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Productivity costs among people involved in traffic accidents

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Abstract *This paper aimed to characterize the productivity costs of people involved in traffic accidents (TA) in a medium-sized municipality. A longitudinal household-based study was conducted from 2013 to 2015. During this period, individuals with TA were interviewed, and followed-up and costs of productivity were calculated. The measured and estimated values were considered for the calculation of the gross and per capita values and facilitated the establishment of costs of lost productivity (days off work) and costs of return to productivity (health professionals, medication, transportation, auxiliary devices and vehicle repair). It was shown that the costs of loss were more significant against the costs of return. Among the items that underpin the return to productivity, higher costs were observed in men, young adults, drivers, users of two-wheeled vehicles, people with public employment relationships, intermediate age groups and fracture-type injuries. It is necessary to evaluate and target the stages of recovery of those involved to minimize the social burden generated by these events.*
Key words *Traffic accidents, Costs and cost analysis, Efficiency*

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Introduction

A traffic accident (TA) is an event that has been the object of a study on a global scale and, in recent years, the number of cases has progressively increased, especially in emerging countries[1]. Despite its low incidence when compared to other public health problems, TAs significantly burden the public system to accommodate those involved and may compromise a nation's productive chain[2], since their repercussions on people's life course are mostly related to individuals of working age. Therefore, there may be disabling or temporary harm reflecting on supporting systems[3,4] and victims' relatives[5].

In a context of events with the potential of generating onus to the nation, there is a need to investigate the dimension of this situation. Thus, the economic evaluation of TAs, among several possibilities, through calculations of monetary values, can measure how much these events affect various segments of society, such as costs in the transportation system, social security system, judicial system, and human productivity[3]. For the latter item, most TA studies have outlined the costs of reduced or lost productivity as the costliest, since they directly reflect the loss of an individual's capacity to produce temporarily or permanently, and even account for more than 60% of TAs' total costs[3,6,7].

This type of cost can be investigated under two aspects: the lost productivity caused by the morbid state or the death-related. For the latter, the estimated costs due to the lost productivity are higher than the former, since, in this evaluation, the individual's remaining working-age lifetime would be considered, while the former is related to the days of work lost[8], or when not missing work, this individual's customary productivity[9] is being reduced.

Although work is the only parameter in the evaluation of productivity costs, the evaluation of other realms, such as school, leisure and housework itself, are not explored and end up having an underestimated evaluation of TA costs[9,10].

As a result, it is essential to expand the context of evaluation of the potential repercussions that TAs cause, primarily to explore the size of the items that underpin the costs of productivity, since these may indicate essential aspects related to the lost production capacity[6,7,9,11,12] and may also explain the costs of the recovery process to resume at pre-TA levels, i.e., how much was spent to return to productivity at pre-event levels.

The lack of studies in this line of research in Brazil precludes the investigation and sizing of several items that underpin productivity costs. Therefore, it is necessary to implement the evaluation of this cost modality, considering the investigation of the items of loss and return, since these can contribute to increased knowledge on the subject and the establishment of policies and channel actions geared to TAs and their repercussions. In this regard, this study aimed to evaluate the costs of lost productivity and costs of return to productivity of people involved in TAs in a medium-sized municipality.

Methods

This research is derived from a baseline study entitled "Epidemiology of traffic accidents: incidence and behavioral determinants in a longitudinal study" that aimed to examine the determinants of people involved in traffic accidents, with an emphasis on the roles of behavioral factors. Therefore, this study was characterized as a prospective cohort and was conducted in the municipality of Jequié, Brazil.

This municipality is located in the southwest region of the state of Bahia and had an estimated population of 161,391 inhabitants in 2013[13]. Considering in that same year the vehicle fleet[14] and its population, the vehicle motorization index corresponded to approximately 32 vehicles per 100 inhabitants (49,770/161,391).

The study period comprised a baseline and follow-up step in six follow-up waves developed from July 2013 to October 2015. Each follow-up wave lasted 14 weeks plus two weeks for adjustments and pending issues, totaling 16 weeks or approximately four months.

The study population consisted of people residing in the urban area of the municipality. The calculation for the sample size was based on the cumulative incidence of traffic accidents of 9%[15], accuracy of 2%, alpha (α) of 5%; design effect of 2 and a study power of 80%. The final sample of the baseline study consisted of 1,406 residents. The sampling was performed by a single-stage conglomerate, and each cluster corresponded to a census tract (CT), and 35 CTs were drawn among the 169 CTs in the urban area.

This paper included all individuals involved in TAs during the follow-up stage. Individuals under the age of 18 years and those over 69 years of age were excluded from the analyses. The increased upper limit of the age group by 10 years concerning the "dependency ratio" indicator that is 18-59 years[16] was motivated by the changes in the Brazilian age composition vis-à-vis the aging population, increased life expectancy and also the changes in the legislation for the age limit to enjoy the retirement benefit.

Comprehensive collection instruments, namely, forms specific to vehicle drivers and non-drivers were used. The questions contained in the forms addressed sociodemographic, occupational aspects, TA characteristics, traffic behaviors, health aspects and aspects of post-traffic accident situations.

TAs' identification occurred during the follow-up stage and was facilitated through four-monthly telephone contacts. Information regarding involvement in this event was always checked in-between connections. If affirmative, an interview was scheduled. The re-interviews were conducted in new periods, respecting the four-month interval. A project team was previously trained to apply the collection tool, make telephone calls and tabulate interviews.

In this paper, we investigated the variables for characterization of participants and cost indicators. Concerning the former, the following groups were defined: *Sociodemographic variables*: gender (male and female); age in full years and categorized into five age groups: 18 to 29 years, 30 to 39 years, 40 to 49 years, 50 to 59 years and 60 to 69 years; marital status had three categories: married/common-law marriage, divorced/separated/widowed, and single; schooling: up to primary school, secondary school and higher education. Regarding the moment of the accident, the type of road user (pedestrian, driver and passenger) and type of vehicle user (two-wheeled vehicle and four-wheeled vehicle) were investigated. *Occupational variables*: the type of employment relationship was divided into four categories: retired, public, private, without relationship/unemployed; vehicle used as a work instrument (yes and no). *Health conditions and bodily injuries:* health insurance (yes and no); type of bodily injury, the lack and existence of the type of bodily injury were evaluated and, for the latter case, classified as single and combined, and the categories investigated included: no bodily injury, cut/laceration only, sprain only, fracture only, cut/laceration and sprain, cut/laceration and fracture, sprain and fracture, patient with multiple injuries). Finally, the amount of injured bodily parts (one body part, two body parts, three or more body parts) was verified.

Costs for lost productivity were based on the economic losses suffered by the temporary or permanent interruption of productive activities due to involvement in TAs. The *costs of return to productivity* were those in which individuals or the State brought in to return to their pre-TA productive activities, that is, goods, services and resources used to help individuals return to any productive activity. Overall, these costs involved spending on health care, aids provided for their recovery and repairs of the tools sustaining the productivity of those involved in TAs.

From the occurrence of the traffic accident, data on costs were collected directly, and these were extracted from the questions related to research in the follow-up waves of the study. Based on these, the results were classified into two categories: 1- "With cost" that included the collection of some cost, in the fields of the questionnaire, with value registration; 2- "Without cost", when there were no costs. Estimates were calculated for the information in which there were no fields to fill the cost value (Figure 1). In the end, general productivity cost indicators were constructed: costs of loss, costs of return and, finally, the total cost (productivity costs) that added the first two.

The *costs of lost productivity* were calculated from the combination of the mean daily wages of the participant multiplied by the number of days not worked. The *costs of return to productivity* were investigated through five items: care provided by health professionals (visits and treatment), use of medication for post-TA treatment, transportation for treatment or visits (bus, taxi, motorcycle taxi and fuel), use of auxiliary devices and repair of the damaged vehicle used as work instrument. Among the five items that evaluated the costs of return to productivity, only the first one was an estimation, and in this regard, the mean values of the visits and sessions of the health plans in the state of Bahia and values of the Table of Procedures, Medications and OPM Management System of the SUS (SIGAT)[17] were used. The costs of health professionals were estimated after obtaining these data, where the number of sessions or visits for the treatment of post-TA events was multiplied by the mean value of the health action by professional category. This calculation was performed in two strata: for those who had a health plan, the value was multiplied by the mean values of the plans, and for those who did not have a health plan, the sessions and visits were multiplied by the SIGAT values. Then, strata were added up to obtain the total value of this cost modality. Finally, both the measured and estimated values were adjusted by the Broad Consumer Price Index - IPCA[18] based on the year 2016.

In the analysis, descriptive statistics were used to characterize the study participants who were

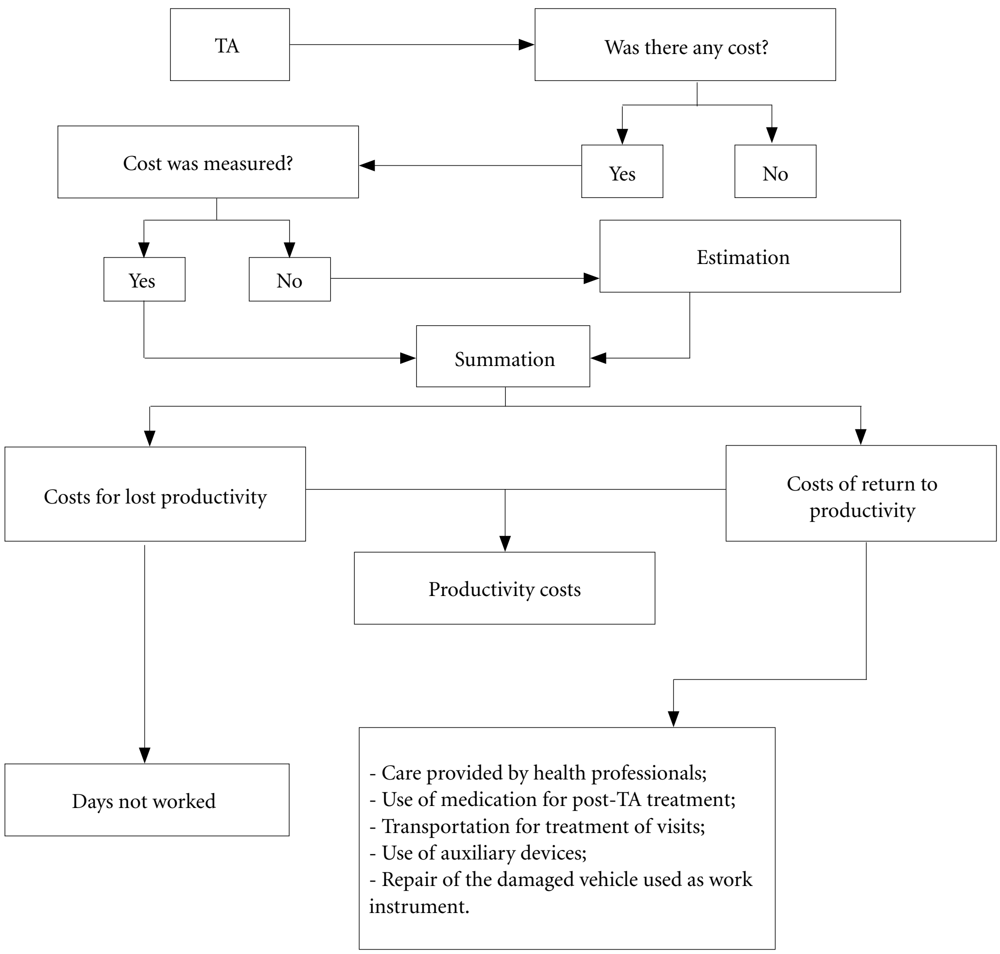

Figure 1. Assessmentofcosts of loss and costs of returnto productivity.

involved in TA and evidenced productivity costs. Then, the simple and relative frequency were calculated for the categorical variables, as were measures of central tendency for the continuous variables, when necessary. The Pearson's chi-square test and Fisher's exact test were used to evaluate the difference between groups with and without productivity costs. In the cost evaluation, the gross (GC) and per capita (PC) values of costs of loss and specific costs of return to productivity were calculated by type of road user, type of vehicle user, type of employment relationship, vehicle used as work instrument, income, health plan, type of bodily injury and number of injured bodily parts. The Kruskal-Walls test was used to compare the different types of cost among the categories of the variables investigated. In all tests, a probability value ≤ 0.05 was used to consider such a statistically significant measure. Statistical software STATA®, version 12.0 was used to produce the data of this paper.

The Research Ethics Committee of the Institute of Collective Health of the Federal University of Bahia approved the study.

Results

During the follow-up period, 305 individuals were involved in TA, and of these, 98 were not interviewed due to losses and refusals, leaving out 207 participants remaining. After the exclusion of 15 people aged under 18 years and over 70 years, 192 individuals were analyzed (111 reported having had some cost after TA and 81 had not). Table 1 shows that among those who indicated a cost, 68.5% were males and were concentrated in the age range of 18-29 years (38.7%).

Also in this group, higher proportions were observed for those who had secondary school education (59.5%) and income between one and three minimum wages (63.1%). Drivers and users of two-wheeled vehicles were the most significant categories of users in the group with cost, respectively, 84.7% and 59.5% (Table 1).

When the type of employment relationship was evaluated (Table 2), in the group with costs, we found that the private relationship was 52.3%, and the participants with public employment relationship and without relationship/unemployed had similar proportions, 21.6% and 24.3%, respectively. Regarding the use of the vehicle and work, it was observed that the majority used the vehicle as a means of transportation at work (92.6%) and a smaller group owned the vehicle as a work instrument (39.6%). For the aspects related to the health plan and injuries, we found proportions of 46.8% for those with a health plan and 30.6% for those with cut/laceration type bodily injuries, both in the group with cost.

Statistically significant differences were observed between groups with costs and without costs of productivity in vehicle user type (Table 1), type of employment relationship, vehicle used as work instrument and type of bodily injury (Table 2).

The total cost of TAs' impact on productivity was approximately R$ 289,774, and of these, productivity losses accounted for 59.4% (R$ 172,086) and costs of return 40.6% (R$ 117,688). When the costs were evaluated according to variables of interest (Table 3), we identified that the gross cost and cost per capita were jointly more significant for those who were male (GC = R$ 241,035 / CP = R$ 3,443), drivers (GC = R$ 251,959 / CP = R$ 2,930), earned three to six minimum salaries (GC = R$ 155,972 / CP = R$ 7,427) and had a health plan (GC = R$ 165,179 / CP = R$ 3,371). Those who suffered bodily injury, including cut/laceration and fracture, had a total GC of R$ 103,367 (CP = R$ 14,771), and the total GC was R$ 119,850 (CP = R$ 5,707) in two different body parts. Statistically significant differences were observed for the costs of return to productivity in the categories of variables gender, vehicle used as a work instrument and type of injury. In this latter variable, differences were also noted for the costs of loss.

Table 4 shows the specific per capita costs of return to productivity. In general, vehicle repair and health professionals' costs accounted for 67.6% and 14.5% of the total, respectively. In some categories, per capita repair costs stood out because they were at least fivefold the other cost types.

Considering the evaluation of the per capita cost values in Table 4, we did not identify significant values in a single category according to the five items of cost of return to productivity. However, when considering at least three items, the most significant were the costs of male drivers in the 30-49 years' age bracket on two-wheeled

Table 1. Characterization of the occurrence of costs according to sociodemographic information of participants involved in TA. Jequié, Bahia, Brazil, 2013-2015.

Characteristics	With cost		Without cost	
	n	%	n	%
Gender	111		81	
Female	35	31.5	30	37.0
Male	76	68.5	51	63.0
Age group (years)	111		81	
18-29	43	38.7	23	28.4
30-39	28	25.3	21	25.9
40-49	18	16.2	14	17.3
50-59	17	15.3	16	19.7
60-69	5	4.5	7	8.7
Mean	36.5		39.3	
Standard deviation	1.30		1.57	
Marital status	111		81	
Married / common-law marriage	64	57.7	51	62.9
Divorced / separated / widowed	2	1.8	9	11.2
Single	45	40.5	21	25.9
Schooling	111		81	
Higher education	20	18.0	24	29.6
Secondary school	66	59.5	43	53.1
Up to primary school	25	22.5	14	17.3
Income (Minimum Wages)	111		81	
No income	3	2.7	1	1.2
< 1	8	7.2	16	19.7
1-3	70	63.1	31	38.3
3-6	25	22.5	25	30.9
> 6	5	4.5	8	9.9
Road user type	111		81	
Pedestrian	2	1.8	---	---
Driver	94	84.7	62	76.5
Passenger	15	13.5	19	23.5
Vehicle user type*	111		81	
Pedestrian	2	1.8	---	---
Two-wheeled vehicle	66	59.5	19	23.5
Four-wheeled vehicle and over	43	38.7	62	76.5

*p < 0.05.

Table 2. Characterization of the occurrence of costs according to occupational information, health plan and injuries of participants involved in TA. Jequié, Bahia, Brazil, 2013-2015.

Characteristics	With cost		Without cost	
	n	%	n	%
Employment relationship*	111		81	
Retired	2	1.8	8	9.9
Public	24	21.6	25	30.8
Private	58	52.3	23	28.4
No relationship/ unemployed	27	24.3	25	30.9
Vehicle to travel to work	111		81	
Yes	63	92.6	32	78.1
No	5	7.4	9	21.9
Vehicle as a work instrument*	111		81	
Yes	44	39.6	1	1.2
No	64	60.4	80	98.8
Health plan				
Yes	52	46.8	47	58.0
No	59	53.2	34	42.0
Type of bodily injury[(a)*]	111		80	
No bodily injury	44	39.6	67	83.7
Only C/L	34	30.6	11	13.8
Sprain only	7	3.3	---	---
Fracture only	6	5.4	---	---
C/L + Sprain	7	6.3	2	2.5
C/L + Fracture	7	6.3	---	---
Sprain + Fracture	4	3.6	---	---
Patient with multiple injuries	2	1.8	---	---
Number of injured bodily parts	67		14	
1 part	28	41.8	7	50.0
2 parts	21	31.3	4	28.6
3 or more parts	18	26.9	3	21.4

(a) C/L: Cut/laceration. Patients with multiple injuries included individuals with multiple injuries in various parts of the body and organs. *$p < 0.05$.

vehicles, with a public employment relationship, who did not use vehicles as a work instrument, earned between three and six minimum wages, with a health plan and suffered bodily injuries such as fracture, cut with fracture and sprain with fracture. The per capita costs of return to productivity concerning injuries in two body parts were more significant in all five cost of return items evaluated (Table 4). Statistically significant differences were observed between the categories of variables health plan and type of injury, respectively, in health professionals and medication costs.

Discussion

This study facilitated the characterization of the occurrence of productivity costs among participants involved in TA, specifying the monetary values for the costs of loss of and return to productivity caused by these events. Their analysis allowed us to show the level of costs when they were stratified by specific components, in particular, the costs of return.

The findings of greater involvement of males and younger age group have already been evidenced in the literature as the main categories of TA involvement[19-21]. It should be noted that this configuration has contributed to the appearance of costs on a scale not yet measured in the family network because when the main household provider is male, the demands in the family context imply economic reorganization from this new context[22].

The differences observed in the occurrence of TA when comparing men and women[23,24] are also evidenced in the evaluation of productivity costs. In this study, the lower productivity costs in women may represent the low involvement and consequent low repercussion of this event[12]. Despite the low incidence of productivity loss in this category, it is important to point out the needs of the type of employment relationship, specifically employment instability, which may have influenced the early return of both men and women and, thus, reduced the estimates presented.

Regarding age and cost, we found that the number of participants was numerically higher in the age group of 18-29 years. However, the age group of 30-49 years concentrated the highest costs per capita of productivity. These findings are corroborated in studies investigating the costs of traffic accidents[25] and pointed out that the greater involvement in the intermediate age groups indicated costs above 50.0% when compared to the lower and higher ranges. Despite the lack of statistical association, it is essential to show that the costs of repairing vehicles as work instruments may have influenced the results of the study.

We identified that users of two-wheeled vehicles had similar proportions of productivity costs when compared to users of four-wheeled vehicles and above. In this category, we also ob-

Table 3. Gross and per capita costs of loss and return to productivity by public road user type, type of vehicle, employment relationship type, type of user, income, health plan and bodily injury. Jequié, Bahia, Brazil, 2013-2015 (In Brazilian Reals, R$).

	Costs of loss		Costs of return		Costs of productivity (total)	
	GC*	PC*	GC*	PC*	GC*	PC*
Gender†						
Female	36,528	1,588	12,211	452	48,739	1,572
Male	135,558	2,766	105,476	1,574	241,035	3,443
Age group (years)‡						
18-29	45,858	1,529	26,973	729	72,831	1,867
30-39	55,059	3,059	53,919	2,247	108,978	4,191
40-49	66,975	5,151	23,38	1,949	90,359	6,024
50-59	3,045	380	6,481	405	9,526	595
60-69	1,150	383	6,931	1,386	8,081	1,616
Road user type‡						
Pedestrian	1,656	828	830	415	2,486	1,243
Driver	151,966	2,533	99,993	1,266	251,959	2,930
Passenger	18,464	1,846	16,865	1,297	35,329	2,718
Vehicle user type(a) ‡						
Two wheels	142,914	2,696	34,759	589	177,673	2,820
Four or more wheels	27,516	1,619	82,090	2,488	109,615	3,045
Type of relationship‡						
Retired	389	194	459	229	848	424
Public	64,670	3,804	52,210	2,748	116,880	5,313
Private	92,825	2,264	44,427	871	137,252	2,590
No relationship/unemployed	14,202	1,183	20,592	936	34,794	1,450
Vehicle used as a work instrument†						
Yes	34,524	2,031	82,432	2,424	116,957	3,249
No	137,562	2,501	35,255	588	172,818	2,659
Income (MW)(b) ‡						
No income	---	---	218	73	218	72
Up to 3	86,620	1,575	39,506	581	126,125	1,752
3-6	80,292	5,735	75,680	3,982	155,972	7,427
> 6	5,176	1,725	2,283	571	7,459	1,492
Health plan‡						
Yes	95,023	2,795	70,155	1,559	165,179	3,371
No	77,064	2,208	47,532	970	124,596	2,396
Type of injury(c) †						
No bodily injury	8,286	552	68,284	2,069	76,570	2,127
Only C/L	16,336	605	12,499	417	28,835	874
Sprain only	7,119	605	3,096	516	10,215	1,702
Fracture only	36,313	6,052	7,424	1,237	43,737	7,289
C/L + Sprain	3,030	505	1,735	289	4,766	681
C/L + Fracture	83,534	11,933	19,862	2,837	103,367	14,771
Sprain + Fracture	14,924	3,374	4,406	1,101	19,329	4,832
Patient with multiple injuries	2,544	1,272	381	190	2,925	1,463
Number of injured bodily parts(d) ‡						
1 part	62,946	2,737	13,894	534	76,840	2,846
2 parts	89,303	4,961	30,547	1,527	119,850	5,707
3 or more parts	11,552	722	4,962	331	16,514	971

(a) The pedestrian category was omitted. (b) MW - Minimum Wage. (c) C/L: Cut/laceration. Patients with multiple injuries included individuals with multiple injuries in various parts of the body and organs. (d) The category "no bodily injury" was omitted. * GC = Gross Cost / PC = per capita. † Value of $p<0.05$ in gender and costs of return; Vehicle used as a work instrument and costs of return; Type of injury and costs of loss; Type of injury and costs of return. ‡ No statistical significance.

Table 4. Specific per capita costs of return to productivity by public road user type, type of vehicle, type of employment relationship, type of user, income, health plan and bodily injury. Jequié, Bahia, Brazil, 2013-2015.

	Professionals R$ 17,091 (14.5%)	Medication R$ 5,819 (4.9%)	Transportation R$ 12,422 (10.6%)	Devices R$ 2,756 (2.4%)	Repair R$ 79,597 (67.6%)
Gender‡					
Female	295	112	295	308	519
Male	310	136	465	152	3,002
Age group (years)‡					
18-29	133	80	229	180	2,374
30-39	416	156	206	162	6,148
40-49	737	289	504	288	2,655
50-59	168	47	95	---	728
60-69	162	114	1.603	---	616
Road user type‡					
Pedestrian	310	76	59	---	---
Driver	342	139	442	173	2,465
Passenger	118	103	331	510	6,519
Vehicle user type(a) ‡					
Two-wheeled	335	134	322	203	582
Four-wheeled or more	132	116	755	118	3,568
Type of relationship‡					
Retired	157	114	32	---	---
Public	414	206	460	255	20,146
Private	284	121	508	180	1,379
No relationship/unemployed	257	70	77	118	1,566
Vehicle used as a work instrument‡					
Yes	215	71	52	---	2,745
No	322	144	486	197	---
Income (MW)(b) ‡					
No income	44	35	95	---	---
Up to 3	275	97	444	205	737
3-6	395	290	468	178	8,127
> 6	685	81	89	---	287
Health plan†					
Yes	554	170	301	182	3,515
No	73	100	543	217	2,119
Type of injury(c) †					
No bodily injury	167	102	118	---	3,145
Only C/L	159	49	645	24	524
Sprain only	342	49	46	237	924
Fracture only	660	224	389	212	---
C/L + Sprain	184	89	118	166	---
C/L + Fracture	489	406	919	216	9,482
Sprain + Fracture	694	183	246	333	---
Patient with multiple injuries	58	218	---	46	---
Number of injured bodily parts(d) ‡					
1 part	272	138	263	202	344
2 parts	510	162	791	204	5,203
3 or more parts	161	82	70	118	705

(a) The pedestrian category was omitted. (b) MW - Minimum Wage. (c) C/L: Cut/laceration. Patients with multiple injuries included individuals with multiple injuries in various parts of the body and organs. (d) The category "no bodily injury" was omitted. † Value of $p < 0.05$ in health plan and costs with health professionals; Type of injury and costs with medication. ‡ No statistical significance.

served a high per capita cost of lost productivity and also most of the items of costs of return to productivity, indicating that the user of this type of vehicle may have generated evident economic repercussions. The findings in the literature on the costs per type of road user have corroborated the results shown in this research, which, in turn, identified pedestrians[26] and users of two-wheeled vehicles[12] as those with the most significant economic impact on productivity. Although one cannot directly evaluate the repercussions on productivity in support systems, it is believed that the economic impact is high, mainly due to motorcyclists' injuries, resulting from greater body exposure.

Although the number of participants and pedestrian costs are lower in this study, it is very likely that external factors (preference for motor vehicle use, inefficient public transportation) and factors related to the development of the traffic system in the municipality where the study was conducted contributed to the roads being preferably occupied by motorized driving vehicles. It is important to remember that the evaluation of productivity costs can have different characteristics when stratified by the type of road user, and this is due to the characteristics of each location[1]. However, the findings of this study may represent the configuration of the urban mobility system in cities with similar characteristics to the municipality investigated[27].

When comparing the type of vehicle user and participants who used the vehicle as a work instrument, we note that the per capita costs of return to productivity, except those of repairs, were higher in users of four-wheeled vehicles and over that used the transport for post-TA treatment. In the second case, costs were concentrated in the treatment with health professionals. In both cases, costs were related to the need to treat TA-derived morbid events, in which the transportation had a significant weight, and it cannot be affirmed whether the expressiveness of this item in these categories was due to the time of treatment or transportation to other locations.

Finally, it is interesting to note that costs with vehicles with four or more wheels, in most cases, can be more burdensome when compared to costs with two-wheeled vehicles, and the two together represent significant repair costs[28]. These differences can be understood by two situations: the first relates to the values of the parts and repair of four-wheeled vehicles, which are often more substantial than the two-wheeled vehicle. The second situation is observed when the values of the total loss of a four-wheeled vehicle are included in the cost evaluation.

Gross costs stratified by employment relationship type categories draw attention to their relatively high level in the public and private categories. This information may indicate the establishment of guarantees of labor rights in the private sector, which are assured with a formal contract and allow income or social security benefit with retirement and, consequently, greater possibilities to restore the pre-TA state of productivity.

Although the incidence of costs was concentrated in the range of 1-3 minimum wages, per capita costs of loss and costs of return to productivity were higher in the range of 3-6 minimum wages. Income is linked to preference and the increased number of people using motor vehicles. However, the TA event has potential repercussions on productivity and has been shown in groups with lower socioeconomic development strata[10]. In this research, it is suggested that the lower costs of return to productivity shown in the higher income strata were due to the access to health services, medication and transportation resulting from the current socioeconomic status of individuals in this category. In the same situation, repair costs can be directly related to the damage and type of vehicle used.

The evaluation of productivity costs by health plan showed that these were greater for those who had it. On the other hand, for those without a health plan, the per capita costs of return to productivity were high in transportation items and auxiliary devices. However, although both groups have the same needs to return to their productive activities, the group that did not have any health insurance could have used the public health services, medication and auxiliary devices distributed free of charge and did not report their use at the time of data collection. In another hypothesis, the severity of the post-TA events and the need to return to work early minimized the costs with health professionals and medication for those who did not have a health plan; for those who did, the values shown in the item of auxiliary devices may have been attenuated due to the health plan coverage of this type of material.

The per capita costs for the investigated items of return to productivity were significant in the categories that included the joint injuries by fractures and another type of bodily injury. These results were already expected, and although they do not directly measure the severity of the event, they have been portrayed as significant events in the evaluation of costs, since fracture, when compared to cut/laceration-type injuries and sprain, is a type of injury which demands more from health services and also increases the time to return to productive activities[26,29]. Similarly, the increased costs would be related to the number of injured body parts. However, the findings of this study do not follow this trend, most probably due to the reduced number of injuries of greater severity.

As a prospective cohort was conducted between the limits inherent to this type of epidemiological study, we highlight the time between the traffic accident and the interview or inter-interviews with potential production of memory bias among the respondents, highlighting the amounts paid for the return to productivity. On the other hand, the collection on costs of return to productivity made directly with the participants contributed to narrowing the gaps between the actual and measured values.

Another limitation refers to the impossibility of including hospital costs due to the lack of investigation of health procedures in these institutions, which could contribute to the evaluation of the costs of returning to pre-TA activity[25]. However, because it is not possible to measure or estimate this realm in this study, the total costs of return to productivity have been underestimated.

Finally, the population-based versus hospital-based strategy either removed or hindered the assessment of costs for a more significant number of cases with greater severity. However, it differed from the studies in the field because it evidenced a part of this population still not very visible in the scientific field[28,30] and who reported productive losses, albeit in a different spectrum than those caused by the most severe cases of TA, yet represents a considerable and deserved attention in the studies on this subject.

Conclusions

This study facilitated the conclusion that the costs of lost productivity were higher than the costs of return. In this last aspect, some specific costs were high in males, young adults, drivers, users of two-wheeled vehicles, people with public employment relationships and in intermediate income brackets. Higher costs were also found for bodily injuries with fracture and in two body parts. However, only the former was the only variable that showed statistically significant differences for costs of loss and return to productivity.

These findings can be sources for the development or implementation of effective traffic policies to reduce the harmful effects of TAs and, thus, minimize the costs of their endpoints. Considering productivity costs, evaluating and targeting strategies in the different stages of recovery of those involved can streamline the time required for the return and, consequently, reduce total costs. We suggest new studies be conducted to evaluate the productivity costs to investigate elements not considered in this research.

Collaborations

JP Cardoso contributed to the study design, data collection, analysis, interpretation of results, discussion and final writing. ELA Mota contributed to the study design, critical revision of the manuscript and revision of the final version. PAA Rios and LN Ferreira collaborated with the study design, data collection, discussion and revision of the final version.

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