha Menon**: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Validation; Visualization; Writing - original draft.

**Mohamed El-Sadig**: Conceptualization; Data curation; Formal analysis; Funding acquisition; Project administration; Supervision; Writing - review & editing.

**Ibrahim Alfaki**: Methodology; Software; Data analysis; Supervision; Validation; Writing - review & editing.

**Ahmed Al Shary**: Data curation.

**Omar Al Sakkaf**: Resources; Supervision.

**Rashad Gamar**: Project administration; Resources; Supervision.

**Saeeda Al Butti**: Project administration; Resources.

**Rami Al-Rifai**: Supervision; Writing - review & editing.

**Michal Grivna**: Funding acquisition; Methodology; Resources; Software; Supervision; Writing - review & editing.

References


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Time Series Representation of Monthly Quadbike Injuries in Dubai, 2017-2021
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Quadbike Injuries Forecast from ETS (A,A,A), Dubai Quadbike Injuries, 2017-2021

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CopyofSupplementaryandDataFinal.xlsx