**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**

Adolescents have the highest 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 adult drivers.[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. Underage driving is linked to adolescents’ aspiration of becoming independent and experience adventure, augmented with peer pressure.[6]

Demographics, socioeconomic factors, behaviours and consequences related to road crashes by adolescent drivers have been studied in high- income countries (HICs) [7,8] where at least one vehicle is available for every two persons. 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-income settings where the number of vehicles per population is lower. Understanding underage 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 early licensure period regardless of age of licensure compared to adults. [5,13-18] The risk of crashes is particularly high in first 12 to 18 months of independent driving after obtaining license which eventually decline. [19]

Our aim is to determine and compare the burden and characteristics of underage adolescent drivers’ age 15 to 17 years, 18-19 years, young drivers 20-24 years and adults 25-35 years involved in road crashes 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 (about 3,530 square kilometers), 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 an ongoing 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 gather 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 categorized in 13-17 years, 18-19 years and 20-24 years who were drivers of motorcycles or any other vehicle and reported to emergency departments of participating hospitals with injuries.

**Outcomes**

ISS >= 16 and death

**Exposure**

Age groups 13-17 years (underage), 18-19 years (early licensure period) and 20-24 years (experienced young drivers)

**Study variables**

Gender, injured body type, vehicle involved in crash, time of the crash, days of the week, helmet use and type of location (intersection or midblock).

**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 patterns, vehicle type etc). 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 groups (13-17 years, 18-19 years compared with 20-24 years) and the outcomes severe injury (ISS ≥ 16) and death.

**Results:**

Table 1 shows descriptive characteristics of young motorcyclists in three age groups underage driving age 13-17 years, early driving age18-19 years and post two years of legal driving age 20-24 years. There were total of 46155 motorcyclists; out of which 9800 (21.2%) were of age 13-17 years, 9859 (21.4%) of 18-19 years and 26496 (57.4%) of age 20-14 years. Almost all were males (99%).Helmet use was high in 20-24 years of age (5%) as compared to 13-17 years of age (2%) and 18-19 years of age (3%). They had similar distribution with respect to other variables of interest. Midblock was location of crashes in almost 70% among three age groups. More than half of motorcyclists had external injuries and about half had injuries on extremities while 30% had head injuries in the three age groups. More than 2% had severe injuries while less than 2% died in these age groups.

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| Table 1: Characteristics of underage motorcyclists versus young motorcyclists of legal age (n=46, 155) | | | |
| Variables | 13-17 years  n=9800 | 18-19 years  n=9859 | 20-24 years  n=26496 |
| Gender  Male | 9780 (99.8) | 9837 (99.8) | 26435 (99.8) |
| Time of crash  Daylight  Dark | 5400 ( 55.1)  4400 ( 44.9) | 4791 (48.6)  5068 (51.4) | 13860 ( 52.3)  12636 ( 47.7) |
| Day of the week  Weekday  Weekend | 6346 ( 64.8)  3454 ( 35.2) | 6393 ( 64.8)  3466 ( 35.2) | 17794 (67.2)  8702 (32.8) |
| Helmet use  Yes  No | 188 (2.0)  9027 (98.0) | 241 (2.6)  9165 (97.4) | 1301 (5.1)  24038 (94.9) |
| Crash Location  Intersection  Midblock | 2491 ( 26.2)  7003 ( 73.8) | 2739 ( 28.8)  6758 ( 71.2) | 7690 ( 30.3)  17676 ( 69.7) |
| Patient transfer  Private  Ambulance  Public  Police  Others | 7314 ( 76.1)  2127 ( 22.1)  134 ( 1.4)  20 (0.2)  13 (0.1) | 7300 ( 75.6)  2166 ( 22.4)  133 ( 1.4)  31 (0.3)  27 (0.3) | 18841 ( 72.6)  6572 ( 25.3)  411 ( 1.6)  71 (0.3)  52 (0.2) |
| Body region Injured (multi response variable)  Head  Face  Chest  Abdomen  Extremities  External | 2940 (30.0)  2778 (28.3)  118 (1.2)  395 (4.0)  5079(51.8)  5453 (55.6) | 3170 (32.2)  3061 (31.0)  89 (0.9)  380 (3.9)  5119 (51.9)  5777 (58.6) | 8439 (31.9)  7852 (29.6)  325 (1.2)  1092 (4.1)  13592 (51.3)  15243 (57.5) |
| Injury Severity score  Less than 16  More than or equal to 16 | 9101 ( 97.6)  220 ( 2.4) | 9150 ( 97.1)  276 ( 2.9) | 24598 ( 97.6)  640 (2.4) |
| Deaths  Yes  No | 177 (1.8)  9595 (98.2) | 191 (1.9)  9640 (98.1) | 459 (1.7)  25954 (98.3) |

Table 2 shows univariate and multivariable analysis with road traffic deaths. Age group 13-17 years and 18-19 years showed higher odds of road traffic deaths in unadjusted model. The odds ratio increased for age 13-17 years in adjusted model while it became protective for 18-19 years. These results for main exposure were statistically not significant. Helmet non-use was associated with odds of road traffic death (OR 3.04; 95%CI 1.67, 6.36) and (OR 4.57; 95% CIs 2.18, 11.20) and the 95% CIs were compatible with effect size. The effect size were in opposite directions for midblock crash compared to crash on intersection in unadjusted model versus adjusted model; OR 1.25; 95% CIs 1.06, 1.49 and OR 0.70; 95% CIs 0.55, 0.90 respectively. The transfer to hospital through private vehicles had protective unadjusted and adjusted odds ratios (OR 0.07; 95% CIs 0.06, 0.09 and OR 0.28; 95% CIs 0.22, 0.36) compared to ambulances.

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| **Table 2: Univariate and multivariable association of Road traffic deaths with age of young motorcyclists** | | | | |
| **Variables** | **No road traffic deaths**  **n=**45189 | **Road traffic deaths**  **n=**827 | **Unadjusted OR (95% CIs)** | **Adjusted OR**  **(95% CIs)** |
| Age groups  20-24 years  18-19 years  13-17 years | 25954 ( 57.4)  9640 ( 21.3)  9595 ( 21.2) | 459 ( 55.5)  191 ( 23.1)  177 ( 21.4) | 1  1.12 (0.94, 1.33)  1.04 (0.87, 1.24) | 1  0.98(0.75, 1.28)  1.09 (0.98, 1.46) |
| Gender  Male  Female | 45088 ( 99.8)  88 ( 0.2) | 827 (100.0)  0 ( 0.0) | 1  0 | 1  0 (0.00, 0.28) |
| Time of crash  Daylight  Dark | 23561 ( 52.1)  15307 ( 33.9) | 422 ( 51.0)  405 ( 49.0) | 1  1.05 (0.91, 1.2) | 1  1.16 (0.94, 1.44) |
| Day of the week  Weekday  Weekend | 29882 ( 66.1)  15709 (33.8) | 558 ( 67.5)  269 ( 32.5) | 1  0.94 (0.81,1.09) | 1  1.10 (0.88,1.37) |
| Helmet use  Yes  No | 1695 (3.9)  41460 ( 96.1) | 9 (1.3)  669 (98.7) | 1  3.04 (1.67, 6.36) | 1  4.57 (2.18, 11.20) |
| Crash Location  Intersection  Midblock | 12729 ( 29.2)  30795 ( 70.8) | 173 ( 24.8)  524 ( 75.2) | 1  1.25 (1.06, 1.49) | 1  0.70 (0.55, 0.90) |
| Patient transfer  Ambulance  Private  Public  Police  Others | 10284 (23.2)  33215 (74.9)  635 (1.4)  110 (0.2)  89 (0.2) | 562 ( 75.2)  133 (17.8)  38 (5.1)  11 (1.5)  3 (0.4) | 1  0.07 (0.06,0.09)  1.1 (0.77,1.51)  1.83 (0.92. 3.27)  0.62 (0.15, 1.65) | 1  0.28 (0.22, 0.36)  1.29 (0.73, 2.22)  1.15 (0.37, 3.34)  1.15 (0.05, 7.27) |
| Injury Severity score  Less than 16  More than or equal to 16 | 42579 ( 98.5)  628 (1.5) | 157 (25.3)  464 (74.7) | 1  200 (164, 244) | 1  128(101, 162) |

Table 3 shows unadjusted and adjusted odds ratios with injury severity scores (ISS equal and more than 16 versus less). Age group 18-19 years was associated with increased odds of severe injuries (unadjusted OR 1.23; 95% CIs 1.06, 1.42 and aOR 1.28; 95% CIs 1.05, 1.55). Weekend and darkness showed association with road traffic deaths when adjusted for other variables but not statistically significant. Non-use of helmet had decreased odds of severe injuries in both unadjusted and adjusted models (OR 0.98; 95% CIs 0.72, 1.37 and OR 0.65; 95% CIs 0.46, 0.94). Weekend and darkness showed increased odds but without significant confidence intervals. Midblock crash was associated with high odds of severe injuries in

univariate as well as multivariable model (OR 1.75; 95% CIs 1.5, 2.05 and OR 2.0; 95% CIs 1.65, 2.47). Transfer to hospital through private vehicles had decreased odds of severe injuries (OR 0.09 95% CIs 0.08, 0.11and aOR 0.13, 95% CIs 0.11, 0.16). The odds of death was highly associated with severe injuries (OR 201; 95%CIs 164, 244) and (aOR 127; 95% CIs 100, 162).

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| **Table 3: Univariate and Multivariable association of Injury severity with age of young motorcyclists** | | | | |
| **Variables** | **ISS less than 16**  **n = 42849** | **ISS more than or equal to 16**  **n = 1100** | **Unadjusted ORs (95% CIs)** | **Adjusted ORs (95% CIs)** |
| **Age groups**  20-24 years  18-19 years  13-17 years | 24598 ( 57.4)  9150 ( 21.4)  9101 ( 21.2) | 604 ( 54.9)  276 ( 25.1)  220 ( 20.0) | 1  1.23 (1.06, 1.42)  0.98 (0.84, 1.15) | 1  1.28 (1.05, 1.55)  1.10 (0.90, 1.35) |
| Gender  Male  Female | 42746 ( 99.8)  88 ( 0.2) | 1100 (100.0)  0 ( 0.0) | 1  0 | 1  0 |
| Time of crash  Daylight  Dark | 22393 ( 52.3)  20456 ( 47.7) | 575 ( 52.3)  525 ( 47.7) | 1  1.0 (0.89, 1.13) | 1  1.02 (0.87, 1.19) |
| Day of the week  Weekday  Weekend | 28364 ( 66.2)  14485 ( 33.8) | 716 ( 65.1z)  384 ( 34.9) | 1  1.05 (0.93, 1.19) | 1  1.09 (0.92, 1.28) |
| Helmet use  Yes  No | 1577 ( 3.9)  39375 ( 96.1) | 40 ( 3.9)  980 ( 96.1) | 1  0.98 (0.72, 1.37) | 1  0.65 (0.46, 0.94) |
| Crash Location  Intersection  Midblock | 12225 ( 29.5)  29147 ( 70.5) | 202 ( 19.3)  843 ( 80.7) | 1  1.75 (1.5 , 2.05) | 1  2.01 (1.65, 2.47) |
| Patient transfer  Ambulance  Private  Public  Police  Others | 9458 ( 22.5)  31892 ( 75.7)  599 ( 1.4)  107 ( 0.3)  66 ( 0.2) | 777 ( 72.2)  241 ( 22.4)  43 ( 4.0)  13 ( 1.2)  2 ( 0.2) | 1  0.09 (0.08, 0.11)  0.87 (0.63, 1.19)  1.48 (0.79, 2.54)  0.37 (0.06, 1.18) | 1  0.13 (0.11, 0.16)  0.79 (0.50, 1.21)  1.25 (0.48, 2.76)  0.17 (0.01, 1.08) |
| Patients’ outcome  Survived  Deaths | 42579 ( 99.6)  157 ( 0.4) | 628 ( 57.5)  464 ( 42.5) | 1  201 (164, 244) | 1  127 (100, 162) |

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