Journal of Transport & Health 14 (2019) 100575

Contents lists available at ScienceDirect

Journal of Transport & Health

journal homepage: www.elsevier.com/locate/jth

Pattern of underreporting of Road Traffic Injuries (RTIs): An investigation of missing burden of RTIs in Pakistan

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ARTICLE INFO

Keywords:
Underreporting
Safety
Road injuries
Police
Hospital records
Awareness

ABSTRACT:

Background: A complete and reliable Road Traffic Injuries (RTIs) data is essential for sustainable transport safety policy and health sector. This paper aims to determine the extent of underreporting of RTIs in Pakistan with police and Punjab Emergency Response Service (PERS), taking Lahore as a case study.

Methods: Official data of RTIs was collected from five public sector hospitals of the Lahore city and matched with police and PERS data to determine the extent of underreporting. Further a population-based data from 540 respondents of the city was collected to identify different factors affecting underreporting.

Results: Discordance analysis revealed that the extent of underreporting with police was 99% and with PERS was 39%. Binary logistic regression and Odd-Ratios (OR) informed that car occupants were 4.34 times more likely to report with police. While young people were less likely to report with both police and PERS at rate of 17% and 50% respectively. Different institutional issues in the system were also highlighted based on informal discussions.

Conclusions: The problem of underreporting is mostly observed for non-fatal crashes and young people. It also recommends to establish a road crash data unit at the city level to assess the actual burden of RTIs.

1. Introduction

Road Traffic Injuries (RTIs) and deaths resulting from Road Traffic Crashes (RTCs) are growing public health problems globally, as trends of high mortality and disability particularly in Low- and Middle- Income Countries (LMIC) have increased substantially since 1990 (Peden, 2005). As RTIs are projected to be the third leading cause of disability and casualties globally by the year 2020 (Lopez et al., 2006), so for the recognition of problem severity, a reliable estimate of RTIs and fatalities are inevitable based on

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https://doi.org/10.1016/j.jth.2019.100575
Received 14 November 2018; Received in revised form 13 May 2019; Accepted 6 June 2019
Available online 20 June 2019
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effective crash reporting system. However, in many countries due to incomplete and poor reporting system the estimation of the real number of road crashes and casualties is difficult. This drawback in traffic crashes reporting system is termed as underreporting. It is a serious issue as if it goes unrecognized; the magnitude of burden of injuries, any road traffic safety problems and associated economic losses can be highly underestimated. This can ultimately lead towards incorrect priorities, less efficient and inappropriate countermeasure for public health issue and safety (International Traffic Safety Data and Analysis Group (IRTAD), 2011). According to World Health Organization (WHO) levels of underreporting can be as high as 50% in LMIC (Peden, 2004). The level of underreporting is defined relative to hospital records (de Geus et al., 2012). While, police are the official source of Road Traffic Fatalities (RTFs) in 71% countries (World Health Organization, 2013).

A number of researches show that data from police sources tend to have higher level of underreporting than health sector (Dandona et al., 2008; Periyasamy et al., 2013). For example, a study conducted in Australia could not match 67% of the hospital's cases with police record (Austin, 1992). While in France only 38% RTIs are found to be reported with police (Aptel et al., 1999; Amoros et al., 2006). Likewise, for New Zealand about less than two-third of hospitalized to be reported road crash injury with police (Alsop and Langley, 2001). A research on cyclist's injuries underreporting found that only 22% of the cyclists and 54% motor vehicles involved in crashes report to police (Langley et al., 2003). While in developing countries like Sri Lanka, this extent is up to 56% (Periyasamy et al., 2013). A study in Ghana found that fatal injuries are fully reported reported with police while slight injuries were unreported (Salifu and Ackaah, 2012). A population-based study in India estimates that about 78% among fatal and only 2% among non-fatal RTIs are likely to be reported to police (Dandona et al., 2008). Police registry captured only 14.4% RTIs while hospitals captured 60.4% in Uganda (Magoola et al., 2018). In Malaysia, reporting rate of RTIs found to be 4.7% with police (Kamaluddin et al., 2019). Underreporting rates of RTIs in a study conducted in Vietnam, ranges from 78.10% to 39.91% (Van et al., 2006). A study in Pakistan revealed that official sources counted only 56% of deaths and 4% of serious injuries caused by RTCs (Razzak and Luby, 1998). Road safety literature concludes that severe the injury, the higher the likelihood of reporting with police (Hopkin et al., 1993; Abay, 2015; Dandona et al., 2001; Magoola et al., 2018).

Pakistan is a developing country of South Asian region having world's sixth largest population of over 200 million (World Health Organization, 2015). Vehicle population of the country has grown at much faster pace in comparison to economy and road infrastructure (Anwaar et al., 2012). According to estimates, RTFs and RTIs cost country's economy approximately 9.6 million US dollars per annum (Ahmed, 2007). However, discrepancies exist between official fatality and injury figures when compared with estimates by other external organizations. For example, Federal Bureau of Statistics (FBS), Pakistan reported 5,280 deaths and 11,173 injuries resulted from RTCs in the period of 2009-2010. However, for the same period World Health Organization (2013) estimates 41,494 deaths/year, nearly eight times more (Kayani et al., 2014). The same discrepancy can further be seen in Table 1., where FBS reports a lesser number of fatalities in 2013 in comparison to 2010 while comparing with WHO reporting rate. Although registered motor vehicles have increased about 22% till 2015. Urban motorization and agglomeration in the city as shown in Table 1., is causing an increase in vulnerable road users but number of RTIs is decreasing.

From the discussion above, it can be concluded that there is definite drawback in RTIs reporting system in the country. Part of this, discrepancies can be the result of lack of clarity in the reporting and recording criteria of police and health sector as indicated by the World Health Organization (2015;2013). For instance, a study reported that police-reporting-based crash data collection system has serious shortcoming as their main focus of data collection is to meet legal requirements (Kayani et al., 2014). Another reason is that some people reconcile after road crash without any legal involvement and some relay on giving and seeking pardon. It is estimated that only 14.3% RTIs are recorded by the police in the country (Hyder et al., 2000).

Table 1
Reported RTFs with different officials and RTIs trend for Pakistan.

Reported Road Crashes Fatalities with different officials for Pakistan				
Official Reported Sources	Fatalities		% Difference	
	2010	2013	2010	2013
Federal Bureau of Statistics, Pakistan	4280	3884		
WHO	5192	7636	17.55%	49.13%
WHO (Estimated)	30131	25781		
RTIs trends reported by FBS, Pakistan 2010-2015				
Demographics	2010	2015		% Variation
Population Density (persons/sq.km)	218	241		9.54%
Registered Vehicles (Thousand)	10443	13388		21.99%
Total Crashes (Numbers)	9723	8080		-16.89%
Fatal Crashes (Numbers)	4280	3221		-24.74%
Non-Fatal Crashes (Numbers)	5443	4859		-10.72%
Number of vehicles involved (Numbers)	10822	9268		-14.35%

1.1. Aims of the study

Despite the aforementioned problem, only Razzak and Luby (1998), estimated the RTIs captured by police considering two sources, while none has investigated the extent and pattern of underreporting and reasons behind it by considering three data sources and population-based study simultaneously. Therefore, this study initiated with aims to:

I. Investigate the extent of underreporting of RTIs in Pakistan taking Lahore as a case study.
II. Explore the different factors affecting underreporting rate.

2. Data and methods

2.1. Data collection

Data was collected data in two stages for this study. In first stage; official data was collected from police, hospitals and Punjab Emergency Response Service (PERS) of the city. In second stage; public opinion was gathered by conducting population-based survey.

2.2. Official data collection

Lahore is the second largest city of Pakistan with population density of 5583 persons/km^2 (Shirazi and Kazmi, 2014). RTIs data for the period of six months between October 2015 to March 2016 was collected from hospitals, police and PERS. For police, data comprised on all the city police stations was collected from Deputy Inspector General (DIG) Traffic Police. The whole city is divided into two police divisions, City division and Saddar division; these divisions are further split into eight police circles which consist of eighty-nine police stations. Punjab Bureau of Statistics (PBS) is the official source of publishing RTIs of the city which also receives the information from police, based on their annual statements. Data from five public sector hospitals (Jinnah hospital, Services hospital, Mayo hospital, Shalimar hospital and Lahore General Hospital) was collected after ethical permission and review board approval. For PERS data, official monthly data sheets were collected after the ethical approval of district emergency office of PERS. Hospital data was kept in emergency registers. All the cases from registers were recorded and Microsoft Excel sheets were developed. Police data was available in data sheets alongside given information of RTIs. While, PERS data was available in Microsoft Excel sheets with all the RTIs information. Before matching surname was also checked either a same victim was registered or not with more than one hospital and other sources after some time. Further, open-ended informal discussions with officials of PERS, police and hospitals were also conducted to identify underreporting issues. These discussions were conducted during the data collection. After discussions, themes were generated to highlight these issues.

2.3. Population based survey data

Due to association of different variables with underreporting, it was decided to conduct a population-based survey in the city to identify the people who failed to report RTIs with officials and their reasons.

For this, convenience sampling method was adopted. This technique is effective to assess the opinion of the people who are conveniently and readily available to participate in the study (Elfil and Negida, 2017). Data was collected from 540 participants out of which 460 have been involved in RTIs while 80 were admitted in the hospitals at the time of survey. While among the whole sample, 30% respondents were the part of fatal collision while remaining 70% have their family members and relatives' part of that. The data was collected from public sector hospitals, different educational institutes, offices and public places. A written informed consent was obtained from each participant. The questionnaire was consisted of five parts:

(1) Socio-demographic characteristics of victims;
(2) Mode of travelling at the time of collision;
(3) Reason of road crashes;
(4) Types of roads and road users who have been involved in RTIs;
(5) Did report RTIs with police, PERS and hospitals?

2.4. Data analysis

2.4.1. Official data

Capture-recapture method is based on set of assumptions that are violated in typical application to traffic injuries as it produces results that suggests high coverage of police reporting even if it may not be true. It can be said while using capture-recapture technique, researcher should always be aware that this technique is based on assumptions that unobserved individual will behave as observed individual (Jarvis et al., 2000). So, in this study to measures the extent of underreporting data linkage method was used. There are two main types of data matching; deterministic and probabilistic method. Both have been used previously and implemented successfully (Kamaluddin et al., 2019). Both methods need a complete or partial set of information so that data can be matched for different parameters (Randall et al., 2013).

To match hospital data with police and PERS data, date of month was the only available variable so a probabilistic method was

applied. For probabilistic method, m-probabilities (matches) likelihood of matching and u-probabilities (non-matches) likelihood of non-matching were calculated. The m-probabilities can be estimated based on values reported in published literature or by selecting random sample of pairs, assigning match status by manual review to calculate the probability that two records agree on a particular identifier when they are true matches. The u-probability can be estimated by observing that two records agree on a specific identifier simply by chance. For example, the u-probability for month of birth will be 1/12 or 0.083. (Cook et al., 2001; Clark, 2004). The value of m-probability is 0.95 based on past literature and calculated value of u-probability was (1/30). When two records were agreed on identifier, a linkage weight (4.86) was calculated by dividing the m-probability by the u-probability and taking the log2 of the quotient. While weight of disagreement (4.29) was calculated by dividing the 1-m probability with the 1-u probability. Then linkage score for each matched pair was computed as sum of weight. A threshold weight (9.15) was determined. Any pair with a total score less than threshold (9.15) was considered as non-matches. So, a match is defined as a record belong to same individual satisfying the threshold weight while non-match is a record that belongs to different individual and do not satisfy the threshold weight.

To evaluate the accuracy of linkage algorithm two metrics were developed. First was sensitivity which measures the ability to correctly classify true matches as matches (A/A + B) in which A was true matches and B was true non-matches. Second was Positive Predictor Value (PPV) which showed the proportion of true matches (A/A + C) in which C was the true non-matches.

To match PERS data with police data multiple identifiers were available, so a stepwise deterministic method was applied for data matching. As both databases were maintained for different purposes so in this case five possible common linking variables were selected (date, injury severity, deaths, vehicle involvement and causes). Record pairs that did not meet the first round of matching criteria were passed to second round of matching criteria for further assessment. If a record pair met the criteria in any step, it was classified as a match otherwise it was classified as non-match. Location was also a key variable but it was not available in PERS data so it could not be used for linkage.

Finally, underreporting rate was measured by using the definition suggested by Watson et al. (2015) in which it was the ratio of matching cases to the total cases of hospitals. The hospital data was used as reference category for police and PERS data. Subsequently, police data was checked against PERS data by taking PERS data as a reference. The underreporting rate of official data was expressed as follows:

$$\textit{Underreporting Rate } \% = (1\text{-}N_A/N_B)*100$$

N_A = Matching cases with police or PERS. N_B = Reported cases with hospitals (Reference Data)

2.4.2. Population based data

A population-based survey was conducted due to misclassification in official data to examine the different variable's effect. The analysis helped to explore the effects of explanatory variables on underreporting. The respondents reporting or non-reporting with officials was taken as dependent variable for this analysis. The categories of selected explanatory variables were gender, age, injury severity, road user, road type, location, mode and reasons of crashes. A descriptive statistics analysis and logistic regression models were used to summarize the extent of underreporting and to examine the effects of different explanatory variables by using Statistical Package for Social Sciences (SPSS) version 21.0.

3. Results

The results of official data are presented in section 3.1 and population-based survey results are presented in section 3.2. Institutional issues found in the official data including poor data bank, data record keeping mismanagement and some other issues are further discussed in section 3.3.

3.1. Extent of underreporting

The underreporting results based on data matching of hospital, police and PERS using date of registration as linking variable are shown in Table 2. Total collected cases from hospitals were 42337 out of which 9751, not belonging to city were excluded. Based on the collected data, reporting rate with hospitals was 59%, 41% with PERS and almost 1% with police. Underreporting rate between hospitals and PERS was almost 39% and between hospital and police was 99%. On matching PERS data with police, underreporting rate was found 98%. This indicates that underreporting rate of RTIs is high with police.

Table 2
Extent of underreporting in police and PERS road injuries data.

Data Linkage	Matches		Non-Matches		Sensitivity[a]	PPV[a]	UR Rate (%)
	True (A)	False (C)	True (D)	False (B)			
Collected Cases: Hospitals = 32586; PERS = 22404; Police = 451							
Hospital and PERS	19986	13	12450	143	99.25	99.93	39%
Hospital and Police	321	4	32135	18	94.69	98.76	99%
PERS and Police	418	8	21953	52	88.93	98.12	98%

[a] Sensitivity and PPV value are more than 95 percent probability which showed the validity of the data linkage algorithm.

Table 3
Underreporting rate between police and PERS based on different linkage variables.

Matching Variables	Reported Cases		Matching Cases	Non-Matching Cases	Underreporting Rate (%)
	Police	PERS			
Crash Severity					
Fatal Crashes	189	6886	138	6748	98
Non-fatal Crashes	104	15354	43	15311	99
Deaths	201	164	152	12	7
Vehicle Involvement					
Rickshaws	26	4339	12	4327	99
Taxi	3	0	0	3	0
Wagons	10	1613	3	1610	99
Flying Coach	5	0	0	5	0
Van	27	0	0	27	0
Bus	22	133	14	119	89
Truck	63	302	33	269	89
Tractor	36	0	0	36	0
Motor Cycle	41	12179	31	12148	99
Car	93	2115	71	2044	96
Jeep	25	0	0	25	0
Others	30	1377	12	1365	99
Causes					
Over speeding	203	6410	124	6286	98
Carelessness	205	5293	67	5226	98
Underage	0	2127	0	2127	100
Wrong turn	0	4655	0	4655	100
U turn	0	3962	0	3962	100
One wheeling	0	15	0	15	100
Tyre burst	0	163	0	163	100
Others	40	1535	21	1514	98

Table 3., further indicates the underreporting level between police and PERS based on deterministic data linkage method. Almost 99% non-fatal RTIs went unreported. Same is the case with crashes involving rickshaws, wagons, motorbikes and cars (100%, 97%, 100%). Among contributor factors, RTIs due to over speeding and carelessness were more likely to be reported with police. However, crashes due to underage driving, wrong turn and one wheeling are 100% underreported. The chances of underreporting of non-fatal RTIs were high while fatal collisions and deaths have low.

3.2. Population-based survey results

In contrast with Table 4., Table 5 and Table 6 shows the results based on Chi-square (χ^2) and binary logistic regression analysis considering the effects of impenetrable factors. In Table 4., reporting rate against each variable was calculated by dividing the reported RTIs of police and PERS to the total respondents of that variable. Both the models for police and PERS were univariate. The Hosmer and Lmaeshow goodness of fit test was performed to check the model fitting. This test produced large p values for both the police and PERS model ($c^2 = 4.743$, df = 8, p = 0.785; $c^2 = 7.099$, df = 8, p = 0.526) which shows that data is best fitted. In Table 4., variables with larger c^2 and less p values (< 0.005) has relationship with reporting rate. Markedly, females including in road travel injuries have low reporting rate with police and PERS (18%, 44%) as shown in Table 4. This finding is similar to the study conducted in France and Malaysia (Amoros et al., 2006; Kamaluddin et al., 2019). However, male's likelihood of reporting with police was high (Odds Ratio (OR) = 1.07, 20%) at 95% Confidence Interval (CI) ($p < 0.05$) as shown in Table 5. Reporting likelihood of younger people (< 20) was low with police (OR = 0.314, 17%) in contrast to 36–40 years age group (OR = 0.244, 62%). It shows that effect of younger people may relate the higher extent of underreporting, particularly those who are < 20 years as found in other regions (Boufous et al., 2008; Dandona et al., 2008; Rosman, 2001; Watson et al., 2015; Kamaluddin et al., 2019). Pedestrians were less likely to report with police (OR = 0.639, 16%). While fatal injuries were less underreported with police at a reporting rate of 67.4% ($p < 0.005$). Reporting likelihood of car occupants (OR = 4.37, 27%) and Light Traffic Vehicle (LTV)/Heavy Traffic Vehicle (HTV) (36%) was high with police (36%) and for drivers was high (OR = 1.433, 52%) with PERS as shown in Table 6. Likewise, likelihood of reporting of RTIs occurring at major roads (OR = 0.965, 51%) and at controlled intersection was high (OR = 1.069, 52%) with PERS. Similarly, fatal crashes (OR = 245.97, 67%) and RTIs due to over speeding (OR = 2.16, 13%; OR = 1.945, 48%) has a higher likelihood of reporting with police and PERS. In agreement with above findings, RTIs reporting with police is found to be low as compared to hospitals and PERS except in case of fatal collisions (Amoros et al., 2006; Boufous et al., 2008; Rosman, 2001; Salifu and Ackaah, 2012).

Table 4
Relationship between reporting rates and explanatory factors based on Chi-square and p-values.

Explanatory Variables	Reporting rate (%)		Explanatory Variables	Reporting rate (%)	
	Police	PERS		Police	PERS
Gender ($\chi^2=0.389$, df = 1, p = 0.53; $\chi^2=2.01$, df = 1, p = 0.15)			Controlled intersection	16	52
Male	20	52	Uncontrolled Intersection	23	48
Female (Ref)[a]	18	44	Parking	10	50
Age ($\chi^2=9.389$, df = 6, p = 0.15; $\chi^2=7.04$, df = 6, p = 0.31)			Access Point (Ref)	23	50
< 20	17	50	**Road Type** ($\chi^2=2.37$, df = 1, p = 0.04; $\chi^2=0.011$, df = 1, p = 0.91)		
21-25	20	44	Major road	24	50
26-30	17	47	Minor road (Ref)	19	49
31-35	21	63	**Mode** ($\chi^2=7.52$, df = 4, p = 0.012; $\chi^2=1.68$, df = 4, p = 0.79)		
35-40	36	50	Motor bike	17	48
41-45	37	54	Car	26	54
> 45 (Ref)	22	60	PSVs	16	51
Road user Type ($\chi^2=1.67$, df = 2, p = 0.43; $\chi^2=1.47$, df = 2, p = 0.47)			Rickshaw	9.7	50
Drivers	20	51	LTV/HTV (Ref)	36	45
Pedestrian	16	46	**Reasons** ($\chi^2=1.49$, df = 5, p = 0.91; $\chi^2=4.71$, df = 5, p = 0.42)		
Passenger (Ref)	19	19	Over speeding	13	48
Injury severity ($\chi^2=234.8$, df = 1, p = 0.00; $\chi^2=0.142$, df = 1, p = 0.70)			Negligence	13	47
Fatal	67	52	Road condition	11	49
Non-fatal (Ref)	4	49	Wrong turn	10	62
Location ($\chi^2=2.94$, df = 4, p = 0.56; $\chi^2=0.915$, df = 1, p = 0.92)			Own mistake	11	67
Mid-block Section	19	51	Vehicle characteristics (Ref)	05	34

[a] Reference group used for each categorical variable during logistic regression modeling in Table 5. and Table 6.

Table 5
Logistic regression analysis of police reporting RTIs.

Explanatory Variables	Estimates	SE	P Value	OR	95% CI	
					Lower	Upper
Gender (male)	0.073	0.597	0.903	1.076	0.334	3.469
Age			0.147			
< 20	-1.158	0.841	0.169	0.314	0.06	1.633
21-25	-1.411	0.911	0.121	0.244	0.041	1.453
26-30	-0.84	0.864	0.331	0.432	0.079	2.347
31-35	0.726	1.062	0.494	2.067	0.258	16.584
36-40	0.868	1.361	0.524	2.383	0.165	34.319
41-45	0.407	1.255	0.746	1.503	0.128	17.601
Road user Type			0.295			
Driver	1.345	0.998	0.178	3.837	0.543	27.128
Pedestrian	0.639	0.524	0.223	1.894	0.678	5.291
Severity (Fatal)	5.505	0.634	0	245.98	70.981	852.392
Location			0.909			
Mid-block section	0.781	1.092	0.475	2.183	0.257	18.551
Controlled Intersection	0.298	1.189	0.802	1.347	0.131	13.844
Uncontrolled Intersection	0.649	1.112	0.559	1.914	0.216	16.921
Parking	0.169	1.476	0.909	1.184	0.066	21.384
Type of road (Major road)	-0.499	0.642	0.437	0.607	0.172	2.137
Mode			0.352			
Motor bike	0.798	0.849	0.347	2.221	0.421	11.725
Car	1.475	0.906	0.103	4.373	0.74	25.825
PSVs	1.227	1.288	0.341	3.41	0.273	42.576
Rickshaw	0.184	1.116	0.869	1.202	0.135	10.7
Reasons			0.595			
Over speeding	0.771	1.719	0.654	2.161	0.074	62.745
Negligence	0.458	1.543	0.767	1.581	0.077	32.517
Road condition	0.109	1.919	0.955	1.115	0.026	47.941
Wrong turn	-0.357	1.629	0.826	0.7	0.029	17.035
Own mistake	-0.378	1.543	0.807	0.686	0.033	14.11

3.3. Institutional issues related to underreporting

As a result of informal discussions with officials' several institutional issues contributing to underreporting were identified which are as follows:

Table 6
Logistic regression analysis of PERS reporting RTIs.

Explanatory Variables	Estimates	SE	P Value	OR	95% C.I.	
					Lower	Upper
Gender (male)	-0.275	0.234	0.24	0.76	0.481	1.201
Age			0.323			
< 20	0.433	0.346	0.21	1.542	0.783	3.035
21-25	0.738	0.368	0.045	2.093	1.017	4.305
26-30	0.559	0.378	0.14	1.748	0.833	3.67
31-35	-0.037	0.451	0.935	0.964	0.398	2.332
36-40	0.712	0.659	0.28	2.038	0.56	7.415
41-45	0.32	0.562	0.57	1.377	0.457	4.143
Road user Type			0.345			
Driver	0.36	0.381	0.345	1.433	0.68	3.021
Pedestrian	-0.144	0.223	0.518	0.866	0.559	1.34
Severity (Fatal)	-0.127	0.233	0.586	0.881	0.558	1.391
Location			0.94			
Mid-block section	0.087	0.405	0.83	1.091	0.493	2.413
Controlled Intersection	0.067	0.457	0.883	1.069	0.437	2.618
Uncontrolled Intersection	0.257	0.423	0.544	1.292	0.564	2.962
Parking	0.053	0.544	0.922	1.054	0.363	3.06
Type of road (Major road)	-0.045	0.289	0.875	0.956	0.542	1.685
Mode			0.673			
Motor bike	-0.11	0.506	0.828	0.896	0.332	2.416
Car	-0.396	0.526	0.451	0.673	0.24	1.886
PSVs	-0.427	0.621	0.492	0.652	0.193	2.205
Rickshaw	-0.358	0.569	0.529	0.699	0.229	2.131
Reasons			0.363			
Over speeding	0.665	0.746	0.372	1.945	0.451	8.395
Negligence	0.665	0.749	0.375	1.944	0.448	8.434
Road Condition	0.688	0.872	0.43	1.99	0.36	11
Wrong turn	0.367	0.789	0.642	1.443	0.307	6.776
Own mistake	-0.067	0.807	0.933	0.935	0.192	4.546

3.3.1. Lack of awareness

Official data from the concerned sources' attribute lack of importance of road travel injury registration both by public and government departments. There are two reasons behind this, firstly the victims do not consider serious to report a road travel injury with police and normally parties involved in RTIs enter into compromise. Secondly, in case of severe injury individuals contact to rescue service for first aid and for shifting to hospital considering lifesaving as a prime obligation. Police focuses the crime and not responsible for reporting injuries only so they collect the data with respect to legal point of view rather than research point of view. However, it is important to consider because statistics received from police are used by PBS.

3.3.2. Legal issues

Most of the time people do not want to involve police because of legal proceedings hinders. Mistreatment by police officials keep people away from reporting a travel injury with police. Due to these legal issues, a bulk of RTC's figure is missed with police road travel injury data bank.

3.3.3. Data record keeping

Data Stratification: Data matching with each other was very difficult because each custodian had its own pattern of reporting variable of road travel injury while PERS had a well-managed data bank and police reporting criteria was different from hospitals and PERS. In this scenario, matching of each case became so difficult. On the other hand, PBS which is an official source of RTIs figure for the city, solely relay on exasperating police reporting which can mislead the actual problem.

Absence of Electronic Record: Electronic record of RTCs is not managed by all the hospitals and police. Only Lahore General Hospital was able to manage the record electronically because their emergency patient receipt was computer generated. Therefore, record is automatically saved according to medical case stratification and has a specific identity number. While other hospitals were not able to provide access to electronic record due to some ethical and technical reasons. Mixing of RTIs burden with other medical cases was one of the reasons. Police updated monthly statement Performa of RTCs manually.

Complexity of the System: There was not any single government unit accumulating the RTIs data from all sources of the city. Only public-sector hospitals are recognized for the data reporting while private hospitals and clinics were not in the orbit of the data source. On the other hand, each source has its own kind of data reporting and managing criteria which makes it further complex in terms of assessment of underreporting of RTIs for researchers.

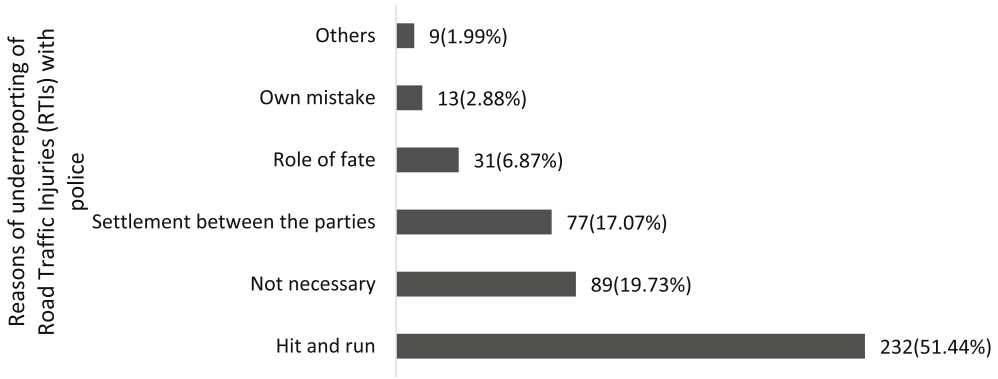

Fig. 1. Reasons of RTIs underreporting with police.

3.4. Reasons of underreporting with police

In the population-based study, among all the non-fatal RTIs cases, 83% of the sample population did not report to the police as shown in Fig. 1. Almost half of them (51.44%) provided 'hit and run case' (the other party ran away after the RTC) a main reason for non-reporting. This misreporting was further followed by reasons including participant considering reporting 'not necessary" (19.73%), "settlement between the parties" (17.07%) and 'role of fate" (6.87%).

4. Discussion

This study delved into the extent of underreporting, its issues and relationship between the reporting based on confounding variables. The rich dataset, based on two stages allowed for an estimation of extent of underreporting and how different crash characteristics influence this extent. The officials record of RTIs resulting of RTCs of hospitals and police have been found incomplete and mismanagement in terms of demographic details of the RTCs victims. It was found that 99% population of RTIs did not find or match to any record in the police data while 39% did not find in PERS record. While matching police and PERS data, underreporting rate for police was found 98%. This discordance indicates the level of underreporting of RTIs to police is somewhat similar to the level of level of discordance found in other studies (Amoros et al., 2006; Boufous et al., 2008; Rosman, 2001; Kamaluddin et al., 2019). This discordance rate was due to the misclassification of the cases (Boufous et al., 2008; Khoso et al., 2011). The hospital and police data were missing for key variables which hindered the matching between the data records of the official sources.

The study is also unique such that reporting rate is separately modeled based on population survey for police and PERS. The analysis is based on OR generated from different factors affecting reporting rate. The results show that teenagers and adults (21-25) have low reporting rate with police having less OR for teenagers (OR= 0.314) and adults (OR= 0.244). While people of age 36-40 and above it reported maximally with police and PERS (OR= 34.319; 7.415). It shows that younger age people involved in road injuries can lead towards underreporting. It informs that car occupants (OR=4.34) are four times more likely to report with the police and same is the case with crashes involving males (OR=1.076) with police. Drivers (OR=1.34) and RTIs occurring on uncontrolled intersections (OR=1.292) are less underreported with PERS. Likewise fatal injuries (OR=0.64) are less underreported while younger people (OR=0.314) are more likely to underreport with police. While non-fatal injuries are reported rarely. These finding are similar to the previous researches conducted in France, Australia, Malaysia and Ghana (Amoros et al., 2006; Watson et al., 2015; Kamaluddin et al., 2019; Salifu and Ackaah, 2012).

Previously in Pakistan, kayani et al., (2014), found that underreporting is a function of fatalism and a road injury appear to go unreported because it is considered to be one's fate. Bhatti et al. (2017), study only identified that rates of RTIs have been doubled in Pakistan since 1997. Razzak and Luby (1998), conducted a study to estimates deaths and RTIs based on two sources. While current study based on official data sources and population-based data, not only determined the extent of underreporting but also explored the different explanatory factors effecting and institutional issues related to this problem. Further this study used three data sources to control the independency while none has used more than two data sources in Pakistan as previous research recommend the use of three or more sources of data to control independency (Meuleners et al., 2006; Rivera and Lam, 2018).

This level of underreporting investigated for Pakistan is found higher than the studies conducted in other countries including France (38%), New Zealand (more than one third) and Australia (67%), Ghana and Sri Lanka (56%) (Aptel et al., 1999; Amoros et al., 2006; Alsop and Langley et al., 2003; Watson et al., 2015; Salifu and Ackaah, 2012; Periyasamy et al., 2013). Misclassification of the cases, lack of awareness among the public and data record keeping is identified as main reasons of underreporting (Boufous et al., 2008; Kamaluddin et al., 2019).

The findings of this study can indicate the better extent of underreporting in Pakistan as Lahore is more regularize city and if the problem exists in this city then picture can be worse for the other cities and areas of Pakistan.

5. Conclusions

The pattern of underreporting of RTIs has been estimated in Lahore by matching hospital, police and PERS data. There is significant underreporting in police data compared to hospital and PERS data. The pattern of underreporting varied according to different explanatory factors. As underreporting varies with different explanatory factors so conclusions are based on extent of underreporting and relationship between factors effecting it. Hence, conclusions and recommendations of this study are validated as null hypothesis has been rejected. Less severe the consequences of the injuries higher the underreporting with police. Age, road user type, gender and type of road were identified variables to have profound influence on underreporting with police. The study concludes that most of the people especially teenagers do not bother road safety as an important issue and due to this reason, they fail to report a road travel injury with police. Likewise, proper electronic record is not available with police and hospitals. Poor data bank with all the government departments is another important factor contributing to underreporting. Also, any updated information managed by hospitals and police with respect to research point of view is missed. PERS manage the data but they do not have a complete follow up of patients admitted in hospitals either by them or individually. Most of the RTIs go unidentified due to absence of any central data base unit and interdepartmental collaboration. Police, PERS and hospital do not share their cases with each other except legal cases.

These results could greatly impact on sustainable road safety research and policy, by highlighting some key inaccuracies with police data currently on which is relied upon. An accurate information of RTIs in terms of frequency is essential for calculating the cost of RTIs, actual burden of travel injuries, economic loss, planning and targeting the safety policies and calculating cost/benefit ratios.

Therefore, this study recommends working on inter-departmental coordination and establishment of road crash data unit or road trauma registry center for the city to enhance the reliability of the crash data. Furthermore, the quality of data and means of archiving needs to be improved as sometime reporting of an injury in hospital can happen at different days which may lead towards over reporting. It also recommends improving the RTIs data dissemination. It is important to note that PBS officially provides RTIs and RTFs database of the city. However, its information solely relies on police data but findings highlight that police data is highly underreported. Thus, the inaccuracies with police data in current practice cannot be overlooked which is likely to mislead actual estimation of economic and social burden caused by RTIs. This information is also valuable for road safety planning, evaluation and countermeasures. Therefore, government should streamline the police reporting system in Pakistan and also need to encourage and educate the public to report road travel injuries with police.

It is suggested that the repetition of the study in other cities of Pakistan can be conducted for longer time period to collect official and population-based data. Re-analysis of underreporting by linking the police, hospitals (public and private), PERS, electronic media and newspapers data will generate a better estimate of the true incidence.

6. Limitations of the Study

This study was initiated by considering the case study of Lahore city to indicate the pattern of underreporting in Pakistan. On the basis of findings, any expansion factor cannot be generated for the whole country because each city has heterogeneity in terms of population behavior, traffic psychology and environment.

Funding

This research received no external funding

Conflicts of interest

The authors declare no conflict of interest.

Financial disclosure

The Authors did not receive any specific funding for this work.

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