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Morbimortality profile by COVID-19 in telework and on-site work in an oil and gas company in Brazil

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Abstract.
BACKGROUND: As a reflection of the health emergency caused by COVID-19, many countries adopted guidelines, which included activity restrictions. As a result, some companies maintained their activities with on-site work and telework.
OBJECTIVE: Analyzing the morbidity and mortality profile due to COVID-19 of workers in telework and on-site work in an oil and gas company.
METHODS: Cross-sectional, quantitative, and analytical study that included 8,394 workers diagnosed with COVID-19 at an oil and gas company in Brazil, from June 2020 to June 2021. The company's Surveillance Program database was used as an information source.
RESULTS: The total prevalence of cases was 21.7%. For teleworking and face-to-face workers, they were 20.7% and 23.3%, respectively. There was a predominance of women (19.7%), white ethnicity/colour (64.7%), higher level position (52.6%), age group over 40 years (36.7%), married (53, 8%), working at the company for a period that ranges from 7 to 10 years (17%), administrative activity (68.5%), and a higher number of symptomatic workers and deaths in telework compared to on-site work.
CONCLUSIONS: The results suggest that testing is important to refrain the virus spread in the company's work environments, as it allowed asymptomatic workers to be diagnosed with COVID-19. The study suggested that on-site work was not a transmission facilitator in the occupational environment, which points out the importance of preventive measures in the workplace and the adoption of remote work for the largest possible number of workers to improve the safety of employees, workers who remained in the on-site work modality.

Keywords: COVID-19, occupational groups, oil and gas industry, teleworking, workplace, occupational health

1. Introduction

The COVID-19 pandemic has had profound impacts on public health, the economy, and the labor market [1]. As a reaction to the health emergency caused by COVID-19, many countries adopted guidelines that included restrictions on activities linked to several sectors [2]. Based on international recommendations, many companies maintained their

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activities in a hybrid mode, that is, with face-to-face and remote work, through telework [3]. The World Health Organization, in the Policy on the Prevention and Mitigation of the Transmission of COVID-19 at Work, highlights the good practices of some countries in the implementation of remote work and states that this modality was essential in the occupational health policy in the context of COVID-19 [4]. Policy measures aimed at limiting mobility were an important instrument in the public health response to COVID-19 to manage epidemic waves [5].

Despite the control measures adopted, the transmission of SARS-CoV-2 in the workplace contributed significantly to the global pandemic of COVID-19, becoming a major challenge for occupational health [6] due to the burden of occupational exposure, sick leave, and guarantee of replacement workers [7], and due to the long-COVID which can extend beyond the acute phase [8].

According to the Occupational Safety and Health Administration – OSHA [9] (2020), through the occupational exposure pyramid, most work tasks in the oil and gas sector are associated with a low or moderate risk of exposure to SARS-CoV-2. Despite this assertion, it is necessary to understand how workers are exposed to infections and diseases in the workplace, in order to assist in managing risks for infectious diseases [7] with control measures taken based on the risk level [10]. However, the lack of occupational health data in several countries around the world, and especially in Brazil, makes it difficult to direct public policies on restrictions and flexibility in work environments [11].

In light of the above, the objective of this study was to identify the profile of illness and deaths due to COVID-19 in workers in telework and on-site work in an oil and gas company. This is an unprecedented study in its purpose of investigating the prevalence of the disease in different types of on-site work and teleworking. Workers who had COVID-19 were identified from June 2020 to June 2021. Thus, the study included a large number of workers with different sociodemographic and occupational characteristics and random geographic distribution in the country.

2. Method

2.1. Study design and population

This is a cross-sectional, quantitative, and analytical study that included 8,394 workers diagnosed with COVID-19 in an oil and gas company operating in Brazil, from June 2020 to June 2021. The source of information was the database of the Company's Occupational Health Surveillance Program. Additionally, data were anonymized before analysis.

The company operates diversely across multiple areas of activity. The industrial unit under study engages in various operations, including oil and gas well operations, oil and gas storage and movement stations, gas compression stations, and produced water treatment and injection stations. Additionally, it conducts maintenance and inspection activities for equipment and facilities, involve general services, transportation, and cargo storage. Furthermore, the company performs activities that provide support to the end processes, such as the acquisition of goods and services, consulting in Health, Environment, and Safety, logistics, human resources and training, building administration, property security, customs clearance, among others.

Inclusion criteria were workers directly linked to the company diagnosed with COVID-19 according to clinical-epidemiological or laboratory criteria, from June 2020 to June 2021. Diagnosis by clinical-epidemiological criteria followed guidelines from the World Health Organization and the Brazilian Ministry of Health during the analyzed period [11]. Laboratory diagnosis of SARS COV-2 infection was defined by serological rapid antigen (TR-Ag), or real-time reverse transcription tests (RT-PCR) [12], being the first performed in the workplace and the others carried out in out-of-work care.

The study was approved by the company and was conducted within ethical standards, approved by the Research Ethics Committee.

2.2. Variables investigated

Sociodemographic, occupational, and clinical variables of the studied workers were used as research variables.

Sociodemographic variables: age group, sex, ethnicity/color, and marital status, and occupational variables: education in the position, time working in the company (in years), State of work and State of residence, and type of activity came from the system of the company's Human Resources department. Information on access to the company's facilities before or at the time of diagnosis and identification of the source of contamination at work were obtained through self-reports by the employee when being monitored by the company, every two days from diag-

nosis, as well as the clinical variables informed by the employee or family member, which included the presence of symptoms, hospitalization, admission to the Intensive Care Unit (ICU), and death.

The work modalities during the study period did not overlap, with individuals exclusively involved in teleworking or in-person work. In the context of teleworking, workers dedicated themselves uninterruptedly to their remote activities, carried out in a home environment and without contact with other co-workers. Workers who performed their duties in person received guidance on disease prevention and were instructed not to report to work if there were signs or symptoms of the disease. Upon arrival at the workplace, all workers underwent tests, and those with negative results were unable to work in person. In the face-to-face environment, social distancing measures were taken, complemented by the use of masks and the availability of hand hygiene materials. On the other hand, when teleworking, workers were instructed to adhere to disease prevention recommendations and not travel to work.

The work activity considered as a shift, refers to workers who are on a shift or on notice, and who generally carry out operational or operational support activities, while the work activity considered administrative refers to other non-operational or support activities carried out in an office. For schooling data, we considered the level of education of the worker in the position at the time of admission to the company. The information of the State of residence different from the State of work was considered due to the fact that it is common workers reside in one State of the federation and work in another, according to the characteristics of the productive process and the needs of the company.

2.3. Statistical analysis

To obtain the prevalence rate of COVID-19 in the company studied, the percentage of the number of cases of the mentioned disease in the investigated period was considered divided by the accumulated amount of the population. For the prevalence of teleworking and on-site work, the percentage of the number of cases of COVID-19 in each type of work in the investigated period was considered divided by the accumulated amount of workers in the respective type of work. The mortality rate was calculated by dividing the number of deaths from COVID-19 by the population at risk, that is, the number of workers in the company; the lethality rate was calculated by dividing the number of deaths from COVID-19 by the number of COVID-19 cases among workers.

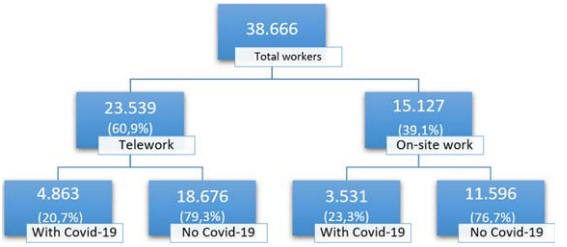

Fig. 1. Flowchart with the number of workers in an oil and gas company in Brazil from June 2020 to June 2021.

The percentages of people sick with COVID-19 by State of work were obtained by the company's Human Resources system and calculated as follows: the number of workers affected by COVID-19 working in the State divided by the total number of workers working in the respective State and the result being multiplied by 100. Absolute values and percentages were used to describe the categorical variables, and the relationship between the type of work and independent variables was evaluated using Pearson's chi-square test. The significance level adopted was 5%. Statistical analyzes were performed using *IBM SPSS* Statistics for Windows, version 20.0 (Armonk, NY: IBM Corp).

3. Results

Of the total 38,666 workers at the company during the period studied, 8,394 were diagnosed with COVID-19. Of these, 4,863 teleworking workers and 3,531 on-site workers were diagnosed with COVID-19, as shown in Fig. 1.

Thus, the total prevalence rate in the company was 21.7%. For teleworking workers, the prevalence ence was 20.7%, while for those working on-site, this indicator reached 23.3%.

The company operates nationwide and the percentage distribution of cases by Brazilian state is described below.

Figure 2 shows the percentage of COVID-19 cases by the state of work. The State of Amazonas (AM) stands out with the highest percentage of cases, followed by Bahia (BA), Sergipe (SE), and Rio Grande do Norte (RN).

The profile of workers with COVID-19 and the relationship between the type of work and sociode-

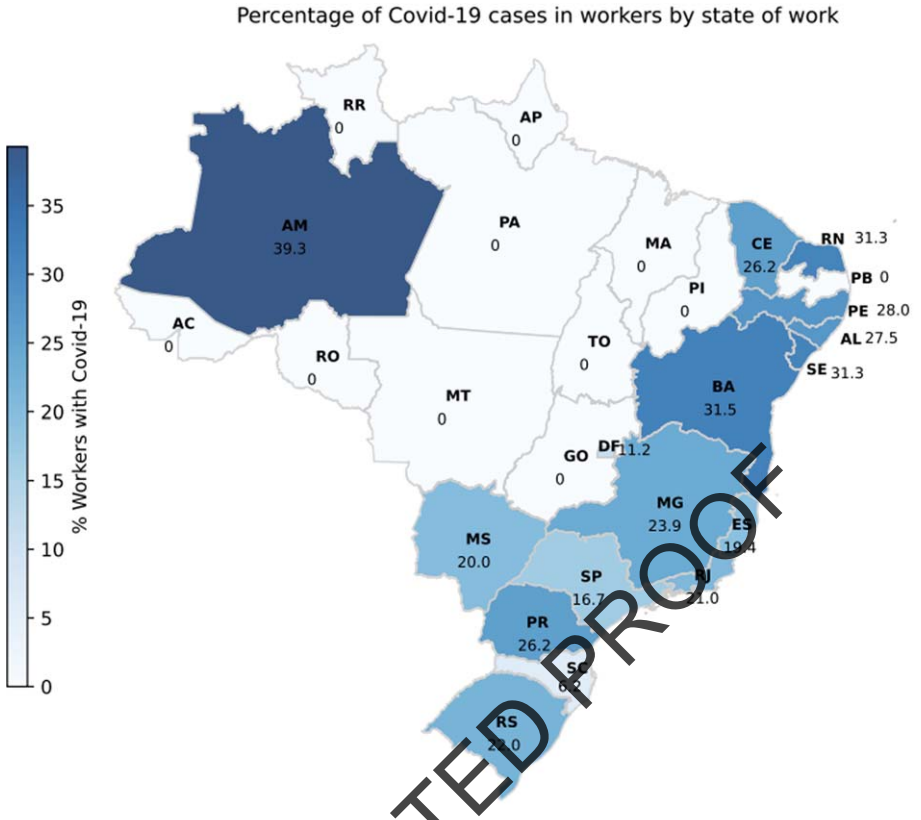

Fig. 2. Percentage of workers with COVID-19 from June 2020 to June 2021 by state of work, in an oil and gas company in Brazil.

mographic, occupational, and clinical variables are described below.

Table 1 shows the sociodemographic characterization of the cases of COVID-19 in the studied company. Most of those infected were male (85.6%), aged between 30 and 39 years (36.4%), white ethnicity/color (60.5%), and married or in a common-law marriage (53.3 %). In the telework modality, there is a predominance of women, aged 40 to 49 years and over 60 years, white ethnicity/colour, and married or in a common-law marriage when compared to on-site work.

Table 2 shows the occupational characterization of workers who had COVID-19.

Of those affected by COVID-19, the level of education in the job position that stands out is the technical level (65.9%). The workers' working time in the company varied between 11 and 20 years in a greater proportion (63.1%). Contamination was similar between administrative and shift work activities, with 50.1% and 49.9%, respectively. Of the infected workers, 55.3% did not have access to the company's facilities before or at the time of diagnosis, 98.6% worked in the same state where they resided and most did not identify the source of contamination at work (97%).

Workers diagnosed with COVID-19 with working time at the company between 7 and 10 years (17.0%; $p = 0.001$) and administrative work activity (68.5%; $p = 0.001$) were mostly teleworking, while workers with a technical level (91.2%; $p = 0.001$) who had access to the company's facilities before or at the time of diagnosis (34.6%; $p = 0.001$) were mostly in the on-site modality. Predominantly, the State of residence of the workers is the same as that of work in the evaluated modalities (Teleworking: 98.1%; On-site: 99.2%; $p = 0.001$).

As for the clinical characteristics of those affected by COVID-19 at the company (Table 3), 8% had symptoms, 7.4% were hospitalized, 2.8% of cases were admitted to the ICU, and the outcome death represented 0.6% of cases of COVID-19 in the company.

In the clinical characterization of the disease between the two types of work, there was a greater number of symptomatic workers (8.8%; $p = 0.001$) and deaths (0.9%; $p = 0.001$) in telework.

Table 1
Sociodemographic characterization of workers who had COVID-19 by type of work in an oil and gas company, Brazil, June 2020 to July 2021

Sociodemographic Variables	Total cases of COVID-19		Modality of Work				*p*-value*
			Telework		On-site		
	N	%	N	%	N	%	
Sex							0.001
Male	7185	85.6	3907	80.3	3278	92.8	
Female	1209	14.4	956	19.7	253	7.2	
Age Group							0.001
Up to 29 years old	225	2.7	119	2.4	106	3	
30 – 39 years old	3056	36.4	1741	35.8	1315	37.2	
40 – 49 years old	2958	35.2	1783	36.7	1175	33.3	
50 – 59 years old	1974	23.5	1059	21.8	915	25.9	
Over 60 years old	181	2.2	161	3.3	20	0.6	
Ethnicity/Colour							0.001
Black	542	7.4	271	6.3	271	9	
Brown	2250	30.7	1189	27.5	1061	35.3	
White	4434	60.5	2797	64.7	1637	54.4	
Yellow	94	1.3	59	1.4	35	1.2	
Indigenous	12	0.2	9	0.2	3	0.1	
Marital status							0.009
Married or Common-law marriage	4471	53.3	2614	53.8	1857	52.6	
Single	3525	42	1993	41	1532	43.4	
Widow/Widower	15	0.2	12	0.2	3	0.1	
Separated or Divorced	383	4.6	244	5	139	3.9	

N = 8.394. *Qui-quadrado de Pearson. p-valor.

Table 4 shows the characterization of deaths among workers who had COVID-19 in the period studied. The mortality rate in the studied company was 0.12% and the lethality rate was 0.56%. Of the deaths by COVID-19, the majority occurred among males (97.87%), aged between 50 and 59 years (55.32%), white ethnicity (63.41%), and married or common-law marriage, such as a common-law marriage (70.21%). The highest number of deaths was observed among workers with a technical level in the company (61.70%), working time in the company between 11 and 20 years (40.43%), and administrative work activity (70.21%). Most workers whose diseases resulted in death were teleworking (91.49%).

4. Discussion

The unprecedented character of the study is highlighted since there are no studies on workers that analyze the profile of illness and death from COVID-19 in the on-site and telework modalities. Another strong point is the high number of people who represents a company's workers and not a survey or sample and workers with different sociodemographic and occupational characteristics and geographical distribution in the country, which allows exceeding the results to other working populations during similar situations of health emergencies due to communicable diseases. The strengths include laboratory confirmation of the disease and the availability of testing for all workers.

The present study found an prevalence rate of 21.7% of cases of COVID-19, higher than that found in a study carried out with health professionals regularly screened with PCR in Italy, which showed an prevalence of 13.6% [14] and research that evaluated only symptomatic professionals, whose prevalence was 14% in Boston [15] and 11.3% in Italy [16]. The prevention policy adopted in the investigated company may consider the high number of identified cases, greater than studies approaching health professionals, which constitutes an occupational category with a higher risk of illness due to COVID-19 since they are directly exposed to contaminated individuals [6]. It is considered that in the company studied, the clinical-epidemiological criterion was used for notification, considering every worker with respiratory symptoms or close contact with a person with a confirmed diagnosis of COVID-19, and testing was carried out, on-demand and indiscriminately, to all workers providing on-site services. Furthermore, at the beginning of the pandemic, the only test available in the country was the serological test, which has low

Table 2
Occupational characterization of workers who had COVID-19 by type of work in an oil and gas company, Brazil, June 2020 to July 2021

Occupational Variables	Total cases of COVID-19		Modality of Work				*p*-value*
			Telework		On-site		
	N	%	N	%	N	%	
Education							0.001
Technical degree	5528	65.9	2306	47.4	3222	91.2	
Higher-education	2866	34.1	2557	52.6	309	8.8	
Working time in the company							0.001
Up to 3 years	200	2.4	160	3.3	40	1.1	
4 – 6 years	242	2.9	145	3	97	2.7	
7 – 10 years	1343	16	827	17	516	14.6	
11 – 20 years	5298	63.1	3028	62.3	2270	64.3	
21 – 30 years	466	5.6	278	5.7	188	5.3	
31 – 35 years	707	8.4	358	7.4	349	9.9	
Over 35 years	138	1.6	67	1.4	71	2	
Access to Company premises before or at the time of diagnosis							0.001
No	4646	55.3	3019	62.1	1627	46.1	
Yes	1980	23.6	759	15.6	1221	34.6	
Uninformed	1768	21.1	1085	22.3	683	19.3	
Work activity							0.001
Administrative	4206	50.1	3329	68.5	877	24.8	
Shift	4188	49.9	1534	31.5	2654	75.2	
State of work other than State of residence							0.001
No	8275	98.6	4772	98.1	3503	99.2	
Yes	119	1.4	91	1.9	28	0.8	
Identification of the contamination source at work							0.195
No	8142	97	4727	97.2	3415	96.7	
Yes	252	3	136	2.8	116	3.3	

N = 8.394. *Qui-quadrado de Pearson. p-valor.

Table 3
Clinical characterization of COVID-19 cases by type of work in an oil and gas company, Brazil, June 2020 to July 2021

Clinical Variables	Total cases of COVID-19		Modality of Work				*p*-value*
			Telework		On-site		
	N	%	N	%	N	%	
Presence of symptoms							0.001
No	7726	92	4433	91.2	3293	93.3	
Yes	668	8	430	8.8	238	6.7	
Death							0.001
No	8347	99.4	4820	99.1	3527	99.9	
Yes	47	0.6	43	0.9	4	0.1	
Hospitalization							0.243
No	7774	92.6	4490	92.3	3284	93	
Yes	620	7.4	373	7.7	247	7	
ICU admission							0.963
No	8112	97.6	4700	96.6	3412	98.6	
Yes	282	3.4	163	3.4	119	3.4	

N = 8.394. *Qui-quadrado de Pearson. p-valor. ICU: Intensive Care Unit.

analytical specificity and favours the high probability of false positive diagnoses [17]. The prevalence of confirmed cases of COVID-19 in June 2021 in Brazil was 8,91%, which may not be accurate, since data does not include a broad testing of the population and, possibly, the number of cases reported represent the most severe ones, therefore, underestimating the real prevalence of the disease [18].

Regarding the modality of work, the research pointed out that there was an prevalence of 23.3%

Table 4
Characterization of COVID-19 deaths among oil and gas company workers, Brazil, June 2020 to July 2021

Variables	Deaths	
	N	%
Sex		
Male	46	97.87
Female	1	2.13
Age group		
30 – 39 years old	1	2.13
40 – 49 years old	10	21.28
50 – 59 years old	26	55.32
Over 60 years	10	21.28
Ethnicity/colour		
Black	1	2.44
Brown	12	29.27
White	26	63.41
Yellow	2	4.88
Marital status		
Married or Common-law marriage	33	70.21
Single	9	19.15
Widow/Widower	1	2.13
Separated or Divorced	4	8.51
Education		
Technical degree	29	61.70
Higher education	18	38.30
Company time		
4 – 6 years	4	8.51
7 – 10 years	6	12.77
11 – 20 years	19	40.43
21 – 30 years	12	25.53
31 – 35 years	4	8.51
Over 35 years	2	4.26
Access to Company Facilities before or at the time of diagnosis		
No	40	85.11
Yes	4	8.51
Uninformed	3	6.38
Work activity		
Administrative	33	70.21
Shift	14	29.79
Place of work other than State of residence		
No	46	97.87
Yes	1	2.13
Identification of the contamination source at work		
No	47	100
Yes	0	0
Type of work		
Telework	43	91.49
On-site	4	8.51
Hospitalization		
No	0	0
Yes	47	100
ICU admission		
No	0	0
Yes	47	100

N = 47.

for workers who were in the on-site modality. This finding may be the result of mandatory testing for all workers, symptomatic and asymptomatic since 92% of the affected ones did not report symptoms. In this sense, it is estimated that asymptomatic people represent approximately 45% of SARS-CoV-2 infections and can transmit the virus to others for a prolonged period [19].

The relevance of the strategy for testing workers is evident, with conduct that includes asymptomatic workers, in addition to other forms of prevention in similar situations. The ability to carry out routine and

frequent COVID-19 tests on workers brings benefits that go beyond identifying those infected and removing them from the collective environment, but also maintaining a productive work environment that provides benefits for the mental health of workers and their families [20]. The study shows that the worker sought the company to be tested, possibly due to the initial moment of the pandemic when tests were not yet available and later they were very expensive in the market since there is a high number of workers in telework testing positive for the disease

Only 3% of those affected by COVID-19 identified the source of contamination as being in the workplace, possibly due to the nature of this particular disease and the multiple possibilities of contamination and transmission by asymptomatic people, which makes it difficult to clarify the moment of contagion [19]. This result indicates that on-site work was not a facilitator of disease outbreaks in the occupational environment during the studied period, which points to the importance of preventive measures reported by other studies [20, 21]. Nevertheless, a study of workers in the oil and gas industry provided evidence that individual factors were the main determinants of SARS-CoV-2 transmission, with little contribution from environmental factors, and identified that social interactions in fields outside of working hours/work are among the risk factors for infection [22]. Thus, it is essential to raise workers' awareness about prevention outside the occupational environment as well. In the present study, possibly the number of workers absent from the company due to telework favoured the development of work in safer conditions for those who remained in on-site work.

An prevalence of 20.7% of COVID-19 cases was identified among workers who were teleworking. This scenario is considered worrying, given the guidelines for social isolation and other preventive measures, in addition to the fact that the journey to the workplace is no longer necessary. In this perspective, the home environment should also be taken into account as a place prone to transmission [17], in cases where family members of those professionals who provide telework continued to locomote beyond their homes however, remote work decreases the risk of infection [7]. Thus, we can infer that there was no full adherence to prevention guidelines, as found in another study [23].

At the same time, people with greater institutional trust are more likely to adhere to risk mitigation recommendations [24]. This note corroborates the results of a study carried out with workers in oil fields, which shows that credibility regarding the effectiveness of preventive measures favours the adherence to protection practices by workers [22]. Analysis of institutional trust and workers' beliefs regarding the effectiveness of preventive measures were not contemplated in this study to correlate with the number of high cases in telework professionals, but they are desirable.

Regarding cases by State of work, the highest percentage of cases was observed in the North and Northeast of the country. In this sense, the State of Amazonas (AM) stands out with the highest percentage of cases, which agrees with the situation of the State for the general population at the time, where there was a high incidence of COVID-19 [25].

Regarding sociodemographic characteristics, the studied group follows the general profile of workers in oil and gas companies, that is, a predominance of men aged 40, in average [26]. However, among those over 60 years old ($n = 161$) who had COVID-19, 11% ($n = 20$) were providing on-site work, which goes against the specific recommendations for the population in this age group, considered at risk. This emphasizes the need for the company to impose rules and enable means to comply with these workers and for the individual to comply with the company's recommendations [27]. The implementation of public policies is imperative to guide occupational health [7, 11], along with conducting studies investigating the relationship between occupation and SARS-CoV-2 infection. These measures aim to promote comprehensive prevention practices, mitigate the spread of the disease, and consequently reduce economic costs on the healthcare system [28].

Regarding education in the job position, we found most cases among workers with a technical level, corroborating the findings in the literature [29] that indicates lower exposure among workers with university education compared to those with less education.

Of the COVID-19 cases in the company, 7.4% were hospitalized and 2.8% were admitted to the ICU and the death outcome represented 0.6% of the COVID-19 cases in the company, a number lower than the percentage of the general population indicated by the WHO, approximately 15% required hospitalization and approximately 5%, intensive care [30]. However, the data obtained corroborate the results of surveys among health professionals with COVID-19, in which 8% were hospitalized and 0.3% died, [31] and a systematic review that identified a fatality rate among professionals 0.69% worldwide and 0.4% in Italy [32].

There were more deaths among telecommuting workers, suggesting that if all employees were working in person, a larger number of workers could have been susceptible to contamination and worsening conditions. This scenario, in turn, could have resulted in an increase in fatalities. This pattern is supported by company guidelines, which recommended that workers in more vulnerable situations remain in telecommuting arrangements, as identified in a previous study that indicated that workers considered vulnerable were predominantly engaged in remote work or on medical leave [33]. The comparison of this result becomes limited since other similar studies were not found in the literature.

It is important to acknowledge the limitations of the current study, notable its cross-sectional design, which precluded the analysis of behavioral variables. Additionally, information regarding the number of individuals cohabiting with teleworking employees and their engagement in telework was not available. The lack of existing literature on this topic pertaining to both on-site work and telework further restricted the ability to make meaningful comparisons of results. Note, when calculating mortality and lethality, the study considered the entire working population without distinguishing between those who are healthy and those who may be more vulnerable.

In-depth studies on behavioural issues and other variables that interfere or are associated with the outcome of COVID-19 infection according to work activity are desirable.

5. Conclusion

The analysis of the collected data suggests that the company's guidelines, which include testing to contain the spread of the virus, can help delay or reduce the spread of COVID-19 within the facilities since few workers with a diagnosis of COVID-19 presented symptomatology, being, therefore, diagnosed and removed from on-site work due to a positive result for the test. Such a strategy should be encouraged by the fact that testing resources are available in companies when generally there are not enough tests in health services for the population at the beginning of health emergencies, which can serve as a parameter on the occurrence of the disease in the community since the workers represent a section of the general population.

Our study identified that on-site work, during the studied period, was not a facilitator of outbreaks in the occupational environment, which points to the importance of preventive measures. The adoption of remote work for as many workers as possible may have favoured on-site work in safer conditions and influenced the number of deaths. It is necessary to take into account other dimensions, in addition to work, that contribute to the transmissibility of the disease and understand adherence to prevention recommendations by workers in telework.

Ethical approval

The study was approved by the Research Ethics Committee of the Health Sciences Center of the Federal University of Espírito Santo (CEP/CCS/UFES), opinion number 5.400.658, and CAAE 57089722.0.0000.5060.

Informed consent

Not applicable

Conflict of interest

Not applicable

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