Epidemiological profile, occupational accidents, and socioeconomic characteristics of workers in the state of Amapá, Brazil: a time series analysis (2007-2017)

Análise de série temporal: perfil epidemiológico, acidentes de trabalho e fatores socioeconômicos de trabalhadores no estado do Amapá, Brasil (2007-2017)

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ABSTRACT | **Introduction:** The state of Amapá is located in Brazil's Legal Amazon and comprises 16 municipalities. Its history is marked by social vulnerability and industrial mining; therefore, its current socioeconomic and occupational context should be analyzed considering possible sociohistorical and geographic influences. **Objectives:** To analyze and/or describe the epidemiological profile of workers, occupational accidents, the socioeconomic context, and time evolution of the number of workers in the state and their relationship with the state's gross domestic product. **Methods:** This is an analytic time series study based on official public data. We used a simple regression test to analyze the relationship between the number of workers and gross domestic product and to assess the time trend of the number of workers. The studied period was from 2007 to 2017. **Results:** The number of workers presented an increasing trend over time ($R^2 = 0.902$; $p < 0.001$), with a relative increase of 49.8% between 2007 and 2017. We observed a positive relationship between the annual increase in the number of workers and the state's gross domestic product ($R^2 = 0.899$; $p < 0.001$). The economic activity with the highest mean number of workers was public administration, defense, and social security. The highest socioeconomic indicators were observed in the state capital Macapá. Non-hazardous waste management was the activity concentrating the highest absolute number of occupational accidents. **Conclusions:** This study highlighted important socioeconomic contrasts within the state. The significant increases in the gross domestic product and number of workers are signs of development, but the high number of occupational accidents represents a serious public health problem.

Keywords | development indicators; occupational health; gross domestic product; occupations; Brazil.

RESUMO | **Introdução:** O estado do Amapá localiza-se na Amazônia Legal brasileira e é composto por 16 municípios. Sua história é marcada pela vulnerabilidade social e pela mineração industrial. Assim, seu atual contexto socioeconômico e laboral deve ser analisado considerando os possíveis fatores sócio-históricos e geográficos de influência. **Objetivos:** Analisar e/ou descrever o perfil epidemiológico dos trabalhadores, os acidentes de trabalho, o contexto socioeconômico e a evolução temporal do quantitativo de trabalhadores amapaenses e sua relação com o produto interno bruto do estado. **Métodos:** Estudo analítico, retrospectivo, de série temporal, baseado em dados públicos oficiais. Utilizou-se o teste de regressão simples para analisar a relação entre o quantitativo de trabalhadores e o produto interno bruto e avaliar a tendência temporal do quantitativo de trabalhadores. O período estudado foi de 2007 a 2017. **Resultados:** O quantitativo de trabalhadores apresentou tendência temporal crescente ($R^2 = 0,902$; $p < 0,001$), com aumento percentual de 49,8% no período de 2007-2017. Observou-se relação positiva entre a evolução anual do quantitativo de trabalhadores e o produto interno bruto do estado ($R^2 = 0,899$; $p < 0,001$). A atividade econômica com maior quantitativo anual médio de trabalhadores foi Administração Pública, Defesa e Seguridade. Macapá foi o município com os melhores indicadores socioeconômicos. A atividade de Coleta de Resíduos Não Perigosos concentrou o maior quantitativo absoluto de acidentes de trabalho. **Conclusões:** Este estudo evidenciou grandes contrastes socioeconômicos dentro do estado. O aumento significativo do produto interno bruto e do quantitativo de trabalhadores é um sinal de desenvolvimento, mas o elevado quantitativo de acidentes de trabalho representa um sério problema de saúde pública.

Palavras-chave | indicadores de desenvolvimento; saúde do trabalhador; produto interno bruto; ocupações; Brasil.

INTRODUCTION

The state of Amapá belongs to the North region of Brazil, within the Legal Amazon. Amapá was created in 1943 from the state of Pará, as a federal territory, being upgraded into a state in 1988. The state of Amapá currently has approximately 846,000 inhabitants, with a population density of 5.93 people per square kilometer. Its territory comprises 16 municipalities, of which the most populated and developed is Macapá, the state capital located by the Amazon river.[1,2]

Regarding economic and occupational aspects, the history of Amapá is undeniably associated with its geographic isolation and Brazil's regional inequalities, as well as with the installation, in the 1950s, of the first industrial mining company of the Eastern Brazilian Amazon. Installed in the municipality of Serra do Navio, Indústria e Comércio de Minérios S.A. (ICOMI) is still the largest economic endeavor in the history of the state. Although this industrial mining activity, prematurely shut down in the last years of the 20th century, brought apparent contributions in employment, income, infrastructure (port, railway, and urban), and socioeconomic development,[1,3,4] it also left marks of severe violations to the environment, worker's health, and environmental health.[3] The cost-benefit results to the local development are questionable, and the negative impacts of the abrupt and disordered interruption of this endeavor hurt the local economy,[3,4] with possible reflexes until the present day.

This way, chronic vulnerability in Amapá — especially considering public health —, occupational health conditions, and other socioeconomic aspects are undeniably of great importance for the economy and for the social and health development of the state. Retrospective time series studies that analyze economic activity indicators such as the gross domestic product (GDP) and the number of workers are essential for comprehending the current development situation, in addition to enabling projections of future scenarios for the state of Amapá. In this sense, this study used the 2007-2017 period as a reference for (1) analyzing and/or describing the epidemiological profile, occupational accidents, and socioeconomic context of the state's municipalities and workers; (2) assessing the influence of the number of workers on the GDP of the state; and (3) outlining the trend over time of the number of workers in the state.

METHODS

DATA AND VARIABLES

This is an analytical, retrospective, time series study, based on secondary data extracted from official public sources. The studied period (2007-2017; n = 11) was chosen because of the implantation (in 2007) of the Technical Epidemiological Nexus, a Brazilian Social Security tool created for minimizing the underreporting of occupational accidents,[5] and of the availability of public data by the Brazilian Social Security[6] and the Brazilian Institute of Geography and Statistics (IBGE)'s Automatic Recovery System (SIDRA).[7]

Data (2007-2017) referring to workers of the state of Amapá (number of employed people) and state GDP (in Brazilian reais [R$]) were extracted from SIDRA.[7] Data on socioeconomic indicators of the state and its 16 municipalities, based on the 2010 census, were extracted from the Atlas of Human Development in Brasil.[8] We analyzed the human development index (HDI) and its 3 components (HDI-Income, HDI-Life Expectancy, and HDI-Education) adapted to subnational levels; the fraction of poor individuals (proportion of people with a per capita household income of R$ 140.00 [US$ 80.00] or less in August 2010); the per capita income in Brazilian reais (the sum of the incomes of all individuals residing in private permanent households divided by the number of individuals). Dollar exchange rates were based on 2010 values.

Data regarding occupational accidents were extracted from the Brazilian Social Security's Yearbooks of Occupational Accident Statistics,[6] including all accidents reported between 2007 and 2017 in the state of Amapá, regardless of the record of an Occupational Accident Communication in the Brazilian Social Security Institute (INSS). We used the yearbooks that provided the most up-to-date information for each studied year, and the classes of economic activities most involved in occupational accidents were defined

by the absolute cumulative sum of accidents reported each year between 2007 and 2017.

For defining the economic activities with the most workers in this period, we classified the extracted data according to each section of the National Classification of Economic Activities (Classificacao Nacional de Atividades Economicas; CNAE). We then analyzed the mean number of workers between 2007 and 2017 in all 21 CNAE sections and approached the 6 sections with the highest mean numbers of workers per year within this period. We highlight that all economic activities were described as sections and classes according to the CNAE standard: CNAE section (letter) – class (4-digit number). This study did not require analysis by a Research Ethics Committee because it was based exclusively on open public data that did not provide individual identification.

STATISTICAL ANALYSIS

Data were organized and analyzed using Microsoft Excel® version 2016, SPSS® version 20.0, and Origin Pro® version 8.5. Data distribution was verified via a Kolmogorov-Smirnov test, which according to Torman et al.[9] is the most adequate for verifying a normal distribution in the sample size of the present study (2007-2017; n = 11). The normal distribution hypothesis was not rejected for any of the analyzed variables.

Therefore, we performed a simple linear regression for analyzing the influence of the number of workers (independent variable) on the state GDP (dependent variable) between 2007 and 2017. The general polynomial model of the simple linear regression is $Y^{\wedge} = \beta_1 X + \beta_0$, where $Y^{\wedge}$ represents the estimated GDP (in Brazilian reais) for a certain number of workers in the state (X), and β_1 represents the angular coefficient of the model (slope of the curve). The angular coefficient illustrates the variation in $Y^{\wedge}$ as a function of X and whether this relationship is positive or negative. For better presenting our results, the GDP variation was proportionally described based on the variation for each 1000 workers, considering the model's β_1 value as reference and the directly proportional linear relationship between $Y^{\wedge}$ and X.

For defining the trend of the number of workers in Amapá over time, we used a simple time series regression test (2007-2017). We tested linear, second order, third order, and exponential polynomial models, finally selecting the linear model ($Y^{\wedge} = \beta_1 X + \beta_0$) based on the best adjustment to the data, the determination coefficient (R^2), and a residue analysis for verifying homoscedasticity. In this case, $Y^{\wedge}$ represents the predicted number of workers, X represents the year, and β_1 is the angular coefficient of the linear model. In both regressions, the level of significance adopted in the F-test for the analysis of variance was $p \leq 0.05$. We also calculated the mean (M), standard deviation (SD, ±), and median.

RESULTS

In the studied period, the mean yearly number of workers in the state of Amapá was M = 124 285.5 ± 16 203.9, with a mean value of 126 683. The number of workers showed an increasing trend ($Y^{\wedge} = 4,641.23X - 9,213,863.82$; $R^2 = 0.902$; $p < 0.001$). Analysis of the angular coefficient of the linear model indicated, from 2007 to 2017, a mean annual increase of 4 641.23 in the number of workers in the state (Figure 1). Moreover, this number increased from 94 960 in 2007 to 142 276 in 2017, which resulted in a positive variation rate of 49.8%.

According to CNAE sections, the economic activities with the highest mean numbers of workers (between 2007 and 2017) were public administration, defense, and social security (CNAE O; M = 51 763.7 ± 8 946.8), motor vehicle and motorcycle sales and repair (CNAE G; M = 26,897.6 ± 3,922.3), administrative activities and complementary services (CNAE N; M = 8,178.6 ± 1,480.8), education (CNAE P; M = 6,908.4 ± 1,583.9), construction (CNAE F; M = 5,942.1 ± 1,471.6), and transformation industries (CNAE C; M = 3,985.7 ± 636.5) (Figure 2). In 2017, 44.8% of all employed persons in the state of Amapá worked for the public administration, defense, and social security (CNAE O).

In 2010, the state of Amapá had an HDI of 0.708 and a per capita income of R\$ 598.98 (US\$ 341.07); 24.07% of the population was considered poor. When analyzing the state municipalities, Macapá, the state

capital, had the highest HDI (0.733), per capita income (R$ 717.88 [US$ 408.77]), and the lowest fraction of poor inhabitants (18.15%). Itaubal, in comparison, had the lowest HDI (0.576), per capita income (R$ 213.26 [US$ 121.43]), and the highest fraction of poor inhabitants (63.69%). The median per capita income among all 16 municipalities of the state was R$ 402.40 (US$ 229.13). Table 1 shows indicators for all 16 municipalities of the state of Amapá.

Within the studied period, the mean annual GDP of the state of Amapá was M = R$ 10,825,324,000.00 ± R$ 3,342,587,000.00. The linear regression of the influence of the number of workers on GDP demonstrated that, for each 1000 new workers, the GDP increased in a mean value of R$ 195,668,730.00 ($Y^{\wedge} = 195{,}668.73X - 13{,}493{,}452{,}880.85$; $R^2 = 0.899$; $p < 0.001$). Between the first and last analyzed years (2007-2017), the GDP varied from R$ 6,012,523,000.00 to R$ 15 479 885 000.00, with a positive variation of 157.5% (Figure 3).

Between 2007 and 2017, 8,202 occupational accidents were reported: a mean number of 745
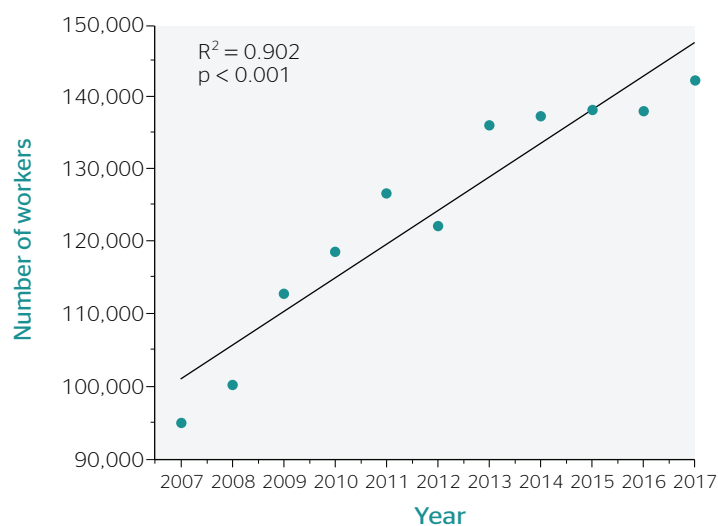
Figure 1. Graphic representation of the time series linear regression of the number of workers in the state of Amapá between 2007 and 2017.
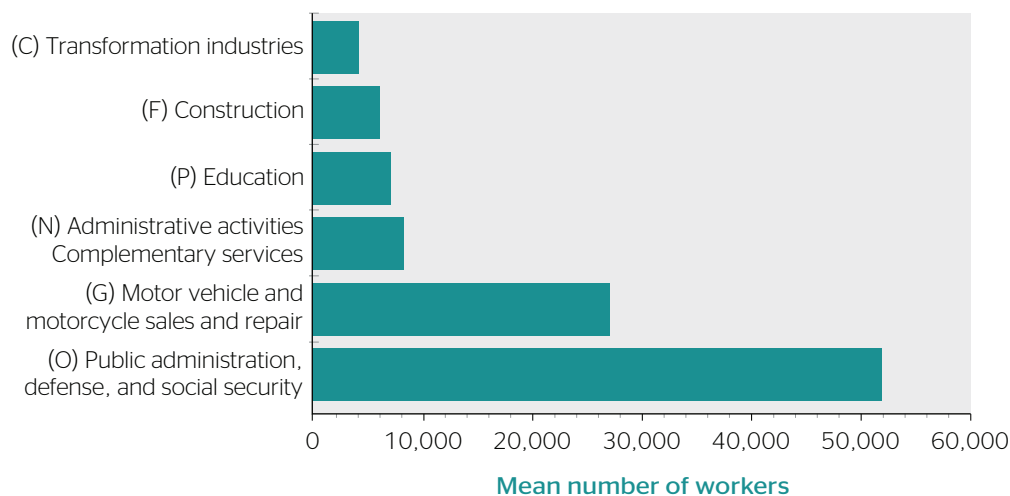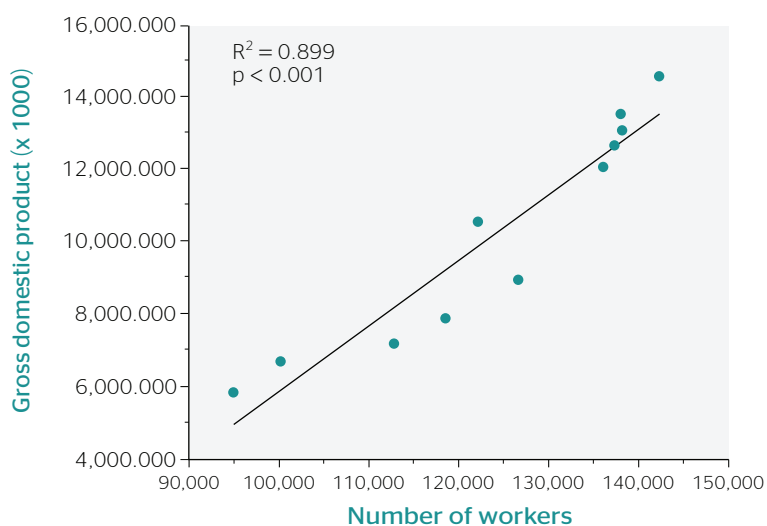

Figure 2. Economic activities with the highest mean numbers of workers between 2007 and 2017 in the state of Amapá, according to sections of the National Classification of Economic Activities (CNAE).
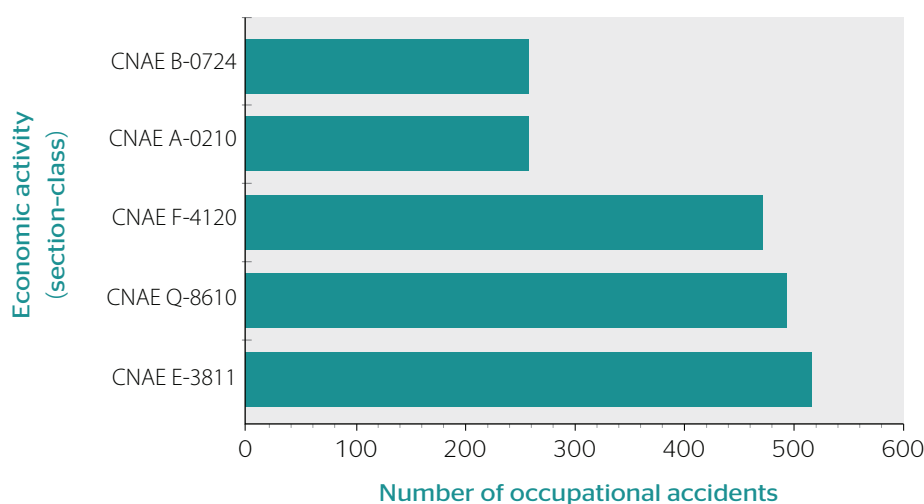
cases per year. The 5 economic activities with the most accidents (according to the CNAE sections and classes) were non-hazardous waste management (CNAE E-3811; n = 507; 6.18%), hospital care (CNAE Q-8610; n = 493; 6.01%), building construction (CNAE F-4120; n = 471; 5.74%), forest production – planted forests (CNAE A-0210; n = 260; 3.17%), and precious metal mining (CNAE B-0724; n = 259; 3.16%) (Figure 4).

DISCUSSION

The state of Amapá suffers with historical effects of the unequal development of Brazilian regions.[10-12] Between the early 1950s and the late 1990s, this state went through a process of territorial division of labor due to industrial mining, with an exponential increase in jobs/income and infrastructure[1,3,12]; currently,

Figure 3. Graphic representation of the linear regression of the number of workers and gross domestic product (× 1.000) in Brazilian reais, state of Amapá, 2007 to 2017.

Figure 4. Economic activities with the highest absolute cumulative numbers of occupational accidents according to sections and classes of the National Classification of Economic Activities (CNAE). State of Amapá, 2007 to 2017. CNAE A-0210 = forest production – planted forests; CNAE B-0724 = precious metal mining; CNAE E-3811 = non-hazardous waste management; CNAE F-4120 = building construction; CNAE Q-8610 = hospital care.

most of its workers are employed by the public administration, defense, and social security (CNAE O; M = 51,763.7 ± 8 946.8) and motor vehicle and motorcycle sales and repair sections (CNAE G; M = 26,897.6 ± 3,922.3). This can be observed as the mean number of workers in administration, defense, and social security (M = 51,763.7) was 6.3 times higher than that of the third largest section in this period (CNAE N; M = 8,178,6 ± 1,480.8). It is important to note the great importance of these 2 economic activities for Amapá: They represent most of the state GDP.[13]

This way, the predominance of these 2 sections (CNAE O and CNAE G) regarding the mean number of workers in this study corroborates the pattern described for the state municipalities by Viana et al.,[10] who classified the economy of 8 municipalities (including the capital Macapá) as "weaker agriculture associated with industry and services" and that of other 8 municipalities as "agriculture and public administration." Descriptions by Viana et al.[10] refer to the first years of the 21st century[10] and bear similarities and relationships with the scenario described by the present study. In this sense, it is possible that the main production sectors in the state's economy continued being characterized by extractivism, low use of high-technology resources and low industrialization, since most of the workforce is formed by public sector workers. This increase in public sector employment was already being perceived in the 1990s.[1]

Moreover, when analyzing the relationship between the economy and health care situations, we noted even more similarities since 8 out of the 16 municipalities were classified as agriculture and public administration-based economies and this classification is associated with lower expenses in health care.[10] Out of these 8 municipalities, 5 (Mazagão, Itaubal, Cutias, Porto Grande, and Pedra Branca do Amaparí) are among the 6 with the worst HDI-Life Expectancy indices (the HDI index assessing health care) in the state, as demonstrated by Table 1. The capital Macapá, which was described by Viana et al.[10] as having a precarious health care structure with low technical and scientific density,[10] is the Brazilian state capital with the lowest number of health care institutions (as of December 2017),[14] the highest rate of poor inhabitants, and the fifth lowest HDI-Life Expectancy. On the other hand, the state's general HDI is higher than that of the North region of Brazil (0.667).[8,11]

When analyzing the income indicator, we observed that the mean per capita income among the state

Table 1. Socioeconomic indicators of the state of Amapá and its municipalities in 2010

Municipalities (state of Amapá)	HDI	HDI-Income	HDI-Life Expectancy	HDI-Education	Per capita income (Brazilian reais)*	Poor inhabitants (%)
Amapá	0.642	0.631	0.790	0.532	406.90	42.01
Calçoene	0.643	0.636	0.759	0.550	417.71	41.85
Cutias	0.628	0.576	0.760	0.566	287.41	47.76
Ferreira Gomes	0.656	0.635	0.820	0.542	416.72	33.75
Itaubal	0.576	0.528	0.758	0.477	213.26	63.69
Laranjal do Jari	0.665	0.641	0.801	0.573	432.92	24.49
Macapá	0.733	0.723	0.820	0.663	717.88	18.15
Mazagão	0.592	0.609	0.758	0.449	353.61	43.51
Oiapoque	0.658	0.693	0.779	0.527	598.38	31.24
Pedra Branca do Amaparí	0.626	0.628	0.779	0.502	397.98	36.14
Porto Grande	0.640	0.610	0.777	0.554	356.65	35.58
Pracuúba	0.614	0.539	0.790	0.544	228.81	55.75
Santana	0.692	0.654	0.794	0.638	469.24	25.39
Serra do Navio	0.709	0.659	0.783	0.692	484.63	29.33
Tartarugalzinho	0.592	0.553	0.794	0.473	250.20	56.61
Vitória do Jari	0.619	0.587	0.781	0.517	309.39	41.64
State of Amapá	0.708	0.694	0.813	0.629	598.98	24.07

* The minimum wage in Brazil in 2010 was R$ 510.00 (US$ 291.40). HDI = Human Development Index.
Source: Atlas of Human Development in Brasil.[8]

municipalities was R$ 402.40 (US$ 229.13). This means that half the municipalities in the state of Amapá had their populations living with a per capita income of around R$ 100.00 (US$ 56.94), which is lower than the Brazilian minimum wage in the same reference period (R$ 510.00 [US$ 290.40]).[15] The municipality with the highest per capita income was Macapá (R$ 717.88 [US$ 408.77]), the capital with around 60% of the state population.[11] Possibly owing to this concentration, the total per capita income of the state was approximately R$ 200.00 (US$ 113.88) higher than the median value among the municipalities.

Considering the number of workers in the state, our time series regression demonstrated a significant increase between 2007 and 2017. This result is in accordance with recent growth trends in the Brazilian labor marker.[16] Menezes-Filho et al.[16] identified, between 2002 and 2012, a 20.25% growth in the Brazilian worker class, while Oliveira[17] observed, between 2000 and 2010 in the North region, an occupational growth rate of + 43.25%. Although these variations are positive, they are still smaller than that found in this study for the state of Amapá, which had a 49.8% increase between the studied years (2007-2017). Still, it is important to note a possible relationship between the growth of the working class and that of the population, since Amapá had one of the highest population growth rates in the last decades (approximately 200% between 1991 and 2019).[2,12]

In this sense, in order to comprehend the growth of the state's working class, it is essential to emphasize that this state is located in a region that is historically marked by chronic social vulnerability and geographic isolation.[10,11,17] This way, government measures for accelerating and recovering growth, in addition to increasing migration possibilities, may have promoted new jobs in different areas of the economy,[1,17-19] considering the decadence of the manganese mining cycle in the state.[1,4] Moreover, the desire to maximize salaries, due to the relevant fraction of the population considered poor, may have potentialized the workforce.[8,17] Finally, public employment, development, and income distribution policies implemented in recent years have encouraged the creation and formalization of new jobs, especially in less economically developed states.[18-20]

In parallel with the increase in the number of workers, we observed an increase in the state GDP of 157.5% between 2007 and 2017, which is around 3 times higher than the increase in the number or workers (49.8%); a significant influence of the number of workers on the GDP increase was also observed. On a national level, we observed a simultaneous evolution of these variables between 2001 and 2008.[21] A study by Silva and Santos[22] demonstrated that, between 2003 and 2013, there was a strong positive correlation ($r = 0.991$) between the number of micro and small businesses and GDP in the North region, while a strong negative correlation ($r = -0.972$) was observed between the mean unemployment rate and the Brazilian GDP.[22] It is possible that the incorporation of people to the workforce and the reduction in unemployment may partially justify the GDP increase via the increase in total income and consumption of goods and services produced by the economy.[23,24] Moreover, the GDP (illustrating economic growth) is related with the employment level. This can be explained by the concept of technical coefficient (employment-output elasticity, which links an increase in the employment rate with economic development.[25]

As for occupational accidents, it is known that their human and economic impacts are more prominent in less developed regions. These accidents, considered a serious national public health issue, involve various segments of the society such as the employer/company, the affected worker and his or her family, the Brazilian social security, and the Unified Health System (SUS).[26,27] In the present study we observed a mean number of 745 occupational accidents reported per year in the analyzed period. Based on the study by Almeida and Barbosa-Branco[28], which described a mean period of sickness leave due to a B91 occupational accident (ADAT-B91) of 75 days,[28] it is possible to estimate that, on average, 56 thousand workdays have been lost per year in Amapá between 2007 and 2017. It is possible that this loss of productivity and human capital exerted a certain impact on the local economy, but we should also consider results reported by Santos,[13] which indicated that only 16.6% of disability benefits approved in the state of Amapá between 2008 and 2012 were of the ADAT-B91 type.[13]

The number of occupational accidents in the 5 activities with the most absolute cumulative accidents between 2007 and 2017 represented 24.5% of all accidents (n = 8,202). Out of these 5 activities, 2 are classified as of high risk for occupational accidents (CNAE E-3811 and CNAE F-4120) and 3, as medium risk (CNAE Q-8610, CNAE A-0210, and CNAE B-0724).[29] Only 1 out of the 5 CNAE classes (building construction, CNAE F-4120) is among the sections with the highest mean number of workers in the state within the studied period. This may demonstrate that a higher number of workers is not enough to justify a higher number of occupational accidents, and other multifactorial causes that lead to accidents should be considered.

CONCLUSIONS

This study showed significant socioeconomic contrasts within the state of Amapá, especially between the capital and some inland municipalities such as Itaubal (with a per capita income 3.3 times lower than Macapá). It is clear that some municipalities in the state had a short contact with and did not benefit much from the technical-scientific-industrial development that happened in Brazil in the 20th and 21st centuries. This demonstrates the need for government attention through public health and economic policies with a high capillarity for reaching inland municipalities with socioeconomic development. In addition, social and economic development should take place simultaneously since they are equally important to the population.

This way, the positive influence of the number of workers in the GDP is a sign that investments and employability are some of the tools for maintaining and accelerating state development. However, we highlight that 44.82% of the state workers were employed by the public administration, defense, and social security (CNAE O) in 2017, being directly or indirectly paid by public funds.

Our results demonstrated significant increases in GDP and the number of workers in Amapá, as well as a strong relationship between these variables. Moreover, we observed that most workers were employed by the public administration, defense, and social security economic activity section (CNAE O) and that those employed by the non-hazardous waste management section (CNAE E-3811) were the most affected by occupational accidents (in absolute numbers).

In addition, high rates of occupational accidents are a relevant public health problem in the state, requiring the development of public policies that protect worker health and reduce the impact of these injuries. In this sense, government investments in professional rehabilitation are essential for reducing the number of lost workdays and of possible early retirements due to occupational accidents, especially when considering results by Miranda et al.,[30] which described the North as the Brazilian region with the lowest mean cumulative incidence of admissions in the INSS's professional rehabilitation services.

A limitation of this study is the fact that it has been exclusively based on secondary public data, which restricted some analyses and conclusions. Moreover, the numbers reported here do not correspond to the entire labor market in the state, which includes unregistered workers with no social security protection. This, in addition to the underreporting observed by Filho,[31] leads to an underestimation of the real number of accidents in Amapá. Finally, we propose the elaboration of studies that assess in detail the informal labor market in the state and that verify the incidence and mortality rates of occupational accidents in the state of Amapá and its municipalities, considering the socioeconomic contexts in which workers are included.

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