**Association of road traffic injuries with independent mobility of adolescents in a megacity of lower middle income country**

**Background**

The freedom of child/adolescents to move freely in the environment without being accompanied by an adult is known as independent mobility. It has positive impact on physical activity as well as on psychological, social, cognitive and spatial development of a child/adolescent. It is also precursor to future fitness and health. Daily independent mobility of adolescents for schools is window of opportunity to meet recommended daily physical activity.

Walking and cycling have decreased over a period of time as reported in many developed countries because of many reasons(1). Short distances are covered by travelling on cars or any other motorized vehicles. There is unavailability of nearby parks and playgrounds. There is a lack of safe environment both social and physical. Neighbors are unfamiliar to each other. The streets have become motor centric. There are concerns about child and adolescents’ safety.

Adolescents are vulnerable to road traffic injuries (RTIs) which are the leading cause of deaths in adolescents 10-19 years. In 2013, the RTI death count in age 10-19 years was 115,186 globally, out of which 90% occur in developing countries(2). There is higher road traffic fatalities and injuries among pedestrians, cyclists and motorcyclists in low and middle income countries where the built environment is least likely to be according to needs of vulnerable road users(3).

The work on independent mobility with respect to road traffic injuries among adolescents is really scarce. Previous literature was primarily on road safety related to school trips. Whether independent mobility of adolescents is associated with road traffic injuries is not well established. The study from Auckland showed that adult accompaniment with 5 to 12 years old was associated with reduced pedestrian injury risk(4). The study from India showed no association of road traffic injuries with independent travel of children 11-14 years old(5).

The objective of this study is to determine an association of adolescents’ independent mobility with road traffic injury in an urban city of lower middle-income setting.

Methods

Study design: This was a cross-sectional study during September till December in 2014.

Setting: The study was conducted in both public and private sector schools of Karachi, Pakistan. Altogether 75 schools participated in the study, out of which 26 (34%) were public schools and 49 (65%) were private schools.

For the public sector schools, list of schools and permission was obtained from the Executive District Office – Education (EDO - Education) for Karachi District. For private schools, list was obtained from director private school association Karachi. Both lists included the location addresses, and phone numbers of contact persons at the schools. Schools for the study were randomly selected from the said list. These schools were first approached through the given phone numbers and email addresses, but because the official lists of schools were not updated, many times contact with schools could not be made. To overcome the issue, two data collectors were dispatched to locate each school in person prior to data collection.

At each public and private sector school approached, permission to conduct the study was obtained from the principal of the school. In their first visit to each school, research assistants explained the study to the management and then to a class of students from the school. Each class and section (if there were multiple sections of a grade in a school) was randomly selected through paper chits to avoid any selection bias. In each class, a parental permission letter giving details of the study (in either Urdu or English language, as advised by the school administration) was distributed to each student. A week’s time was given for students to get the letters signed by their parents or guardians. It was ascertained that a weekend fell in between before the research assistants’ second school visit, so as to allow for adequate time for parents to read the permission letters.

Participants: Adolescents (aged 10 to 19 years) in grades 6 to 10 were enrolled from schools. Only those students who had assented to participate and whose parents had given them permission to enroll in the study were included for data collection. For students’ assent, oral script was used.

Variables

*Outcome:* Any road traffic injury that resulted in any first aid or consultation in healthcare setting

*Exposures:* Parental licensing to independent mobility of adolescents was asked by whether they were allowed to cross main road, travel to and from school alone, travelling in bus, cycling, travelling in night versus day time and activities alone on the weekend. The responses were either yes or no.

Data sources/measurements: All the information was asked from adolescents in a written questionnaire. The study questionnaire for school adolescents was available in Urdu and English. The questionnaires had multiple choice questions. The study questionnaires were first pilot tested to see their effectiveness, acceptability, and clarity for study participants, and modifications were made accordingly before launching the main data collection process. For data collection, research assistants were trained about administering the questionnaires. Each question in the data collection tool was explained to students by research assistants to ensure clarity in comprehension. The questionnaires took approximately 25 minutes to be filled by a class of students.

Study size: The sample size for the study population was 1,270 school students. Since there was no past information on adolescents’ school mobility patterns in Pakistan, it was estimated that at least 50% students may be active commuters in the study population with 95% confidence level and a bound on error of ± 5%. The sample size required after multiplying with design effect of 3 and inflating the sample size by 10% to account for non-responders was approximately n=1267. The size of each class in schools is 15-30 students so list of around 100 schools was randomly generated with 40% public and 60% private schools to get sample of 1267 school adolescents. This percentage share of public versus private schools depicts the enrollment of children in urban areas in Pakistan(6).

There were numbers of class rooms/sections in school for our desired Grades 6-8. We attempted to have equal representation of grades overall in total sample of schools so the research team used to inform which grade they want to survey.

Quantitative variables: Age was the only quantitative variable in the data and we grouped it into 10-14 years and 15-19 years. These age categories are used in road injury research as both are different in terms of injuries burden.

Statistical analysis**:** We performed analysis using R. Descriptive statistics were computed for categorical variables by computing their frequencies. Odds ratio (ORs) and their 95% conﬁdence intervals (CIs) were computed for univariate associations between outcome RTI and exposure variables i.e. adolescents’ independent mobility and confounders such as age and gender by logistic regression analysis. All exposure variables were considered for inclusion in the final model by running multiple logistic regression to have adjusted ORs and their 95% CIs.

Results

Data of 1267 adolescents were included in the study with girls in majority (60%). Around 70% of the adolescents reported no adult accompaniment on their school travel and the same percentage reported walking to schools. Half of the adolescents reached school within 5 to 15 minutes. Overall 21% of the adolescents reported road traffic injuries (Table 1).

In the unadjusted analyses, boys (OR 0.45, 95%CIs 0.34, 0.59), 31 to 45 minutes (OR 2.92;95% CIs 1.54,5.42) or greater than 45 minutes (OR 2.87;95% CIs 1.16, 6.76), parents licensing to cross main roads alone (OR 1.61; 95% CI 1.23,2.12), allowed to use public buses (OR 1.93; 95% CIs 1.4, 2.64) and adolescents who were on their own or with someone of the same age for weekend activity (OR 3.54; 95% CIs 2, 6.79). have higher odds of RTI (Table 2)

In the adjusted logistic regression model;), boys (aOR = 1.51 ; 95% CI = 1.09, 2.09), adolescents who were allowed to cross main roads alone (aOr =1.3; 95% CI = 1.0,1.8), when their time to reach school is within 31 to 45 minutes (aOr 2.43; 95% CIS 1.22, 4.77), adolescents who did any activity outside home alone on last weekend (aOR=2.5; 95% CI = 1.3, 4.9) and when they had mix pattern of weekend activities with adults as well as some activities alone (aOR=2.1; 95% CI = 1.1, 4.1) have higher odds of RTI. (Table 3).

Discussion

This study shows that some measures of independent mobility in adolescents are associated with RTI. The findings of this study need to be interpreted carefully. Some variables of independent mobility such as crossing main roads and weekend activities alone were significantly associated with RTIs, while others such as use of public bus and alone on school trip were insignificant in unadjusted analyses .

Study finding showed adolescents who were allowed to cross main roads are associated with road traffic injuries. This is consistent with previous studies finding that the number of streets crossed by children and adolescents is associated with injuries (7). Karachi is devoid of safe road environment for pedestrians - there are no pedestrians’ signals to assist in crossing roads. The vehicles do not giveway to pedestrians at crosswalks and edestrians cross roads on their judgment of safety.

The vulnerability of adolescents is two-fold; due to such risky environment for pedestrians and due to their own risk taking approach. Until the age of 18 the adolescent brain is developing are in brain development process. The understanding of adolescent’s higher risk taking may depend on the biological development of the brain, as the brain matures both cognitively and emotionally from childhood into full adulthood(8). A qualitative study from India – a neighboring country of Pakistan with similar road environment – report that adolescents display various distracted behavior as pedestrians such as using ear phones and mobile phones as well as talking and playing with friends(9).

The activities on last weekend by adolescents are associated with RTIs. The risk was the greatest when adolescents were alone or with their peers for weekend activity. The effect estimate was bit less when the adolescents reported mix pattern of activities i.e. sometimes they were accompanied by adults and sometimes not. This is understandable that leisure time activities with peers provoke many risky behaviors. Previous studies have shown that children and adolescents with unsafe road safety behaviours have peers with similar behaviours(10). Our study also showed risk of RTIs when adolescents were accompanied by adults in their trips but the effect size shows insignificant result. The previous study in Auckland showed protective effect of adult accompaniment but not significantly(4). The setting of two studies are different particularly the built environment of Karachi versus Auckland are poles apart for pedestrians. In Univariate analysis, adolescents’ accompaniment with adults/parents shows protective association but it was not significant.

The other two variables that were significantly associated with RTIs were time to reach school and gender. Time to reach school was seen to be associated with RTIs if it was between 31 to 45 min.

This seems logical as long time duration means more road exposure time in risky road environment. All the other categories of time also shown risk but not significantly.

More boys had more share of injuries and this is not a surprise finding particularly in setting of Karachi. In a local context, generally boys take care of chores outside home(11). Previous study in India, showed boys had more road trips than girls (5, 12). Adolescent boys get parents licensing for many activities compared to girls. Boys also show less risk perception than girls in general as well as in roads(13). All of these gender differences could explain increase risky behaviors and the frequency of RTIs among boys.

Limitations

There are limitations in this study. First of all, the association between injury and independent mobility should not be confused with temporality due to cross sectional design of the study. Not only the study design but the temporality cannot be gauged due to difference in the time reference for measurement of outcome and exposures. RTI was asked for “ever in lifetime of adolescents” while the exposures were the current status of adolescents.

Second, the sample size calculation was based on original study question of prevalence of various commuting modes to schools, but it does not address the question of whether the sample size is enough for our planned analysis. The most data heavy analysis of this study is the multivariable logistic regression. According to some simulation studies, one needs at least 10, but maybe as many as 25 or more, events (participants with the outcome, in this case RTI) per parameter in the model, and at least as many non-events(14). In our case, we have 12 parameters (minus reference categories) meaning that one would need 120 events if we use the 10 events per parameter (EPV) rule of thumb and at least as many non-events to have some confidence in your estimated effect sizes. You have 266 events, and 1001 non-events, so that covers it. If I however want 25 EPV then I would need 300 events, and we don’t have that many but close to that.

Third, details on mode of RTI was not collected. The details whether injury occurred to adolescents as pedestrians or occupants of various types of vehicles could further help to assess the situation.

Conclusion

In the absence of safe road environment, adolescents in Karachi while commuting independently or along with peers are associated with road injuries. It is important for urban planners, environmentalists and public health practitioners to prioritize safe road environment that could promote safe independent mobility for adolescents. Independent mobility is important to decrease level of sedentary lifestyles for adolescents that in turn prevent chronic diseases when they would approach to their adulthood.

Table 1: Descriptive of adolescents 10-19 years surveyed from schools in Karachi, Pakistan. 2014

|  |  |  |
| --- | --- | --- |
| Variables | levels | n(%) |
|  |  |  |
| n |  | 1267 |
| Age groups (%) | 10 to 14  15 to 19 | 748 (59)  519 (41) |
| Gender (%) | Boy | 508 (40.1) |
|  | Girl | 759 (59.9) |
| Grade (%) | 6 | 264 (20.8) |
|  | 7 | 255 (20.1) |
|  | 8 | 200 (15.8) |
|  | 9 | 343 (27.1) |
|  | 10 | 205 (16.2) |
| Type of School (%) | Private | 754 (59.5) |
|  | Public | 513 (40.5) |
| Mode of transport to school (%) | 2 or 3 wheelers | 169 (13.3) |
|  | Four wheelers | 186 (14.7) |
|  | Walking | 912 (72.0) |
| School travel was alone or accompanied (%) | Alone or with someone of same age | 901 (71.1) |
|  | Either with parent or any other adult | 271 (21.4) |
|  | Mix travel pattern; alone or with parents | 95 ( 7.5) |
| Time to reach school (%) | < 5 mins | 464 (36.6) |
|  | > 46 mins | 23 ( 1.8) |
|  | 16 to 30 mins | 89 ( 7.0) |
|  | 31 to 45 mins | 48 ( 3.8) |
|  | 5 to 15 mins | 643 (50.7) |
| Mode of transport on way back to home from school (%) | Four Wheelers | 203 (16.0) |
|  | Two or Three Wheelers | 107 ( 8.4) |
|  | Walking | 957 (75.5) |
| Home travel from school was accompanied with (%) | Mix travel pattern; alone or with parents | 86 ( 6.8) |
|  | On own or with other child | 1042 (82.2) |
|  | Parent or adult | 139 (11.0) |
| Parents trust on child when in traffic alone (%) | Always | 576 (45.5) |
|  | Never | 224 (17.7) |
|  | Sometime | 467 (36.9) |
| Adolescent allowed to cross main roads (%) | No | 719 (56.7) |
|  | Yes | 548 (43.3) |
| Adolescent allowed to go on public bus (%) | No | 1030 (81.3) |
|  | Yes | 237 (18.7) |
| Adolescent activity over the weekend (%) | Activities either with parents or alone | 442 (34.9) |
|  | No activity on the weekend | 139 (11.0) |
|  | On own or with other young person | 456 (36.0) |
| Road traffic injuries | With a parent or other adult  No road traffic injuries  Road traffic injuries | 230 (18.2)  1001(79)  266 (21) |
|  |  |  |

Table 2: Univariate association of road traffic injury with independent variables in adolescents (n= 1267)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Level | | No road traffic injury | Road traffic injury | OR (95% CIs) |
| n |  | | 1001 | 266 |  |
| Age groups (%) | 10 to 14 | | 603 ( 60.2) | 145 ( 54.5) | 1 |
|  | 15 to 19 | | 398 ( 39.8) | 121 ( 45.5) | 1.26(0.96, 1.66) |
|  | |  |  |  |  |
| Gender (%) | Boy | | 360 ( 36.0) | 148 ( 55.6) | 2.23 (1.7, 2.94) |
|  | Girl | | 641 ( 64.0) | 118 ( 44.4) | - |
| Type of School (%) | Private | | 588 ( 58.7) | 166 ( 62.4) |  |
|  | Public | | 413 ( 41.3) | 100 ( 37.6) | 0.86 (0.65,1.13) |
| Mode of transport to school (%) | 2 or 3 wheelers | | 132 ( 13.2) | 37 ( 13.9) | 1.13 (0.75,1.67) |
|  | Four wheelers | | 138 ( 13.8) | 48 ( 18.0) | 1.4(0.97,2.01) |
|  | Walking | | 731 ( 73.0) | 181 ( 68.0) | 1 |
| School travel was alone or accompanied (%) | Alone or with someone of same age | | 700 ( 69.9) | 201 ( 75.6) | - |
|  | Either with parent or any other adult | | 221 ( 22.1) | 50 ( 18.8) | 0.79 (0.55,1.1) |
|  | Mix travel pattern; alone or with parents | | 80 ( 8.0) | 15 ( 5.6) | 0.65 (0.35,1.13) |
| Time to reach school (%) | < 5 mins | | 379 ( 37.9) | 85 ( 32.0) | 1 |
|  | > 46 mins | | 14 ( 1.4) | 9 ( 3.4) | 2.87 (1.16,6.76) |
|  | 16 to 30 mins | | 67 ( 6.7) | 22 ( 8.3) | 1.46 (0.84,2.47) |
|  | 31 to 45 mins | | 29 ( 2.9) | 19 ( 7.1) | 2.92 (1.54,5.42) |
|  | 5 to 15 mins | | 512 ( 51.1) | 131 ( 49.2) | 1.14 (0.84,1.55) |
| Mode of transport on way back to home from school (%) | Four Wheelers | | 150 ( 15.0) | 53 ( 19.9) | 1.44 (1,2.03) |
|  | Two or Three Wheelers | | 83 ( 8.3) | 24 ( 9.0) | 1.17 (0.71,1.87) |
|  | Walking | | 768 ( 76.7) | 189 ( 71.1) | 1 |
| Home travel from school was accompanied with (%) | On own or with other child  Parent or adult  Mix travel pattern; alone or with parents | | 819 ( 81.8)  111 ( 11.1)  71 ( 7.1) | 223 ( 83.8)  28 ( 10.5)  15 ( 5.6) | 1  0.93 (0.59,1.42)  0.78 (0.42,1.34) |
| Parents trust on child when in traffic alone (%) | Always | | 446 ( 44.6) | 130 ( 48.9) | 1 |
|  | Never | | 184 ( 18.4) | 40 ( 15.0) | 0.75 (0.5,1.1) |
|  | Sometime | | 371 ( 37.1) | 96 ( 36.1) | 0.89 (0.66,1.19) |
| Adolescents allowed to cross main roads (%) | No | | 593 ( 59.2) | 126 ( 47.4) | 1 |
|  | Yes | | 408 ( 40.8) | 140 ( 52.6) | 1.61(1.23,2.12) |
| Adolescents allowed to go on public bus (%) | No | | 837 ( 83.6) | 193 ( 72.6) | 1 |
|  | Yes | | 164 ( 16.4) | 73 ( 27.4) | 1.93(1.4,2.64) |
| Adolescent activity over the weekend (%) | Activities either with parents or alone | | 340 ( 34.0) | 102 ( 38.3) | 2.91(1.63,5.6) |
|  | No activity on the weekend | | 126 ( 12.6) | 13 ( 4.9) | 1 |
|  | On own or with other same age | | 334 ( 33.4) | 122 ( 45.9) | 3.54(2, 6.79) |
|  | With a parent or other adult | | 201 ( 20.1) | 29 ( 10.9) | 1.4(0.71,2.88) |

Table 3: Multivariable logistic regression of factors associated with road traffic

injury among adolescents (n=1267)

|  |  |  |
| --- | --- | --- |
| Variables | Odds ratio | 95% CIs |
| Gender  Girls  Boys | 1  1.51 | -  1.09,2.09 |
| Mode of transport on way back to home from school (%)  Walking  Two or three wheelers  Four wheelers | 1  1.16  1.25 | -  0.69, 1.89  0.83, 1.87 |
| Allowed to cross main road alone  No  Yes | 1  1.34 | -  1.0,1.79 |
| Allow to travel on public buses  No  Yes | 1  1.31 | -  0.92, 1.85 |
| Any activity outside home on last weekend  No  Yes, alone or with someone of same age group  Yes, mix ( adult or alone/ same age group)  Yes, with parents or adults | 1  2.51  2.10  1.36 | -  1.36, 4.96  1.15, 4.11  0.69, 2.82 |
| Time to reach school  < 5 minutes  5 to 15 minutes  16 to 30 minutes  31 to 45 minutes  >46 minutes | 1  1.10  1.20  2.43  2.33 | -  0.80, 1.51  0.66, 2.11  1.22, 4.77  0.89, 5.83 |

References

1. Hosking J, Ameratunga S, Bullen C. How can we best intervene in the trip to school? Pathways from transport to health. Australian and New Zealand journal of public health. 2011;35(2):108-10.

2. Kyu HH, Pinho C, Wagner JA, Brown JC, Bertozzi-Villa A, Charlson FJ, et al. Global and national burden of diseases and injuries among children and adolescents between 1990 and 2013: findings from the global burden of disease 2013 study. JAMA pediatrics. 2016;170(3):267-87.

3. Organization WH. Global status report on road safety 2013: supporting a decade of action: summary. World Health Organization; 2013.

4. Roberts I. Adult accompaniment and the risk of pedestrian injury on the school-home journey. Injury Prevention. 1995;1(4):242-4.

5. Tetali S, Edwards P, Murthy G, Roberts I. Road traffic injuries to children during the school commute in Hyderabad, India: cross-sectional survey. Injury prevention. 2016;22(3):171-5.

6. School education in Pakistan A Sector Assessment Asian Development Bank; 2019.

7. Macpherson A, Roberts I, Pless IB. Children's exposure to traffic and pedestrian injuries. American journal of public health. 1998;88(12):1840-3.

8. Casey BJ, Getz S, Galvan A. The adolescent brain. Developmental review. 2008;28(1):62-77.

9. Jagnoor J, Sharma P, Parveen S, Cox KL, Kallakuri S. Knowledge is not enough: barriers and facilitators for reducing road traffic injuries amongst Indian adolescents, a qualitative study. International Journal of Adolescence and Youth. 2020;25(1):787-99.

10. Kwon MS, Vorobyev V, Moe D, Parkkola R, Hämäläinen H. Brain structural correlates of risk-taking behavior and effects of peer influence in adolescents. PloS one. 2014;9(11):e112780.

11. Marzi I, Reimers AK. Children’s independent mobility: Current knowledge, future directions, and public health implications. International journal of environmental research and public health. 2018;15(11):2441.

12. Dandona R, Kumar GA, Ameratunga S, Dandona L. Road use pattern and risk factors for non-fatal road traffic injuries among children in urban India. Injury. 2011;42(1):97-103.

13. Reniers RL, Murphy L, Lin A, Bartolomé SP, Wood SJ. Risk perception and risk-taking behaviour during adolescence: the influence of personality and gender. PloS one. 2016;11(4):e0153842.

14. Pajouheshnia R, Pestman WR, Teerenstra S, Groenwold RH. A computational approach to compare regression modelling strategies in prediction research. BMC medical research methodology. 2016;16(1):107.