**Road crashes among underage motorcyclists’ compared with young motorcyclists of legal driving age: A Cross-Sectional Study from an Urban Setting in Low-Middle Income Country, Karachi, Pakistan**

**Abstract**

**Introduction**

The burden from deaths and injuries in motorcyclists is high in low- and middle income countries. Many injured motorcyclists are underage in these settings. The aim of this study is to assess the association between age and severe injury and death in young motorcyclists.

**Methods**

We analyzed road traffic injury surveillance data from five hospitals in Karachi between January 2007 and June 2014. We used logistic regression to assess the association of the age of motorcyclists, categorized as underage riders 13-17 years, early licensure age 18-19 years and late licensure age 20-24 years with severe injury and death in emergency room.

**Results**

The study sample included 38,910 motorcycle riders. There were 8806 (22.6%) motorcyclists of age 13-17 years, 8502 (21.9%) of age 18-19 years and 21,602 (55.5%) motorcycles of age 20-24 years. Almost all were males (99%). The age group 18-19 years was associated with higher odds of severe injury (OR 1.40; 95% CI 1.11, 1.75) while the odds of severe injuries were lower for age group 13-17 years (OR 0.99; 95% CI 0.76, 1.28) in adjusted analysis. The odds of death were higher, but not significantly higher, in both the 13-17 years (aOR 1.57; 95% CIs 0.98, 2.49) and 18-19 years age groups (aOR1.21; 95% CIs 0.78, 1.85) as compared with the 20-24 years age group.

**Conclusion**

Motorcyclists in the age group 18-19 has significantly higher odds of severe injuries, as compared with the age group 20-24 years. The age of young motorcyclists was not significantly associated with death.

**Background**

About 200,112 young people aged 10-24 years died from road traffic injuries in 2019, the most common cause of death in this age group.[1] Out of the total number of road traffic deaths among those aged 10-24 years, 51,353 (26%) deaths were in motorcyclists.[1] An overwhelming 94% of deaths of motorcyclists occur in low and middle income countries and 84% of those involved are males.[1]

In the US, Underage adolescents’ drivers are involved in fatal crashes three times more often compared with adults.[2] The number of road traffic crashes per one million miles driven is six times higher in adolescents compared with adults.[3](3) Adolescents are vulnerable to road traffic crashes due to limited experience and more risk taking behaviors.[4, 5]

In most countries the minimum driving age is 18 years but many adolescents start to drive earlier than the legal age if they have access to vehicles in the household.[6, 7] Underage driving is linked to adolescents’ aspiration of becoming independent and experience adventure, augmented with peer pressure.[8]

Demographic and socioeconomic factors, behaviors and consequences related to road crashes by adolescent car drivers have been studied in high- income countries (HICs).[9, 10] The common crash risks in HICs among adolescent drivers are speeding, violation of safety rules, drink driving and use of cell phones.[11, 12] Graduate driving license program in some high income countries aims to restrict the road traffic exposure of adolescent drivers; and have been shown to successful in reducing fatal crashes in young drivers.[13]

It is unclear how underage drivers are contributing to the crash burden in low and middle income settings. Studies from many Asian countries show that underage motorcycle riding exists and boys as young as eight years have been reported to ride motorcycles.[14-18] Underage riders rarely use helmets and are often involved in crashes.[16] Understanding underage motorcycle driving can be critical in suggesting preventive measures in low-income settings, as these countries account for about 90% of road deaths in adolescents globally.[19]

Unlike high-income countries, many low-income settings lack stringent rules for obtaining driving license. Previous studies report high crash rates in the early licensure period regardless of age of licensure compared to adults.[4, 20-25] The risk of crashes is particularly high in the first 12 to 18 months of independent driving after obtaining license.[26]

The aim of this study is to assess the association between age and severe injury and death in young motorcyclists.

**Methods**

**Design**

We conducted a cross-sectional study using data collected between 2007 and 2015.

**Setting**

The study setting is Karachi, a large urban area of Pakistan with an estimated population of 18 million and a total length of the road network of over 8,000 kilometers.[27]

Injury data were extracted from a road traffic injury surveillance project in emergency departments (ED) of all of the three government trauma centers in the city, and the two private tertiary care hospitals. The detailed methods have been described previously.[28] These hospitals receive nearly all major trauma cases from the city. Almost 98% of study patients were enrolled from the three public hospitals.

The research assistants of the surveillance project gathered demographic information on the injured patients and details of the crash by asking victims, their relatives, ambulance drivers or any eyewitnesses. The system was piloted in late 2006 and formally launched in 2007.

**Participants**

Road traffic crash victims of age 13-24 years who were riders of motorcycles and reported to emergency departments of participating hospitals with injuries.

**Outcomes**

The two outcomes were severe injury and death in emergency room, defined as an injury severity score (ISS) ≥ 16 .[29, 30]

**Exposure**

Age, categorized as 13-17 years (underage riders), 18-19 years (early licensure age) and 20-24 years (late licensure age).

**Co-variates**

Gender, night time or daylight during crash, weekday versus weekend, summer versus winters months, crash in intersection versus mid-blocks, crash location within city versus outside city, helmet use, transporting vehicle, hospital, Glasgow Coma scale (GCS) and injured body regions.

**Ethics approval**

Study was approved by the Institutional Review Board of the Jinnah Post Graduate Medical Center, which is the coordinating site of this road surveillance project.

**Data analysis**

We performed the analysis using R.[31] All variables were categorical and are described using frequencies and percentages. We used logistic regression to assess the association of age group (13-17 years and 18-19 years compared with 20-24 years) and the outcomes severe injury (ISS ≥ 16) and death. We conducted a complete case analysis, estimated 95% confidence intervals, and interpreted differences with confidence intervals that excluded no difference as statistically significant.

**Results**

The original dataset included 56,592 riders of motorcycles aged 13-24 years. After removing patients with missing values, the final study sample included 38,910 patients. The details of missing data is given in Table 1. Some of the variables, such as vehicles involved in crash and type of collision (head-on, rear-end etc), were not included in the analysis due to 50% percent missing data.

**Table 1: Missing data in variables of interest**  n =56,592

|  |  |
| --- | --- |
| Variables | N (%) |
| Glasgow coma scale | 8507 (15.03) |
| Helmet use | 2720 (4.81) |
| Place of crash | 2363 (4.18) |
| Midblock versus intersection crashes | 2344(4.14) |
| Profession | 2318 (4.09) |
| Injury severity score | 1811 (3.2) |
| Daylight versus night time | 1351 (2.39) |
| Weekday versus weekend | 1479(2.61) |
| Transporting vehicle | 1041(1.84) |
| Gender | 15 (0.03) |
| Season | 0 |
| Hospital | 0 |

Table 2 shows descriptive characteristics of the young motorcyclists in the three age groups. There were 8806 (22.6%) motorcyclists aged 13-17 years, 8502 (21.9%) aged 18-19 years and 21,602 (55.5%) aged 20-24 years. Almost all were males (99%). Majority (77%) were students in the age group 13-17 years, more than half (55%) were students in 18-19 years while majority (72%) were professionals in age 20-24 years. Helmet use was very low in all age groups 1.5 %, 2% and 4% respectively in age 13-17 years, 18-19 years and 20-24 years. Midblock was the location in more than 70% of crashes among the three age groups. More than 60% motorcyclists had external injuries, more than 50% had extremity injuries, and more than 30% had head and face injuries in all three age groups. Around 2% had severe injuries and 1% died.

**Table 2: Characteristics of underage motorcyclists versus young motorcyclists of legal driving age (n=38,910)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **13-17 years**  **n=8806 (%)** | **18-19 years**  **n=8502 (%)** | **20-24 years n=21602 (%)** |
| Gender  Male  Female | 8754 (99.4)  52 (0.6) | 8447 (99.4)  55 (0.6) | 21438 (99.2)  164 (0.8) |
| Profession  Student  Professional | 6774 (76.9)  2032 (23.1) | 4637 (54.5)  3865 (45.5) | 5959 (27.6)  15643 (72.4) |
| Time of the day  Daylight  Night time | 5305 (60.2)  3501 (39.8) | 4536 (53.4) 3966 (46.6) | 12422 (57.5)  9180 (42.5) |
| Days of the week  Weekday  Weekend | 5791 (65.8)  3015 (34.2) | 5574 (65.6)  2928 (34.4) | 14626 (67.7) 6976 (32.3) |
| Season  Winter  Summer | 2666 (30.3)  6140 (69.7) | 2661 (31.3)  5841 (68.7) | 6591 (30.5)  15011 (69.5) |
| Road Structure  Intersection  Midblock | 2112 (24.0) 6694 (76.0) | 2183 (25.7)  6319 (74.3) | 5914 (27.4)  15688 (72.6) |
| Crash location  Inside city  Out of city | 8595 (97.6)  211 (2.4) | 8252 (97.1)  250 (2.9) | 20966 (97.1)  636 (2.9) |
| Helmet use  Yes  No | 128 (1.5)  8678 (98.5) | 189 (2.2)  8313 (97.8) | 931 (4.3)  20671 (95.7) |
| Patient transfer vehicle  Ambulance  Police  Private  Public  Others | 2056 (23.3)  12 (0.1)  6638 (75.4)  93 (1.1)  7 (0.1) | 2059 (24.2)  19 (0.2)  6309 (74.2)  101 (1.2)  14 (0.2) | 5937 (27.5)  31 (0.1)  15321 (70.9)  284 (1.3)  29 (0.1) |
| Hospital  1  2  3  4  5 | 3045 (34.6)  222 (2.5)  7 (0.1)  3360 (38.2)  2172 (24.7) | 3130 (36.8)  167 (2.0)  7 (0.1)  2723 (32.0)  2475 (29.1) | 7998 (37.0)  443 (2.1)  18 (0.1)  7106 (32.9)  6037 (27.9) |
| GCS Score  13 to 15  9 to 12  6 to 8  4 to 5  3 | 8339 (94.7)  318 (3.6)  50 (0.6)  11 (0.1)  88 (1.0) | 8012 (94.2)  344 (4.0)  43 (0.5)  13 (0.2)  90 (1.1) | 20321 (94.1)  869 (4.0)  134 (0.6)  37 (0.2)  241 (1.1) |
| Body region injured (multi responses)  Head Injury  Face Injury  Extremity Injury  Abdominal Injury  Chest Injury  Spine Injury  External Injury | 2924 (33.2)  2763 (31.4)  5055 (57.4)  143 (1.6)  128 (1.5)  24 (0.3)  5473 (62.2) | 3106 (36.5)  2859 (33.6)  4898 (57.6)  135 (1.6)  96 (1.1)  15 (0.2)  5477 (64.4) | 7747 (35.9)  6919 (32.0)  12486 (57.8)  322 (1.5)  254 (1.2)  56 (0.3)  13740 (63.6) |
| Injury Severity score  Less than 16  More than or equal to 16 | 8604 (97.7)  202 (2.3) | 8264 (97.2)  238 (2.8) | 21064 (97.5)  538 (2.5) |
| Outcome  Survived  Death | 8707 (98.9)  99 (1.1) | 8398 (98.8)  104 (1.2) | 21335 (98.8)  267 (1.2) |

Table 3 shows unadjusted and adjusted associations of age group with severe injury (ISS => 16). The odds of severe injury were lower in the age group 13-17 years (OR 0.97; 95% CIs 0.75, 1.25 and aOR 0.97 95% CIs 0.75, 1.25) while the odds of severe injury were higher in the age group 18-19 years (unadjusted OR 1.39; 95% CIs 1.11, 1.74, and aOR 1.39; 95% CIs 1.11, 1.74). The age group 18-19 years was significantly associated with severe injury.

Association of night time versus daylight, weekend versus weekday, summers versus winters and crash location with severe injuries were statistically not significant in adjusted analysis. The odds of severe injury were higher for midblock crash in unadjusted as well as adjusted analysis (OR 2.02; 95% CIs 1.7, 2.42 and aOR 1.60; 95% CIs 1.27, 2.03) and this association was statistically significant.

The odds of severe injuries were lower for the absence of helmet use in unadjusted analysis (OR 0.57; 95% CIs 0.43, 0.76) but it was higher in adjusted analysis (aOR 1.94; 95% CIs 1.30, 2.92). Transferring vehicle and hospital were significantly associated with severe injuries. GCS were significantly associated with severe injuries.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 3: Univariate and Multivariable association of severe injury with age of young motorcyclists (n=38,910)** | | | | |
| **Variables** | **ISS less than 16**  n = 37932 | **ISS more than or equal to 16**  n = 978 | **Unadjusted ORs**  **(95% CIs)** | **Adjusted ORs**  **(95% CIs)** |
| Age groups  20-24 years  18-19 years  13-17 years | 21064 (55.5)  8264 (21.8)  8604 (22.7) | 538 (55.0)  238 (24.3)  202 (20.7) | 1  1.13 (0.96, 1.31)  0.92 (0.78, 1.08) | 1  1.39 (1.11, 1.74)  0.97 (0.75, 1.25) |
| Gender  Male  Female | 37668 (99.3)  264 (0.7) | 971 (99.3)  7 (0.7) | 1  1.03 (0.44, 2.02) | 1  2.04 (0.73, 4.74) |
| Profession  Student  Professional | 16952 (44.7)  20980 (55.3) | 418 (42.7)  560 (57.3) | 1  1.08 (0.95, 1.23) | 1  1.04 (0.85, 1.28) |
| Time of the day  Daylight  Night time | 21674 (57.1)  16258 (42.9) | 589 (60.2)  389 (39.8) | 1  0.88 (0.77, 1) | 1  1.08 (0.90,1.29) |
| Days of the week  Weekday  Weekend | 25325 (66.8)  12607 (33.2) | 666 (68.1)  312 (31.9) | 1  0,94 (0.82, 1.08) | 1  0.93 (0.77, 1.12) |
| Season  Winter months  Summer months | 11610 (30.6)  26322 (69.4) | 308 (31.5)  670 (68.5) | 1  0.96 (0.84, 1) | 1  1.13 (0.94, 1.37) |
| Road Structure  Intersection  Midblock | 10061 (26.5)  27871 (73.5) | 148 (15.1)  830 (84.9) | 1  2.02 (1.7, 2.42) | 1  1.60 (1.27, 2.03) |
| Crash location  Inside city  Out of city | 36950 (97.4)  982 (2.6) | 863 (88.2)  115 (11.8) | 1  0.2 (0.16, 0.25) | 1  0.73 (0.53, 1.01) |
| Helmet use  Yes  No | 1195 (3.2)  36737 (96.8) | 53 (5.4)  925 (94.6) | 1  0.57 (0.43, 0.76) | 1  1.94 (1.30, 2.92) |
| Patient transfer vehicle  Ambulance  Police  Private  Public  Others | 9265 (24.4)  55 (0.1)  28112 (74.1)  451 (1.2)  49 (0.1) | 787 (80.5)  7 (0.7)  156 (16.0)  27 (2.8)  1 (0.1) | 1  1.5 (0.62, 3.08)  0.07 (0.05, 0.08)  0.7 (0.46, 1.03)  0.24 (0.01, 1.1) | 1  2.28 (0.67, 6.33)  0.27 (0.22, 0.34)  1.17 (0.68, 1.93)  0.42 (0.01, 3.76) |
| Hospital  1  2  3  4  5 | 13766 (36.3)  563 (1.5)  21 (0.1)  13056 (34.4)  10526 (27.7) | 407 (41.6)  269 (27.5)  11 (1.1)  133 (13.6)  158 (16.2) | 1  16.16(13.55, 19.26 )  17.72 (8.19, 36.28)  0.34 (0.28, 0.42)  0.51 (0.42, 0.61) | 1  13.09 (9.95, 17.23)  9.75 (2.60, 32.66)  0.47 (0.36, 0.61)  0.79 (0.61, 1.02) |
| GCS Score (%)  13 to 15  9 to 12  6 to 8  4 to 5  3 | 36435 (96.1)  1271 (3.4)  100 (0.3)  29 (0.1)  97 (0.3) | 237 (24.2)  260 (26.6)  127 (13.0)  32 (3.3)  322 (32.9) | 1  22.76 (18.81, 27.52)  109.23 (82.19, 145.04)  147 (90.17, 240.47)  351.01 (276.48, 448.33) | 1  10.12 (8.13,12.60)  85.26 (60.67,119.88)  97.27 (54.53, 172.93)  356.94 (270.18, 475.28) |

Table 4 shows the unadjusted and adjusted analyses of death. In the unadjusted analyses, the age groups 13-17 years (OR 0.91; 95% CIs 0.72, 1.14) and 18-19 years (OR 0.99; 95% CIs 0.78, 1.24) were not significantly associated with death, as compared with the 20-24 years age group. The odds of death were higher in both the 13-17 years (aOR 1.37; 95% CIs 0.87, 2.12) and 18-19 years (aOR1.21; 95% CIs 0.79, 1.82) age groups, as compared with the 20-24 years age group.

The odds of death were higher in the night time (aOR 1.42; 95% CIs 1.02, 1.96) and summer (aOR 1.59; 95%CIs 1.11, 2.29). There were no statistically significant association of students/professionals, weekday/weekend, road structure and crash location with deaths in adjusted analysis. The odds of deaths were higher for the absence of helmet use in unadjusted analysis (OR 3.11; 95% CIs 1.43, 8.71) and in adjusted analysis (aOR 3.99; 95% CIs 1.09, 16.22).

Compared with ambulances, the transfer to hospital in private vehicles was significantly associated with lower odds of death in both unadjusted (OR 0.07; 95% CIs 0.05, 0.08) and adjusted (aOR 0.22; 95% CIs 0.15, 0.32) analyses. There was significant differences in deaths based on which hospital patient was treated. Both ISS and GCS were significantly associated with death.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 4: Univariable and Multivariable associations of age group and death (n=38,910)** | | | | |
| **Variables** | **Survived**  n=38440(%) | **Death**  n=470 (%) | **Unadjusted OR**  **(95% CIs)** | **Adjusted OR**  **(95% CIs)** |
| Age group  20-24 years  18-19 years  13-17 years | 21335 (55.5)  8398 (21.8)  8707 (22.7) | 267 (56.8)  104 (22.1)  99 (21.1) | 1  0.99(0.78, 1.24)  0.91(0.72, 1.14 ) | 1  1.21 (0.79, 1.82)  1.37 (0.87, 2.12) |
| Gender  Male  Female | 38170 (99.3)  270 (0.7) | 469 (99.8)  1 ( 0.2) | 1  0.3 (0.02, 1.34) | 1  0.07 (0.00, 1.18) |
| Profession  Student  Professionals | 17206 (44.8)  21234 (55.2) | 164 (34.9)  306 (65.1) | 1  1.51(1.25, 1.83) | 1  1.29 (0.89, 1.88) |
| Time of the day  Daylight  Night time | 22002 (57.2)  16438 (42.8) | 261 (55.5)  209 (44.5) | 1  1.07 (0.89, 1.29) | 1  1.42 (1.02, 1.96) |
| Days of the week  Weekday  Weekend | 25677 (66.8)  12763 (33.2) | 314 (66.8)  156 (33.2) | 1  1 (0.82, 1.21) | 1  1.02 (0.73, 1.43) |
| Season  Winter months  Summer months | 11783 (30.7)  26657 (69.3) | 135 (28.7)  335 (71.3) | 1  1.1 (0.9, 1.35) | 1  1.59 (1.11, 2.29) |
| Road Structure  Intersection  Midblock | 10111 (26.3)  28329 (73.7) | 98 (20.9)  372 (79.1) | 1  1.35(1.09, 1.7) | 1  1.11 (0.76, 1.63) |
| Location of crash  Out of city  Inside city | 905 (2.8)  30903 (97.2) | 25 (6.0)  391(94.0) | 1  0.47 (0.32, 0.71) | 1  0.76 (0.42, 1.48) |
| Helmet use  Yes  No | 1243 (3.2)  37197 (96.8) | 5 (1.1) 465 (98.9) | 1  3.11(1.43, 8.71) | 1  3.99 (1.09, 16.22) |
| Patient transfer vehicle  Ambulance  Police  Private  Public  Others | 9674 (25.2)  58 (0.2)  28196 (73.4)  463 (1.2)  49 (0.1) | 378 (80.4)  4 (0.9)  72 (15.3)  15 (3.2)  1 (0.2) | 1  1.77 (0.53, 4.32)  0.07 (0.05, 0.08)  0.83 (0.47, 1.35)  0.52 (0.03, 2.39) | 1  0.85 (0.07, 8.01)  0.22 (0.15, 0.32)  0.94 (0.35, 2.20)  0.48 (0.01, 11.71) |
| Hospital  1  2  3  4  5 | 13922 (36.2)  822 (2.1)  32 (0.1)  13082 (34.0)  10582 (27.5) | 251 (53.4)  10 (2.1)  0 (0.0)  107 (22.8)  102 (21.7) | 1  0.67 (0.33, 1.21)  0 (0, 2.58)  0.45 (0.36, 0.57)  0.53 (0.42, 0.67) | 1  0.09 (0.04, 0.23)  0.00 (0.00, 0.88)  0.66 (0.44, 0.98)  0.55 (0.35, 0.85) |
| GCS Score (%)  13 to 15  9 to 12  6 to 8  4 to 5  3 | 36611 (95.2)  1506 (3.9)  209 (0.5)  52 (0.1)  62 (0.2) | 61 (13.0)  25 (5.3)  18 (3.8)  9 (1.9)  357 (76.0) | 1  19.96(6.13, 15.71)  51.69 (29.24, 87.18)  103.88 (46.15, 210.75)  3455.88(2412.57, 4903.91) | 1  2.51 (1.42, 4.32)  5.23 (2.60, 10.20)  9.22 (3.50, 22.60)  609.06 (389.70, 967.76) |
| Injury Severity score  Less than 16  More than or equal to 16 | 37815 (98.4)  625 (1.6) | 117 (24.9)  353 (75.1) | 1  182.55 (146.44, 229.07) | 1  18.09 (11.64, 28.21) |

**Discussion**

Our study shows that the age group 18-19 years had significantly higher odds of severe injuries compared to the age group 20-24 years. While the young underage motorcyclists (13-17 years) and motorcyclists within two initial years of legal age of driving (18-19 years) do not have significantly higher odds of death, compared to late licensure age (20-24 years).

Severe injuries in 18-19 years’ motorcyclists might be due to inexperience of the riders who might have just learnt and started independent riding.[3] Additionally, they may have a sense of achievement by obtaining a license that may have increased their confidence. This confidence might lead to aggressive driving resulting in severe injuries. In contrast, many of the riders of this age may have not obtained a license thus they may be oblivious to traffic rules and regulations, subsequently involving in road crashes.

Irrespective of status of licensing, the quality of driving skills and road safety knowledge of rider are questionable due to poor license obtaining system. The professional training of driving is mostly limited to learning driving without much understanding of rules and regulations.[32, 33]

Compared to 18-19 years riders, 20-24 years old may have experience of riding over the years after obtaining license improving their judgement for risks in the road. In contrast, underage riders may have to be extra careful riding as they are fearful of facing police. However all three age groups are vulnerable to severe injuries and death as shown in table 2. A study from New Zealand showed consistent result that motorcyclists aged 15-19 years were at higher odds of injury compared with older riders more than 25 years of age.[34] Furthermore, research also showed that younger drivers were more involved in crashes than older drivers, when adjusted for duration of license.[35]

The legal age to obtain a license in Pakistan is 18 years but there are many underage motorcyclists. Underage driving in Pakistan may be due to various socioeconomic reasons.

Motorcycle is an accessible and cheap transport for lower middle class in Pakistan. Alternate and convenient transportation options are very limited in Karachi city.[27] In the absence of a safe built environment for walking, short quick trips to markets by underage boys are also common. Leisure trips for thrill seeking by underage boys are also reported due to almost non-existent recreational activities in Pakistan.

Motorcycle driving is not considered safe and modest for women and therefore use it as passengers.[36] This is another reason for underage boys to ride motorcycles in the absence of legal drivers in the household to support commute of women.

The age limit for obtaining driving license should be appropriate to contextual factors. Else, underage riders of motorcycles in Pakistan continue to drive as the enforcement of road safety laws is weak in Pakistan.[15, 37] There is a need to discuss how to make laws that are easy to follow in a local context. Modification in laws such as early licensing and mandatory helmet should be put into effect to promote safety.

**Limitations**

Missing data was a challenge as we missed around 17,700 data points however the analysis of this study is the best possible effort for the study question. Age was used in our study as proxy for experience in driving. We did not know the actual period of driving experience nor the status of driving license. For example, the motorcyclists of 18 years of age may just have started riding or had experience of a few years of underage driving. We believe it was the only possibility to test study hypothesis and the study evidence would contribute to literature of young road users. The death was taken for emergency room and any death beyond was not captured and we may missed many deaths. However recording death beyond emergency is beyond the scope of study due to absence of electronic data systems.

**Conclusion**

The age groups of young motorcyclists both underage 13-17 years and early licensing age 18-19 years are not significantly associated with higher risk of road deaths but early licensing age 18-19 years is significantly associated with severe injuries. This surge in severe injuries in 18-19 years might be due to recklessness linked to confidence with the attainment of legal driving age and/or driving license, could be inexperience as many would have started driving at this age and may be unawareness of road safety rules.

**References**

[1] IHME. Global burden of disease study 2019 (GBD 2019) data resources.: Institute for Health Metrics and Evaluation; . 2019.

[2] Walshe EA, Ward McIntosh C, Romer D, Winston FK. Executive function capacities, negative driving behavior and crashes in young drivers. International journal of environmental research and public health. 2017;14:1314.

[3] Banz BC, Fell JC, Vaca FE. Focus: Death: Complexities of Young Driver Injury and Fatal Motor Vehicle Crashes. The Yale journal of biology and medicine. 2019;92:725.

[4] Gershon P, Ehsani JP, Zhu C, Sita KR, Klauer S, Dingus T, et al. Crash risk and risky driving behavior among adolescents during learner and independent driving periods. Journal of Adolescent Health. 2018;63:568-74.

[5] Sarkar S, Andreas M. Acceptance of and engagement in risky driving behaviors by teenagers. Adolescence. 2004;39:687.

[6] Shults RA, Banerjee T, Perry T. Who's not driving among US high school seniors: A closer look at race/ethnicity, socioeconomic factors, and driving status. Traffic injury prevention. 2016;17:803-9.

[7] Zamani-Alavijeh F, Niknami S, Bazargan M, Mohamadi E, Montazeri A, Ghofranipour F, et al. Risk-taking behaviors among motorcyclists in middle east countries: a case of islamic republic of Iran. Traffic injury prevention. 2010;11:25-34.

[8] Alderman EM, Johnston BD. The teen driver. Pediatrics. 2018;142.

[9] Bates LJ, Davey J, Watson B, King MJ, Armstrong K. Factors contributing to crashes among young drivers. Sultan Qaboos university medical journal. 2014;14:e297.

[10] Hanna CL, Hasselberg M, Laflamme L, Möller J. Road traffic crash circumstances and consequences among young unlicensed drivers: a Swedish cohort study on socioeconomic disparities. BMC Public Health. 2010;10:1-8.

[11] Boulagouas W, García-Herrero S, Chaib R, Febres JD, Mariscal MÁ, Djebabra M. An investigation into unsafe behaviors and traffic accidents involving unlicensed drivers: a perspective for alignment measurement. International Journal of Environmental Research and Public Health. 2020;17:6743.

[12] Jewett A, Shults RA, Bhat G. Parental perceptions of teen driving: Restrictions, worry and influence. Journal of safety research. 2016;59:119-23.

[13] Tefft BC, Williams AF, Grabowski JG. Driver licensing and reasons for delaying licensure among young adults ages 18-20, United States, 2012. Injury epidemiology. 2014;1:1-8.

[14] Lutfi AZ. The Phenomenon of Underage Motorbike Riders in Junior High School Students: A Critical Review of Juvenile Delinquency. Journal of Indonesian Social Sciences and Humanities. 2020;10:121-34.

[15] Pervez A, Lee J, Huang H. Identifying factors contributing to the motorcycle crash severity in Pakistan. Journal of advanced transportation. 2021;2021.

[16] Piyapromdee U, Adulyanukosol V, Lewsirirat S. Increasing Road Traffic Injuries in Underage Motorcyclists. The Thai Journal of Orthopaedic Surgery. 2015;39:3-7.

[17] Rahman NH, Rainis R, Noor SH, Mohamad SMS. The Buffering analysis to identify common geographical factors within the vicinity of severe injury related to motor vehicle crash in Malaysia. World journal of emergency medicine. 2016;7:278.

[18] Rathinam C, Nair N, Gupta A, Joshi S, Bansal S. Self-reported motorcycle riding behaviour among school children in India. Accident Analysis & Prevention. 2007;39:334-9.

[19] Nantulya VM, Reich MR. Equity dimensions of road traffic injuries in low-and middle-income countries. Injury control and safety promotion. 2003;10:13-20.

[20] Ehsani JP, Bingham CR, Shope JT. The effect of the learner license Graduated Driver Licensing components on teen drivers’ crashes. Accident Analysis & Prevention. 2013;59:327-36.

[21] Lewis-Evans B. Crash involvement during the different phases of the New Zealand Graduated Driver Licensing System (GDLS). Journal of safety research. 2010;41:359-65.

[22] Masten SV, Foss RD, Marshall SW. Graduated driver licensing and fatal crashes involving 16-to 19-year-old drivers. Jama. 2011;306:1098-103.

[23] Mayhew DR, Simpson HM, Pak A. Changes in collision rates among novice drivers during the first months of driving. Accident Analysis & Prevention. 2003;35:683-91.

[24] McCartt AT, Shabanova VI, Leaf WA. Driving experience, crashes and traffic citations of teenage beginning drivers. Accident Analysis & Prevention. 2003;35:311-20.

[25] Simons-Morton BG, Ouimet MC, Zhang Z, Klauer SE, Lee SE, Wang J, et al. Crash and risky driving involvement among novice adolescent drivers and their parents. American journal of public health. 2011;101:2362-7.

[26] Curry AE, Metzger KB, Williams AF, Tefft BC. Comparison of older and younger novice driver crash rates: Informing the need for extended Graduated Driver Licensing restrictions. Accident Analysis & Prevention. 2017;108:66-73.

[27] Hoor-Ul-Ain S. An empirical review of Karachi's transportation predicaments: a paradox of public policy ranging from personal attitudes to public opinion in the megacity. Journal of Transport & Health. 2019;12:164-82.

[28] Razzak JA, Shamim MS, Mehmood A, Hussain SA, Ali MS, Jooma R. A successful model of road traffic injury surveillance in a developing country: process and lessons learnt. BMC public health. 2012;12:1-5.

[29] Schröter C, Urbanek F, Frömke C, Winkelmann M, Mommsen P, Krettek C, et al. Injury severity in polytrauma patients is underestimated using the injury severity score: a single-center correlation study in air rescue. European journal of trauma and emergency surgery. 2019;45:83-9.

[30] VanDerHeyden N, Cox TB. TRAUMA SCORING. Current Therapy of Trauma and Surgical Critical Care: Elsevier; 2008. p. 26-32.

[31] Team R Core. R: a language and environment for statistical computing [Internet]. Vienna, Austria: R Foundation for Statistical Computing; 2020. 2017.

[32] Hussain M, Shi J. Effects of proper driving training and driving license on aberrant driving behaviors of Pakistani drivers–A Proportional Odds approach. Journal of Transportation Safety & Security. 2019:1-19.

[33] Batool Z, Carsten O, Jopson A. Road safety issues in Pakistan: a case study of Lahore. Transportation planning and technology. 2012;35:31-48.

[34] Mullin B, Jackson R, Langley J, Norton R. Increasing age and experience: are both protective against motorcycle injury? A case-control study. Injury Prevention. 2000;6:32-5.

[35] McCartt AT, Mayhew DR, Braitman KA, Ferguson SA, Simpson HM. Effects of age and experience on young driver crashes: review of recent literature. Traffic injury prevention. 2009;10:209-19.

[36] Adeel M, Anthony GO Y, Zhang F. Gender, mobility and travel behavior in Pakistan: Analysis of 2007 Time Use Survey. 2013.

[37] Waseem M, Ahmed A, Saeed TU. Factors affecting motorcyclists’ injury severities: An empirical assessment using random parameters logit model with heterogeneity in means and variances. Accident Analysis & Prevention. 2019;123:12-9.