

Original article

Factors Associated With the Illness of Nursing Professionals Caused by COVID-19 in Three University Hospitals in Brazil

Larissa Bertacchini de Oliveira ¹, Luana Mendes de Souza ², Fábia Maria de Lima ³,
 Jack Roberto Silva Fhon ⁴, Vilanice Alves de Araújo Püschel ⁴, Fábio da Costa Carbogim ^{2,*}

¹ Hospital Das Clínicas HCFMUSP, Faculdade de Medicina, Universidade de São Paulo, São Paulo, Brazil

² Faculdade de Enfermagem, Universidade Federal de Juiz de Fora, Juiz de Fora, Minas Gerais, Brazil

³ Escola de Enfermagem, Universidade Federal Do Pernambuco, Recife, Pernambuco, Brazil

⁴ Escola de Enfermagem, Universidade de São Paulo, São Paulo, Brazil



ARTICLE INFO

Article history:

Received 6 December 2021

Received in revised form

2 March 2022

Accepted 3 March 2022

Available online 15 March 2022

Keywords:

nurse practitioners

occupational exposure

occupational health

SARS-cov-2

ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) pandemic has demonstrated the importance of implementing strategic management that prioritizes the safety of frontline nurse professionals. In this sense, this research was aimed at identifying factors associated with the illness of nursing professionals caused by COVID-19 according to socio-demographic, clinical, and labor variables.

Methods: A cross-sectional study was conducted in three Brazilian university hospitals with 859 nursing professionals, which include nurses, technicians, and nursing assistants, between November 2020 and February 2021. We present data using absolute and relative frequency. We used Chi-square test for hypothesis testing and multiple logistic regression for predictive analysis and chances of occurrence.

Results: The rate of nursing professionals affected by COVID-19 was 41.8%, and the factors associated with contamination were the number of people in the same household with COVID-19 and obesity. Being a nurse was a protective factor when the entire nursing team was considered. The model is significant, and its variables represent 56.61% of the occurrence of COVID-19 in nursing professionals.

Conclusion: Obesity and living in the same household as other people affected by COVID-19 increases the risk of contamination by this new coronavirus.

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1. Introduction

The coronavirus disease 2019 (COVID-19) is an acute respiratory syndrome caused by a new coronavirus called severe acute respiratory disease coronavirus (SARS-CoV-2) [1]. The SARS-CoV-2 is a single-stranded RNA virus that can be transmitted through the air and direct contact between people. In COVID-19, clinical manifestations are variable and disorders can range from respiratory failure to organic dysfunctions related to the activation of the inflammatory response and induction of the thrombotic system [2].

The first cases of the disease were identified in China at the end of 2019. After its rapid spread worldwide, COVID-19 has become a pandemic and emergency public health disease, declared by the World Health Organization (WHO) on 11th March 2020 [3].

According to WHO, more than 264 million people have been infected worldwide by SARS-CoV-2, and more than 5.2 million

deaths had occurred due to COVID-19 as of December 2021 [1]. With the availability of the vaccine since December 2020, there has been a slowdown in the record of daily deaths [4].

Even though vaccination does not occur homogeneously across countries, it represents a crucial measure in interrupting the natural history of the disease [5]. In this context, which involves scientific, economic, and political challenges, health professionals decisively contribute to preventing new cases and treating infected patients [4]. However, the COVID-19 pandemic has demonstrated the importance of implementing strategic management that prioritizes the safety of frontline health professionals [6].

Recent research has reported that during the pandemic, frontline workers, especially nursing professionals, have suffered from psychological damage, work overload, lack of personal protective equipment (PPE), and a high risk of biological exposure while caring for infected people [6].

Fábio da Costa Carbogim: <https://orcid.org/0000-0003-2065-5998>

* Corresponding author. Faculdade de Enfermagem, Universidade Federal de Juiz de Fora. Rua José Lourenço Kelmer, São Pedro, sn. Juiz de Fora, MG, CEP, 36036-900, Brazil.
 E-mail address: fabiocarbogim@gmail.com (F.d.C. Carbogim).

In addition, in other recent respiratory epidemics, it has been reported that working conditions, demographic characteristics, such as the work sector, comorbidities, prior training, and mental health support, can influence the chances of contamination of nursing professionals during crises in health systems [7,8].

In Brazil, COVID-19 represents one of the greatest challenges in public health due to the scalar expansion of the epidemic and weak government management to control it [9]. In addition, before the vaccine became available, Brazilian nursing professionals lived for almost a year in direct contact with patients with uncertain prognoses, a significant increase in the number of visits, lack of PPE, and the imposition of imprecise measures in public health and conflicting messages from authorities [9].

Therefore, it was in this scenario that preceded mass vaccination in Brazil that this research was carried out.

This study explored factors associated with the illness of Brazilian nursing professionals caused by COVID-19 during a period that preceded vaccination in the country. It is noteworthy that the literature has pointed out the following as the main associated factors: prolonged and unprotected contact with infected patients, intensifying work hours, reducing breaks and rest, increasing physical and mental illness, lack of training, lack of PPE, and having comorbidities, such as heart and eye diseases, respiratory diseases, diseases that affect immunity and obesity [8,10,11]. These findings have the potential to serve as a reference for the evaluation and comparison of health risk factors of frontline nursing professionals around the world.

2. Materials and methods

2.1. Study design and setting

We conducted a cross-sectional online survey to collect data from clinical nursing professionals.

A convenience sample of nurses was recruited from three Brazilian teaching hospitals. During data collection, we included all nurses, nursing technicians, and nursing assistants working in direct clinical care of patients. The study population consisted of 4,112 professionals. In Brazil, the nursing team is composed of the nurse, nursing technician, and nursing assistant. The nurse is the team leader, who has at least a bachelor's degree in nursing (minimum of 4,000 hours); the nursing technician obtains the diploma after two years of training (minimum 1,800 hours) and the nursing assistant (about 800 hours of training), who provides basic hygiene, nutrition, and comfort care to the patient.

The collection was discontinued in February 2021, considering this was the month when the widespread vaccination of health professionals began in Brazil. We excluded professionals who partially answered the research questionnaire, were vaccinated, or for any reason, were away from care functions.

It is noteworthy that in this study, we used a non-probabilistic sample.

2.2. Data collection

We conducted the study at three teaching hospitals in Brazil, between November 2020 and February 2021. Two hospitals are in the southeast region and the other in the northeast region of the country. The first, Instituto do Coração Hospital das Clínicas HCFMUSP, Faculdade de Medicina, Universidade de São Paulo, São Paulo, SP, BR, is characterized by high-complexity in cardiology, pulmonology, and cardiac and thoracic surgery, with 485 hospital beds, 100 of which are for the treatment of severe acute respiratory syndrome (SARS-COVID-19). The second, located in Minas Gerais, is characterized by medium- and high-complexity, with

clinical, surgical, and pediatric care, with 126 hospital beds, 13 of which are for SARS-COVID-19. The third institution, located in the State of Pernambuco, is characterized by high clinical, surgical, and pediatric complexity, with 404 hospital beds, 120 for adult patients with SARS-COVID-19, and 40 for pediatric patients with SARS-COVID-19. We chose these hospitals because they are referral hospitals for COVID-19 in their regions and are public teaching hospitals.

We collected data using Research Electronic Data Capture (RedCap). The questionnaire included socio-demographic characteristics, comorbidities, working conditions, and illness due to COVID-19. We sent an e-mail to all nursing professionals where they could access a link to RedCap, and it was also available on the computers of all units in the hospitals.

We established as a dependent variable having or not having illness due to COVID-19, and as independent variables, the socio-demographic characteristics and clinical and working conditions of the nursing professionals.

The data collection instrument was constructed using as a reference guideline related to risk factors, the biosafety of professionals and biosafety during the pandemic period [3,6,10,11].

It should be noted that during the period of data collection there were still no validated instruments that could be used.

2.3. Data analysis

We transferred the final version of the database from Microsoft Excel® to Stata software version 15.0 and analyzed data at a 95% confidence level ($p < 0.05$).

The descriptive analysis of socio-demographic, clinical, and labor variables and the respective outcome (occurrence or not COVID-19) was performed, using absolute and relative frequency. For the hypothesis tests, the outcome was illness caused by COVID-19.

For this purpose, we used the chi-square or Fisher exact test. We used a multivariate analysis of the multiple logistic regression type to identify which socio-demographic, clinical, and labor variables were predictors of the outcome under investigation and their chances of occurrence. Initially, we estimated models containing variables that had a p -value < 0.25 in the bivariate analysis. We performed the stepwise method, and the final reduced model, using the likelihood-ratio test, the Wald test, and the coefficient of determination (R^2), considering the variables with a p -value < 0.10 .

2.4. Ethical considerations

The Ethics Committee on Human Research at each hospitals approved the research. It was registered with Certificate of Ethical Appreciation number 33982220.2.1001.5133 and opinion number 4.414.831.

3. Results

3.1. Demographic data

Participants included 859 nursing professionals, including nurses, nursing technicians, and nursing assistants. There was a predominance of female participants (85.2%), White race (39.8%), age between 31 and 59 years (70.5%), who had a partner (57.8%), income/monthly between one and three (US\$210 to US\$630), minimum wages (55.4%), and lived in the same environment with one to three people (67.9%).

Considering the occurrence of COVID-19 in the study sample, the rate of affected nursing professionals was 41.8%. The number of people in the same household affected by COVID-19 was associated

with the disease in nursing professionals. Regarding the change of residence, 48 participants (5.6%) reported that they moved from their homes due to the pandemic (Table 1).

3.2. Occupational characterization and clinical aspects of the health of professionals

As for labor aspects, the professionals (53.3%) worked in the area exclusive to patients with COVID-19, with a work week between 30 and 36 hours (79%), as a nursing technician (56.7%), working in only one institution (74.7%).

Of the nursing professionals, 662 (77.6%) were trained to care for patients with COVID-19. Furthermore, regarding the provision of mental health support, we found that 46.6% responded positively, whereas 20.5% of the sample could not confirm whether the institution provided this activity. Another relevant factor was that 67.5% of contaminated professionals worked in just one hospital. We found that the variables hospital, work sector, mental health support, and working in another institution were associated with the occurrence of COVID-19 (Table 2).

Regarding the clinical variables related to the participants' comorbidities, the majority, 639 (74.4%) of the nursing professionals, reported not being in the risk group. However, 54 (6.3%) had cardiovascular diseases, and 42 (5%) were obese, both being the most frequently reported comorbidities (Table 3).

Table 1
Socio-demographic characterization and illness due to COVID of nursing professionals from three university hospitals (N = 859)

Variables	Occurrence COVID-19 n (%)	Non-occurrence COVID-19 n (%)	χ^2 or Fisher exact test (p [†])
Sex			0.713
Female	305 (84.72)	423 (85.63)	
Male	55 (15.28)	71 (14.37)	
Age group			0.990
Up to 30 years old	83 (23.06)	114 (22.85)	
31-59 years old	254 (70.56)	352 (70.54)	
60 years or more	23 (6.39)	33 (6.61)	
Marital status			0.362
With partner	213 (59.66)	281 (56.54)	
No partner	144 (40.34)	216 (43.46)	
Race			0.125
White	160 (44.44)	187 (37.86)	
Black	47 (13.06)	87 (17.61)	
Yellow	9 (2.50)	21 (4.25)	
Brown	139 (38.61)	195 (39.47)	
Indigenous	3 (0.83)	1 (0.20)	
Prefer not to answer	2 (0.56)	3 (0.61)	
Individual monthly income			0.489
1 to 3 MS [*]	189 (53.24)	280 (57.03)	
4 to 6 MS [*]	126 (35.49)	166 (33.81)	
7 to 9 MS [*]	31 (8.73)	31 (6.31)	
10 or more MS [*]	9 (2.54)	14 (2.85)	
Monthly family income			0.130
1 to 3 MS [*]	107 (30.14)	170 (34.62)	
4 to 6 MS [*]	138 (38.87)	174 (35.44)	
7 to 9 MS [*]	55 (15.49)	91 (18.53)	
10 or more MS [*]	55 (15.49)	56 (11.41)	
People/household			0.391
None	3 (0.83)	7 (1.40)	
One to three	238 (66.11)	346 (69.34)	
Four or more	119 (33.06)	146 (29.26)	
People/household affected with COVID-19			<0.001
None	17 (4.72)	443 (89.07)	
One	232 (64.44)	40 (8.10)	
Two	65 (18.06)	8 (1.62)	
Three	26 (7.22)	2 (0.40)	
Four	11 (3.06)	1 (0.20)	
Five or more	9 (2.50)	3 (0.61)	
Changed residence			0.412
Yes	23 (6.41)	25 (5.09)	
No	336 (93.59)	466 (94.91)	

* Abbreviations: MS.(Minimum salary/month (US\$2100.00).

† p-value from chi-square test or Fisher exact test.

Table 2
Labor characterization of the nursing professionals (N = 859)

Variables	Occurrence COVID-19 n (%)	Non-occurrence COVID-19 n (%)	χ^2 or Fisher exact test (p [*])
Hospital			0.012
Institution 1	179 (49.86)	230 (46.09)	
Institution 2	42 (11.70)	96 (19.24)	
Institution 3	138 (38.44)	173 (34.67)	
Professional category			0.198
Nurse	156 (43.33)	192 (38.95)	
Nursing assistant/technician	204 (56.67)	301 (61.05)	
Work sector			0.003
Ambulatory	14 (3.92)	29 (5.86)	
Surgery center	18 (5.04)	25 (5.05)	
Sterilization center	5 (1.40)	4 (0.81)	
Hemodynamics	10 (2.80)	11 (2.22)	
Emergency unit	13 (3.64)	37 (7.47)	
Diagnostic support	6 (1.68)	20 (4.04)	
Adult Inpatient unit	168 (47.06)	170 (34.34)	
Pediatric unit	5 (1.40)	5 (1.01)	
Clinical intensive care	18 (5.04)	31 (6.26)	
Coronary intensive care	13 (3.64)	9 (1.82)	
Surgical intensive care	29 (8.12)	37 (7.47)	
Neonatal intensive care	2 (0.56)	13 (2.63)	
Respiratory intensive therapy	9 (2.52)	18 (3.64)	
Other	47 (13.17)	86 (17.37)	
COVID-19 unit			0.209
Yes	201 (55.83)	257 (51.50)	
No	159 (44.17)	242 (48.50)	
Weekly working hours			0.250
30 hours/week	142 (39.55)	167 (54.05)	
36 hours/week	140 (39.00)	224 (61.37)	
40 hours/week	58 (16.16)	86 (59.72)	
44 hours/week	5 (1.39)	3 (37.50)	
60 hours/week	9 (2.51)	8 (1.63)	
Other	5 (1.39)	5 (1.02)	
COVID-19 training			0.573
Yes	276 (76.67)	386 (78.30)	
No	84 (23.33)	107 (21.70)	
Mental health support			0.002
Yes	145 (40.39)	253 (51.21)	
No	140 (39.00)	140 (28.34)	
I do not know	74 (20.61)	101 (20.45)	
how to answer			
Works at another institution			<0.001
Yes	117 (32.50)	98 (19.88)	
No	243 (67.50)	395 (80.12)	
Mental illness			0.346
Yes	128 (35.75)	162 (32.66)	
No	230 (64.25)	334 (67.34)	
Leave due to mental illness			0.746
Yes	16 (4.49)	20 (4.04)	
No	340 (95.51)	475 (95.96)	

* p-value from chi-square test or Fisher exact test.

No statistical association was found for the variables risk group, cardiovascular disease, respiratory disease, diabetes, cancer, immunosuppression, autoimmune disease, age over 60 years, pregnancy, smoking, and other clinical conditions. However, the variable obesity was associated with the occurrence of COVID-19 in nursing professionals.

As for exposure to occupational risk factors, most (62.3%) used public transportation to travel to the workplace. Regarding PPE, 338 (39.4%) of the professionals reported a lack, especially regarding the surgical mask (19.4%), mask N95/PFF2 (17.4%), face shield (7.4%), goggles (3.9%), waterproof apron (15.2%), cap (3.25%), and procedure gloves (4.9%). We identified that the variables lack of PPE ($p < 0.012$) and lack of N95/PFF2 masks ($p < 0.012$) were associated with COVID-19 in professionals.

3.3. Factors associated with professional contamination by COVID-19

The final reduced and adjusted model (Table 4) demonstrates that the risk of an obese nursing professional acquiring COVID-19 is three times higher (OR: 3.28; 95% CI 1.05-10.27) than non-obese

Table 3
Clinical characterization of nursing professionals (N = 859)

Variables	Occurrence COVID-19 n (%)	Non-occurrence COVID-19 n (%)	χ^2 or Fisher exact test (p*)
Risk group			
Yes	98 (27.30)	115 (23.33)	0.186
No	261 (72.70)	378 (76.67)	
Cardiovascular disease			0.916
No	337 (93.61)	468 (93.79)	
Yes	23 (6.39)	31 (6.21)	
Respiratory disease			0.685
No	345 (95.83)	486 (97.39)	
Yes	15 (4.17)	13 (2.61)	
Diabetes			0.204
No	346 (41.74)	483 (58.26)	
Yes	15 (53.57)	13 (46.43)	
Neoplasia			0.179
No	357 (99.17)	498 (99.80)	
Yes	3 (0.83)	1 (0.20)	
Drug immunosuppression			0.742
No	358 (99.44)	497 (99.60)	
Yes	2 (0.56)	2 (0.40)	
Autoimmune disease			0.443
No	357 (99.17)	492 (98.60)	
Yes	3 (0.83)	7 (1.40)	
Over 60 years old			0.626
No	351 (97.50)	489 (98.00)	
Yes	9 (2.50)	10 (2.00)	
Tobacco use			0.146
No	352 (97.78)	479 (95.99)	
Yes	8 (2.22)	20 (4.01)	
Obesity			0.001
No	332 (92.22)	485 (97.19)	
Yes	28 (7.78)	14 (2.81)	

* p value from chi-square test or Fisher exact test.

Table 4

Reduced and adjusted logistic regression model, considering the occurrence of COVID-19 and socio-demographic, clinical, and labor characteristics (N = 859)

Variables	Odds ratios (95% CI)*	Multivariate analysis (p†)
Obesity		
Yes	3.28 (1.05–10.27)	0.040
Profession		
Nurse	0.58 (0.36–0.96)	0.036

* Confidence Interval.

† Coefficient of Determination (R^2) = 56.61%; p < 0.001.

nursing professionals. However, being a nurse versus being a technician or an assistant is a protective factor because nurses spend less time with patients. The model is significant ($p < 0.001$), and its variables represent 56.61% of the occurrence of COVID-19 in nursing professionals. However, there are other elements not investigated that can also determine the occurrence of the disease.

4. Discussion

The study presents relevant data on factors associated with the illness of nursing professionals caused by COVID-19, according to socio-demographic, clinical, and labor variables in three Brazilian hospitals.

Since the beginning of the COVID-19 pandemic, the contamination of health care professionals, especially nursing professionals, has been frequent. Although it is not usually possible to establish a direct cause-and-effect relationship, the nursing team, by providing direct care to patients affected by COVID-19, is considered more susceptible than the general population [12].

In Brazil, we have more than 2.5 million nursing professionals (61% nursing technicians, 23% nurses, and 16% nursing assistants), representing more than 60% of health care workers [13]. A cross-sectional, national study carried out with nursing professionals showed high rates of infection and deaths resulting from COVID-19. There were 13,261 confirmed cases and 325 deaths in the 19-week

period in Brazil [12]. Therefore, the illness of these professionals has a decisive impact on the entire health care system.

In the present study, the rate of contaminated professionals is consistent with that reported in the literature, which has described a proportion ranging from 36.8% for health professionals in general to 68.2% for nursing assistants [14].

In addition, it was possible to identify that the number of people in the same household affected by COVID-19 was associated with a professional's illness.

A cohort study conducted by Shah et al. [15] to assess the risk of hospitalization by COVID-19 involved 158,445 health care workers and 229,905 family members living in the same household. The results showed that family members of health professionals are twice as likely to be hospitalized for COVID-19 as the general population. The study also reported that health care workers and their families of working age (18–65 years) were responsible for one in six hospitalizations due to the disease.

Another study, carried out in six public hospitals in Ethiopia with 1,134 professionals, assessed the perceived risk and concern about illness due to COVID-19. Most participants were nurses and described a perceived risk of coronavirus infection of 88% and potential risk of infection for the family of 91% [16].

In addition, research has described that the application of measures that mitigate exposure to risk factors, such as the adequate provision of PPE, regular rest periods, and more recently, vaccination, reduce the chances of professionals becoming ill due to COVID-19 [12,17]. In the present investigation, there was a relationship between illness and the variable's type of hospital institution, having another job, sector in which the professional worked, lack of PPE, lack of N95/PFF2 masks, and receiving mental health support. It was also verified that despite the high contamination of Adult Inpatient Unit professionals, there were no significant differences between specific units for patients with COVID-19 and units that did not provide this service. Despite the higher risk of exposure for professionals working in specific sectors to patients with COVID-19, complex investigations are needed that analyze other variables, including behavioral and individual vulnerability factors.

A systematic review conducted by Mhango et al. [18] points out that the main factors of illness of professionals with COVID-19 are related to the lack of PPE, exposure to infected patients, work overload, and work sector. Another study reports that behavior to minimize the severity of the disease, carelessness in the adoption of precautions and hygiene, as well as conditions that affect physical and mental health can contribute to the acquisition of COVID-19. Therefore, precarious working conditions, reduced availability or inappropriate use of PPE, reduced rest periods, exposure to areas with high production of fluids/aerosols, and poor information are risk factors for illness due to COVID-19 [19]. In addition, added to environmental and behavioral risk factors, there are increasing records of mental exhaustion among frontline professionals. In this sense, a meta-analysis assessed the outcome of the COVID-19 pandemic scenario in the mental health of health care professionals. It concluded that frontline professionals, especially nurses and physicians, compared with professionals who did not provide direct patient care, had a higher level of anxiety (13.0 versus 8.5%, $p < 0.001$, OR: 1.6152; 95% CI 1.3283–1.9641; $p < 0.0001$) and depression (12.2 versus 9.5%; $p = 0.004$; OR: 1.3246; 95% CI 1.0930–1.6053; $p = 0.004$), in addition to somatization and insomnia [20].

Studies show a greater predisposition of nursing professionals to mental disorders during the COVID-19 pandemic [20,21]. Some factors trigger or predispose to psychological conditions. These include the risk of direct contact with infected patients, loss of patients, poor working conditions, performing tasks under tremendous pressure,

irregular working hours, long hours, being a woman, and reduced self-care due to the lack of time and energy [22–24].

We found that nursing professionals with obesity were three times more likely to become ill from COVID-19. In addition, when comparing oneself with other nursing professionals, being a nurse appeared as a protective factor through the regression model. Regarding the protective factor, we believe that it is related to the Brazilian care model, in which the nurse manages the work of the technical team. The technical nursing and nursing assistants teams provide direct care to patients, and the nurse is privately responsible for delivering care only in medium- and high-complexity procedures. It is also noteworthy that the investigation involved several hospital services and not exclusively critical sectors where direct care provided by nurses is frequent.

As for the clinical variables associated with the risk of illness due to COVID-19, obesity, together with cardiovascular disease, respiratory disease, diabetes, cancer, immunosuppression, among others, have been described in the literature [10,11], whereas older age, male sex, diabetes, and hypertension were associated with higher mortality in the general population [11]. The mechanisms that connect obesity to the risk of serious clinical manifestations are still not clear. However, studies indicate that excess adipose tissue may favor a hyperimmune response in patients with COVID-19, compromising the pulmonary, renal, and cardiovascular systems [25].

A systematic meta-analysis review described the relationship between high body mass index (BMI) and severe clinical manifestations of COVID-19. The authors reported a prevalence rate of 0.11 (95% CI 0.07–0.15) to 0.86 (95% CI 0.69–1.02) among critically ill patients with COVID-19 who had a BMI $>25 \text{ kg/m}^2$. Therefore, patients with a high BMI with other comorbidities should receive special attention to reduce the morbidity and mortality associated with COVID-19 infection [26]. It is essential to highlight that data collection for this research occurred before vaccinations were implemented in Brazil. In February 2021, nursing professionals were included as a priority group for immunization against COVID-19.

We expect that the results of this study can contribute to understanding the dynamics of the pandemic on the health of nursing professionals. It is noteworthy that since 2016, the Brazilian Health System has been suffering from fiscal austerity policies, affecting the quality of health care for the Brazilian population and especially the working conditions of health professionals [13,27]. Added to this scenario is the absence of effective management in confronting COVID-19, contributing to the country having occupied one of the first places regarding the number of deaths from the disease [27].

The present study has strengths and limitations that must be pointed out. The main advance of knowledge was the identification of factors associated with contamination and illness of nursing professionals by COVID-19. The results can be used in other studies to compare the health risk factors of frontline nursing professionals, in the current context and in future pandemic contexts. As for the limitations, the study design stands out, as it is not able to assess the prevalence of the disease. In addition, the non-probabilistic sample size was established for convenience.

5. Conclusion

The main factors associated with the illness of nursing professionals caused by COVID-19 were the number of people in the same household and being obese. Additionally, we verified the relationship between illness and variables, such as the type of hospital working institution, having another job, sector of work, lack of PPE, lack of N95/PFF2 masks, and support in mental health. However, being a nurse as opposed to a nurse technician or a nurse assistant represented a protective factor.

We verified that not all variables were associated with illness from COVID-19. It suggests that other factors may be related to the sickness of nursing professionals, and further research is necessary.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contributions

Study design: LBO, LMS, JRSF, FML, VAAP and FCC; data collection: LBO, LMS and FML; all the authors contributed to data analysis and interpretation, statistical analysis, study supervision and writing the manuscript.

Conflict of interest

The authors report no biomedical financial interests or potential conflicts of interest.

Acknowledgments

The authors are grateful for the support of Instituto do Coração Hospital das Clínicas HCFMUSP, Faculty of Medicine, University of São Paulo, São Paulo, Brazil.

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