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

**Add abstract**

Adolescents bear the largest burden of road traffic deaths.[1] Underage adolescents’ drivers are involved in fatal crashes three times more often compared with adults.[2] The number of road traffic crashes per million miles driven is six times higher in adolescents compared with adults. [3] Adolescents are vulnerable to road traffic crashes due to limited experience and risky 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 vehicle in the household 1. Underage driving is linked to adolescents’ aspiration of becoming independent and experience adventure, augmented with peer pressure.[6]

Demographic and socioeconomic factors, behaviors and consequences related to road crashes by adolescent car drivers have been studied in high- income countries (HICs) [7,8]. The common crash risks in HICs among adolescent drivers are speeding, violation of safety rules, drink driving and use of cell phones. [8-10] 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.[11]

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 driving exist and young boys as young as 8 years were reported to drive motorcycles.2-5 Underage drivers rarely use helmets and are often involved in crashes.4 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.[12]

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. [5,13-18] The risk of crashes is particularly high in the first 12 to 18 months of independent driving after obtaining license. [19]

Our aim is to determine association of age of young motorcyclists (13-17, 18-19 and 20-24 years) with injury severity and in-hospital death due to road crash in Karachi, Pakistan.

**Methods**

**Design**

The study is cross-sectional design during the period 2007-2014.

**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.

Injury data were extracted from road traffic injury surveillance project based on emergency departments (ED) in all of the three government trauma centers in the city, and the two private tertiary care hospitals. The detailed methods have been described previously.[20]

These hospitals receive nearly all major trauma cases from the city. The data collectors 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 drivers of motorcycles or any other vehicle and reported to emergency departments of participating hospitals with injuries.

**Outcomes**

Injury severity score ISS >= 16 6 and in hospital death due to road traffic crash.

**Exposure**

Age, categorised as 13-17 years (underage), 18-19 years (early licensure age) and 20-24 years (post two years of licensure age).

**Study variables**

Gender, injured body region, time of the crash, weekday versus weekend, helmet use, type of location (intersection or midblock), transport vehicle to hospital and Glasgow Coma scale (GCS).

**Ethics approval**

Ethics of study methods were approved from the Institutional Review Board of the Jinnah Post Graduate Medical Center, which is coordinating site of this road surveillance project.

**Data analysis**

We performed the analysis using R.[21] The categorical variables are described using frequencies and percentages (age, gender, injury region, crash location, transport vehicle to hospital and GCS). Chi-square tests were used to assess crash characteristics associated with drivers of motorcycles versus other drivers. 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 in hospital death. We conducted a complete case analysis, estimated 95% confidence intervals, and interpreted confidence intervals of differences that excluded no difference as statistically significant.

**Results:**

Table 1 shows descriptive characteristics of the young motorcyclists in the three age groups 13-17 years (underage driving age), 18-19 years (early licensure age) and age 20-24 years (post two years of licensure age). There were a total of 37,702 motorcyclists; out of which 8,099 (21.5%) were of age 13-17 years, 8,048 (21.3%) of 18-19 years and 21,555 (57.2%) of age 20-14 years. Almost all were males (99.8%). Helmet use was very low in all age groups but higher in 20-24 years of age (5%) as compared to 13-17 years of age (2%) and 18-19 years of age (2%). The distributions of other variables of interest were similar across groups. Midblock was the location of crashes in almost 70% among the three age groups. Overall, more than half of motorcyclists had external injuries, about 60% had extremity injuries, and 30% had head injuries. More than 2% had severe injuries whereas less than 2% died.

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| Table 1: Characteristics of underage motorcyclists versus young motorcyclists of legal age (n=37,702) | | | |
| **Variables** | **13-17 years**  **n=8,099** | **18-19 years**  **n=8,048** | **20-24 years**  **n=21,555** |
| Gender  Male | 8080 (99.8) | 8028 (99.8) | 21501 (99.8) |
| Time of crash  Daylight  Dark | 4465 (55.1)  3634 (44.9) | 3877 (48.2)  4171 (51.8) | 11261 (52.2)  10294 (47.8) |
| Day of the week  Weekday  Weekend | 5250 (64.8)  2849 (35.2) | 5221 (64.9)  2827 (35.1) | 14427 (66.9)  7128 (33.1) |
| Helmet use  Yes  No | 149 (1.9)  7524 (98.1) | 186 (2.4)  7547 (97.6) | 978 (4.7)  19734 (95.3) |
| Crash Location  Intersection  Midblock | 1967 (25.0)  5913 (75.0) | 2119 (27.2)  5658 (72.8) | 5881 (28.5)  14790 (71.5) |
| Transport to hospital  Private  Ambulance  Public  Police  Others | 6003 (75.4)  1826 (22.9)  102 (1.3)  16 (0.2)  10 (0.1) | 5924 (74.9)  1834 (23.2)  105 (1.3)  23 (0.3)  21 (0.3) | 15144 (71.5)  5609 (26.5)  335 (1.6)  38 (0.2)  40 (0.2) |
| Glasgow coma scale (GCS)  13 to 15  9 to 12  6 to 8  4 to 5  3 | 7598 (93.8)  301 (3.7)  60 (0.7)  14 (0.2)  126 (1.6) | 7539 (93.7)  321 (4.0)  48 (0.6)  13 (0.2)  127 (1.6) | 20114 (93.3)  932 (4.3))  142 (0.7)  48 (0.2)  319 (1.5) |
| Body region Injured (multi response variable)  Head  Face  Chest  Abdomen  Extremities  External | 2550 (31.5)  2338 (28.9)  80 (1.0)  113 (1.4)  4432 (54.7)  4784 (59.1) | 2700 (33.5)  2546 (31.6)  63 (0.8)  114 (1.4)  4437 (55.1)  4939 (61.4) | 7103 (33.0)  6537 (30.3)  230 (1.1)  317 (1.5)  11619 (53.9)  13138 (61.0) |
| Injury Severity score (ISS)  Less than 16  More than or equal to 16 | 7589 (97.6)  183 (2.4) | 7515 (97.0)  231 (3.0) | 20158 (97.5)  519 (2.5) |
| Deaths  Yes  No | 138 (1.7)  7939 (98.3) | 144 (1.8)  7880 (98.2) | 363 (1.7)  21135 (98.3) |

Table 2 shows unadjusted and adjusted analyses of road traffic deaths. The age group 13-17 years (OR 1.06; 95% CIs 0.87, 1.24) and 18-19 years (OR 1.01; 95% CIs 0.83, 1.23) had higher odds of road traffic deaths in unadjusted analyses. The odds ratio increased for the age group 13-17 years in the adjusted model while it decreased in the 18-19 years age group but the confidence intervals were not statistically significant. Helmet non-use was associated with increased odds of death (OR 3.12; 95% CIs 1.6, 7.29) and (aOR 9.98; 95% CIs 2.53, 46.11). The odds ratios were in opposite directions for midblock crash compared to crash on intersection in unadjusted model versus adjusted model (OR 1.4; 95% CIs 1.15, 1.71 and aOR 0.74; 95% CIs 0.50, 1.10) respectively. Compared with ambulances, the transfer to hospital in private vehicles was associated with reduced odds of death in both unadjusted (OR 0.07; 95% CIs 0.06, 0.09) and adjusted (aOR 0.28; 95% CIs 0.22, 0.36) analyses. There was an inverse relationship between GCS and death, and as GCS decreased the odds increased,both in unadjusted and adjusted analysis. An ISS of 16 or more was associated with increased odds of deaths.

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| **Table 2: Unadjusted and adjusted associations of age group and death** | | | | |
| **Variables** | **Survived**  **n=36954** | **Deaths**  **n=645** | **Unadjusted OR**  **(95% CIs)**  **n = 36, 103** | **Adjusted OR**  **(95% CIs)**  **n = 32, 813** |
| Age group  20-24 years  18-19 years  13-17 years | 21135 (57.2)  7880 (21.3)  7939 (21.5) | 363 (56.3)  144 (22.3)  138 (21.4) | 1  1.01 (0.83, 1.23)  1.06 (0.87, 1.24) | 1  1.04 (0.68, 1.56)  1.09 (0.71, 1.66) |
| Gender  Male  Female | 36863 (99.8)  82 (0.2) | 645 (100.0)  0 (0.0) | 1  0 | 1  0 (0.00, 0.28) |
| Time of crash  Daylight  Dark | 19223 (52.0)  17731 (48.0) | 334 (51.8)  311 (48.2) | 1  1.01(0.86, 1.18) | 1  1.45 (1.03, 2.04) |
| Day of the week  Weekday  Weekend | 24396 (66.0)  12558 (34.0) | 439 (68.1)  206 (31.9) | 1  0.91(0.77, 1.08) | 1  0.85 (0.59, 1.21) |
| Helmet use  Yes  No | 1292 (3.6)  34151 (96.4) | 7 (1.2)  577 (98.8) | 1  3.12 (1.6, 7.29) | 1  9.98 (2.53, 46.11) |
| Crash Location  Intersection  Midblock | 9827 (27.6)  25807 (72.4) | 127 (21.4)  466 (78.6) | 1  1.4 (1.15, 1.71) | 1  0.74 (0.50, 1.10) |
| Patient transfer  Ambulance  Private  Public  Police  Others | 8760 (24.1)  26887 (74.1)  511 (1.4)  69 (0.2)  68 (0.2) | 495 (77.8)  105 (16.5)  26 (4.1)  7 (1.1)  3 (0.5) | 1  0.07 (0.06,0.09)  0.9 (0.59, 1.32)  1.8 (0.75, 3.66)  0.78 (0.19, 2.11) | 1  0.28 (0.18, 0.41)  1.23 (0.45, 2.90)  0.24(0.01, 3.01)  0.30 (0.00, 10.53) |
| Glasgow Coma Scale (GCS)  13 to 15  9 to 12  6 to 8  4 to 5  3 | 35091 (95.0)  1511 (4.1)  227 (0.6)  63 (0.2)  62 (0.2) | 67 (10.4)  33 (5.1)  23 (3.6)  12 (1.9)  510 (79.1) | 1  11.44(7.43, 17.27)  53.07 31.85, 85.47  99.76(49.31, 187.51)  4308.24 (3044.22, 6211.56) | 1  2.01 (1.15, 3.44)  3.70 (1.89, 7.02)  6.55 (2.58, 15.47)  574.02 (367.12, 012.49) |
| Injury Severity score (ISS)  Less than 16  More than or equal to 16 | 35035 (98.4)  628 (1.5) | 141 (27.2)  464 (74.7) | 1  169.7 (137.76, 210.13) | 1  19.03 (12.33, 29.57) |

Table 3 shows unadjusted and adjusted associations of age group with severe injury (ISS => 16). The age group 18-19 years was associated with increased odds of severe injury (unadjusted OR 1.19; 95% CIs 1.02, 1.4 and aOR 1.4; 95% CIs 1.15, 1.76). Darkness (OR 0.96; 95% CIs 0.84, 1.1and aOR 1.04; 95% CIs 0.87, 1.24) and weekend (OR 1.05; 95% CIs 0.91, 1.2 and aOR 0.94; 95% CIs 0.78, 1.13) had ORs in opposite direction in unadjusted and adjusted analysis but not statistically significant. Non-use of helmet had decreased odds of severe injuries in both unadjusted and adjusted models (OR 0.9; 95% CIs 0.65, 1.3 and aOR 0.53; 95% CIs 0.35, 0.83). Midblock crash was associated with high odds of severe injuries in unadjusted as well as adjusted analysis (OR 1.85; 95% CIs 1.56, 2.21 and aOR 1.93; 95% CIs 1.55, 2.42). Transfer to hospital through private vehicles had decreased odds of severe injuries (OR 0.09 95% CIs 0.08, 0.11 and aOR 0.28, 95% CIs 0.23, 0.34). Low GCS had linear relationship with severe injuries in both unadjusted and adjusted analysis.

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| **Table 3: Unadjusted and adjusted association of Injury severity score (ISS) with age of young motorcyclists** | | | | |
| **Variables** | **ISS less than 16**  **n = 35262** | **ISS more than or equal to 16**  **n = 933** | **Unadjusted ORs**  **(95% CIs)**  **n= 36, 195** | **Adjusted ORs**  **(95% CIs)**  **n = 32,888** |
| Age groups  20-24 years  18-19 years  13-17 years | 20158 (57.2)  7515 (21.3)  7589 (21.5) | 519 (55.6)  231 (24.8)  183 (19.6) | 1  1.19 (1.02, 1.4)  0.94 (0.79, 1.11) | 1  1.42 (1.15,1.76)  0.97 (0.77,1.21) |
| Gender  Male  Female | 35169 (99.8)  82 (0.2) | 933 (100.0)  0 (0.0) | 1  0 | 1  0 |
| Time of crash  Daylight  Dark | 18363 (52.1)  16899 (47.9) | 495 (53.1)  438 (46.9) | 1  0.96 (0.84, 1.1) | 1  1.04 (0.87, 1.24) |
| Day of the week  Weekday  Weekend | 23280 (66.0)  11982 (34.0) | 606 (65.0)  327 (35.0) | 1  1.05 (0.91, 1.2) | 1  0.94 (0.78, 1.13) |
| Helmet use  Yes  No | 1187 (3.5)  32611 (96.5) | 34 (3.9)  840 (96.1) | 1  0.9 (0.65, 1.3) | 1  0.53 (0.35, 0.83) |
| Crash Location  Intersection  Midblock | 9503 (27.9)  24517 (72.1) | 154 (17.3)  735 (82.7) | 1  1.85 (1.56, 2.21) | 1  1.93 (1.55, 2.42) |
| Patient transfer  Ambulance  Private  Public  Police  Others | 8119 (23.4)  25937 (74.8)  485 (1.4)  65 (0.2)  60 (0.2) | 674 (73.8)  198 (21.7)  29 (3.2)  10 (1.1)  2 (0.2) | 1  0.09 (0.08, 0.11)  0.72 (0.48, 1.04)  1.85 (0.89, 3.46)  0.4 (0.07, 1.29) | 1  0.28 (0.23, 0.34)  0.56 (0.33, 0.93)  2.55 (0.88, 6.31)  0.19 (0.01, 1.22) |
| Glasgow Coma Scale (GCS)  13 to 15  9 to 12  6 to 8  4 to 5  3 | 33688 (95.5)  1285 (3.6)  132 ( 0.4)  33 ( 0.1)  124 ( 0.4) | 250 (26.8)  217 (23.3)  107 (11.5)  36 (3.9)  323 (34.6) | 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  15.31(12.35, 18.97)  67.11(48.99, 91.90)  69.42(40.03, 119.93)  255.61(192.52, 342.03) |

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