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cecilia@claves.fiocruz.br

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Menezes Seerig, Lenise; Bacchieri, Giancarlo; Giacomelli Nascimento, Gustavo; Barros,
Aluisio J D; Demarco, Flávio Fernando

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Use of motorcycle in Brazil: users profile, prevalence of use and traffic accidents occurrence – a population-based study

Uso de motocicletas no Brasil: perfil dos usuários, prevalência de uso e ocorrência de acidentes de trânsito – estudo de base populacional

Lenise Menezes Seerig¹

Giancarlo Bacchieri¹

Gustavo Giacomelli Nascimento²

Aluisio J D Barros¹

Flávio Fernando Demarco¹

Abstract *This study aimed to describe the profile of motorcycle users and determine the prevalence of use. Also, to evaluate the reason for using a motorcycle, users' perceived risk of traffic accident, pattern of helmet wearing and number of accidents related to motorcycle use in the last 12 months. This cross-sectional study was conducted in the city of Pelotas, Southern Brazil. Sampling process was carried out in two stages, with the primary unit being the census track and the secondary the house. The study included 3,004 individuals aged 10 to 59 years, which answered a structured questionnaire. The outcome of the study was the use of motorcycle. The prevalence of motorcycle use was 25%. The majority of the riders were composed by males (79%). Individuals aged from 18 to 35-years-old comprised 42% of the total number of users, mainly as riders (24%). Forty percent of the users were not using properly the helmet strap. The major part of the users (76%) had a perception of high risk for accidents. The prevalence of accidents was 8%; it was higher among males and among those individuals aged from 18 to 35 years. The use of motorcycle was widespread in the population. Users were aware of the risk of accident, even though they reported to not wear correctly the helmet.*

Key words *Motorcycles, Accidents, Traffic, Epidemiology, Public policies*

Resumo *Este estudo buscou descrever o perfil dos usuários de motocicleta e determinar a prevalência de uso desta. Além disso, avaliar a razão para o uso da motocicleta, o risco percebido de acidente de trânsito, o padrão de uso do capacete e o número de acidentes com injúrias ocorridos nos últimos 12 meses. Estudo transversal realizado na cidade de Pelotas com processo de amostragem conduzido em dois estágios. A primeira unidade foi o setor censitário e a segunda a casa dos indivíduos. Foram incluídos 3.004 indivíduos com idades entre 10 e 59 anos, que responderam um questionário estruturado. O desfecho do estudo foi o uso de motocicleta. A prevalência do uso de motocicleta foi de 25,1%. A maioria dos motociclistas foi composta por homens (79%). Indivíduos com idade entre 18 e 35 anos representaram 42% do total de usuários, especialmente como motoristas (24%), e 40% reportaram não usar adequadamente o capacete. A maior parte dos usuários (76%) considerou estar em alto risco para acidentes. A prevalência de acidentes foi de 8%, sendo mais alto entre os homens e entre os indivíduos com idade entre 18 a 35 anos. A motocicleta é amplamente usada nesta população. Usuários estão cientes do risco de acidentes, embora tenham reportado não usar o capacete de forma adequada.*

Palavras-chave *Motocicletas, Acidentes de trânsito, Epidemiologia, Políticas públicas*

¹ Programa de Pós-Graduação em Epidemiologia, Departamento de Medicina Social, Faculdade de Medicina, Universidade Federal de Pelotas (UFPel). R. Mal. Deodoro 1160/3º, Centro. 96020-220 Pelotas RS Brasil. ffdemarco@gmail.com

² Programa de Pós-Graduação em Odontologia, Faculdade de Odontologia, UFPel. Pelotas RS Brasil.

Introduction

Brazil has suffered deep economical changes since the 1990s, which have led to the reduction of income inequalities and the increase of goods consumption among the poorer. The government policy against the economical crisis has started in 2008 and focused on reducing taxes and favouring access to bank credit^{1,2}. In this context, the automobile and the motorcycle industries were among the targeted sectors to be benefited by this economical policy. In addition to that, few improvements in public transportation were made, thus it remained inefficient and relatively costly^{3,4}.

Some factors may explain the 400% increase in motorcycles observed in Brazilian metropolises^{5,6} since 2003: a) favoured access to bank credit; b) lower cost compared to cars; c) inefficiency of public transportation. Thus, motorcycle was considered an alternative transportation. This increase, however, was accomplished by undesired consequences, such as high number of traffic accidents involving motorcycles, with many cases involving fatal victims⁷. According to the Brazilian laws, to ride a motorcycle individuals must be over 18 years-old; have specific license after being submitted to mandatory training; and always wear the helmet⁸.

In 2010, the World Health Organization (WHO) estimated more than 1,2 millions deaths caused due to traffic accidents. For 2030, traffic accidents are expected to be the 5th cause of deaths⁹. In Brazil, external causes – where the traffic accidents are included – represented the second greater cause of deaths, being the first among individuals age 5 to 39 years-old¹⁰. National data revealed that the number of deaths and severe injuries has overcome 150 thousand individuals, with a total cost (social and economic) estimated in US\$ 28 billions^{2,11}. A recent study showed that between 1996 and 2009 the mortality rate increased from 0.5 to 4.5 per 100.000 habitants in Brazil – an increase of 800% in mortality rates during the period with a 19% average annual increase¹².

In order to prevent traffic accidents there is a need for more investigation in relation to the epidemiological patterns of motorcycle use. It is a concern to identify the most vulnerable individuals, especially in low- and middle-income countries, which are responsible for more than 90% of the traffic accidents in the world^{13,14}. In Brazil, main victims of transit are motorcycle riders and pedestrians¹⁵. However, studies investigating the use of motorcycle and the prevalence of accidents in the country are mostly originated from emer-

gency care services data¹⁶. Thus, it is essential to know the prevalence of use and the profile of these users to better evaluate the risks that those are submitted. It will allow the implementation of more effective public prevention policies.

Therefore, this study aimed to investigate the profile of motorcycle users – riders and passengers, and the prevalence of use. In addition, we aimed to evaluate the reason for using a motorcycle, users' perceived risk of traffic accident, pattern of helmet wearing and number of accidents related to motorcycle use in the last 12 months.

Materials and methods

Between January and June 2012, a population-based cross-sectional study was carried out in the urban zone of Pelotas. The city is located in Southern Brazil, with an estimated population of 328,000 habitants¹⁷. This investigation was part of a general survey, involving different health outcomes¹⁸. For the sample size calculation, it was estimated a prevalence of 20% for motorcycle use, based on the number of motorcycles registered in the traffic department (DETRAN-RS), with an acceptable error of 5 percentage points and a design effect of 2.0. The sample size was determined as 566 individuals, including 15% for losses or refusals. The final sample included 3,920 individuals because the other outcomes investigated in the survey required higher sample.

The sample selection was performed in two stages and the primary stage unit was the census tracts from the last National Census¹⁷. One hundred and thirty, out of the 495 existents, census tracts were systematically sorted, and they were ordered by their geographic location. In these census tracts, all inhabited private houses were listed (excluding those without habitants and those only with commercial purposes), being systematically chosen 12 houses in each sector. In each house, all individuals aged 10 to 59 years-old were interviewed, excluding those individuals physically impaired to use motorcycle and those mentally compromised to answer the questionnaire.

Data collection was made by previously trained interviewers, through visits to the individuals' houses. The research instrument was a structured questionnaire, previously tested, and composed by each specific outcome investigated. Moreover, a general section was related to socio-economic and demographic information. Before individuals could be classified as a lost, they should be searched at least for three times.

Motorcycle use was defined as the outcome of this study. Its use was registered if it was considered by the interviewed as the current option of transportation for any purpose, including leisure, commuting to work or study or familial transport. Motorcycle users were classified as riders or passengers. The non-habitual use of motorcycle was considered current use.

The independent variables collected were sex, age (complete years; subsequently categorized in adolescents (10-17 years); and adults (18-35 years/36-49 years/50-59 years), skin color (white/dark black/light black/others), years of schooling (complete years of study; subsequently categorized in four categories: 0-4 years/5-8 years/9-11 years/12 years or more) and economical level (based on the IEN – Indicador Econômico Nacional/ National Wealth Score - in quintiles)¹⁹.

Also, the purpose of motorcycle use was investigated, with the following options: commuting to work or study; leisure; to conduct the children or relatives to school or work; work (motorcycle office boy or taxi) and other work requiring the use of motorcycle (for example sales promoter, post office workers/mailman).

The frequency of use (dependent variable) was characterized by the use of the motorcycle during the week, on the weekends or on both. The number of daily hours use was asked.

In relation helmet wearing, it was asked about how the individual kept the helmet strap fastened (properly used – fastened and tightened when starting to ride the motorcycle; not properly used – always closed but not fastened or never closed). In relation to risk of traffic accidents perception, a Likert scale was used, with five levels, ranging from very high risk to very low risk.

Motorcycle accident was defined as a traffic accident with injury to the motorcycle user, in a rider or in a passenger condition. These accidents included falls, collisions and pedestrians running over. The questionnaire focused on the accidents happened in the last 12 months and investigated the number of accidents. It was applied also including those individuals that stated not using a motorcycle currently. This was made in order to detect those individuals that were not using the motorcycle due to sequels or fear caused by previous accidents. These individuals were not included in the prevalence analysis.

Data quality control was carried out with the application of the question about current use of motorcycle to 10% of the sample size, randomly selected. For results comparison, *kappa* index was used.

Statistical analysis was performed using the STATA 12 software package (StataCorp., College

Station, TX, USA) using the *svy* command for conglomerate samples.

The study had the approval of the Federal University of Pelotas Ethic Committee. All the individuals included in the study have signed the informed consent form.

Results

In the 1,722 houses visited, 3,152 individuals aged from 10 to 59 years were found. From those, 3,004 were interviewed, resulting 13.2% of losses and refusals. No differences were observed between age groups, however it was higher amongst the males (57%). The Design Effect (DEF) for the current use of motorcycle was 2.5. A *kappa* index of 0.81 was found for this question when comparing interview and quality control, indicating high repeatability.

Table 1 describes the sample interviewed. It shows a higher number of females (56.1%) and age range between 18 and 49 years (63.7%). Approximately 60% of the adults (individuals aged 18-years or beyond) interviewed and 75% of the adolescents (individuals aged 10 to 17-years-old) presented from 4 to 11 years of schooling. In relation to the 754 motorcycle users identified in the total sample, there was a predominance of men as riders (79.8%) and women as passengers (73%). Young adults (aged between 18 and 35 years) were half of the riders, while among the passengers the predominant age range was between 10 to 35 years (68.4%). Eighteen adolescents (5%) informed that they use the motorcycle as riders. Approximately 2/3 of the riders were situated in the intermediate quintiles of income and the passengers were predominantly in the lower income level.

The prevalence of motorcycle use in the surveyed population was 25.1% (95%CI 22.6-27.6) and according to the motorcycle condition use, rider or passenger, it was 12% 95CI% (10.6-13.4) and 13.1% 95CI% (11.4-14.8), respectively.

Table 2 shows that the prevalence of use among the females was 21.3% 95CI% (18.7-23.9), while among the males it was 29.9% 95CI% (26.7-33.2). The rate of riders was 5 times higher among men compared to women (21.9 *versus* 4.3%, $p < 0.001$). In the passenger condition, the results were in the opposite way with a higher proportion of women compared to men (17.1 *versus* 8%, $p < 0.001$). Approximately 25% of the adolescents and adults aged 18 to 49 years old used the motorcycle. Among the older ones, the prevalence of use was lower (17.1%). In general,

Table 1. Description of total sample and the use of motorcycle according to socioeconomic and demographic variables and according to user condition (driver or rider). Pelotas, Brazil, 2012.

Variables	General		Motorcycle user condition			
	Total Sample		Rider		Passenger	
	N	%	N	%	N	%
Sex						
Male	1320	43.9	289	79.8	106	27.0
Female	1684	56.1	72	20.2	287	73.0
Skin color						
White	2360	78.6	287	79.5	293	74.6
Dark black skinned	390	13.0	42	11.6	61	15.5
Light black skinned	219	7.3	27	7.5	33	8.4
Others	35	1.2	5	1.4	6	1.5
Age						
10-17 years	576	19.2	18	5.0	133	33.8
18-35 years	1111	37.0	181	50.1	136	34.6
36-49 years	803	26.7	120	33.2	78	19.9
50-59 years	514	17.1	42	11.6	46	11.7
Years of Schooling - Adults (N = 2260)						
0-4 years	237	10.5	23	7.1	24	10.7
5-8 years	635	28.1	112	34.5	71	31.6
9-11 years	706	31.2	130	40.0	87	38.7
12 years or more	682	30.2	60	18.5	43	19.1
Years of Schooling - Adolescents (N = 576)						
0-4 years	119	20.6	4	22.2	22	16.5
5-8 years	341	59.2	14	77.8	93	69.9
9-11 years	109	18.9	-	-	17	12.8
12 years or more	7	1.2	-	-	1	0.8
IEN 5quintiles						
1 (20% poorer)	552	18.5	69	19.2	94	24.0
2	592	19.9	62	17.2	81	20.7
3	626	21.0	82	22.8	86	22.0
4	600	20.1	88	24.4	84	21.5
5 (20% richer)	609	20.4	59	16.4	46	11.7
Total	3004		361		393	

riders were aged 18 to 35 years (16.3%) and 36 to 49 years (15%) ($p < 0.001$). Among adolescents, 23.1% used the motorcycle in the passenger condition, and there was a decrease in the prevalence of passenger condition with aging, since it was reported by only 9% of the individuals aged 50 to 59 years. The prevalence of motorcycle use for both conditions, as rider or passenger, was lower in the richest quintile (17.2%)

The prevalence of accidents in the last 12 months was 8% (95%CI 5.6-10.3). Among men and women the occurrence was 10.6% and 5%, respectively ($p < 0.001$). The highest proportion of accidents happened in the age group of 18 to 35 years (12.3%). The prevalence of accidents in riders was 13.9% (95%CI 9.8-17.9) and 2.5% (95%CI 0.8-4.2) in passengers (data not shown).

In the survey, it was noted 21 accident victims that were not using the motorcycle currently due to previous accidents. If those individuals were included in the analysis, the prevalence of accident would be 10.5% (95%CI 8.4-12.8)

Table 3 shows that 75.9% of the users had a perception of very high or high risk of suffering a traffic accident. The large majority (62.4%) reported to use the motorcycle for less than 1 hour /day and 6.5% used for more than 4 hours/daily. Half of the sample (49.9%) used the motorcycle during the week and on the weekends. More than 40% reported wearing the helmet without adjusting the strap properly or they have not fastened the strap.

The reasons for motorcycle use are described in Table 4. More than half of the users, have indi-

Table 2. Prevalence of motorcycle use in general and for condition (driver or rider) and traffic accidents related, according to socioeconomic and demographic condition. Pelotas, Brazil, 2012.

Variables	Motorcycle use						Accidents last 12 months	
	Total		Rider		Passenger			
	N	%	N	%	N	%	N	%
Sex	p < 0,001		p < 0,001		p < 0,001		p < 0,001	
Male	395	29,9	289	21,9	106	8,0	42	10,6
Female	359	21,3	72	4,3	287	17,1	18	5,0
Skin color	p = 0,717		p = 0,843		p = 0,5113		p = 0,690	
White	580	24,6	287	12,2	293	12,4	49	8,5
Dark black skinned	103	26,4	42	10,8	61	15,6	7	6,8
Light black skinned	60	27,4	27	12,3	33	15,1	4	6,7
Others	11	31,4	5	14,3	6	17,1	-	-
Age	p < 0,001		p < 0,001		p < 0,001**		p < 0,001	
10-17 years	151	26,2	18	3,1	133	23,1	3	2,0
18-35 years	317	28,5	181	16,3	136	12,2	39	12,3
36-49 years	198	24,7	120	15,0	78	9,7	14	7,1
50-59 years	88	17,1	42	8,2	46	9,0	4	4,6
Schooling***	p < 0,001		p < 0,001		p < 0,001		p = 0,333	
0-4 years	47	19,9	23	9,8	24	10,2	4	8,5
5-8 years	183	28,8	112	17,6	71	11,2	10	5,5
9-11 years	217	30,7	130	18,4	87	12,3	23	10,6
12 years or more	103	15,1	60	8,8	43	6,3	8	7,8
IEN (quintiles)	p = 0,02		p = 0,081		p = 0,002		p = 0,647	
1 (20% poorer)	163	29,5	69	12,5	94	17,0	15	9,2
2	143	24,2	62	10,5	81	13,7	8	5,6
3	168	26,9	82	13,1	86	13,8	13	7,7
4	172	28,7	88	14,7	84	14,0	14	8,1
5 (20% richer)	105	17,2	59	9,7	46	7,6	10	9,5
Total	754		395		359		60	

* Values of p obtained by Poisson regression, using the *svy* command for conglomerate samples. ** p value of linear trend. *** only for adults (20 years or more).

cated the use for commuting to work or study; almost 15% used to conduct children and relatives to school or work; 75% used for leisure and only 2% had the motorcycle as their tool for work, like taxi or motorized office boys.

Discussion

The main finding of this study was that motorcycle users (riders and passengers) had a widespread distribution in the investigated population, meaning that men and women of several ages and from different socioeconomic classes are using motorcycle. The increased number of motorcycles was not followed by public policies focusing on this specific vehicle^{9,15,16,20,21}. According to the literature, motorcycle users have 7 times greater risk of death and 4 times higher risk of body lesion when compared to automobile users¹⁵. In

five Brazilian metropolises it was observed that in 61% to 82% accidents involving motorcycle, there were victims, while in automobile accidents this rate was lower². Such finding clearly demonstrates the risk involved when motorcycles are used. National data from Brazil shows that the number of motorcycle on the streets has increased 4 times from 2008 to 2011²². As a consequence, there was an expressive increase of 350% in the deaths caused by motorcycle use from 2000 to 2010¹⁵. The increased number of motorcycles in the country could be attributed to the inefficiency and high cost of public transportation in addition to the bank credit benefit to purchase a new vehicle. The amount of money paid monthly to get a new vehicle is similar to the cost of public transportation, besides the user has the feeling of more freedom and independence in his own vehicle²³. Around 40% of the individuals that bought a motorcycle in 2012 in Brazil had the purpose to

Table 3. Characteristics of motorcycle use in relation to the daily use, perception of risk for accidents, frequency of use and use of helmet. Pelotas, Brazil, 2012. (n = 754)

Variables	N	%
Perception of risk		
Very high	333	44.2
High	239	31.7
Medium	136	18.1
Low	34	4.5
Very low	11	1.5
Daily hours use		
Up to one hour	470	62.4
Two to three hours	231	30.1
More than 4 hours	49	6.5
Frequency of use		
Weekdays	222	29.5
Weekends	156	20.8
Both	375	49.9
Helmet strap		
Fastened and tightened when starting to ride the motorcycle	426	56.6
Always closed but not fastened	276	36.6
Never closed	51	6.7

Table 4. Reason for motorcycle use. Pelotas, Brazil, 2012. (n = 754).

Variables	N	%
Reason for use		
Commuting to work or school	434	57.4
Leisure	559	75.9
Children of relatives transportation	110	14.6
Motored office boy or taxi	16	2.2
Other kind of work	26	3.4

replace the use of public transportation, according to the National Association of Motorcycle Producers²². Thus, motorcycle should be considered the true popular transportation in Brazil²³.

Our findings demonstrated that the proportion of men and women using the motorcycle is similar; however, a huge difference is observed in role played by them. While men were predominantly riders, women were mostly passengers. Despite of that, this study showed a high rate of female among the drivers (more than 20%), compatible with the data from motorcycle buyers (25% in 2011)²². Therefore, it is essential that approaches leading to accident prevention should also be directed to females. Another population

based study²⁴ carried out in Iran found less than 4% of women riders, but this difference could be related to cultural differences between the countries and also related to the role that women play in the society.

We expected that motorcycle users would be young individuals from the lowest socioeconomic position. However, the present study demonstrated that motorcycle use was distributed homogeneously in the population, revealing that there is not a specific pattern for motorcycle uses. Despite of the low prevalence of motorcycle use for work in our study, previous studies have suggested that this type of activity was responsible for increasing the number of traffic accidents²⁵⁻²⁷. In this specific population, other purposes appeared to be more relevant causes, since families have motorcycles as their first transportation option (work/school and leisure). Almost 50% of those interviewed reported to use motorcycles on weekdays and weekends, suggesting that motorcycle is the main transportation vehicle. It was also possible to verify that individuals that less often use motorcycles are the 20% richer and those above 50 years old. It is also alarming that 5% of motorcycle riders were below 18-years-old, which is the minimum age to legally drive in Brazil. This fact emphasizes the lack of surveillance by the Brazilian traffic authority^{13,15}. Moreover, the predominately daily use was shorter than one hour, turning clear that the focus of the public policies to prevent traffic accidents should be on the large number of users and not on the amount of time individuals are spending over the motorcycle.

Even though the large majority has declared that the risk for accidents is very high or high, individuals continue to elect the motorcycle as the main vehicle. Subjects prefer the motorcycle because of its rapid and easy dislodgement, with a better cost/benefit when compared to public transportation^{3,4}. However, motorcyclists should be faced as a vulnerable group in the traffic context, once the vehicle has no additional security equipment apart from the helmet²⁸. This risk should be perceived in order to make decision and change risky behaviors²⁹. Therefore, it is necessary people believe that safety measurements are effective, influencing them to use properly the protection equipment and to respect the laws.

Although, a high risk of accident was perceived in the sample, almost half of the users are not properly wearing the helmet. In 2013, the Brazilian National Transit Council (CONTRAN) released official instructions regarding the adequate helmet wearing and its mandatory use for motorcyclists. According to the document, the

helmet should be adequately placed, with the strap fastened under the lower jaw³⁰. The incorrect use of the helmet can produce an undesirable effect; the helmet can be launched to distance in the case of an accident, inhibiting its protective effect³⁰. Also, the type of helmet should be considered, since open-face helmets did not always offer adequate protection against craniomaxillofacial injury even when used properly³¹.

Considering the accidents, our results corroborate the findings from studies carried out in emergency care services and hospitals. They indicated that young males are the most frequent victims^{7,9,15,20,21,32-37}, due the proper characteristics of youth, such as the impulsivity and necessity of self-affirmation³⁴. These data reinforce the concerns demonstrated by the WHO in relation to the morbidity/mortality for external causes in which young males are the priority focus of prevention^{16,30}. Our findings support the importance of public health policies in order to prevent the motorcycle accidents. The cost for the individuals and for the public health system to treat those suffering motorcycle accidents is very high. This is a concern not only in Brazil, but also in other low- and middle-income countries where there is a widespread use of motorcycles. Mortality among Brazilian motorcyclists increased by more than 700% between 1998 and 2008¹⁵. Hospitalizations covered by the Brazilian Unified Health System due to motorcycle accidents had an increase of 83% in five years. In the same period, the increase in hospitalizations due to all types of road accidents was about 9%²⁵.

This study is not free of limitations. First, information collected was self-reported. Thus, it can be in some degree affected by recall bias. Second, the cross-sectional design of the present study could not allow the establishment of a historic and trend of motorcycle use; neither to identify changes in the users profile. Finally, it was not possible to collect precisely the reason why some individuals were not using motorcycle anymore.

This study has several strengths that should be emphasized. Initially, the sampling process allowed the knowledge of population data, without the bias of taking data from emergency care services or from hospitals. This assures internal validity of our findings and avoids the overestimation of accidents. Also, the city of Pelotas has characteristics – Index of Human Development (0.81), schooling level, age variation groups and income level – which are similar to the major part of Brazilian cities. Thus, our findings could be extrapolated to other cities with similar profile.

The World Health Organization⁹ has reinforced the need of producing epidemiological data that are the basis for formulation of public policies for accident prevention. Findings revealed in our study are within the scope requested by the WHO; thus it can be useful to produce public policies in Brazil and also in other countries experiencing similar issues. Public policies for motorcycle accidents prevention should be as effective as the market policies toward the increase of motorcycle selling. Stricter rules to obtain drivers' license, effective transit surveillance, and investments in traffic engineering are fundamental actions to enhance the safety of motorcycle use.

Collaborations

LM Seerig, G Bacchieri, GG Nascimento, AJD Barros and FF Demarco participated equally in all stages of preparation of the article.

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