Accident Analysis and Prevention 71 (2014) 115–119

Contents lists available at ScienceDirect

Accident Analysis and Prevention

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

Seatbelt wearing rates in middle income countries: A cross-country analysis

Andres I. Vecino-Ortiz, David Bishai, Aruna Chandran, Kavi Bhalla, Abdulgafoor M. Bachani, Shivam Gupta, Ekaterina Slyunkina, Adnan A. Hyder*

International Injury Research Unit, Department of International Health, Johns Hopkins Bloomberg School of Public Health, 615 North Wolfe Street, Baltimore, MD 21205, USA

ARTICLE INFO

Article history:
Received 31 December 2013
Received in revised form 30 April 2014
Accepted 30 April 2014
Available online 3 June 2014

Keywords:
Injuries
Seat belts
Road safety
Traffic accidents
Middle income countries

ABSTRACT

In settings with low seatbelt use prevalence, self-reported seatbelt use estimates often lack validity, and routine observational studies are scarce. In this paper, we aim to describe the prevalence of seatbelt use and associated factors in drivers and front-seat passengers across eight sites in four countries (Egypt, Mexico, Russia, Turkey) using observational studies as well as to produce estimates of country-level and site-level variance. As part of the *Bloomberg Philanthropies Global Road Safety Program*, data on driver and passenger seatbelt use across four middle-income countries was collected between October 2010 and May 2011 (n = 122,931 vehicles). Logistic regression and Intraclass Correlation Coefficient analyses for sites- and country-level clustering were performed. We found high variability of seatbelt wearing rates ranging from 4 to 72% in drivers and 3–50% in front-seat passengers. Overall, average seatbelt wearing rates were low (under 60% in most sites). At the individual level, older and female drivers were more likely to wear seatbelts, as well as drivers of vehicles transiting at times of increased vehicle flow. We also found that 26–32% and 37–41% of the variance in seatbelt use among drivers and front-seat passengers respectively was explained by differences across sites and countries. Our results demonstrate that there is room for improvement on seatbelt use in middle-income countries and that standardized cross-country studies on road safety risk factors are feasible, providing valuable information for prevention and monitoring activities.

1. Introduction

Lack of seatbelt use is a major risk factor for road traffic injuries (RTI) in middle income countries (World Health Organization et al., 2009). Whereas four-wheeled vehicle use grows every year, seatbelt use remains relatively low, and the rate of seatbelt use is lagging behind vehicle ownership trends (World Health Organization et al., 2009). Middle income countries now have the largest proportion of global deaths from RTI and are starting to see that most traffic deaths occur in vehicle occupants as opposed to pedestrians (Peden et al., 2004). Among other risk factors such as speeding or drinking and driving, seatbelt use is an important determinant of fatality and injuries severity among car occupants. For example, 53% of drivers and passengers who died in the United States in 2009 were unrestrained, and current research shows that the probability of dying or having a severe injury from a car crash for an unrestrained individual is twice that for a restrained person (Peden et al., 2004; NHTSA, 2010; Abbas et al., 2011). When properly worn, seatbelts provide protection by preventing contact of passengers with the interior of the vehicle or with each other; seatbelts also avoid the ejection of passengers out of the vehicle and distribute the energy of the impact over the body (Abbas et al., 2011). As a result, wearing seatbelts decreases the risk of dying in a crash by more than 60% (Peden et al., 2004; Crandall et al., 2001).

The *Bloomberg Philanthropies Global Road Safety Program (BPGRSP)* is an international initiative carried out by international and national partners from each one of the participating countries (Hyder et al., 2012). This project is funded by Bloomberg Philanthropies and aims to promote a group of evidence-based interventions on road safety in an effort to close the evidence to action gap in road safety (Hyder et al., 2012). The BPGRSP involves ten countries (Kenya, Brazil, Cambodia, China, Egypt, India, Mexico, Russia, Turkey, and Vietnam), which make up 50% of the global road traffic fatalities. Four of the ten countries worked on seatbelts: Egypt, Mexico, Russia and Turkey in eight different locations

* Corresponding author at: 615 North Wolfe Street, Suite E-8132, Baltimore, MD 21205, USA. Tel.: +1 410 955 3928; fax: +1 410 614 1419.
E-mail address: ahyder1@jhu.edu (A.A. Hyder).

http://dx.doi.org/10.1016/j.aap.2014.04.020
0001-4575/

(Hyder et al., 2012). The Johns Hopkins Bloomberg School of Public Health's International Injury Research Unit (www.jhsph.edu/IIRU) is responsible for monitoring and evaluation of the project in all sites.

Previous literature has demonstrated the advantage of observational studies on seatbelt use to assess its prevalence (Bendak, 2005; Iribhogbe and Osime, 2008; Routley et al., 2007). However, little data is routinely collected on seatbelt use in low and middle income countries, and self-reported seatbelt use is generally considered to be a low-validity metric, especially in low-prevalence settings (Hyder et al., 2012; Ozkan et al., 2012). For this reason, observational studies on seatbelt use have been proposed for assessing prevalence at national and local level. Whereas observational studies are important to explore national-level differences in seatbelt use that can result from different levels of traffic regulation, law enforcement, and other related factors, cross-country studies allow researchers to collect and analyze standardized data to provide comparable and valid estimations across countries. This is important for both BPGRSP and for monitoring the Global Decade of Action on Road Safety (World Health Organization, 2013; Hyder et al., 2013).

The BPGRSP provides an excellent platform to collect data on seatbelt use across several countries and this paper presents an initial comparison of those findings. Our goal is to describe the prevalence of seatbelt use and explore factors associated with its use in drivers and front-seat passengers across eight sites in four countries and establish a baseline measurement for future longitudinal assessments. We hope this data will also add value to focus national road safety initiatives on this risk factor for road fatalities and injuries.

2. Materials and methods

Seatbelt baseline observations were conducted at the start of the BPGRSP in eight sites in Egypt, Mexico, Russia and Turkey between October 2010 and May 2011. All sites were agreed upon with the respective governments which considered that seatbelt use should be monitored in these specific areas. A site is in all cases comprised a city or a metropolitan area. For example in Mexico we had three sites, each one of them corresponding to an entire city: León, Cuernavaca and Guadalajara-Zapopan. These observational studies were carried out using a standardized protocol and sites comprising specific province, districts and cities, chosen in consultation with national partners. Sample sizes were calculated for all sites using the expected prevalence of seatbelt use based on reported national estimates from Egypt, Russia, and Turkey (World Health Organization, 2009). City-specific estimates were obtained for the case of Mexico (Hijar-Medina et al., 1996; CENAPRA, 2009). Power calculations were made assuming a 5% alpha error level and 20% of beta error level.

All potential observation points (intersections with a functioning traffic light) within each site were systematically listed and a simple random sample was selected after discarding those that entailed safety concerns for observers. Each observation point involved one supervised trained observer who worked for a time slot of maximum 1.5 h. This slot was rotated at different times of the day during a one-week period of observation. Observers at each location captured seatbelt use and selected driver's (estimated age and gender) and vehicle characteristics of all vehicles transiting through the observation point during the 90-min slots.

Our standardized methodology was applied at all sites and allowed us to conduct cross-country analyses. We estimated means and proportions of our independent variables and seatbelt prevalence. Given expected differences in sample sizes between sites, we produced population weights and subsequently performed bivariate logistic regression analyses with Huber/White clustered standard errors to explore the relationship between seatbelt use and associated factors (Wong and Mason, 1985). These included estimated driver's age group; peak time, defined as transit during the hours 8–10 and 16–18 h; National Gross Domestic Product (GDP) and population size. While we recognize that site-specific GDP would be more predictive of seatbelt use in the evaluated areas (rather than national GDP), obtaining this information from reliable sources proved to be challenging; however, we still include national GDP and look forward to include site-specific GDP in future studies. Driver's sex and age groups were estimated by each individual observer. Details on the observation study carried out in individual sites are described elsewhere (Perez-Nunez et al., 2013; Ma et al., 2012). Sociodemographic characteristics were not available for Turkish and Egyptian sites; in coordination with our partners, we hope to capture these data in further rounds (although we do not expect to significantly change over short periods of time).

Our regression analyses assessed the relationship between the independent variables mentioned and seatbelt use while accounting for the clustering effects of the province and country where the observations were carried out (Wooldridge, 2002). Furthermore, we estimated the Intraclass Correlation Coefficient (ICC) that represents the fraction of the variance of seatbelt use that is attributable to differences between countries and locations (Wong and Mason, 1985; Snijders and Bosker, 1999). This method has been previously used and recommended in the injury field to demonstrate how evaluating the impact of clustering in injury analysis improves the quality of the analysis and helps to understand the sources of variance (Bangdiwala, 2011).

The observational studies were reviewed and approved by the Institutional Review Board at Johns Hopkins School of Public Health. Also, the IRB of each of the implementing local institutions in each country reviewed and approved the research protocol.

3. Results

We surveyed 122,931 vehicles across 8 sites in four countries between October 2010 and May 2011. Site-specific samples ranged from 1000 to 40,000 vehicles per site. Most of our sample comprised male (83%) and middle-age drivers (64%). Almost half of our observations were done during weekdays and 25% of them were captured during peak hours. The average GDP per capita was I$13,470; and the population size of our sites range from 700,000 to almost 7 million inhabitants (Table 1).

Overall, seatbelt prevalences are around 50% or lower in most of sites for both drivers and front-seat passengers. The prevalence of seatbelt use among drivers was higher than among front-seat passengers in all sites. We also found that front-seat passenger use of seatbelt was highly related to driver's seatbelt wearing. Mexican and Russian sites had the highest driver seatbelt use rates while lower prevalences were seen in Cairo and Afyon for both drivers and front-seat passengers (Table 2).

Logistic regression analysis showed that male and younger drivers were less likely to wear a seatbelt across all sites (Table 3). Front-seat passengers were also more likely to wear a seatbelt with older drivers. Vehicles observed during peak-time and weekdays were more likely to have drivers wearing seatbelts. Higher GDP per capita was consistently correlated with an increased likelihood of seatbelt wearing among both drivers and front-seat passengers.

The ICC coefficient results were important to explain variation in seatbelt use. We found that a considerable fraction of the variability in driver and front-seat passenger seatbelt use was explained by both differences across countries (32% of variability for drivers and 41% for front-seat passengers) and between sites

Table 1
Descriptive statistics of the independent variables by site.

	Cairo (Egypt)		Cuernavaca (Mexico)		Guadalajara-Zapopán (Mexico)		León (Mexico)		Lipetsk (Russia)		Ivanovo (Russia)		Ankara (Turkey)		Afyon (Turkey)	
	n = 17,621		*n* = 1000		*n* = 1982		*n* = 1012		*n* = 25,798		*n* = 9127		*n* = 25,966		*n* = 40,425	
	%/Mean	95% CI	%/Mean	95% CI	%/Mean	95% CI	%/Mean	95% CI	%/Mean	95% CI	%/Mean	95% CI	%/Mean	95% CI	%/Mean	95% CI
Driver's sex (male)			81.1%	78.6–83.5	73.4%	71.4–75.3	83.3%	81.1–85.6	89.9%	89.6–90.3	86.2%	85.4–86.8				
Estimated driver's age																
Less than 30 years			24.6%	21.9–27.3	26.2%	24.3–28.1	30.2%	27.4–33.1	93.2%	92.8–93.5	34.2%	33.2–35.2				
30–59 years			75.4%	72.6–78.0	73.8%	71.9–75.7	69.8%	66.9–72.6	6.8%	6.5–7.2	59.7%	58.7–60.7				
Above 59 years			0.0%	–	0.0%	–			0.0%		0.1%					
Weekdays	54.1%	53.4–54.9											48.0%	47.4–48.7	41.5%	41.1–42.0
Peak times	29.3%	28.7–30.1											25.8%	25.3–26.4	21.9%	21.5–22.3
GDP per capita[a]	6337	–	14,757	–	14,757	–	14,757	–	20,770		20,770	–	15,965		15,965	–
Population of site[b]	6759	–	343	–	2777		1470	–	1174		1061	–	4571		701	–

[a] Country's Gross Domestic Product per capita (I$ 2010 Purchasing Power Parity).
[b] Population of site in thousands in 2011.

located within the same country (26% of variability for drivers and 37% for front-seat passengers) this implies that most of the variability in seatbelt use is captured by effects at the site and country level, whereas the remaining variance is potentially explained by individual level variables.

4. Discussion

This paper estimates the prevalence and selected determinants of the variance on seatbelt use in drivers and front-seat passengers across eight sites in four countries. These results come from early data collected for the BPGRSP, using a standard protocol for all sites. We believe this is an important step forward toward the collection of systematic new data on road safety risk factors and can help inform the monitoring and evaluation of interventions in the future.

Overall, these results highlight the low seatbelt wearing prevalences we found in these eight sites. Naturally, our estimates belong to specific locations and cannot be assumed to be nationally representative estimates. However, it is interesting that except for Mexico, seatbelt use rates from our study were lower than officially reported prevalence rates (Tables 2 and 4) (World Health Organization, 2009, 2013). This is an important finding because reported national prevalences are often obtained by self-report surveys, which are known to overestimate the actual seatbelt prevalence rates (Ozkan et al., 2012). The most striking case is Egypt, for which the reported national estimates for seatbelt use is more than four times higher than the prevalences we found (World Health Organization, 2009). While these differences may be real, our data provides an indication that direct observations can be used instead of self-report when estimating national prevalence on seatbelt use.

We found that seatbelt wearing rates are higher among older, and female drivers, which is consistent with previous literature on risk aversion and might be important to inform intervention efforts (Bishai, 2004; Agnew et al., 2008). Interestingly, seatbelt wearing rates for drivers increase at times where average speeds are lower (increased vehicle flows); whether seatbelt use is or is not a function of speed or whether it is related to confounding factors is still to be determined. However, potential pathways we hypothesize for this result might be an increased perceived risk of being fined by the police or through an increased GDP (correlated with higher traffic flow) that carries higher standards of technology for vehicles and enforcement.

The higher seatbelt wearing rates by front-seat passengers associated with older drivers who wear seatbelts might be suggesting a "peer-effect" that is worth further exploration. The lower seatbelt prevalences among front-seat passengers might be related to the lower enforcement on seatbelt use they face, which might also be a focus for future police training. We believe that by focusing enforcement on these findings and increasing awareness through social marketing strategies, seatbelt use can be further improved.

We found that the variance of seatbelt use among drivers and front-seat passengers is markedly explained by both country-level and site-level differences, especially in front-seat passengers. We believe this might be caused by differences in law enforcement across sites despite sharing similar seatbelt legislation. All countries in our study require seat-belt use for both drivers and front-seat passengers (Mexico and Egypt do not require seatbelt use for rear-seat passengers) and have a National Road Safety Agency (Table 4). These results thus suggest that legislation alone is not sufficient and that by focusing on enforcement, it may be possible to increase seatbelt use across countries.

We found several limitations in our approach. All eight sites in four countries included in this study have different levels of law enforcement. However, our results raise questions about perceived levels (Table 4) for enforcement reported elsewhere (World Health

Table 2
Prevalence of seatbelt use across sites.

Country	Location	Month of observation	Driver's seatbelt use (%)	Front seat passenger seatbelt use (%)	Front seat passenger seatbelt use among vehicles with drivers wearing seatbelt (%)
Egypt	Cairo	May, 2011	15.96	3.79	24.68
Mexico	Cuernavaca	November, 2010	72.5	31.97	43.21
	Guadalajara/Zapopán	November, 2010	52.52	28.43	46.97
	León	November, 2010	54.25	27.5	41.44
Russia	Lipetsk	October, 2010	54.95	23.42	37.55
	Ivanovo	April, 2011	52.01	50.02	59.12
Turkey	Ankara	November, 2010	21.89	19.64	48.01
	Afyon	November, 2010	4.21	3.46	69.21

Table 3
Bivariate robust logistic regression results of seatbelt use on pooled data (weighted odds ratios).

	Driver	95% confidence interval[a]	*n*	Front seat passenger	95% confidence interval[a]	*n*
Male	0.62	(0.54–0.72)	38,265	0.76	(0.62–0.93)	30,021
Estimated driver's age						
Less than 30 years	Ref	Ref	38,265	Ref	Ref	23,179
30–59 years	1.25	(1.11–1.42)		1.30	(1.12–1.52)	
Above 59 years	1.60	(1.30–1.96)		4.27	(3.13–5.33)	
Weekday	1.54	(1.46–1.63)	84,012	0.66	(0.58–0.76)	39,840
Peak time	1.11	(1.04–1.19)	83,556	0.79	(0.63–1.01)	39,607
GDP per capita (2010 PPP)	1.01	(1.01–1.02)	122,931	1.01	(1.01–1.02)	70,510
Population	0.99	(0.98–0.99)	122,931	0.99	(0.98–0.99)	70,510
Driver using seatbelt	–	–	–	19.06	(16.69–21.77)	70,194
ICC for country effects	0.32 (0.15)			0.41 (0.27)		
ICC for province effects	0.26 (0.15)			0.37 (0.20)		

PPP, Purchasing Power Parity; GDP, Gross Domestic Product; ICC, Intraclass Correlation Coefficient.
[a] Huber–White standard errors.

Table 4
Data reported to World Health Organization by country, 2013.

Country	Seatbelt law applies to all occupants	Driver seatbelt wearing rate (%)	Perceived level of enforcement out of 10	National Road Safety Agency	Fraction of deaths in car occupants among all road traffic deaths (%)	Source
Egypt	No	70[a]	5	Yes	48[a]	Central Agency For Public Mobilization & Statistics, 2010
Mexico	No	29	5	Yes	68[a]	National Institute of Statistics Geography and Information, 2009
Russia	Yes	97	6	Yes	53	Road Safety Department, 2010
Turkey	Yes	50[b]	8	Yes	59	Police and Gendarmerie, 2010

[a] Data from Global Status Report on Road Safety, 2009.
[b] Police records.

Organization, 2009, 2013). Our protocol also involved estimating the "sex" and "age group" of the driver. Such observations were based on the judgment of the observer as it has been done in previous literature and despite the use of broad age ranges, it may have resulted in misclassification (Routley et al., 2007; Bhatti et al., 2011). In addition, we are assuming that all vehicles have seatbelts fitted in, which may not be true for all cars in middle income countries.

We believe that it is fundamental to strengthen efforts on monitoring evaluation and surveillance. This study demonstrates that systematic large-scale monitoring is possible and it provides valuable information to policy-makers on potential interventions that can be tailored to each site. We also recommend considering enforcement as the key tool to increase seatbelt use. The variability of seatbelt use that we found within each country might be explained by differences in enforcement, and countries should investigate this further.

This paper provides estimates of a key road safety risk factor for occupant injuries and deaths – seatbelts – in four middle income countries using a standardized approach. More studies are needed among a greater number of countries in order to guide interventions and future investments. This is especially true in middle income countries with higher fractions of deaths in car occupants, most of them preventable by using seatbelts. We hope that this study opens the dialogue in the current Global Decade of Action for road safety toward more rigorous data to help closing the implementation gap in road safety (Hyder et al., 2012).

Acknowledgements

Thanks to Ricardo-Perez-Nuñez for his collaboration on this paper. This study was carried out as part of the *Global Road Safety Program*, funded by Bloomberg Philanthropies (Grant No. 111882).

References

Abbas, A.K., Hefny, A.F., Abu-Zidan, F.M., 2011. Seatbelts and road traffic collision injuries. World J. Emerg. Surg. 6, 18–23.

Agnew, J.R., Anderson, L.R., Gerlach, J.R., Szykman, L.R., 2008. Who chooses annuities? An experimental investigation of the role of gender, framing, and defaults. Am. Econ. Rev. Pap. Proc. 98, 418–422.

Bangdiwala, S.I., 2011. Are injuries correlated? Interpreting the intraclass correlation coefficient. Int. J. Inj. Control. Saf. Promot. 18, 169–171.

Bendak, S., 2005. Seat belt utilization in Saudi Arabia and its impact on road accident injuries. Accid. Anal. Prev. 37, 367–371.

Bhatti, J.A., Ejaz, K., Razzak, J., 2011. Influence of an enforcement campaign on seat-belt and helmet wearing, Karachi-Hala Highway, Pakistan. Ann. Adv. Automot. Med. 55, 65–70.

Bishai, D., 2004. Does time preference change with age? J. Popul. Econ. 17, 583–602.

CENAPRA, 2009. Iniciativa Mexicana de Seguridad Vial y Prevencion de Lesiones en el Transito (IMESEVI). Construccion de Lınea Base. Reporte final, 1st ed. Secretarıa de Salud, Mexico, DF.

Crandall, C., Olson, L.M., Sklar, D., 2001. Mortality reduction with air bag and seat belt use in head-on passenger car collisions. Am. J. Epidemiol. 153, 219–224.

Hijar-Medina, M.C., Flores-Aldana, M.E., Lopez-Lopez, M.V., 1996. Safety belt use and severity of injuries in traffic accidents. Salud Publ. Mex. 38, 118–127.

Hyder, A.A., Allen, K.A., Di Pietro, G., et al., 2012. Addressing the implementation gap in global road safety: exploring features of an effective response and introducing a 10-country program. Am. J. Public Health 102, 1061–1067.

Hyder, A.A., Allen, K.A., Peters, D.H., Chandran, A., Bishai, D., 2013. Large-scale road safety programmes in low- and middle-income countries: an opportunity to generate evidence. Glob. Public Health 8, 504–518.

Iribhogbe, P.E., Osime, C.O., 2008. Compliance with seat belt use in Benin City, Nigeria. Prehosp. Disaster Med. 23, 16–19.

Ma, S., Tran, N., Klyavin, V.E., Zambon, F., Hatcher, K.W., Hyder, A.A., 2012. Seat belt and child seat use in Lipetskaya Oblast, Russia: frequencies, attitudes, and perceptions. Traffic Inj. Prev. 13 (Suppl. 1), 76–81.

National Highway Traffic Safety Administration – NHTSA, 2010. Traffic Safety Facts. NHTSA's National Center for Statistics and Analysis. NHTSA, Washington, DC http://www-nrd.nhtsa.dot.gov/Pubs/811363.pdf (accessed 04/2013).

Ozkan, T., Puvanachandra, P., Lajunen, T., Hoe, C., Hyder, A.A., 2012. The validity of self-reported seatbelt use in a country where levels of use are low. Accid. Anal. Prev. 47, 75–77.

Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A.A., Jarawan, E., et al., 2004. World Report on Road Traffic Injury Prevention. World Health Organization, Geneva, Switzerland.

Perez-Nunez, R., Chandran, A., Hijar, M., Celis, A., Carmona-Lozano, M.S., Lunnen, J.C., Hyder, A.A., 2013. The use of seatbelts and child restraints in three Mexican cities. Int. J. Inj. Control Saf. Promot. (Epub ahead of print).

Routley, V., Ozanne-Smith, J., Li, D., Hu, X., Wang, P., Qin, Y., 2007. Pattern of seat belt wearing in Nanjing, China. Inj. Prev. 13, 388–393.

Snijders, T.A.B., Bosker, R.J., 1999. An introduction to basic and advanced multilevel modeling. The Cromwell Press, Trowbridge, UK.

World Health Organization, FIA Foundation, Global Road Safety Partnership, World Bank, 2009. Seatbelts and Child Restraints. A Road Safety Manual for Decision-Makers and Practitioners. FIA Foundation, London, UK http://whqlibdoc.who.int/road_safety/2009/9780956140302_eng.pdf (accessed 04/2013).

World Health Organization, 2009. Global Status Report on Road Safety. Time for Action. World Health Organization, Geneva, Switzerland http://www.who.int/violence_injury_prevention/road_safety_status/2009 (accessed 04/2013).

World Health Organization, 2013. Global Status Report on Road Safety. Supporting a Decade of Action. World Health Organization, Geneva, Switzerland.

Wong, G., Mason, M.M., 1985. The hierarchical logistic regression model for multilevel analysis. J. Am. Stat. Assoc. 80, 513–524.

Wooldridge, J.M., 2002. Econometric Analysis of Cross Section and Panel Data. MIT Press, Cambridge, MA.