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Original article

Mental disorders and delivery motorcycle drivers (motoboys): A dangerous association

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ABSTRACT

Objective. – Low and middle-income countries experience an expressive growth in the number of circulating motorcycles, paralleled by an increasing number of traffic accidents. Delivery motorcycles drivers (“motoboys”) are generally perceived as accountable for this scenario. Although traffic accidents have a multivariate etiology, mental disorders, such as substance use disorders (SUD) and attention deficit/hyperactivity disorder (ADHD), are often involved. This paper aims at investigating the prevalence of ADHD, SUD and other mental disorders in a sample of Brazilian motoboys, and additionally, to evaluate the association between psychiatric diagnoses, motorcycle accidents and traffic violation tickets.

Method. – A convenient sample of subjects was invited to participate in a cross-sectional assessment including an inventory of traffic accidents and violations. Psychiatric diagnoses were based on semi-structured and clinical interviews.

Results. – A sample of 101 motoboys was assessed. Overall, 75% of subjects had a positive lifetime history of at least one psychiatric disorder. SUD was the most frequent diagnosis (43.6% for alcohol, 39.6% for cannabis). ADHD was associated with a higher number of traffic accidents ($p = 0.002$), and antisocial personality disorder (APD) was associated with a greater number of traffic violations ($p = 0.007$).

Conclusions. – The prevalence of mental disorders was much higher in our sample than in the general population. ADHD and APD, but not SUD, were associated with negative traffic outcomes. These findings have implications for public mental health planning since mental disorders can be both prevented and treated, improving driving behavior and increasing road safety.

1. Introduction

Road traffic injuries are a major but neglected public health issue [14]. Yearly, 1.2 million people worldwide die in traffic accidents, while 50 million more are injured. About 85% of the deaths and 90% of the disability-adjusted life years (DALYs) caused by road traffic accidents in the world occur in low and middle-income countries (LAMIC) [15]. Projections indicate that mortality will increase by about 65% around the world, and by as much as 80% in these countries over the next 20 years [21].

As a result of emerging economies and increased urbanization, motorcycles are widely used in LAMIC as a mode of transportation. Fast speed, high maneuverability, and low cost have lead to an exponential growth in the number of circulating motorcycles [23]. This is particularly true for most southeastern Asian countries, where the proportion of two-wheeled vehicles compared to other vehicles varies from about 37% to 95%, as seen in Vietnam [10]. The average number of motorcycles per thousand people in a number of Asian cities is nearly 200, which is seven times the average found in other cities worldwide [24]. Unsurprisingly, South-East Asia has the highest proportion of global road fatalities [13]; nevertheless, even in developed countries, the risk of dying for every kilometer traveled from a motorcycle crash is 20 times higher than from other motor vehicles [26].

While the number of motorcycles per inhabitant is still relatively low in Latin American countries compared to these Asian nations, a dramatic increase in the fleet has been observed over the last 20 years. Particularly in Brazil, the annual production of motorcycles went from around 200,000 in the 1980s to over two million in 2008 [1], which was accompanied by a 400% increase in male motorcycle-related mortality [18].

In developing countries like Brazil, motorcycles are used not only for travel or leisure, but also to deliver documents and small commodities (e.g., food, drugs, flowers, books). With a box fastened

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at the back of the motorcycle, messengers can rapidly drive through traffic jams and deliver packages of up to 20 kg at customers' doors. In Brazil, where these deliverymen are called "motoboys", over 140,000 people work in this business in the city of São Paulo only. Although there are no official statistics, motoboys are generally perceived as accountable for the increase in the number of traffic accidents in major Brazilian cities [25]. A recent study conducted in Porto Alegre, where the present study was conducted, found that among the 502 patients hospitalized in an emergency care unit after a traffic accident, 342 (68.1%) were motorcycle drivers [8].

Although traffic accidents have a multivariate etiology, the major causes might be attributed to human error [19]. In this context, two main factors are associated with human errors: substance use and inattention, which might be accounted, at least in part, by the diagnoses of substance use disorders (SUD) and attention-deficit/hyperactivity disorder (ADHD). It is estimated that 30–50% of the subjects with SUD (alcohol or cannabis, mostly) have a comorbidity with ADHD [28,29]. Surprisingly, despite the increasing number of individuals working as motoboys in developing countries, the continuous growth of motorcycle traffic accidents and the potential connection between accidents and both ADHD/SUD, little attention has been given to the study on the association between mental health and delivery motorcycle drivers.

Thus, the aims of this study were:

(i) to describe key characteristics of a sample of Brazilian delivery motorcycles drivers – particularly demographics that may be related to risk or protective factors;
(ii) to assess the prevalence of psychiatric disorders – particularly ADHD and SUD in a convenience sample of motoboys;
(iii) to investigate the association between psychiatric diagnoses and main traffic outcomes, namely motorcycle accidents and violation tickets.

We hypothesized a high frequency of mental disorders among motoboys and an association between negative driving outcomes and the presence of a lifetime diagnoses of either ADHD or SUD.

2. Method

2.1. Subjects

The study was conducted in Porto Alegre, a state capital with 1,360,000 inhabitants in southern Brazil. A convenience sample of subjects was recruited from three locations:

(i) the city's largest emergency and trauma hospital (Hospital de Pronto Socorro [HPS]);
(ii) delivery motorcycle companies, identified through the phone book;
(iii) the main public motorcycle parking lot, located downtown.

All subjects admitted at HPS from September 2006 to April 2008 due to a traffic accident who reported working as a motoboy were contacted by phone after hospital discharge and invited to participate, if eligible. A one-page letter briefly describing the project and inviting subjects to participate was sent to all delivery motorcycle companies that we were able to identify. Additionally, flyers were distributed to all motoboys at the parking lot on different occasions during 3 consecutive months. With the exception of subjects from HPS – who were actively recruited by phone – all other prospective participants were required to call the study center to check whether they met inclusion criteria and eventually schedule their evaluation.

Participants were enrolled in the study if they were (i) currently working as motoboys; (ii) between 19 and 34 years of age; (iii) living in the metropolitan area of Porto Alegre; and (iv) literate. Subjects were excluded if they presented with health problems that could interfere with their ability to drive (psychosis; sensory or motor difficulties; apnea; or epilepsy). Study procedures and goals were briefly described over the phone, and subjects were invited to come to the study center for a 4-h evaluation. Upon arrival, all participants received a detailed project description and signed a written informed consent. All subjects were paid approximately U$ 5 per hour of participation to compensate for their off-duty time. The study protocol was approved by the Institutional Review Board of Hospital de Clínicas de Porto Alegre.

2.2. Study procedure

After contacting the study center and when meeting full inclusion criteria, subjects were scheduled for evaluation. Subjects were evaluated during one night (from 6 to 10 p.m.) on a weekday, and were scheduled in groups of two to four motoboys per session. All assessments were conducted in private, separate rooms.

The full evaluation comprised:

(i) a sociodemographic questionnaire, including an assessment of socioeconomic status, as defined by the Brazilian Association of Market Research [4] using a scale of five socioeconomic levels, from 'A' (highest) to 'E' (lowest);
(ii) a self-reported descriptive history of traffic accidents and violations;
(iii) the block design and vocabulary subtests of the Portuguese version of the Wechsler Adult Intelligence Scale (WAIS-III) [32], applied by a psychologist (RSC);
(iv) a semi-structured psychiatric diagnostic interview (Mini-International Neuropsychiatric Interview [MINI]), adapted and validated for use in Brazil [3], followed by an evaluation of adult ADHD symptoms, using the Adult Self-Report Scale (ASRS), also validated for use in the Brazilian population [16], both conducted by a psychiatrist (CMS);
(v) assessment of childhood externalizing disorders, including ADHD, using the Schedule for Affective Disorders and Schizophrenia for School-Age Children, Epidemiological Version (K-SADS-E) [20], modified to assess DSM-IV criteria, Portuguese version [17], applied by trained researchers (RK, BM and CK), whose inter-rater reliability had been previously evaluated (Kappas from 0.77 to 1.00, $p < 0.001$).

The diagnosis of ADHD was obtained through a three-stage process:

(i) evaluation with the two semi-structured interviews, K-SADS-E (for childhood symptoms) and ASRS (for adult symptoms);
(ii) review of each diagnosis derived through the K-SADS-E by an experienced child psychiatrist (CMS);
(iii) telephone interview with one of the parents of all subjects who reported a subthreshold diagnosis of ADHD (≥ 4 symptoms in any dimension or age of onset > 7 years).

With regard to the history of traffic accidents and violations, subjects were asked to inform (i) their best estimates for number of lifetime motorcycle traffic accidents, regardless of responsibility (i.e., whether they judged they had caused the accident or not) or circumstance (i.e., whether they took place while working or during leisure time); and (ii) best estimates for total number of tickets received for traffic violations, again either during leisure or working hours. Reported accidents were further classified as with or without victims, based on subjects' report of whether these had

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resulted or not in a referral to a physician or an emergency room. Each part of the evaluation was conducted by a different member of the research team, blinded to results of the other evaluations. We here report results for the association between psychopathology and self-reported traffic behavior.

2.3. Statistical analyses

For the primary analyses in this study, all psychiatric diagnoses were defined as study factors, and traffic measures were considered outcomes. The following three-stage strategy was adopted: (i) assessment of potential confounders; (ii) for each mental disorder, association between study factors and outcomes was analyzed after adjusting for potential confounders; and (iii) diagnoses that were associated with the same outcome ($p \leq 0.2$) were combined, together with respective potential confounders, in the final models. The following covariates were assessed as potential confounders: age, gender, IQ, educational level, socioeconomic status, marital status, psychiatric comorbidities, recruitment site, religion, employment status, and amount of traffic exposure. Statistically, a confounder was defined as a covariate associated with both independent and dependent variables ($p \leq 0.2$). Additionally, traffic exposure was included as a covariate in all models based on a conceptual rationale. This variable was defined as an estimate of the number of hours working as a motoboy (hours per day $\times$ days per week $\times$ 4 $\times$ months working as motoboy). Association between diagnoses and traffic behavior was tested using analysis of covariance (ANCOVA). Comparison among categorical variables was performed using χ^2 or Fisher's exact test; continuous variables were compared by Student T test or Mann-Whitney U test, according to data distribution. A 5% level of significance was accepted in all analyses.

3. Results

A total of 101 motoboys participated in the study. Recruitment sites (HPS, companies, parking lot) contributed with 40, 25, and 10 subjects for the present sample, respectively. The 26 remaining subjects were enrolled after calling the study center following the referral of a friend/co-worker who had previously participated in the research, in a manner similar to snowballing techniques. Referrals were not financially reimbursed by the study. The sample was predominantly male (95%), white (63.4%), and had completed high school (66.3%). Sociodemographic characteristics of study participants are presented in Table 1.

Only 37 out of 101 participants reported being legally employed. Subjects reported having a motorcycle driver's license for a mean of 71.16 months (range 6–156) and working as a motoboy for a mean of 57.51 months (range 5–156). Seventeen subjects were working as delivery motorcycle drivers before obtaining a license. The mean of current working hours was 9.79 (S.D. 2.98) per day. Twenty-three subjects reported working 7 days per week, and 37 had a six-day work-week.

Table 1
Sociodemographic characteristics of the sample ($n = 101$).

Characteristic	N	%
Age distribution in years		
19–26 years	44	43.6
27–34 years	57	56.4
Marital status		
Single	40	39.6
Married/civil union	61	60.4
Ethnicity		
European descent	64	63.4
Non-European descent	36	35.6
Highest education		
Less than high school	34	33.7
Completed high school	59	58.4
Some college	8	7.9
Socioeconomic status[a]		
B	25	24.8
C	62	61.4
D/E	14	13.9

[a] As defined by the Brazilian Association of Market. Research [15], in a scale comprising five socioeconomic levels, from 'A' (highest) to 'E' (lowest).

Lifetime prevalence of psychiatric diagnoses was notably high. The most prevalent lifetime DSM-IV disorders were substance use disorder (mostly alcohol) (43.6%) and cannabis (39.6%), and mood disorders (31.7%), which included only cases of major depressive disorder ($n = 28$) and dysthymia. Several cases of childhood externalizing disorders were also identified in our sample, particularly of conduct disorder ($n = 29$) and ADHD ($n = 15$). There were also 14 cases of antisocial personality disorder (ASPD). Overall, the lifetime prevalence estimate of any disorder was 75%, with 54% of respondents having two or more diagnoses. None of the participants were at the time receiving treatment for psychiatric diagnoses. The distribution of these disorders was similar across different sources of recruitment, as seen in Table 2.

Personal history of traffic accidents and violations yielded an average of 4.52 tickets for traffic violations (S.D. = 6.38), 6.82 accidents (S.D. = 7.45), and 2.23 (S.D. = 2.0) accidents with victims. Twenty subjects reported no previous tickets for traffic violations, but only two reported never being involved in motorcycle traffic accidents. Nine subjects reported having had their driver's license suspended at least once.

Table 2
Lifetime prevalence of psychiatric disorders stratified by recruitment source.

Disorder	n	Total (%)	Recruitment site			X^2	df	P
			Hospital	Companies	Other			
Anxiety disorders	13	12.9	8	3	2	3.548	2	0.170
Mood disorders	32	31.7	16	4	12	4.164	2	0.125
Substance use disorders								
Alcohol	44	43.6	16	11	17	0.405	2	0.817
Cannabis	40	39.6	14	9	17	1.364	2	0.506
Cocaine	33	32.7	13	7	13	0.442	2	0.802
Solvents/inhalants	12	11.9	3	3	6	1.521	2	0.467
ADHD	15	14.9	5	3	7	0.936	2	0.626
Oppositional defiant disorder	16	15.8	9	2	5	2.586	2	0.274
Conduct disorder	29	28.7	14	7	8	1.520	2	0.468
Antisocial Personality disorder	14	13.9	3	6	5	3.508	2	0.173

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Table 3
Association between attention–deficit hyperactivity disorder, substance use disorder, and antisocial personality disorder with reported traffic outcomes (mean, CI95%).

	Attention-deficit hyperactivity disorder		Substance use disorder		Antisocial personality disorder	
	Absent	Present	Absent	Present	Absent	Present
Violation tickets	6.50 (4.34–8.67)	6.29 (2.79–9.80)	5.98 (3.14–8.83)	6.81 (4.84–8.78)	3.57[b] (1.41–5.73)	9.22[b] (5.78–12.67)
Accidents	6.28[a] (3.89–8.67)	13.44[a] (9.72–17.17)	10.11 (7.01–13.20)	9.61 (7.41–11.82)	9.24 (6.90–11.58)	10.48 (6.67–14.28)
Accidents with victims	1.96 (1.16–2.77)	3.52 (2.20–4.85)	2.90 (1.83–3.86)	2.59 (1.83–3.35)	2.88 (2.07–3.68)	2.61 (1.32–3.89)

Analyses adjusted for exposure to traffic and all covariates associated with study factor and outcome at $p \leq 0.2$ (which included the diagnoses of ADHD, SUD, and ASPD for all three outcomes). The following variables were also entered in the multivariate model: for violation tickets, age, socioeconomic status and employment status; for accidents, age, anxiety disorders and IQ; and for accidents with victims, mood and anxiety disorders, IQ, employment status, and recruitment site.
[a] $p = 0.002$.
[b] $p = 0.007$.

We tested the association between traffic outcomes (violation tickets, accidents, and accidents with victims) and all psychiatric diagnoses investigated. The initial analyses, corrected only for exposure to traffic, revealed an association between ADHD and both violation tickets and accidents; it also showed an association between ASPD and violation tickets, and between anxiety disorders and accidents with victims. No other psychiatric diagnosis was associated with the measured traffic outcomes. After inclusion of all potential confounders in the final models, only two associations remained statistically significant (Table 3). The presence of an ADHD diagnosis was associated with a higher number of traffic accidents ($p = 0.002$): those with ADHD had an average of 13.44 accidents (CI95% 9.72–17.17) compared to a mean of 6.28 accidents (CI95% 3.89–8.67) for those without ADHD. Additionally, the presence of ASPD was associated with an increased number of traffic violations ($p = 0.007$). Individuals with this diagnosis reported a mean of 9.22 tickets (CI95% 5.78–12.67), whereas those without the diagnosis had an average of 3.57 violation tickets (CI95% 1.41–5.73).

4. Discussion

Delivery motorcycles drivers, motorcycle couriers, or simply motoboys, are a ubiquitous phenomenon in the large cities of many developing countries. Whether bringing the comfort of a warm pizza on a Sunday night or delivering an anxiously awaited business report, they have become a necessary part of city life. Motorcycle riders weave in and out of traffic, allowing for a quick and non-stop movement of goods. While over the last decade thousands of young men have joined this risky profession, available information on their involvement in urban traffic accidents and the reasons for this outcome are still scarce. In this context, our findings document for the first time an association between both ADHD and ASPD and driving outcomes in this specific population.

Data reported here document a high lifetime prevalence of psychiatric disorders in delivery motorcycle drivers with 75% of respondents reporting a lifetime history of at least one of the DSM-IV/MINI disorders considered in the survey. Compared to the prevalence for a similar age group (18–29 years) in the U.S., our sample presented higher frequencies of psychiatric diagnoses, except for anxiety disorders [12]. Figures were also substantially higher compared to a previous age-adjusted lifetime prevalence study conducted in three Brazilian cities, including Porto Alegre [2], where rates for the most prevalent mental disorders (phobic states, depressive disorder and alcohol abuse/dependence) did not surpass 15%.

Our findings documenting an association between ADHD and traffic accidents concur with previous studies reporting an increase in the risk of negative driving outcomes in adults with ADHD. A meta-analysis focusing on diseases and accident involvement yielded a relative risk of 1.54 (1.12–2.13) for ADHD, with observational studies consistently indicating that ADHD groups receive more driving citations than control groups, including speeding and other traffic violations, license suspensions and driving without a license [11]. Barkley et al. have identified problems in driving abilities, including cognitive deficits regarding attention, reaction time, impulsiveness, and rule following; deficient driving knowledge; less competent handling of simulated vehicles; and less safe driving habits [5–7].

Traffic offences have been described as one of the most common symptoms of antisocial personality disorder in community samples. Swanson et al. [27] found that 81.7% of youngsters with ASPD had a history of traffic offenses; in the Epidemiological Catchment Area study [22] it was present in 56% of the ASPD sample.

Whereas the association between traffic violation tickets and ASPD verified in this study was expected, it is unclear why no association was found between SUD and any traffic outcome, considering the long known role of alcohol in traffic crashes [19]. The high prevalence of SUD in our sample may have limited the power to detect statistically significant associations with specific traffic outcomes. High levels of comorbidity may also have played a role; of notice, our sample did not include any cases of ADHD without SUD as a general category, limiting our ability to disentangle the effects of ADHD by itself and SUD. However, our analyses systematically pointed to a main effect of ADHD, whereas no specific effect for SUD was detected. Furthermore, even after subdividing SUD into "alcohol" and "illegal substances" – as we had cases of ADHD comorbid to just one of these two categories –, results remained in the same direction.

Findings of this study need to be interpreted in light of some limitations. The use of a convenience sample from a specific cultural and geographic background precludes the generalization of findings. The absence of a control group of other motorcycle or car drivers and our small sample size might have obscured some potential associations between other mental disorders and driving outcomes. Third, this study relied on self-report measures of history of traffic accidents and violations. Although there is no guarantee that participants were truthful in their answers, precautions were taken to maximize reliability, as participants were informed that their answers would remain confidential. Moreover, objective data gathered from driving authorities regarding subjects' official traffic records were found to generally underestimate subjects' reports of both tickets and accidents (data available upon request).

The strengths of the study were the systematic and extensive clinical evaluation, including parental input when needed, and the blinded evaluation of the association between psychiatric diagnoses and traffic outcomes. In order to avoid selection biases, we developed three recruitment strategies to expand and diversify our sample as much as possible, partly based on snowballing techniques, chain-referral and respondent-driven sampling, as

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recommended by Heckathorn [9]. The fact that analyses were adequately controlled for potential confounders was also a major strength of the study.

In conclusion, we found a much higher prevalence of mental disorders in motoboys than in the general young adult population. The diagnoses of ADHD and APD, but not SUD, were associated with negative traffic outcomes, including tickets and accidents. Since mental disorders can be both prevented and treated, awareness of these associations can improve driving behavior and increase road safety. Death and injury on the road is pandemic, especially among young people [14]. Road planners and law enforcement agents can make a difference in the effort to make road traffic safe. This issue assumes an even more important public mental health perspective if we consider that ADHD is a mental disorder with available efficacious treatment interventions [30] that have proven to be effective also in improving driving behavior [31].

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