Original article

DETERMINANTS OF LENGTH OF STAY IN COVID-19 PATIENTS AT EKA KOTEBE GENERAL HOSPITAL, ETHIOPIA - A REVIEW.

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ABSTRACT

Coronavirus, which causes many humans and animals' diseases, is the very reason of this very severe pandemic known as Corona disease. In this way, respiratory diseases such as the common cold are caused by this phenomenon. The research is done in order to discover the parameters that affect the length of an inpatient hospital stay utilising the approach of zero -truncated regression model. This study was population-based and it was carried out in Eka Kotebe General hospital visiting emergencies department (ED) from March 2020 to December 2020. The zero-truncated regression model and the descriptive statistics were used for the analysis of the data. Generally, patients stayed in the hospital for an average of 14 days after admission. It can be also noted that 35% of all 342 patients who were a part of study. Of the 100 patients, only 38 (38%) were women and 94 died during hospitalization. Our statistical analysis produced a P-value lower than 0. A value of 0. 001 (0. 001) implies too much broadly distributed data as well. As a result, the Zero-truncated Negative binomial regression is the model that is being proposed. The results of implementation of Zero-truncated negative Binomial regression prove that these aspects of patient as sex, age, mortality status, symptom status and, Comorbidity status conduct much refection on length of stay in hospital. This research verified that the male patients aged 50 years and above, who were either asymptomatic or suffered from mild symptoms of the COVID-19 infection but also had a comorbidity, had greater stay in the hospital.

Key Words: COVID-19, hospital stay length, zero-truncated regression model, and zero-   truncated Negative-binomial regression

1. Introduction

Corona is the main disease between humans and animals that is caused by coronavirus 2. It often, leads to respiratory infections, from the common cold to the severest ones like Middle East respiratory syndrome and Severe acute respiratory syndrome are examples of such illnesses. Originally in December 2019 in China; it became a worldwide pandemic with 286,910,703 infections and 5,363,034 deaths by 31/12/2021. Ethiopia had its first cases on March 13, 2020, and the number of cases has been on the rise ever since then, reaching an estimated 415,443 cases and 6,926 deaths as of December 31, 2021. [1][2]

Indeed , the massive number of COVID-19 pandemic modeling has been carried out in many studies . On the other hand, there is a lack of journal papers that face this situation. Demographics and clinical status, including age, gender, nutritional status, comorbidities (e. g. hypertension, diabetes, heart disease; chronic obstructive pulmonary disease, asthma), symptoms (e. g. fever & dyspnea), laboratory parameters (e. g. d-dimer, c-reactive protein, white blood cell count, radiographic parameters, lactate dehydrogenase, and aspartate aminotransferase)[3][4][5][6].

With a purpose of investigating the determinants of hospital admission duration, the zero-truncated regression model was used in this study. Physicians would do it using the patient demographics and their clinical conditions to attention health resource shortages and to help governments develop a better response strategy.

Aim:

To investigate the determinants influencing the duration of inpatient hospital stays among COVID-19 patients, utilizing a zero-truncated regression model, with a focus on demographic and health-related factors.

Objectives:

Identify the key parameters affecting the length of hospital stays among COVID-19 patients admitted to Eka Kotebe General Hospital's emergency department.

Analyze the demographic characteristics, symptom severity, and comorbidity status of patients to understand their impact on hospitalization duration.

Utilize descriptive statistics and regression analysis to elucidate patterns and relationships within the data.

Assess the efficacy of the Zero-truncated Negative Binomial regression model in capturing the variability of hospital stay durations.

Provide insights into optimizing patient care and resource allocation in managing COVID-19 cases based on the identified determinants of hospitalization leng

2. Methodology

The study was designed in the COVID-19 Treatment Center at Eka' Kotebe general hospital. It was discovered in Addis Ababa, capital of Ethiopia. The study subjects were COVID-19 patients who were treated in this center between March 13, 2020 and December 31, 2020.

342 patients samples were taken from total 3081 patients who were treated in this center within the study period. We employed a simple sampling technique involving a random choice of the patient sample.

We concentrated on the factors such as age, gender, the presence of symptoms, the co-morbidity, diabetes, asthma, hypertension, and chronic obstructive pulmonary disease (COPD) and the severity of illness. The length of stay in hospital (days) was the depended variable and data were analyzed with STATA software version 14.

2.1.Statistical method

2.1.1.Zero-Truncated Count Data Model.

The zero truncated count data model is used to estimate count response variables with zero structural missingness in the observed data. In this process, the smallest outcome will be y=1. For this reason, in our research, the result factor ,length of stay in hospital ,shall be recorded for at least 1 day. Therefore, the probability distribution for zero-truncated ,count data has this general form;

$$Prob(Y = y,) = \frac{f(Y = y,)}{[f(Y > 0)]} = \frac{f(Y = y,)}{[1 - f(Y = 0)]} \, for \, y = 1,2,3,\ldots$$

2.1.2.Zero-Truncated Poisson regression model.

The Poisson Regression with a zero-truncated is used to express count data where a zero value cannot occur. This modeling fits the cases when given data displays equal mean and variance allowing to see no additional dispersion in the data. The complement likelihood of the zero-truncated, Poisson model is given by

$$P(y.) = \frac{P(y; \mu)}{1 - P_0(y; \mu)}, y = 1,2,3,\ldots$$

$$P(y) = \frac{\mu_i{}^{y_i} e^{-\mu_i}}{y_i!} \, And \, P_0(y; \mu) = e^{-\mu_i}$$

Therefore, $P(Y = y_i | y_i > 0) = \frac{\mu_i{}^{y_i} e^{-\mu_i}}{y_i!(1 - e^{-\mu_i})}, i = 1,2,\ldots,n$

2.1.3.Zero-Truncated negative Binomial regression model.

A zero-truncated negative,binomial regression model is the one that is used to analyze count data when there are no zero values or when there is evidence of overdispersion. The likelihood function for a model of zero-truncated negative Binomial regression is spelled out as follows:

$$g(y.) = \frac{f(y.)}{1 - f(0)}$$

$f(y.) = \binom{r+y-1}{y} \sum_{j=0}^{y} \binom{x}{j} (-1)^j \left(\frac{c}{c+r+j}\right)^k \, And \, f(0) = \left(\frac{c}{c+r}\right)^k$

Therefore, $f(y; r, c, k) = \frac{\binom{r+y-1}{y} \sum_{j=1}^{y} \binom{y}{j} (-1)^j \left(\frac{c}{c+r+j}\right)^k}{1 - \left(\frac{c}{c+r}\right)^k}, y = 1,2,3,\ldots$

The linear function is $\eta = \beta_0 + \beta_1 X_1 + \cdots + \beta_p X_p$

2.1.4.Choosing the best model

An analysis of variance shows that the actions are more varied than the model allows. When overdispersion is in favor of the zero-truncated ,negative Binomial Regression model, and an information criterion, such as Akaike's Information Criterion (AIC); or Bayesian Information Criterion (BIC), choose at least Akaike's Information Criterion, or a model with Bayesian Information Criterion ; (or both) as the best model for data analysis.

3.Results and Discussions.

3.1.Descriptive statistics

342 subjects were allocated to this study. As can be seen in the Table 2, the average length of hospital stay for the patients was , days. The minimum time of stay in the hospital is 1 day (patients may pass away within 24 hours of admission) and the maximum is 36 days. The bars in figure- 1 indicate that most of the patients stayed from 7 to 17 days, about seventy mighty had been treated for 14 days, and those who stayed for the period beyond 30 days were very rare.

Table 1: The Summary of the length ,of stay in hospital

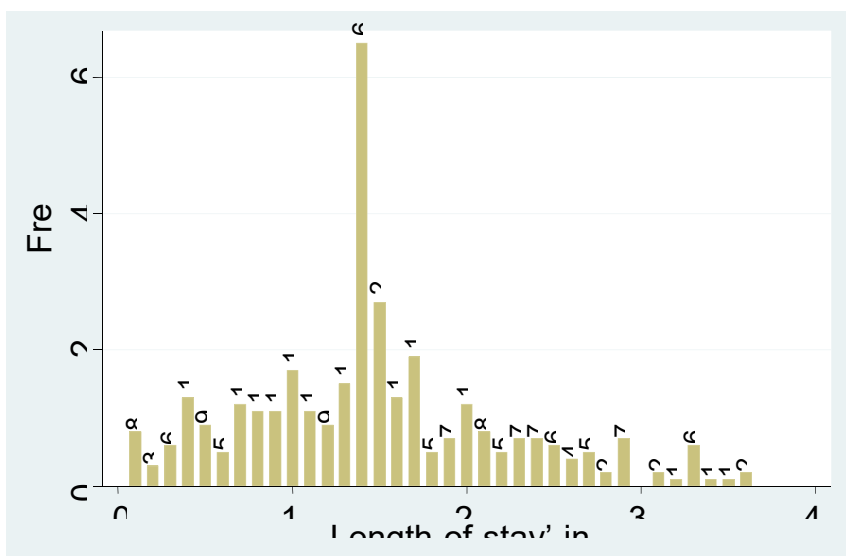| Variable	Observation	Mean.	Std. Dev.	Min.	Max.
Length of stay in hospital	342	14.68	7.32	1	36

Figure 1: Histogram of Length, of stay in hospital

Table 2 exhibits the number and proportion of the explanatory factors such as sex, age, patient status, severity of illness, existence of a symptom, co-morbidity depression, diabetes, asthma, hypertension, and chronic obstructive pulmonary disease.Here, from this result, of the 342 patients considered in the study, about 121 (35. About 38% of the respondents were women and 221 (64. 62%), were males. About 121 (5. 179 (85%) were younger than 20 years and 177 (51%). (75%) were 20-50 years, and 145 (42. 40%) were 50 years or older. By far the majority of the patients, there are approximately 148 of them (43. 27%) were the moderately severe stage, 46 people (13. 45%) were in the moderate stage, 100 people (29. 24% were in the severe stage and 48 individuals were in the same stage (48 people, 14. 04%).

Table 2: The number and percentage distribution of explanatory variables

Variables	Categories	Freq.	Percent
Age	<20	20	5.85
	20-50	177	51.75
	>50	145	42.40
Sex	Female	121	35.38
	Male	221	64.62
Status	Death	94	27.49
	Discharge	248	72.51
Illness severity	Mild	148	43.27
	Moderate	46	13.45
	Sever	100	29.24
	Critical	48	14.04
Symptom Presence	Asymptomatic	131	38.30
	Symptomatic	211	61.70
Comorbidity	No	167	48.83
	Yes	175	51.17
Diabetic	No	281	82.16
	Yes	61	17.84
Hypertension	No	254	74.27
	Yes	88	25.73
Asthma	No	316	92.40
	Yes	26	7.60
COPD	No	320	93.57
	Yes	22	6.43

3.1.1.Zero Truncated Regression Analysis.

According to Table 3, AIC and BIC for zero-truncated' negative binomial regression are lower than zero-truncated, Poisson regression; with P<0. 001 signifying unequal variances and means. Overdispersion is observed. Hence, the chosen model is zero-truncated; negative binomial regression.

Keeping other variables constant, the expected length of stay for male patient's would be 1. 171 times longer than for female patients. As a result, when other factors are equal, men's time in office increases.

Controlling other variable in the model, the expected length of stay for the patients age 50 + is 1. 138 times longer than that of patients in the age group of less than 20 years. This, therefore, implies that amongst the other variables that have been held constant, hospitalization rises with age.

Table 3: The parameter estimates, of zero truncated regression analysis

Variables	Categories	Zero- Truncated 'Poisson'			Zero-Truncated 'Negative Binomial'		
		IRR.	P-value.	95% CI.	IRR	P-value	95% CI
Sex	Female' (ref.)						
	Male	1.173	0.000	1.104, 1.246	1.171	0.006	1.047, 1.310
Age	<20 (ref.)						
	20-50	1.041	0.527	0.920, 1.177	1.034	0.473	0.822, 1.302
	>50	1.143	0.048	1.001, 1.306	1.138	0.037	1.036, 1.240
Status	Death (ref.)						
	discharge	1.338	0.000	1.228, 1.457	1.463	0.000	1.281, 1.670
Symptom	Asymptomatic (ref.)						
	Symptomatic	0.912	0.008	0.852, 0.976	0.711	0.039	0.493, 0.929
Comorbid	No (ref.)						
	yes	1.229	0.000	1.141, 1.324	1.241	0.002	1.080, 1.426
Diabetic	No (ref.)						
	yes	0.886	0.005	0.815, 0.964			
Asthma	No (ref.)						
	yes	0.858	0.009	0.765, 0.962			
COPD	No (ref.)						
	yes	0.808	0.012	0.684, 0.955			
Severity	Mild (ref.)						
	Moderate	1.083	0.089	0.988, 1.187			
	Severe	1.020	0.684	0.928, 1.120			
	Critical	0.827	0.004	0.727, 0.940			
Constant		9.769	0.000	8.350, 11.429	9.012	0.000	6.806, 11.933
ln alpha					-1.754		-1.978, -1.529
Alpha					0.173		0.138, 0.217
AIC		2648.931			2300.371		
BIC		2698.784			2342.554		
ref. = reference category IRR= incidence rate ratio Dispersion = mean: P-value < 0.001							

The expected 'length' of stay for a patient; in the hospital who is discharged from the hospital is equal to 1. In this case 463 is the length of stay anticipated in a hospital who dies in it; holding the rest of the variables in the model identical. This therefore implies that as long as other variables remain the same, the deaths will reduce the dwell time.

Keeping other variables constant, the expected length of stay for patients with co-morbidities is 1. Roughly 241 times that of patients without comorbidities. In this case, the fact that the duration of hospitalization is extended for any comorbidity and controlling all of the other variables in the representation is omitted.

3.2. Discussion

This study reveals that elderly COVID-19 patients over 50 years old are hospitalized more than those under 20 years old. This is congruent with the presented data about longer hospital stay with age. [7]

This research indicates that being asymptomatic is responsible for higher probability for prolonged hospitalization than patients who are symptomatic. Nevertheless, they were in conflict with those studies that showed that the presence of symptoms was the reason for prolonged hospitalization. Moreover, it wasn't corroborated with the data finding that there isn't any variation in length of stay between symptomatic and asymptomatic patients.

This again is in line with the previous researching which showed that the male patients will have longer hospital stays than the female patients. [4][5][6][8]

4.Conclusion.

The results of this study showed that the typical hospital stay was 14 days long. Through the application of the zero-truncated negative binomial regression model, it was found that the duration of patients' stays were associated with being male, being over 50 years of age, being released from the hospitals after recovering from COVID-19 infection, showing no-symptoms, and existing any other accompanying conditions.

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Conflict of Interest

There are no-conflicts of interest declared; by the authors.

References

1. Hafeez A, Ahmad S, Siddqui SA, Ahmad M, Mishra S. A review of COVID-19 (Coronavirus Disease-2019): diagnosis, treatments, and prevention. EJMO. 2020;4(2):116-125.

2. Worldometer. COVID-19 Coronavirus Pandemic. Coronavirus Update [Internet]. Accessed December 31, 2021. Available from: https://www.worldometers.info/coronavirus.

3. Agarwal N, Biswas B, Singh C, Nair R, Mounica G, et al. Early Determinants of Length of Hospital Stay: A Case-Control Survival Analysis among COVID-19 Patients admitted in a Tertiary Healthcare Facility of East India. Journal of Primary Care & Community Health. 2021 Oct;12:21501327211054281.

4. Wu S, Xue L, Legido-Quigley H, et al. Understanding factors influencing the length of hospital stay among non-severe COVID-19 patients: A retrospective cohort study in a Fangcang shelter hospital. PloS one. 2020;15(10):e0240959.

5. Thiruvengadam G, Lakshmi M, Ramanujam R. A Study of factors affecting the length of Hospital Stay of COVID-19 Patients by Cox-Proportional Hazard Model in a South Indian Tertiary Care Hospital. Journal of Primary Care & Community Health. 2021 Mar;12:21501327211000231.

6. Ran J, Song Y, Zhuang Z, Han L, et al. Blood pressure control and adverse outcomes of COVID-19 infection in patients with concomitant hypertension in Wuhan, China. Hypertension Research. 2020;43(11):1267-1276.

7. Faes C, Abrams S, Van Beckhoven D, et al. The time between symptom onset, hospitalization and recovery or death: statistical analysis of Belgian COVID-19 patients. International Journal of Environmental Research and Public Health. 2020;17(20):7560.

8. Lavery AM, Preston LE, Ko JY, Chevinsky JR, et al. Characteristics of hospitalized COVID-19 patients discharged and experiencing same-hospital readmission—United States, March-August 2020. Morbidity and Mortality Weekly Report. 2020;69(45):1695