Risk factors associated with COVID-19 Intensive Care Unit hospitalisation in Guyana: A cross-sectional study

Steven Seepersaud[1], Charles Ameh[2]

Affiliations:

[1]Georgetown Public Hospital Corporation, Georgetown, Guyana
[2] Liverpool School of Tropical Medicine and University of Liverpool, Liverpool, United Kingdom

Corresponding Author

Steven A. Seepersaud
Georgetown Public Hospital Corporation
Thomas & New Market Streets
Georgetown
Guyana
Email: stevenseepersaud@gmail.com

DOI: 10.48107/CMJ.2021.10.001

DOAJ: 11b50912230647e7a31e1b302cde79ca

ABSTRACT

Objective

The purpose of the study was to determine risk factors associated with COVID-19 ICU hospitalisation at Georgetown Public Hospital Corporation (GPHC), Guyana.

Methods

A retrospective chart-review was conducted on all COVID-19 admissions from March to September 2020. The predictive factors were demographics, comorbidities, signs and symptoms of COVID-19 and laboratory findings on admission. Descriptive frequency analysis was done for all independent variables and the Chi-square test was used to compare differences between groups where suitable. Univariate and multivariate binary logistic regression was used to examine the association between the independent variables and the risk for ICU hospitalisation.

Results

There were 136 patients with COVID-19 at GPHC during March to September 2020 and after exclusion, 135 patients were used in the study. There were 72 (53.4%) patients who required non-ICU care, while 63 (46.6%) ICU care and average age ± SD (median) was 51 ±16 (n= 49) and 56 ±18 (n= 60), respectively. In the multivariate regression model, the odds of ICU admission for those aged 40-65 was 0.14 ($p < .01$) compared to those > 65 years. Patients with class 2 and above obesity had higher odds of ICU admission compared to non-obese patients OR 11.09 ($p = .006$). Patients with 2 and 3 or more comorbidities also had higher odds of ICU admission compared to those with no comorbidities OR 7.83 ($p = .03$) and 132 ($p < .001$), respectively. Patients with LDH 228-454 U/L and > 454 U/L on admission had higher odds of ICU admission compared to those with normal LDH OR 19.88 ($p = .001$) and 23.32 ($p = .001$), respectively. Patients with albumin < 3.50 mg/dL on admission also had higher odds of ICU admission compared to those with normal albumin OR 5.78 ($p = .005$).

Conclusion

Risk factors associated with ICU hospitalisation were advanced age, obesity, multiple comorbidities, elevated LDH and low albumin. Protecting the population at risk for ICU admission and prioritizing them for vaccination is

recommended to reduce the risk of running out of ICU capacity.

Keywords: COVID-19, coronavirus, sars-cov-2, ICU, hospitalisation

INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has overwhelmed many health care systems worldwide, causing significant morbidity and mortality.[1] The first case in Guyana was recorded in March 2020, and by the end of September, there had already been 2894 confirmed COVID-19 cases, many of which required in-hospital and intensive care. Several studies in Latin America and the Caribbean (LAC) and internationally have highlighted risk factors for severe COVID-19, such as advanced age, male sex, obesity and comorbidities.[2–8] However, there are no studies from Guyana on risk factors for COVID-19 hospitalisation, whether Intensive Care Unit (ICU) or general admission. At a minimum, the knowledge of risk factors allows public health authorities to identify high-risk and vulnerable groups so targeted health strategies can be implemented. It is also important to know factors which are associated with ICU hospitalisation because ICU admission indicates severe illness and therefore, ICU hospitalisation is a proxy for COVID-19 severity. Moreover, ICU hospitalisation has significant resource implications, especially in Guyana, which has one of the lowest Gross Domestic Product (GDP) in South America.[9] ICU capacity is limited due to insufficient resources, but also ICU is needed for other medical conditions, so if COVID-19 cases take up all available capacity, there is a broader impact on health for the Guyana population. For the most part, LAC countries have lower capacity healthcare systems with fewer hospital beds, fewer healthcare professionals and weaker disease surveillance than Organisation for Economic Co-operation and Development (OECD) countries.[10] Therefore, it becomes imperative for health authorities in Guyana to recognise trends and patterns with ICU hospitalisation for COVID-19. The objective of this study is to determine the risk factors for ICU hospitalisation among patients with COVID-19 in Guyana.

MATERIALS AND METHODS

A cross-sectional study using secondary data analysis was conducted. Anonymised and de-identified patients' medical records for COVID-19 patients admitted to Georgetown Public Hospital Corporation (GPHC) from March to September 2020 were reviewed.

All identifying data was removed from the patient records by the medical records department of GPHC. A unique identifying code was used to identify the patient. This identifying code was kept in the records department securely and was not available to the researchers. The data collected was encrypted and will be securely stored for five years. The relevant information was then extracted from the spreadsheet, coded, entered into SPSS Version 27 for analysis.

The setting for the study was GPHC, Guyana, where the first case of COVID-19 was diagnosed in March 2020. It is the largest speciality hospital in Guyana and the only one managing moderate to severe COVID-19 cases at the time of study with 12 official COVID-19 ICU beds. The study population used was all the COVID-19 admissions to GPHC, Guyana from March to September 2020.

The sampling frame used for the study was the list of all COVID-19 admissions to GPHC from March to September 2020. The inclusion criteria included all adult patients' (patients ≥ 18 years old) with Polymerase chain reaction (PCR) confirmation of COVID-19 from March to September 2020. The exclusion criteria included patients' records with a negative COVID-19 PCR and patients' records with missing or incomplete data.

This study used secondary data in the form of patient charts which were not publicly available and hence ethical approval was sought and obtained from the University of Liverpool Master of Public Health Virtual Programme Research Ethics Committee, GPHC Research Ethics Committee and Institutional Review Board (Ministry of Health, Guyana). Due to the retrospective nature of the study and the de-identification of the data, written consent was waived.

Demographics (sex, age and ethnicity), comorbidities (diabetes mellitus (DM), hypertension (HTN), Obesity (≥ class 2), cardiovascular disease (CVD), chronic kidney disease (CKD), chronic lung disease, chronic liver disease, other and number of comorbidities), signs and symptoms of COVID-19 on admission (fever, shortness of breath, cough, fatigue, vomiting, diarrhoea and number of symptoms), laboratory findings on admission (haemoglobin, platelet count, white blood cell count, creatinine, blood urea nitrogen (BUN), aspartate transaminase (AST), alanine transaminase (ALT), lactate dehydrogenase (LDH) and albumin) were obtained from this dataset. Data was also collected on mechanical ventilation and non-invasive positive-pressure ventilation (NIPPV) and vasopressor requirement. These independent variables were chosen from prior studies on risk factors for severe COVID-19 disease.[2-8] The outcome analysed was ICU hospitalisation which was defined as any patient on the COVID-19 ward who required ICU care or intervention including but not limited to high flow nasal oxygen (HFNO), NIPPV, endotracheal intubation and mechanical ventilation, tracheostomy and vasopressor support. The clinicians explicitly decided which patients were for ICU admission.

Descriptive frequency analysis was done for all independent variables, and the Chi-square test was used to compare differences between groups where suitable. Univariate and multivariate binary logistic regression was used to examine the association between the independent variables and the risk for ICU hospitalisation. The backward stepwise selection process was used to select independent variables to include in the final regression model. Additionally, the odds ratio (OR) and the 95% confidence interval (CI) were stated, and a p-value of <.05 was considered to be statistically significant. All statistical analyses were performed on IBM SPSS Statistics Version 27. Additionally, the assumptions required to perform binary logistic regression were considered.[11]

RESULTS

There was a total of 136 confirmed COVID-19 cases admitted to the ward at GPHC from 1st March to 30 September 2020, and after the exclusion of one case, because the record showed that the patient was < 18 years old, 135 patients' records were used for this study. There was sufficient data on predictive factors as evidenced by > 95% of data available for each case. 63 (46.6%) patients required ICU admission, and of those, 23 (36.5%) required endotracheal intubation and mechanical ventilation, 18 (28.6%) required NIPPV, 2 (3.2%) required tracheostomy and 20 (31.7%) required vasopressor support. Also, there were no HFNO machines in use at the time of study.

The average age ±SD for non-ICU and ICU hospitalisation was 51 ±16 and 56 ±18, respectively. No statistically significant ethnic and gender differences were found between groups. All measured comorbidities (obesity, DM, CVD and CKD) were statistically higher in the ICU group, p <.01, as seen in table 1.

There was a statistically significant difference in the various age categories, p= .02, between ICU and non-ICU admissions, however, mean age was not statistically significant between groups, p= .42. Subgroup analysis for age showed statistically significant differences regarding ICU admission for ages 40-65, p= .03 and >65, p= .009. The comorbidities with statistically significant differences among non-ICU and ICU hospitalisation were obesity, p <.001, DM, p <.001, CVD, p= .003, CKD, p <.001. Subgroup analysis for comorbidities showed statistically significant differences regarding ICU admission for 0 comorbidity, p= .001and 1 comorbidity, p= .01. The signs and symptoms with statistically significant differences among non-ICU and ICU hospitalisation were cough, p= .02, shortness of breath, p <.001 and fatigue, p= .004. Also, the laboratory findings on admission with statistically significant differences among groups were BUN, p= .004, creatinine, p= .003, LDH, p <.001 and albumin, p= .003. The key predictors between non-ICU and ICU hospitalisation were highlighted in Table 1.

The variables chosen for the multivariate logistic regression were age group, obesity, number of comorbidities, LDH and albumin. In the final model the significant variables were age group (OR= .14, p= .005), class 2 and above obesity (OR= 11.09, p= .006), two comorbidities (OR= 7.83, p= .03) and three or more comorbidities (OR= 132.15, p <.001), LDH 228-454 U/L (OR= 19.88, p= .001), LDH >454 U/L (OR= 23.32, p= .001) and albumin <3.5 g/dL (OR= 5.78, p= .005). In the model, the Cox & Snell and Nagelkerke R^2 values were 0.504 and 0.673, respectively and the Hosmer and Lemeshow test p-value was 0.210 indicating goodness-of-fit. There results of univariate and multivariate logistic regression analysis were highlighted in tables 2 and 3.

DISCUSSION

There was an almost equal proportion of patients with

Table 1: Key predictors among COVID-19 patients at GPHC from March to September 2020 by hospitalisation status.

Predictor	**Non-ICU Hospitalisation (N= 72)**		**ICU Hospitalisation (N= 63)**	**P-value**
Age, average±SD	51 ±16		56 ±18	p= .42
Age group (years), n (%)				p= .02
	18-39	18 (54.5)	15 (45.5)	p= .80
	40-65	39 (64)	22 (36)	p= .03
	> 65*	15 (36.6)	26 (63.4)	p= .009
Obesity, n (%)	Yes	4 (11.8)	30 (88.2)	p= <.001
Diabetes Mellitus, n (%)	Yes	18 (34)	35 (66)	p= <.001
Cardiovascular Disease, n (%)	Yes	5 (23.8)	16 (76.2)	p= .003
Chronic Kidney Disease, n (%)	Yes	1 (6.2)	15 (93.8)	p= <.001
Number of Comorbidities, n (%)				p= <.001
	0*	17 (85)	3 (15)	p= .001
	1	36 (66.7)	18 (33.3)	p= .012
	2	17 (53.1)	15 (46.9)	p= 1.00
	≥ 3	2 (6.9)	27 (93.1)	p= 1.19
Cough, n (%)	Yes	34 (44.7)	42 (55.3)	p= .02
Shortness of Breath, n (%)	Yes	38 (41.8)	53 (58.2)	p= <.001
Fatigue, n (%)	Yes	51 (47.2)	57 (52.8)	p= .004
BUN (mg/dL), n (%)				p= .004
	7-18*	41 (64)	23 (36)	p= .56
	>18	25 (39)	39 (61)	p= .70
	<7	6 (85.7)	1 (14.3)	p= .005
Creatinine (mg/dL), n (%)				p= .003
	0.4-1.4*	55 (61.8)	34 (38.2)	p= .65
	> 1.4	16 (35.6)	29 (64.4)	p= .51
	< 0.4	1 (100)	0 (0)	p= <.001
LDH (U/L), n (%)				p= <.001
	103-227*	26 (83.9)	5 (16.1)	p= .05
	228-454	32 (53.3)	28 (46.7)	p= .92
	> 454	12 (42.9)	26 (57.1)	p= <.001
	Not available	2 (33.3)	4 (66.7)	p= 1.69
Albumin (g/dL), n (%)				p= .003
	3.5-5.3*	33 (70.2)	14 (29.8)	p= .61
	< 3.5	25 (38.5)	40 (61.5)	p= <.07
	Not available	14 (60.9)	9 (39.1)	p= 1.88

*Baseline comparative group

ICU and non-ICU hospitalisation, 63 (46.6%) and 72 (53.4%), respectively and 23 patients (36.5%) in the ICU required mechanical ventilation due to respiratory failure. It is consistent with the high rates of acute hypoxemic respiratory failure which usually requires ICU admission as seen in many patients with COVID-19 globally.[12] Additionally, there was a significantly higher proportion of several comorbidities seen in ICU vs non-ICU hospitalisation including DM (56% vs 25%) (p <.001), obesity (≥ class 2) (48% vs 6%) (p <.001), CVD (25% vs 7%) (p= .003) and CKD (24% vs 0.4%) (p <.001). This is consistent with evidence that shows that patients with comorbidities are at higher risk of ending up with deteriorating outcomes of COVID-19 disease, particularly respiratory failure.[13–16]

In the multivariate regression model, the odds of ICU admission for those aged 40-65 was .14 (p <.01) compared to those > 65 years. However, 41% of ICU hospitalisation were in the > 65 age group, which is consistent with other studies that confirm that elderly COVID-19 patients are more at risk for severe disease.[2,5,7] Picon et al. and Soares et al. also identified other risk factors for COVID-19 hospitalisation in Brazil

Table 2: Univariate analysis of significant risk factors associated with ICU hospitalisation due to COVID-19 at GPHC from March to September 2020.

Predictor	P-value	Univariate OR (95% CI), P-value	
Age group (years) (vs. > 65)	p <.001	18-39	0.481 (0.189-1.224), p= .12
		40-65	0.325 (0.143-0.741), p= .007
Obesity (≥ class 2) (vs. No)	p <.001	Yes	15.45 (5.02-47.51), p <.001
Diabetes Mellitus (vs. No)	p <.001	Yes	3.75 (1.80-7.77), p <.001
Cardiovascular Disease (vs. No)	p= .003	Yes	4.56 (1.56-13.31), p= .005
Chronic Kidney Disease (vs. No)	p= .005	Yes	22.18 (2.83-173.58), p= .003
Number of Comorbidities (vs. 0)	p <.001	1	2.83 (0.733-10.94), p= .13
		2	5.00 (1.22-20.48), p= .02
		≥ 3	76.50 (11.56-506.02), p <.001
Cough (vs. No)	p= .01	Yes	2.23 (1.11-4.49), p= .02
Shortness of Breath (vs. No)	p <.001	Yes	4.74 (2.09-10.75), p <.001
Fatigue (vs. No)	p= .002	Yes	3.91 (1.46-10.45), p= .007
BUN (mg/dL) (vs. 7-18)	p= .006	> 18	2.78 (1.35-5.69), p= .005
		< 7	.29 (.03-2.62), p= .27
Creatinine (mg/dL) (vs. 0.4-1.4)	p= .01	> 1.4	2.93 (1.39-6.17), p= .005
		< 0.4	.00 (.00), p= 1.00
LDH (U/L) (vs. 103-227)	p= .001	228-454	4.55 (1.54-13.44), p= .006
		> 454	11.26 (3.47-36.53), p <.001
		Not available	10.40 (1.48-72.99), p= .01
Albumin (g/dL) (vs. 3.5-5.3)	p= .004	< 3.5	3.77 (1.69-8.39), p= .001
		Not available	1.51 (0.53-4.30), p= .43

Table 3: Final model multivariate analysis of risk factors associated with ICU hospitalisation due to COVID-19 at GPHC from March to September 2020

Final Predictor	P-value	Multivariate OR (95% CI), P-value	
Age group (years) (vs. > 65)	p= .01	18-39	.74 (.18-2.98), p= .68
		40-65	.14 (.37-.55), p= .005
Obesity (≥ class 2) (vs. No)	p <.001	Yes	11.09 (1.98-62.06), p= .006
Number of Comorbidities (vs. 0)	p= .002	1	2.73 (.48-15.31), p= .25
		2	7.83 (1.20-50.97), p= .03
		≥ 3	132.15 (9.49-1839.47), p <.001
LDH (U/L) (vs. 103-227)	p= .005	228-454	19.88 (3.31-119.11), p= .001
		> 454	23.32 (3.78-143.79), p= .001
		Not available	4.78 (.28-80.54), p= .27
Albumin (g/dL) (vs. 3.5-5.3)	p= .01	< 3.5	5.78 (1.68-19.81), p= .005
		Not available	1.52 (.23-10.05), p= .65

and included male gender and the presence of comorbidities.[5,7] These findings are similar to those obtained from this study, and while male gender was not identified as a statistically significant risk (p= .68) factor for ICU hospitalisation in Guyana, > 60% of all admissions were male.

The proportion of comorbidities seen in the ICU and non-ICU settings are consentient with other studies in the LAC region.[5–7] In the multivariate regression model the odds of ICU admission for patients with class 2 and above obesity had higher odds of ICU admission compared to non-obese patients OR 11.09 (p= .006). Obesity is of particular concern because it is linked to reduced immune function and decreases lung capacity which makes ventilation on a background of COVID-19 problematic.[17–19] The number of comorbidities among COVID-19 patients were directly proportional to ICU hospitalisation. Patients with 2 and 3 or more comorbidities also had higher odds of ICU admission compared to those with no comorbidities OR 7.83 (p= .03) and 132 (p <.001) respectively. Patients who have multiple comorbidities may have a compromised immune system and these underlying conditions adds more stress to the body which makes them more susceptible to COVID-19.[13] It, therefore, underscores the risk of severe COVID-19 disease among patients with multiple pre-existing conditions.

Acosta et al. and Valenzuela identified hypertension, obesity and older age as risk factors for severe COVID-19 in Peru.[2,20] While obesity and older age were also identified in this study, hypertension was not, and it may be due to lower rates of hypertension (42%) among the study population. Yomayusa et al. also identified patients at an advanced age with pre-existing comorbidities, in particular cardiovascular disease, hypertension and diabetes mellitus have a significant risk of progression to severe disease.[15] Other than obesity (≥ class 2), no other single comorbidity was identified as a stand-alone risk factor for ICU hospitalisation in Guyana, but the number of comorbidities was inversely proportion to severe COVID-19 disease.

Rodriguez et al. found that increased body mass index (BMI), C-reactive protein (CRP) and SpO_2/FIO_2 ratio on admission were significantly associated with the need for ICU care among COVID-19 patients.[6] While this study also found that increased BMI was associated with severe COVID-19 disease, CRP and SpO_2/FIO_2 ratio were not assessed because it was not readily available for most patients in the study sample. Patients with elevated LDH (228-454 U/L) and two times the upper limit (> 454 U/L) had higher odds of ICU admission compared to those with normal LDH OR 19.88 (p= .001) and 23.32 (p= .001) respectively, while patients with albumin levels below the lower limit (< 3.5 mg/dL also had higher odds of ICU admission compared to those with normal albumin OR 5.78 (p= .005). It is consistent with several studies that focused on laboratory parameters among COVID-19 patients.[21–23] Elevated LDH is associated with a hyperinflammatory state and hypoalbuminemia is associated with organ dysfunction, both of which are linked to the pathophysiology of severe COVID-19 disease.[24] These parameters can be used in clinical practice to guide treatment and ICU hospitalisation.

Additionally, no clinical manifestations were included in the final model, which indicates that symptom profiles of COVID-19 patients on admission were not a reliable predictor of ICU hospitalisation in Guyana. However, shortness of breath (p <.001) was found to be strongly associated with ICU hospitalisation. The COVID-19 virus can rapidly infect the lungs and causes a triggered inflammatory immune response which affects gas exchange and ultimately makes it difficult to breathe.[25]

The method used was a cross-sectional study design using secondary data analysis, and one of its main strengths is the ability to infer associations between predictive factors (risk factors) and a specific outcome (ICU hospitalisation) using the odds ratio generated after statistical analysis.[26] A cross-sectional study was appropriate because it was carried out at one point in time and focused on the outcome and characteristics associated with it.[27] Another strength of using the cross-sectional study design was that it was relatively fast and inexpensive to perform because the patients' medical records were made available for review. Also, since whole population sampling was used, the results were considered representative of Guyana's population. Another strength of the study is that none of the assumptions for logistic regression were violated.[28]

However, since the data was collected from one time period, it was difficult to analyse developmental trends such as serial symptom profiles and laboratory parameters after admission. Another limitation to the cross-sectional study design was that even though correlations between risk factors and ICU hospitalisation were made, it was difficult to determine causal relationships. An alternative study method is cohort study which is more adept to determining the causal relationship between predictive factors and outcome by following patients over a more extended time.[29] However, a limitation of the findings was that the relatively small sample size (n=135) used in the study might have overstated the results and applied undue significance to one or more of the risk factors identified, however this was higher than the minimum sample size calculated and all cases during the study period. Another limitation was that the results were obtained from a single hospital setting (GPHC, Guyana) and may have restricted the generalizability of the findings, but this was the only hospital with the outcome measure of interest.

The wider relevance of the findings for public health is that it provides much needed data on the impact of the novel coronavirus in Guyana and the LAC region. It also identifies patients who are vulnerable and at high risk for severe disease and poor outcomes. The findings, therefore, can be used to improve public health strategy for example 1) protecting persons who are vulnerable to severe COVID-19 disease can be implemented e.g., elderly, those with multiple comorbidities and those with obesity, 2) the identified vulnerable groups can be prioritised for vaccination when the COVID-19 vaccine becomes available in Guyana and the LAC and 3) the findings allow for planning and resource allocation for COVID-19 patients who require ICU care.

There is a need for further research on the risk factors for hospitalisation among COVID-19 patients in the LAC so correlations can be made within the region. Moreover, a cohort study design is recommended to determine causal relationships between predictive factors and non-ICU or ICU hospitalisation.

CONCLUSION

The major risk factors associated with ICU hospitalisation among COVID-19 patients at GPHC, Guyana were advanced age, obesity, multiple comorbidities, elevated LDH and low albumin levels. These patient factors and laboratory parameters can be used to guide clinical and public health practice during the pandemic. Protecting the population at risk for ICU admission and prioritizing them for vaccination is recommended to reduce the risk of running out of ICU capacity.

Ethical approval statement: This research was approved by the Institutional Review Board of Guyana, Georgetown Public Hospital Corporation research committee and University of Liverpool research committee.

Conflict of interest statement: There were no real or perceived conflicts of interest encountered during this research.

Informed consent statement: Due to the retrospective nature of the study and the de-identification of the data, written consent was waived.

Funding statement: This research was fully self-funded by the corresponding author.

Authors' contribution: Every author has made a substantial contribution to the conception and design of the study, and data acquisition, analysis and interpretation and involved in drafting the manuscript or revising it critically for intellectual content. Final approval for submission was given by every author.

REFERENCES

1. Coronavirus disease (COVID-19) – World Health Organization [Internet]. WHO. 2020 [cited 6 July 2020]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019.
2. Acosta G, Escobar G, Bernaola G, Alfaro J, Taype W, Marcos C et al. Description of patients with severe COVID-19 treated in a national referral hospital in Peru. Revista Peruana de Medicina Experimental y Salud Pública. 2020;37(2):253-8. doi: 10.17843/rpmesp.2020.372.5437.
3. Sales-Peres S, de Azevedo-Silva L, Bonato R, Sales-Peres M, Pinto A, Santiago Junior J. Coronavirus (SARS-CoV-2) and the risk of obesity for critically illness and ICU admitted: Meta-analysis of the epidemiological evidence. Obesity Research & Clinical Practice. 2020;14(5):389-397. doi: 10.1016/j.orcp.2020.07.007.
4. Hamer M, Kivimäki M, Gale C, Batty G. Lifestyle risk factors, inflammatory mechanisms, and COVID-19 hospitalization: A community-based cohort study of 387,109 adults in UK. Brain, Behavior, and Immunity. 2020;87:184-187. doi: 10.1016/j.bbi.2020.05.059.
5. Picon R, Carreno I, da Silva A, Mossmann M, Laste G, Domingues G et al. Coronavirus disease 2019 population-based prevalence, risk factors, hospitalization, and fatality rates in southern Brazil. International Journal of Infectious Diseases. 2020;100:402-410. doi: 10.1016/j.ijid.2020.09.028.
6. Rodriguez M, Peters A, Perez I, Spencer M, Barbe M, Porte L et al. Covid-19 in South America: Clinical and Epidemiological Characteristics Among 381 Patients During the Early Phase of the Pandemic in Santiago, Chile. 2020. doi: 10.1016/j.ijid.2020.09.028.
7. Soares R, Mattos L, Raposo L. Risk Factors for Hospitalization and Mortality due to COVID-19 in Espírito Santo State, Brazil. The American Journal of Tropical Medicine and Hygiene. 2020;103(3):1184-1190. doi: 10.4269/ajtmh.20-0483.
8. Wang L, He W, Yu X, Hu D, Bao M, Liu H et al. Coronavirus disease 2019 in elderly patients: Characteristics and prognostic factors based on 4-week follow-up. Journal of Infection. 2020;80(6):639-645. doi: 10.1016/j.jinf.2020.03.019.
9. The World Bank in Guyana [Internet]. World Bank. 2020 [cited 30 October 2020]. Available from: https://www.worldbank.org/en/news/factsheet/2020/09/02/the-world-bank-in-guyana.
10. OECD [Internet]. Read.oecd-ilibrary.org. OECD. 2020 [cited 25 October 2020]. Available from: https://read.oecd-ilibrary.org/view/?ref=129_129907-eae84sciov&title=COVID-19-in-Latin-Amercia-and-the-Caribbean_An-overview-of-government-responses-to-the-crisis.
11. Ranganathan P, Aggarwal R. Common pitfalls in statistical analysis: Linear regression analysis. Perspectives in Clinical Research. 2017;8(2):100. doi: 10.4103/picr.PICR_87_17.
12. Wilcox S. Management of respiratory failure due to covid-19. BMJ. 2020:m1786. doi: 10.1136/bmj.m1786.
13. Sanyaolu A, Okorie C, Marinkovic A, Patidar R, Younis K, Desai P et al. Comorbidity and its Impact on Patients with COVID-19. SN Comprehensive Clinical Medicine. 2020;2(8):1069-1076. doi: 10.1007/s42399-020-00363-4.
14. Zhou Y, Yang Q, Chi J, Dong B, Lv W, Shen L et al. Comorbidities and the risk of severe or fatal

outcomes associated with coronavirus disease 2019: A systematic review and meta-analysis. International Journal of Infectious Diseases. 2020;99:47-56. doi: 10.1016/j.ijid.2020.07.029.

15. Yomayusa N, Acevedo K, Reina A, Rincón K, Toloza C, Gomez O et al. Clinical course, biomarkers, management and outcomes of patients hospitalised due to COVID-19 in Colombia. 2020. doi: 10.21203/rs.3.rs-57978/v1.

16. Jain V, Yuan J. Predictive symptoms and comorbidities for severe COVID-19 and intensive care unit admission: a systematic review and meta-analysis. International Journal of Public Health. 2020;65(5):533-546. doi: 10.1007/s00038-020-01390-7.

17. Tanaka S, Isoda F, Ishihara Y, Kimura M, Yamakawa T. T lymphopaenia in relation to body mass index and TNF-α in human obesity: adequate weight reduction can be corrective. Clinical Endocrinology. 2001;54(3):347-354. doi: 10.1046/j.1365-2265.2001.1139cn2155.x.

18. Alwarawrah Y, Kiernan K, MacIver N. Changes in Nutritional Status Impact Immune Cell Metabolism and Function. Frontiers in Immunology. 2018;9. doi: 10.3389/fimmu.2018.01055.

19. Simonnet A, Chetboun M, Poissy J, Raverdy V, Noulette J, Duhamel A et al. High Prevalence of Obesity in Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) Requiring Invasive Mechanical Ventilation. Obesity. 2020;28(7):1195-1199. doi: 10.1002/oby.22831.

20. Valenzuela G, Rodriguez-Morales A, Mamani R, Ayala R, Pérez K, Sarmiento C et al. Cardiovascular Risk Factors and Evolution of Patients Attended with COVID-19 in a National Reference Hospital from Lima, Peru. 2020. doi: 10.20944/preprints202006.0237.v1.

21. Kermali M, Khalsa R, Pillai K, Ismail Z, Harky A. The role of biomarkers in diagnosis of COVID-19 – A systematic review. Life Sciences. 2020;254:117788. doi: 10.1016/j.lfs.2020.117788.

22. Mardani R, Ahmadi Vasmehjani A, Zali F, Gholami A, Mousavi Nasab SD, Kaghazian, H, Kaviani M, Ahmadi N, 2020. Laboratory parameters in detection of covid-19 patients with positive rt-pcr; a diagnostic accuracy study. *Arch Acad Emerg Med* 8(1): e43.

23. Mardani R, Ahmadi Vasmehjani A, Zali F, Gholami A, Mousavi Nasab SD, Kaghazian H, Kaviani M, Ahmadi N. Laboratory Parameters in Detection of COVID-19 Patients with Positive RT-PCR; a Diagnostic Accuracy Study. Archives of Academic Emergency Medicine. 2020;8(1):e43. doi: 10.22037/aaem.v8i1.632.

24. Salinas M, Blasco Á, Santo-Quiles A, Lopez-Garrigos M, Flores E, Leiva-Salinas C. Laboratory parameters in patients with COVID-19 on first emergency admission is different in non-survivors: albumin and lactate dehydrogenase as risk factors. Journal of Clinical Pathology. 2020:jclinpath-2020-206865. doi: 10.1136/jclinpath-2020-206865.

25. Hariyanto T, Japar K, Kwenandar F, Damay V, Siregar J, Lugito N et al. Inflammatory and hematologic markers as predictors of severe outcomes in COVID-19 infection: A systematic review and meta-analysis. The American Journal of Emergency Medicine. 2021;41:110-119. doi: 10.1016/j.ajem.2020.12.076

26. Mann C. Observational research methods. Research design II: cohort, cross sectional, and case-control studies. Emergency Medicine Journal. 2003;20(1):54-60. doi: 10.1136/emj.20.1.54.

27. Levin K. Study design III: Cross-sectional studies. Evidence-Based Dentistry. 2006;7(1):24-25. doi: 10.1038/sj.ebd.6400375.

28. Pallant J. SPSS survival manual. London, UK: McGraw-Hill; 2013.

29. Bruce N, Pope D, Stanistreet D. Quantitative methods for health research. Chichester, UK: Wiley; 2008.