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Associated factors from loss productivity among people involved in road traffic accident: a prospective study

Fatores associados à perda de produtividade em pessoas envolvidas em acidentes de trânsito: um estudo prospectivo

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ABSTRACT: ***Objective:*** To study associated factors with loss productivity in people involved road traffic accidents (RTA). ***Methods:*** The population based cohort study was conducted in Jequié, Brazil between 2013 to 2015. The instrument for interview was used in people involved in RTA and interview in four months. Individuals, occupational, health conditions, injury and support variables were used for bivariate and multivariate analysis. ***Results:*** The cumulative incidence was loss productivity was 61.1% and density incidence of 7.45 cases/100 person-month. Multivariate analysis showed association for injury (IDR = 4.23; 95%CI = 2.90 – 6.17) and vehicle used with work instrument (IDR = 2.80; 95%CI = 1.62 – 4.85). ***Conclusion:*** Public policies are needed to ensure traffic safety in order to minimize the effects of RTA about productivity and to carry news studies to expand knowledge about loss productivity.

Keywords: Accidents, traffic. Efficiency. Prospective studies.

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RESUMO: ***Objetivo:*** Estudar fatores associados à perda de produtividade em pessoas envolvidas em acidentes de trânsito (AT). ***Métodos:*** Realizou-se uma coorte prospectiva de base comunitária no município de Jequié, Bahia, Brasil, entre 2013 e 2015. Foi aplicado instrumento de coleta em forma de formulário em participantes que se envolviam em AT, seguido de entrevistas a cada quatro meses. Investigou-se, por meio da análise bivariada e multivariável, a associação entre perda de produtividade e variáveis sociodemográficas e ocupacionais, condições de saúde e gravidade das lesões. ***Resultados:*** Observaram-se incidência cumulativa de perda de produtividade de 61,1% e densidade de incidência geral de 7,45 casos/100 pessoas/mês. A análise multivariável demonstrou associação com perda de produtividade para quem utilizava o veículo como instrumento de trabalho (razão de densidade de incidência — RDI = 4,23; intervalo de confiança de 95% (IC95%) = 2,90 – 6,17) e aqueles que apresentaram lesão corporal (RDI = 2,80; IC95% = 1,62 – 4,85). ***Conclusão:*** São necessárias políticas públicas que assegurem a segurança no trânsito a fim de minimizar os efeitos dos AT sobre a produtividade, além da realização de novos estudos na área para ampliar o conhecimento sobre o tema.

Palavras-chave: Acidentes de trânsito. Eficiência. Estudos prospectivos.

INTRODUCTION

Traffic accidents (TA) are currently one of the major causes of morbidity and mortality on a global scale, especially in developing countries, and are considered the leading cause of death among 15- to 29-year-olds[1]. In 2013, the World Health Organization estimated 1.25 million deaths from TA, while non-fatal injuries ranged from 20 to 50 million[2]. The burden produced by these accidents ranges from vehicle transportation and people transport services to repair and maintenance of damaged roads. However, when the focus is on the individual, productivity assessment becomes the major issue in terms of economic and social burden[3]. Accordingly, it has been studied as an important factor of interest to society, as it represents how much a nation has failed to develop[4].

When there is an event with injuries, depending on the cause and the way it affects one's condition, it can lead to changes in productive activities. This, in turn, may present limitations in performance or even cause inability to perform them and, in either case, result in a temporary or definitive course[5].

TA have the potential to generate such compromising effects that they impact people's health, quality of life and the way they perform their daily activities, especially productive activities. These alterations, in turn, entail changes in the dynamics of social relations and/or economic disturbances. In the latter aspect, it has been shown that at least 60% of the total costs of a TA are represented by lost productivity[6-10].

An important part of the knowledge obtained about TA and productivity takes into consideration the individual's work, assessing its partial or total impediment. In this

situation, it is important to take into account other proposals that evaluate issues other than work[6], that is, to include other productive activities, such as studies and housework, which in turn are also considered human production and which indicate social and economic contributions[11,12].

As a factor, repercussions on productivity have been studied along with other aspects[3,6-10,13], such as financial and family repercussions. For this reason, it is important to focus on the scope of studies of the repercussions of TA on the loss of the productive capacity of the people involved and to highlight the related factors.

However, the scarcity of the subject in the scientific literature makes it impossible to show which factors would in effect contribute to the problem, and thus the opportunity to elucidate the complexity of this subject is lost. Given the above, this study aimed to evaluate factors associated with lost productivity in people involved in TA.

METHODS

STUDY TYPE AND LOCATION

This study involved a prospective, community-based longitudinal study conducted in Jequié. This city is located in the southwestern region of the state of Bahia, and in 2010, it had a population of 151,895 (91.8% living in the urban area), being considered the eighth most populous Bahia municipality. In that same year, 109,206 (71.9%) people were between 14 and 69 years old, and 66,855 inhabitants (47.9%) were male[14]. The proportion of economically active people in 2010 was 63.9% (68,115)[15]. In 2013, 33,899 (85.5%) school-age individuals were enrolled in basic education[16].

SELECTION AND FOLLOW-UP OF PARTICIPANTS

The study sample was based on the cumulative incidence of 7.8% TA in the Magalhães study[17]. An accuracy of 2.0%, alpha (α) of 5.0%, design effect of 2 and study power of 80% were added to the calculations, resulting in a final sample of 1406 households. The sampling process was by single stage cluster, considering 169 urban conglomerates or census tracts (CT), and of these, 35 were chosen.

The study participants included persons living in the CT drawn who were involved in TA and who were at least 14 years old. The data collection period was from July 2013 to October 2015 and included a baseline step and six follow-up waves lasting four months each, totaling 24 months of follow-up. At baseline, all households in each CT were covered for identification and registration in the study.

In follow-up, the participants were contacted by telephone to verify their involvement in a TA in the last four months and to schedule interviews or re-interviews to follow-up on

post-TA repercussions. TA was considered any accident occurring on a public road, which may or may not have caused injury. In this phase, there was loss of follow-up when the person moved to another location without the possibility of contact by telephone, e-mail or project team visit, or when death occurred.

For those involved in TA, the cases of difficult location were those people who were not found at home, had no telephone or worked outside the municipality. In these cases, exhaustive interview attempts were made from the identification of the TA until the completion of follow-up.

For the study to be carried out, a research team was formed and trained for the various research phases (telephone contacts, appointments, interviews, review and tabulation).

DATA COLLECTION INSTRUMENT

The data collection instrument consisted of a form with questions related to sociodemographic and occupational aspects, TA characteristics, behaviors in traffic, health aspects and post-TA situations. To evaluate the instrument, a pretest step was conducted in a CT not included in the study, and during the development of the longitudinal step, the test and retest were assessed by intraobserver and interobserver agreement.

OUTCOME VARIABLE

The outcome variable corresponded to lost productivity and was identified by the question about "performing after TA any usual activities, including working, going to school, playing and doing chores, among others." The answer categories for this question were "yes" and "no."

COVARIABLES

The following variables were addressed in this study:

- Sociodemographic variables: sex (male and female); age in three age groups (14 to 17 years, 18 to 45 years, and over 45 years); marital status, in three categories (married/stable union, divorced/separated/widowed and single), children (having or not having children and number of children); schooling (up to elementary school, high school and higher education); income assessed in minimum wages (MW) and presented in three categories (no income, 1 to 3 MW, and >3 MW); vehicle driver (yes and no). At the time of the accident, the vehicle's use situation (yes and no) and mode of transportation (walking, two-wheeled vehicle and four-wheeled vehicle) were investigated;

- Occupational variables: type of occupational relationship, in three categories (public/retired, private and no occupation/unemployed); vehicle used for work (yes and no); motor vehicle used for commuting to work (yes and no); pain interfered with work (yes and no);
- Variables regarding health conditions and injury severity: health status investigated in five categories and categorized into good health (categories: excellent, very good and good) and poor health (categories: poor and very poor); health insurance (yes and no); comorbidity (yes and no); presence and type of bodily injury in two categories (cut/laceration/sprain and multiple injuries with two or more bodily injuries); and physical sequel with limited mobility (yes and no).

ANALYSIS OF DATA

We calculated the total number of people involved in TA and the absolute frequencies of people who had lost productivity according to categories of variables of interest.

We calculated the *overall cumulative incidence* (number of new TA cases divided by the number of study participants over 24 months multiplied by 100) and the incidence density (ID) for each variable (number of TA cases divided by the number of person-months of follow-up and multiplied by 100). In this last analysis, the incidence density ratio (IDR) was obtained by dividing the ID of the exposure category by the ID of the non-exposure category.

In the multivariate analysis, for the constitution of the initial model, the probability value of the χ^2 test, equal to or less than 20%, was used as a criterion for selecting the variables and the outcome. For the final model, the backward method was implemented, applying as a criterion of permanence in the model the probability value equal to or less than 5% for the Wald test and the lowest value of the Akaike information criterion (AIC). The modeling used was Poisson regression, since it allows the estimation of IDR in this epidemiological study modality[18]. To evaluate the model, we used the goodness-of-fitness test. In all analyses, 95% confidence intervals (95%CI) were used. Stata® statistical software version 12.0 was used to analyze the data.

Approval of this study was obtained from the Research Ethics Committee of the Institute of Collective Health of the Federal University of Bahia, Certificate of Presentation for Ethical Consideration (CAAE) No. 13691013.5.0000.5030, Decision No. 249.611, April 2, 2013.

RESULTS

During the follow-up period, 305 people were involved in TA. Of these, 31.8% (97) were not interviewed, due to refusals (4.9%), losses (6.5%) and non-local people (20.3%).

The comparison between respondents and non-respondents did not show significant differences. Another five participants were excluded because they were under 14 years old. Finally, 203 participants constituted the final sample. The overall cumulative incidence of lost productivity due to TA over the 24-month follow-up period was 61.1% (124). The incidence density was 7.45 cases/100 person-months, the mean follow-up was 8.19 months with a standard deviation of 6.46 months. The sum of follow-up times resulted in 1664 person-months.

Table 1 shows the absolute frequencies, ID and IDR for lost productivity according to sociodemographic conditions. An association with lost productivity was observed in 14- to 17- year olds (IDR = 3.03; 95%CI = 1.04 - 7.36) and 18- to 45-year-olds (IDR = 1.78; 95%CI = 1.17 - 2.76), and for those who were single (IDR = 1.73; 95%CI = 1.19 - 2.52), had no children (IDR = 1.82; 95%CI = 1.26 - 2.64)), had an income of one to three minimum wages (IDR = 1.61; 95%CI = 1.05 - 2.52) and used two-wheeled vehicles (IDR = 1.94; 95%CI = 1.33 - 2, 85). In participants who were divorced, separated or widowed, there was a protective association for lost productivity (IDR = 0.31; 95%CI = 0.06 – 0.95).

Regarding occupational characteristics (Table 2), an association was also found for lost productivity among participants who had a private work relationship (IDR = 2.29; 95%CI = 1.46 - 3.69), vehicle for work (IDR = 4.63; 95%CI = 3.14 - 6.75) and vehicle to commute to work (IDR = 3.03; 95%CI = 1.23 - 9.65).

Table 3 refers to the investigation of the outcome according to health conditions and injury severity. Not having health insurance (IDR = 1.74; 95%CI = 1.21 - 2.53) and having bodily injury (IDR = 4.42; 95%CI = 3.04 - 6.47) were the only factors in this group associated with lost productivity.

In the multivariate analysis (Table 4), those who used a vehicle for work (IDR = 4.23; 95%CI = 2.90 - 6.17) and those with bodily injuries (IDR = 2.80; 95%CI = 1.62 - 4.85) remained associated with lost productivity. The goodness-of-fit test indicated that the model fit the data well (Pearson goodness-of-fit = 207.72; p = 0.237).

DISCUSSION

This study made it possible to investigate lost productivity in a cohort of households in a medium-sized municipality. Most studies conducted on this subject have been designed by monitoring people based on the place of hospital care, a condition that allowed immediate access to post-TA participants, especially the most severe cases, and their monitoring every six months[19-23]. In this study, the methodological strategy of using home baseline and four-monthly waves of monitoring may have contributed to direct access to those involved in TA.

Regarding people not found for TA involvement interviews, the percentages observed in this group may be directly related to the methods applied in the active search of participants

Table 1. Absolute frequencies, person-time (PT), incidence density (ID), incidence density ratio (IDR) and 95% confidence interval (95%CI) for lost productivity according to sociodemographic conditions. Jequié, Bahia, Brazil, 2013–2015.

Characteristics	N	n	PT	ID	IDR	95%CI
Sex						
Female*	66	38	560	6.78	1.00	
Male	137	86	1104	7.79	1.14	0.77 – 1.72
Age (years)						
14 to 17	7	6	40	15.00	3.03	1.04 – 7.36
18 to 45	131	86	976	8.81	1.78	1.17 – 2.76
≥ 46*	65	32	648	4.93	1.00	
Marital status						
Married (a)/stable union*	119	67	1036	6.46	1.00	
Divorced/separated/widowed	12	3	148	2.02	0.31	0.06 – 0.95
Single(a)	72	54	480	11.25	1.73	1.19 – 2.52
Children						
Yes*	119	62	1076	5.76	1.00	
No	84	62	588	10.54	1.82	1.26 – 2.64
Number of children						
1*	40	23	352	6.53	1.00	
2	45	21	384	5.46	0.83	0.44 – 1.58
3 or +	34	18	340	5.29	0.81	0.41 – 1.56
Schooling						
Higher education*	44	22	396	5.55	1.00	
High school	112	72	864	8.33	1.50	0.91 – 2.51
Up to elementary school	47	30	404	7.42	1.33	0.74 – 2.43
Income (MW)						
None	7	6	40	15.00	2.88	0.98 – 7.03
1 to 3	132	88	1048	8.39	1.61	1.05 – 2.52
>3*	64	30	576	5.2	1.00	
Vehicle driver						
Yes	190	117	1528	7.65	1.48	0.69 – 3.78
No*	13	7	136	5.14	1.00	
Mode of transportation						
Walking	2	2	8	25.00	5.89	0.69 –9.12
2-wheeled vehicle	89	73	500	14.6	3.44	2.36 – 5.05
4-wheeled vehicle	112	49	1156	4.23	1.00	

*Reference category; MW: minimum wage.

who were involved in the less severe events. In these cases, it is believed that the immediate return to the usual pre-TA activities contributed to the reduction of success regarding the location of these individuals, scheduling and conducting the interviews. On the other hand, the exhaustive use of the strategy of locating the individual involved in a TA may have reduced the number of losses compared to strategies that limited a specific number of attempts to locate those individuals.

The cumulative incidence of lost productivity was significant and higher regarding the results of the National Household Sample Survey[24] and the National Health Survey[25], which revealed, respectively, values of 30.7 and 47.0% for TA involvement and inability to perform daily activities. The results of this study showed a worrisome situation, as it represented a number of people who stopped producing socially and economically.

Regarding sociodemographic information, males in the intermediate age and single groups have been shown to be involved in TA more often and, consequently, to have the greatest repercussions on their productivity[26-28]. The results of this study indicated categories that deserve attention, because the social burden of TA is even greater in the younger age groups[29], due to the expansion of the protection time by

Table 2. Absolute frequencies, person-time (PT), incidence density (ID), incidence density ratio (IDR) and 95% confidence interval (95%CI) for lost productivity according to occupational variables. Jequié, Bahia, Brazil, 2013–2015.

Characteristics	N	n	PT	ID	IDR	95%CI
Type of occupation						
Public/retired*	62	29	628	4.61	1.00	
Private	87	65	612	10.62	2.29	1.46 – 3.69
No occupation/no job	54	30	424	7.07	1.53	0.88 – 2.64
Vehicle used for work						
Yes	47	46	188	24.7	4.63	3.14 – 6.75
No*	156	78	1476	5.28	1.00	
Motor vehicle for going to work						
Yes	98	67	164	9.25	3.03	1.23 – 9.65
No	14	5	724	3.04	1.00	
Pain interfered with work						
Yes	76	51	588	8.67	1.25	0.86 – 1.81
No	124	73	1056	6.91	1.00	

*Reference category.

the security systems. It should also be recalled that the protective association for lost productivity found among divorced, separated and widowed individuals was a curious finding, still without consistent evidence in the literature, and may be related to older people, more experienced in traffic and less affected regarding productivity after TA.

According to the way of getting around, there was an association with lost productivity for those who used two-wheeled vehicles. These findings were similar to those of the study by Tournier et al.[30] and help to reinforce the discussion on the importance of TA repercussions among users of two-wheeled vehicles, especially when assessing the severity of injuries[7] and the economic impacts generated[31]. Although the consensus on body exposure and the severity of bodily injuries is higher in cyclists and pedestrians, the increase

Table 3. Absolute frequencies, person-time (PT), incidence density (ID), incidence density ratio (IDR) and 95% confidence interval (95%CI) for lost productivity according to health conditions and severity of injuries. Jequié, Bahia, Brazil, 2013–2015.

Characteristics	N	n	PT	ID	IDR	95%CI
Health status						
Good*	198	121	1608	7.52	1.00	
Poor	5	3	121	5.35	0.71	0.14 – 2.13
Health insurance						
Yes	108	58	1008	5.75	1.00	
No*	95	66	656	10.00	1.74	1.21 – 2.53
Comorbidity						
Yes	78	50	648	7.71	1.05	0.72 – 1.53
No*	125	74	1016	7.28	1.00	
Bodily injuries						
Yes	85	75	428	17.52	4.42	3.04 – 6.47
No*	118	49	1236	3.96	1.00	
Type of injury						
Cut/laceration/sprain*	56	47	304	15.46	1.00	
Multiple injuries	28	27	120	22.50	1.45	0.87 – 2.38
Sequelae						
Yes	25	25	100	25.00	1.64	0.97 – 2.70
No*	60	50	328	15.24	1.00	

*Reference category.

in motorcycle use has been significant in recent years and has contributed to the magnitude of these findings.

It is noteworthy that the profile of the type of vehicle used is directly related to the development of the traffic system in different regions of the world[1]. In Brazil, TA injuries in the five major regions of the country have shown important differences when evaluated by mode of transportation[32] and, therefore, may indicate different results when analyzing lost productivity.

Regarding the type of employment relationship, there was an association of the private type with lost productivity, and in this case, it is important to point out that the forms of contractual employment that do not offer rights guarantee may have produced an increase in such cases, especially when there is job loss[27].

The association between vehicle used for work and lost productivity indicated the importance and utility of the motor vehicle in the relationship between urban mobility and work. In this assessment, the time of exposure to traffic should be considered for people who use motor vehicles in their work, as this period is relatively longer compared to the time of people who use a vehicle just to commute to work. This fact increases the probability of lost productivity due to TA[33], either due to vehicle damage or injury to those involved.

Table 4. Incidence density ratio (IDR) and 95% confidence interval (95%CI) for lost productivity according to variables of the final Poisson regression model. Jequié, Bahia, Brazil, 2013–2015.

Characteristics*	IDR	95%CI
Age		
≤ 45 years	1.10	0.69 – 1.75
Marital status		
Single	1.21	0.80 – 1.83
Income		
None	1.10	0.70 – 1.72
Up to 3 MW	1.43	0.54 – 3.77
Mode of transportation		
Walking	3.31	0.73 – 14.84
Two-wheeled vehicle	1.34	0.74 – 2.40
Vehicle for work		
Yes	4.23	2.90 – 6.17
Bodily injuries		
Yes	2.80	1.62 – 4.85

*Reference categories: Age: >45 years; marital status: married, stable union, divorced, widowed; income: more than 3 minimum wages (MW); mode of transportation: vehicle with 4 or more wheels; bodily injuries: no; vehicle for work: no.

A similar situation can be seen with regard to people using the vehicle for commuting. In this case, the findings of this study reflect the growth of cities, the need to move between places and the encouragement of the use of motorized vehicles to meet these needs in a shorter period of time. Developing strategies that encourage the safe use of alternative transport, such as cycling, can have positive results in reducing TA and its effects on productivity[34].

The association with lost productivity could also be observed in people who did not have health insurance. This finding may indicate more opportunities for recovery, such as providing health care with shorter waiting times between the accident and care for those with insurance. On the other hand, the inefficiency of the social security system in minimizing the occurrence of lost productivity, assuming that the care given cannot maintain the individual's productive capacity at normal levels, would be another condition to be considered.

Injury has been demonstrated to be an important factor in the study of lost productivity[27], since it produces an immediate reduction in the individual's productive capacity and, depending on its severity, may contribute to the prolonged state of reduced capacity and recovery to pre-TA levels. In addition, the severity of the injury influences the development of permanent functional limitations[26]. When this factor is considered in hospitalized and non-hospitalized persons, there is an important source of information to distinguish the severity with which these events contribute to the states of lost productivity[6], but this aspect was not evaluated in this study.

In the multivariate analysis, only those who used a vehicle for work and sustained bodily injury remained associated. This reinforces the strong relationship that these two factors have in causing the investigated effect, which deserves attention, since today, the movement of people due to work is among the great needs of society, and when traffic structure does not develop properly, the generation of negative events, such as TA, has the potential to change the individual's daily life. Thus, physical injury has a direct effect on the ability to produce, whether at work or in any other productive activity.

Regarding the limitations of the study, the follow-up losses inherent in this type of study were minimized by developing contact strategies along the study path. In addition, it was observed that the evaluation of injuries and comorbidities were self-reported and not based on medical records or directly confirmed by expert or medical reports. However, the investigation of post-TA repercussions has been successfully demonstrated through instruments in the area[13]. The severity of the repercussions on productivity was another factor not investigated and that would allow us to evaluate the event in specific dimensions at the individual and society level or even according to the types of productive activities[30].

It was also not possible to explore in detail lost productivity in the family environment of those involved in TA, thus missing an opportunity to investigate further developments regarding this subject. Although little explored, studies investigating this situation have

contributed to the identification of important factors, such as stress and economic impact on the families of those involved in TA[30,35].

Finally, it was not possible to determine the effectiveness of the social security system in minimizing the occurrence of lost productivity and whether public and private health facilities were able to prevent this outcome[36].

CONCLUSION

It was observed that lost productivity was associated with factors related to the vehicle being used for work and bodily injury. These findings reinforce the need for public policies aimed at traffic safety to minimize the effects of TA on producing injuries and negative effects in workers who use vehicles as a tool for their livelihood. Further studies are suggested to broaden the understanding of factors related to lost productivity.

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