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Ecological analysis of accidents and lethal violence in Vitória, Southeastern Brazil

ABSTRACT

OBJECTIVE: To analyze the socioeconomic background and its relationship with spatial distribution of mortality due to violence.

METHODS: Ecological study conducted to explore the space distribution of mortality due to violence in the city of Vitória, Southeastern Brazil, between 2000 and 2003, based on population and socioeconomic information. Mortality data were correlated with information on victim's place of residence, type of violence, gender, and skin color. Data were analyzed using space average, odds ratio, and cluster analysis.

RESULTS: There were reported 828 deaths due to violence during the study period, accounting for 17% of all deaths in the city. Of these, 72% were homicides, 21.8% traffic accidents, and 6% suicides. Violence victims were mostly young black males, living in poorer areas of the city. In contrast, as for suicide and traffic accidents, the victims were older white females living in the wealthiest area of the city.

CONCLUSIONS: The study showed that violence is a phenomenon occurring in all socioeconomic levels but black people at the lowest level are more likely to die from homicides while white well-off people are more likely to die from suicide and traffic accidents.

DESCRIPTORS: Accidents, mortality. Violence, mortality. External Causes. Mortality. Socioeconomic Factors. Ecological Studies.

INTRODUCTION

Accidents and violence constitute a set of health events that may lead to death. They can be classified as accidental – due to traffic, occupation, falls, poisoning, drowning and other types of accidents – or intentional causes (assaults and self-inflicted injuries). All these events are included in the International Classification of Diseases (ICD) under external causes of morbidity and mortality.^{15,16}

In Brazil, external causes accounted for 9.3% of all deaths in 1980¹⁴ and 14.6% in 2003, ranking third among leading mortality indicators nationwide, in the Southeast region of Brazil (13.3%) and in the city of Vitória, state of Espírito Santo (17.3%).^a

Homicides, suicides, and traffic accidents are the leading external causes of death in the state of Espírito Santo. Damages, injuries, traumas and deaths due to transport accidents and violence are associated to high emotional and social cost and lead to great utilization of the public security, health, and traffic safety apparatus.^a In addition, homicides and transport accidents are more

^a Brazilian Ministry of Health. Indicators and Core Data - Brazil – 2002 IDB-2002. Brasília; 2002. [cited 2007 Mar 07]. Available from: <http://tabnet.datasus.gov.br/cgi/tdb2002/matrix.htm>

likely to be targeted in state-run interventions through actions such as law proposals for crime reduction and control or the implementation of traffic engineering and control measures.

Effective monitoring and control of accidents and lethal violence in the city of Vitória has been considered maximum prerogative and technology has been applied for digital mapping with a system of capture, storage, management, analysis, and presentation of spatial data. The geographical information system (GIS) has contributed for more effective policy formulation for multisectoral intervention through analyses of spatial data in health.^{17,18,23}

Thus, the objective of the present study was to analyze the socioeconomic background and its relationship with spatial distribution of mortality due to homicide, suicide and traffic accident.

METHODS

The study area was the city of Vitória. Vitória has a territorial area of 93,381 km² comprising an island – the city's cradle –, and a continental section, of recent development. The city is divided into seven administrative areas (area I – Downtown; area II – Santo Antônio; area III – Bento Ferreira; area IV – Maruípe; area V – Praia do Canto; area VI – continental Vitória and area VII – São Pedro). Despite its more recent development, area VI (continental Vitória) is the most densely populated part of the city. Between 1980 and 2004, the city's population doubled: from 207,515 inhabitants in 1980, 253,758 in 1990, to 305,898 in 2004 of which 144,349 men and 161,549 women.

An ecological study was conducted. Population and socioeconomic information were obtained from the local Department of Treasury (SEMFA) and the Brazilian Institute of Geography and Statistics (IBGE) based on the 2000 Population Census, projected or not for the study period. Mortality data were obtained from the Mortality Information System (SIM) and the Municipal Health Department of Vitória (SEMUS) provided data on specific and total mortality. Since the year 2000, SEMUS has been monitoring all accidents and violence and investigating all deaths occurring in the city.

External causes of deaths included transport accidents, homicides and suicides occurring in the city between 2000 and 2003. Transport accidents were classified according to the International Classification of Diseases, 10th revision (ICD-10) under codes V01 to V89 and subgrouped as follows, based on the victim's means of transportation: pedestrian (V01 to V09), cyclist (V10 to V19), motorcycle rider (V20 to V29), occupant of three-wheeled motor vehicle (V30 to V39), car occupant (V40 to V49), occupant of pick-up truck or van

(V50 to V59), occupant of heavy transport vehicle (V60 to V69), bus occupant (V70 to V79) and others (V80 to V89). For the analysis, they were grouped as pedestrian, motorcycle rider, and vehicle occupant accident which included all accidents with occupants of car, bus, pick-up truck, and heavy transport vehicle but excluding cyclist, three-wheeled motor vehicle and other accidents. Subgrouping was carried out due to specific interventions required for these three categories of accidents.

Information on homicide and suicide were classified under the ICD-10 Chapter XX, V01 to Y98, and death due to assault (homicide) under codes X85 to Y09. Data on events of undetermined intent (Y10 to Y34) obtained from SIM were reassessed through review of medical examiner and police reports and newspaper headlines. They were reclassified according to the findings of the local monitoring agency.

Data analysis included a consistency analysis followed by an early exploratory descriptive analysis by administrative area. Deaths due to transport accidents and homicides were correlated with the victim's information: place of residence (district, microregion), age, gender, race/skin color.

Georeferencing of information and spatial analysis were carried out based on the city's digital network divided into administrative areas. Spatial average was estimated using latitude/longitude coordinates of district points, and simple and weighted averages were estimated based on the occurrence of the following events: homicide, transport accident, suicide and the variable race/skin color to assess distribution differences.

To estimate the spatial average variables of point coordinates were created using the functions GetX and GetY in the calculator of ArcView program and through a routine in an electronic chart for estimating averages based on the following formulas:

Simple average:

$$(x_{mc}, y_{mc}) = (\sum_{i=1}^n x_i/n, \sum_{i=1}^n y_i/n), \text{ where:}$$

x_{mc}, y_{mc} are coordinates of center average;

x_i, y_i are coordinates at the i point, and n is the number of points.

Weighted average:

$$(x_{wmc}, y_{wmc}) = (\sum_{i=1}^n w_i * x_i / \sum_{i=1}^n w_i, \sum_{i=1}^n w_i * y_i / \sum_{i=1}^n w_i), \text{ where:}$$

x_{wmc}, y_{wmc} are defined coordinates of the weighted center average, and W_i is the weight of i point;

A text format file was created with coordinates of weighted and non-weighted averages and average mapping for the island and continental areas of the city of Vitória.

For georeferencing of information ArcView 9.2 was used. After data formatting in the charts, the application ArcMap was used to create thematic maps showing the distribution of georeferenced cases in the city.

Socioeconomic data was analyzed through clusters according to the Urban Quality of Life Index^a (UQLI) available, calculated by the local administration. UQLI is a compound, quantitative, descriptive indicator resulting from other combined single indicators. It consists of four dimensions:

- Education dimension: refers to the level of schooling: proportion (%) of illiterate people over 15 years of age; proportion (%) of household heads with less than four years of schooling; proportion (%) of household heads with 15 years or more of schooling.
- Income dimension: refers to income concentration and inequality: mean income of household heads in monthly minimum wages (MMWs); proportion (%) of household heads with income less than 2 MMWs; proportion (%) of household heads with income over 10 monthly minimum wages.
- Housing dimension: measures the level of comfort: mean number of persons per household; mean number of bathrooms per household.
- Environmental dimension: reflects infrastructure of urban services: proportion (%) of households with adequate water supply linked to the main water system; proportion (%) of households with adequate sewage system linked to the main or rain water system; proportion (%) of households with adequate garbage collection – collected by the city collection service or placed in large containers for collection.

UQLI classification scores ranges from 0 to 1 with increasing quality of life and better life conditions close to 1.

RESULTS

Between 2000 and 2003, there were 828 deaths due to accidents and violence accounting for 17% of all deaths in the city. Of these, 72% were homicides, 21.8% transport accidents and 6% suicides. These deaths were reclassified which allowed to identifying all causes of deaths previously categorized as undetermined (Table 1).

The comparison of event occurrences in the administrative areas showed homicide as the main cause of death, accounting for most deaths in six out of seven administrative areas. As for traffic accidents, the highest rates were found in Praia do Canto, Downtown and continental Vitória. São Pedro was the most violent area, accounting for 19% of all deaths due to violence in the city, of which 92.5% were homicides. In Praia do Canto running overs and suicides occurred more frequently than homicides. Of all deaths, the area of occurrence was not identified in 35 events (4.22%) (Table 2).

Figure 1 shows the spatial distribution of homicides and suicides in the city's administrative areas. Of 597 homicides, 62% were clustered in three administrative areas: São Pedro, Maruípe, and Bento Ferreira. Suicides had a different distribution compared to homicides, with higher number of cases in Praia do Canto, Santo Antônio, and Continental Vitória.

A distinct pattern is seen in the spatial distribution of deaths due to homicide and transport accident (Figure 2). Homicides were more clustered in the north of the island and traffic accidents in the south. In continental Vitória, there is no major difference in the spatial distribution of these deaths.

The distribution of events by age showed that median age of vehicle occupants involved in accidents was 35 years. Accidents with motorcycle occupants pre-

Table 1. Distribution of deaths due to first and end external causes after death review. Vitória, Southeastern Brazil, 2000–2003.

Deaths due to external causes	End			Total
	Accident	Homicide	Suicide	
First				
Accident	56	0	1	57
Motor bike accident	6	0	0	6
Traffic accident	16	0	0	16
Transport accident	29	0	0	29
Unspecified accident	43	0	0	43
Drowning	0	0	2	2
Running over	18	0	0	18
Undetermined intent	13	88	26	127
Homicide	0	509	0	509
Suicide	0	0	21	21
Total	181	597	50	828

Source: Municipal Health Department of Vitória

^a Municipal Administration of Vitória. Urban Quality of Life Index (UQLI) of Vitória districts – 1991 and 2000. [cited 2008 Nov 24]. Available at: <http://www.vitoria.es.gov.br/secretarias/estrategica/iqul1991a2000.htm>

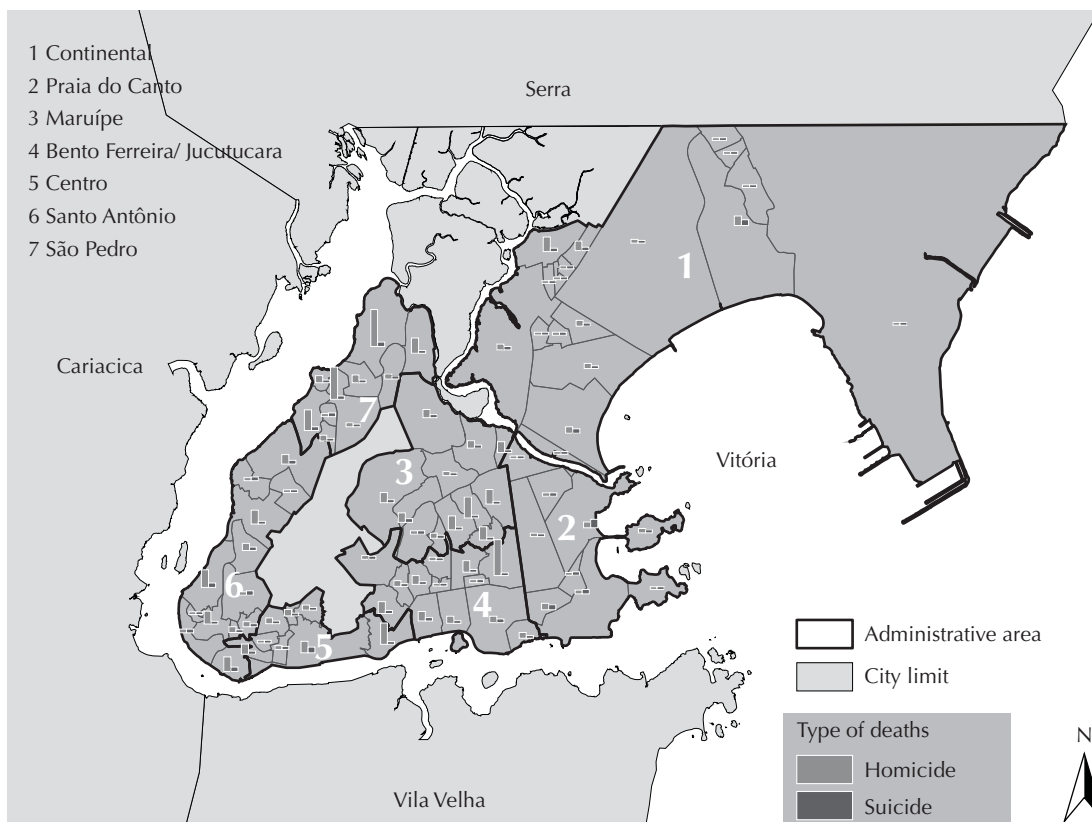
Table 2. Distribution of deaths by administrative areas and cause. Vitória, Southeastern Brazil, 2000–2003.

Administrative area	Motor bike accidents		Traffic accidents		Running over		Homicide		Suicide		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Centro	4	3.92	11	10.78	23	22.55	60	58.82	4	3.92	102	12.31
Santo Antônio	1	0.91	2	1.82	8	7.27	89	80.91	10	9.09	110	13.28
Bento Ferreira	2	1.59	3	2.38	12	9.52	107	84.92	2	1.59	126	15.21
Maruípe	3	2.17	4	2.9	10	7.25	119	86.23	2	1.45	138	16.7
Praia do Canto	4	7.27	7	12.73	15	27.27	14	25.54	15	27.27	55	6.64
Continental Vitória	5	4.95	17	16.83	19	18.81	51	50.5	9	8.91	101	12.19
São Pedro	0	0	4	2.48	3	1.86	149	92.55	5	3.1	161	19.45
Area of occurrence Unidentified	5	14.28	7	20	12	34.28	8	22.85	3	8.57	35	4.22
Total	24	2.9	55	6.65	102	12.31	597	72.1	50	6.03	828	100

Source: Municipal Health Department of Vitória
 Pearson's chi-square (24)= 196.9513 p= 0.0000

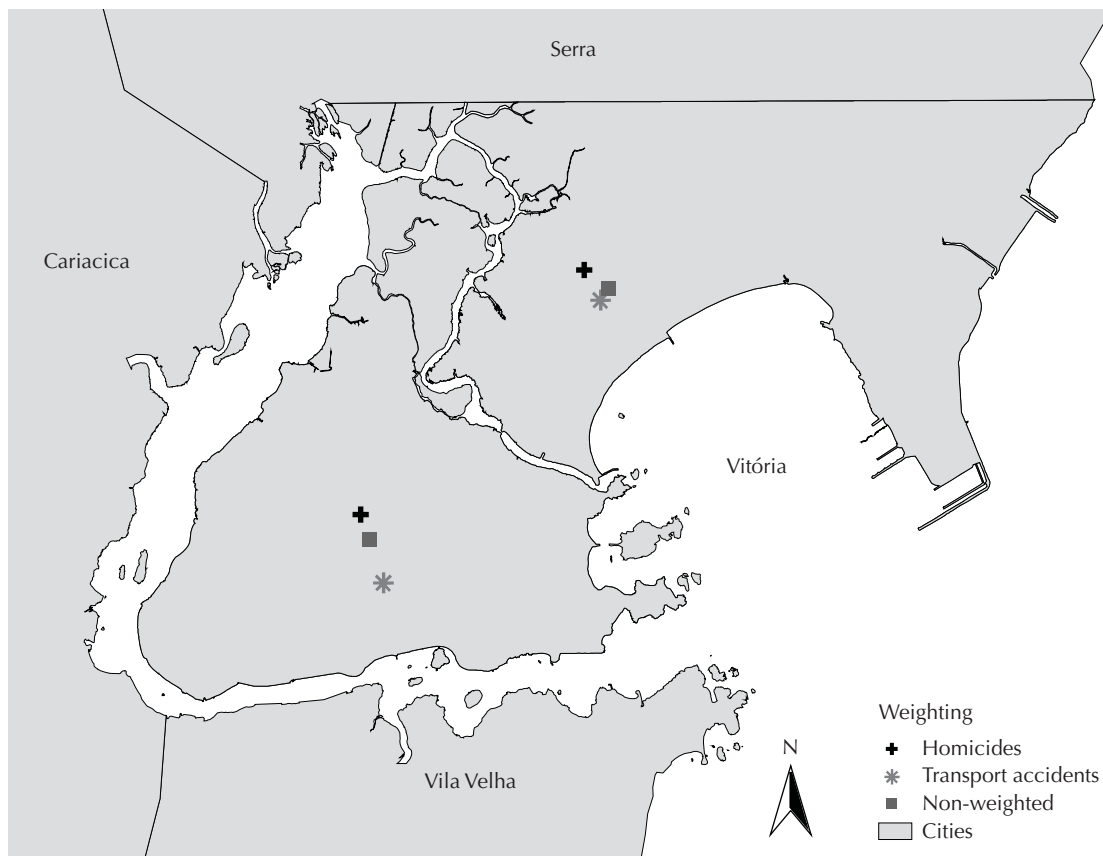
dominantly occurred in young people of productive age (median age of 25 years). Median age of running over victims was 37; 25% were 60 years or more and 25% were less than 23 years. Median age of homicide victims was 24 years, and 75% of them were less than 35 years. Mean age of suicide victims was 37 years.

In the cluster analysis administrative areas were classified according to UQLI. Inequality was found in the island of Vitória; there were areas of high UQLI very close to those with low UQLI, such as Praia do Canto and Bento Ferreira, situated south to the island. The northern area of the island had low UQLI with areas



Source: Municipal Health Department of Vitória

Figure 1. Distribution of homicides and suicides by administrative areas of the city of Vitória. Vitória, Southeastern Brazil, 2000–2003.



Source: Municipal Health Department of Vitória

Figure 2. Spatial distribution of homicides and land transport accidents in the island and continent. Vitória, Southeastern Brazil, 2000–2003

of very low quality of life such as São Pedro and part of Santo Antônio. Continental Vitória showed a more homogeneous pattern, predominantly with intermediate to high UQLI.

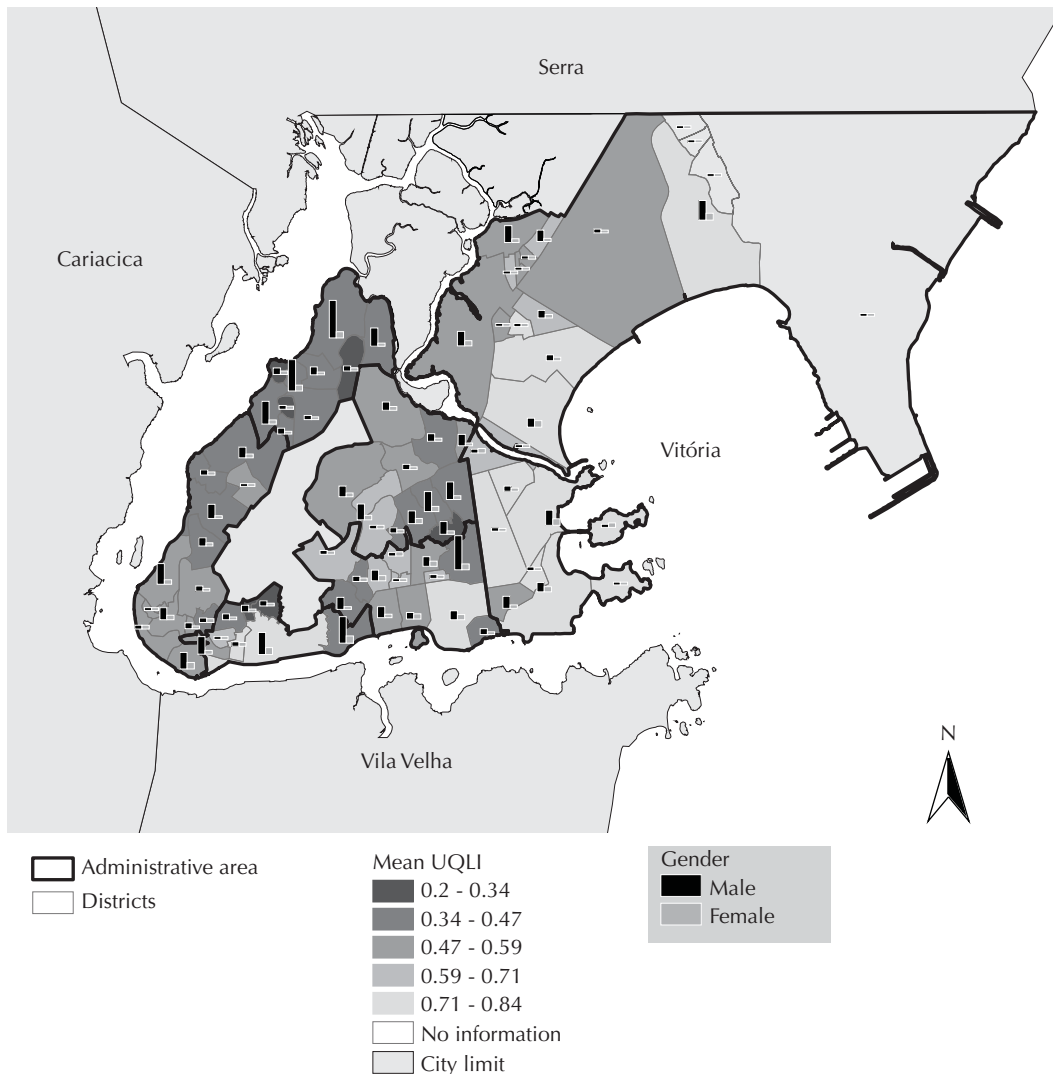
The distribution of men and women by administrative area was similar to the city's general distribution, 52% women and 48% men. The analysis of violent death distribution by gender showed that 87.8% of the victims were men and 12.2% were women. Figure 3A illustrates the predominant disparity between men and women in areas with the lowest UQLI.

Homicide deaths were found in all areas but more frequently in those with lower UQLI and they decreased with increasing UQLI. The highest death rates were seen in São Pedro, where 92.5% of deaths were due to homicides, followed by Maruípe (86.2%) and Bento Ferreira (84.9%). São Pedro area showed the lowest UQLI while Maruípe and Bento Ferreira areas had a heterogeneous pattern with high, intermediate and low UQLI. Figure 3B shows the spatial distribution of homicide deaths by UQLI and race/skin color. It shows a different pattern from that seen for deaths

due to traffic accident and suicide. Overall, victims of homicide and other violent deaths were mostly black people (77%), who were also the victims in 84% of homicides and 69% of running overs, and these deaths occurred in the northern area of the island in districts with the lowest UQLI. In contrast, suicide and transport accidents occurred more frequently among white people and in high UQLI areas in the southern part of the island. Compared to white, black people were 3.7-fold (95% CI: 2.5;5.5) more likely to die due to homicide in Vitória. In continental Vitória, no statistically significant difference was found in the spatial distribution although a similar pattern of deaths by race/skin color was seen.

DISCUSSION

The ecological approach applied in the present study allowed to analyzing homicide, suicide and traffic accidents in clusters of districts; however, this approach has intrinsic limitations. Ecological studies are based on population rather than individuals, and the relationship between these events and clusters of districts does not necessarily reflect the individual status. This design



Fonte: Secretaria Municipal de Saúde de Vitória

Figure 3A. Distribution of deaths according to the urban quality of life index in the administrative areas by gender. Vitória, Southeastern Brazil, 2000–2003.

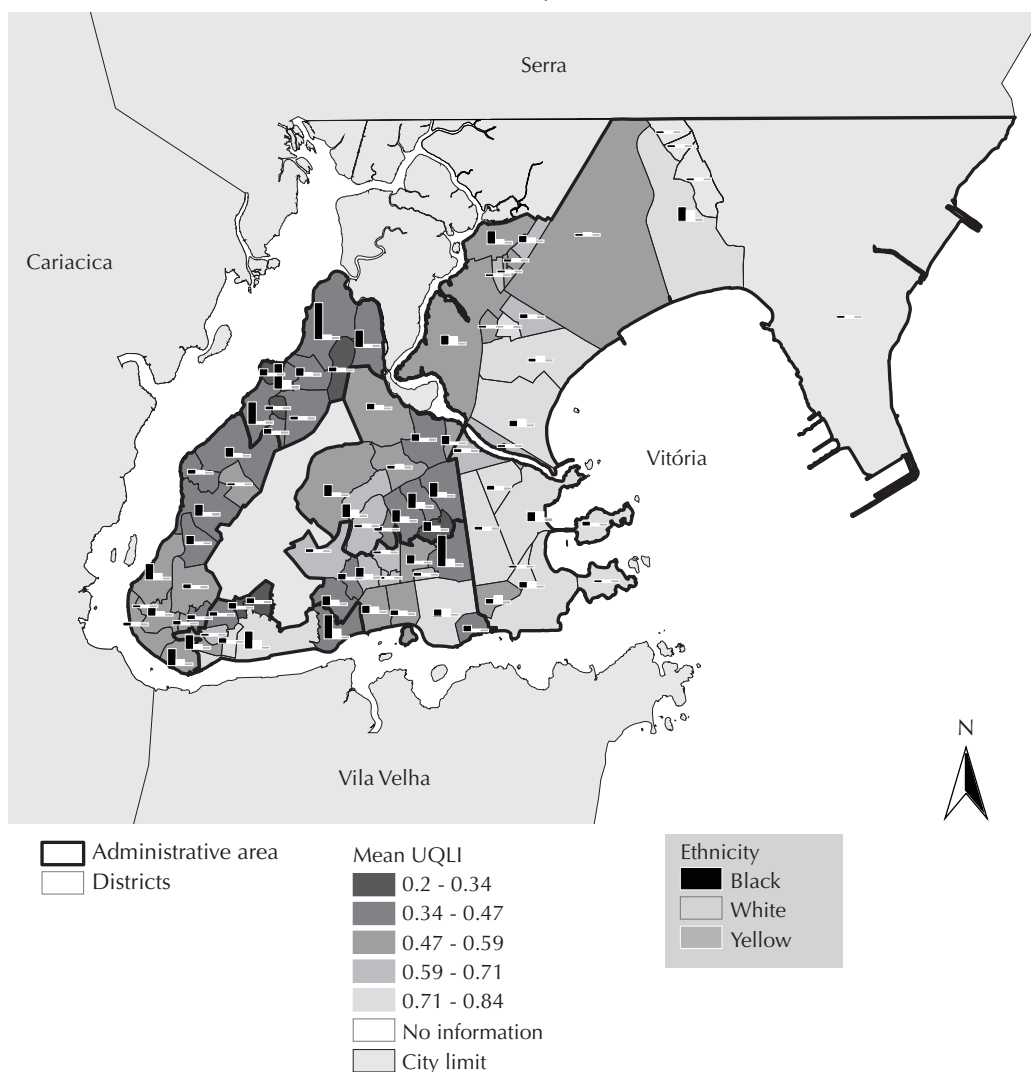
may also produce the so-called ecological fallacy (inappropriate generalization of the characteristics of a cluster, such as a district, to its constituent elements such as inhabitants, neighborhoods or health units). In addition, the study of administrative areas may have led to varied results because of specific characteristics of each district. However, this choice is justified by the fact that the implementation of public policies is based on administrative areas.

Life conditions in the city improved between 1991 and 2000 with increased mean UQLI. However, a study conducted in 2006²⁰ in all Brazilian municipalities showed that Vitória is a capital city with one of

the highest rates of homicide and injuries. The high death rate seen in the city is comparable to that found nationwide, where 14% of all deaths are due to external causes,^a ranking third among mortality indicators nationwide.

Several studies support the findings of our study and reported a growing trend of these events and pointed homicides as the leading cause of death due to external causes.^{6,11} According to Moraes et al,¹⁴ traffic accidents were the leading cause of death in Brazil until 1990s when they were surpassed by homicides, which reportedly were the leading external cause of death in the year 2000.⁴

^a Ministry of Health. Indicators and core data - Brazil - 2002 IDB-2002. Brasília; 2002. [cited 2007 Mar 07]. Available at: <http://tabnet.datasus.gov.br/cgi/tdb2002/matriz.htm>



Source: Municipal Health Department of Vitória

Figura 3B. Distribution of deaths according to the urban quality of life index in the administrative areas ethnicity, Vitória, Brazil, 2000–2003.

Several authors have described a strong relationship between urban decay and its impacts on life conditions, supporting the assumption that violence is not only brought about by poverty but rather by a set of related factors.^{2,13,18,21} They claim there is a correlation between the magnitude of homicides seen in macroregions with the lowest UQLI and poor socioeconomic conditions.^{2,3}

According to Minayo,¹³ (1990) the process of urbanization in Brazil has brought about migration flows into the cities encouraged by false promising ideals of consumption. These migrants have settled in the city's outskirts and slums, areas where basic infrastructure is almost inexistent in violation of fundamental human rights, making residents of these areas more vulnerable to violence as verified in our study.

A similar background was described in the city of Recife, northeastern Brazil,⁶ where mortality rates due to homicides are higher among those with poorer life conditions and traffic accidents and suicides are more frequent among those better off. Lima & Ximenes⁶ claim that most traffic accidents occur in better off areas probably due to greater flow of cars and people.

Some authors^{4,6} have reported male excess mortality. Barata et al² suggest that life conditions at the place of residence have greater impact on male deaths and that mortality rates decrease as life conditions improve. Laurenti et al⁵ also noted that higher male mortality cannot be explained by gender (biological variable) but rather by social and behavioral factors (gender variable).

Nationwide, male adolescents and young adults are the most vulnerable to these deaths, especially those with

lower socioeconomic condition living in urban areas, a trend that has also been described in various studies of mortality due to violent causes.^{1,8,9,a} In the city of São Paulo (southeastern Brazil), over a 35-year period (1960–1995), homicide rates among male adolescents aged 15–19 increased from 9.6 to 186.7 per 100,000 inhabitants, i.e., by 1.800%.¹¹ These victims are characteristically unskilled young people with lower income and no perspectives of entering the formal labor market. Deaths due to homicide are a major cause of years of potential life lost.^{6,19}

In Vitória, the proportion of deaths of vehicle occupants in traffic accidents was similar to that reported in the city of Belém, northern Brazil,¹⁰ where in 1979, male victims aged between 20 and 49 accounted for more than 50% of all deaths. The characteristics of running over victims were similar to those described in Recife (northeastern Brazil), where elderly people were the main victims, especially elderly women over 60.⁶ As for motorcycle accidents, a similar trend to that of other Brazilian cities is seen in Vitória where most victims are young adults.²² In regard to suicides, corroborating the findings of the present study⁷, other studies showed higher rates among adults aged 35–54.

Most importantly, the present study found that ethnicity is an important marker of social inequality. Compared to White people, the Black population was nearly 4-fold more likely to die. This finding corroborates Minayo findings¹³ reporting that non-White young

people are the most vulnerable to violence reflecting the state of social inequality of those living in areas with low urban quality of life and experiencing violence in their daily life. It also points out the hidden violence of these social environments.

Besides investigating lethal violence in Vitória, the present study established a single database of georeferenced data integrating four different municipal departments: health, transportation, public security and citizen's rights. It also provided input to redirect public policies with the implementation of "Vitória da Paz" (victory of peace), an intervention program for traffic accident prevention in high-risk areas, to reinforce municipal police actions at school areas in São Pedro area and to reassign police force in the city. These actions call for ongoing efforts because violence is not an isolated phenomenon and has social roots that are changing and adjusting to the machinery of the state administration.

It is essential to increase violence surveillance and to call the attention of public authorities for the need of improving coordination of the different sectors for an effective, competent response to these events. The best public effort would be to focus on prevention of these deaths and promotion of integrated multisectoral actions because the problems experienced in these areas due to poverty, social inequality and exclusion – including daily violation of basic human rights – seem to be fundamentally arising from equity and social justice issues.

^a Yazabi LM, Ortiz Flores LP. Mortalidade infanto-juvenil. In: O jovem na Grande São Paulo. São Paulo: Fundação Seade; 1988

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