COVID-19 and its Repercussion on the Nutritional Status and Gestational Anemia from Socio-Demographic-Obstetric Factors

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Issue Details
Issue Title: Issue 1
Received: 15 January, 2021
Accepted: 08 February, 2021
Published: 31 March, 2021
Pages: 998 - 1006

Abstract

Introduction: Currently, the impact of COVID-19 on sociodemographic and obstetric factors, linked to nutritional status and anemia in pregnant women, represents a significant change in management and healthcare paradigms.
Objectives: To consider a multiple logistic regression model and multiple comparisons (Mann-Whitney *U* test) based on sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19.
Methods: In this study, 113 medical records of pregnant women attended between November 2019 and April 2020 at a Hospital II-1 in Trujillo, Peru were analyzed. Multiple logistic regression model showed a good fit and allowed to correctly classify most of pregnant women.
Results: The covariates; employment situation, obstetric history, nutritional condition and anemia were significant. Differences were observed between sociodemographic factors such as employment status, obstetric factors such as obstetric history, and factors related to nutritional status and clinical symptoms of anemia.
Conclusions: The impact of COVID-19 reflected in the relationships between sociodemographic and obstetric factors with nutritional status and the anemia diagnosed in pregnant women treated in a Hospital II-1 in Trujillo, Peru, was evidenced.

Keywords

Pandemic; obstetric; employment; nutrition, logistic regression.

INTRODUCTION

In the current world situation, the impact of Covid-19 on sociodemographic factors (such as age, educational level, marital status, employment status) and obstetric factors (such as parity, poor obstetric history and intergenesis period), related to nutritional status and anemia in pregnant women represents a significant change in the management and healthcare paradigms (WHO, 2020; WHO, 2019b). Except in countries such as China, Russia, Japan, Germany, the Netherlands, Norway, Belgium, Australia, Sweden and Switzerland, the levels of poverty and extreme poverty have reduced their gaps to negative (WHO, 2019a). If before, more than a third of the world pregnant population (on average) was already malnourished and showed significant levels of anemia, today we can estimate that this proportion increased significantly to more than 65% (OMS, 2020; Centro Nacional de Información de Ciencias Médicas de Cuba, 2020). In Peru, of the 100% of women who began their pregnancy in December 2019, 64% already showed signs of mild and moderate anemia, increasing the percentage of women affected, from a global average of 51%, before the pandemic, to 68% as of March 2020 during the pandemic. That is, the nutritional status and anemia of pregnant women were already considered a priority for health policies, today the same international organizations such as the United Nations Food and Agriculture Organization, (FAO) the Pan American Health Organization (PAHO), the World Food Program (WFP) and the United Nations Children's Fund (UNICEF) (FAO, OPS, WFP and UNICEF, 2020), have launched the global alert to closely observe this phenomenon throughout the world, especially in countries in the process of development like ours. In Trujillo Hospitals, Peru, fighting malnutrition and anemia today represents a greater effort and an immense subsistence problem at all socio-demographic levels of the population. There is no access to foods rich in nutrients despite the fact that the geogenic dietary recipes recommended by the health establishment are known and that are generally low cost, but now they are unattainable because no family can generate the necessary resources to obtain them. From there, the objective of this research was to determine the impact of COVID -19 on the relationship between sociodemographic and obstetric factors with nutritional status and anemia in pregnant women treated at a Hospital II-1 in Trujillo, Peru.

METHODS

Study data

In this study, 113 medical records of pregnant women attended between November 2019 and April 2020 at a Hospital II-1 in Trujillo, Peru were analyzed. Sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19 were evaluated (see Table 1).

Table 1. Sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19 at a Hospital II-1 in Trujillo, Peru

Factor	Covariate	Measurement
Sociodemographic	Age (X_1)	(< 19, 19-35, > 35 years)
	Education (X_2)	Iliterate, primary education, high school, university
	Maritl status (X_3)	Single, married, cohabiting, widow, divorcee
	Employment status (X_4)	Dependent employee, independent employee, unemployed
Obstetric	Parity (X_{45})	Nulliparous, primiparous, multiparous, great multiparous
	Obstetric history (X_6)	No, yes
	Intergenesis period (X_7)	Short, normal, long
Nutritional condition	Nutritional condition (X_8)	Underweight, normal, overweight, obesity
Anemia	Anemia (X_9)	No, yes

The Sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19 at a Hospital II-1 in Trujillo, Peru were studied using a multiple logistic regression model in R package (R Core Team, 2020). The logistic model is described below (for details see Bartolo et al. 2007 and Villegas et al. 2020):

Multiple logistic regression model

Let the p independent variables be expressed by the vector $X^{\mathrm{T}} = (X_1, X_2, \dots, X_p)$ and it relates the probability of a certain independent event occurring denoted by the vector X^{T} with conditional probability $P\,(Y = 1\,/\,X\,) = \text{Ï€}(x)$ as a function of p independent variables that can be quantitative or qualitative depending on the type of study design. The logit of the multiple logistic regression models is presented by the following equation

$$g(x) = \text{Î}^2{}_0 + \text{Î}^2{}_1 x_1 + \text{Î}^2{}_2 x_2 + \text{â€¦} + \text{Î}^2{}_p x_p,$$

where $\text{Î}^2{}_0, \text{Î}^2{}_1, \text{â€¦}, \text{Î}^2{}_p$ are parameters of the multiple logistic regression model. In this case the logistic regression model is

$$\text{Ï€}(x) = p_j = \frac{e^{g(x)}}{1 + e^{g(x)}},$$

Parameter estimation

Assuming we have a sample of n independent observations $(x_i, y_i), i = 1,2, \text{â€¦}, n$. Fitting the model requires that we obtain estimators of the vector $\text{Î}^{2\mathrm{T}} = \left(\text{Î}^2{}_0, \text{Î}^2{}_1, \text{â€¦}, \text{Î}^2{}_p\right)$. The resulting likelihood equations can be expressed as follows

$$\underset{i=1}{\overset{n}{\text{â}}}\,[y_i - \text{Ï€}(x_i)] = 0$$

$$\underset{i=1}{\overset{n}{â}} x_{ij}[y_i - Ï€(x_i)] = 0$$

para $i = 1,2, â€¦, n$. $\widehat{Î²}$ denotes the solution of these equations.

Hypothesis testing for the logistic regression model

The likelihood ratio test for the total significance of the *p* coefficients for the independent variables in the model is based on the *G* statistic.

$$G = 2\left\{\underset{i=1}{\overset{n}{â}}\left[y_i \ln\left(\widehat{Ï€}_i\right) + (1 - y_i)\ln\left(1 - \widehat{Ï€}_i\right)\right] - \left[n_1 \ln(n_i) + n_0 \ln(n_0) - n\ln(n)\right]\right\}$$

The fitted values, $\widehat{Ï€}_i$, on the model are based on the vector containing *p* + 1 parameters, $\widehat{Î²}$, on the null hypothesis that the *p* coefficients for the covariates in the model are equal to zero. The *G* statistic has a Chi-square distribution with *p* degrees of freedom.

The Wald test is obtained from the calculation of the following matrix

$$W = \widehat{Î²}^{\mathrm{T}}\left[V\hat{a}r\left(\widehat{Î²}\right)\right]^{-1}\widehat{Î²}$$
$$= \widehat{Î²}^{\mathrm{T}}(XVX)\widehat{Î²},$$

where *V* is a diagonal matrix of dimension $n\ Ã— n$ with elements $\widehat{Ï€}_i\left(1 - \widehat{Ï€}_i\right)$ and *W* has a Chi-square distribution with *p* + 1 degrees of freedom on the hypothesis that each of the *p* + 1 coefficients are equal to zero.

Analysis of residuals for the logistic regression model

Pearson residuals

Pearson residuals are defined by

$$r_j = \frac{y_i - m_j\hat{p}_j}{\sqrt{m_j\hat{p}_j(1 - p_j)}},$$

where, y_i represents the number of responses, $y = 1$, among the m_j individuals with $X_j = x$ (some individuals having the same *x* value), $j = 1, \ldots, p$.

$$\hat{p} = \widehat{Ï€}(x) = \frac{e^{\hat{g}(x)}}{1 + \hat{g}(x)},$$

and $g(x) = \widehat{Î²}_0 + \widehat{Î²}_1 x_1 + \widehat{Î²}_2 x_2 + â€¦ + \widehat{Î²}_p x_p$.

Thus, a Pearson residual with an absolute value greater than 2 indicates an outlier.

Pearson's $Ï‡^2$ statistic is the sum of squares of the Pearson residuals.

$$Ï‡_P^2 = \underset{i=1}{\overset{J}{â}} r_J^2$$

ISSN: 0304-2294

Standardized Pearson residuals

The standardized Pearson residuals are defined by:

$$r_{sj} = \frac{r_j}{\sqrt{1 - h_j}},$$

where, r_j is the Pearson residuals and h_j is the leverage, that is, the element of the main diagonal of the matrix H.

Deviance residuals

Deviance residuals are defined as:

$$d_j = \hat{A} \pm \left\{ 2 \left[y_i \ln\left(\frac{y_j}{m_j \hat{p}_j}\right) + (m_j - y_j) \ln\left(\frac{m_j - y_j}{m_j(1 - p_j)}\right) \right] \right\}^{1/2}$$

Deviance is the sum of squares of deviance residuals.

$$\text{Ï ‡}_D^2 = \underset{j=1}{\overset{p}{\text{â}}} d_j^2$$

If the deviance is greater than 4 in absolute value, then the corresponding observation is outlier.

Multiple comparisons on sociodemographic-obstetric factors, nutritional status and anemia.

For the comparison of sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19 at a Hospital II-1 in Trujillo, Peru, the Mann-Whitney *U* test was used, originally proposed by Wilcoxon (1945) for the case of equal sample sizes ($n_1 = n_2$). Festinger (1946) independently developed a procedure equivalent to that of Wilcoxon. But Mann and Whitney (1947) were the first to extend the procedure to the case of unequal sample sizes and the first to also provide tables to enable the procedure to be used with small samples.

RESULTS

In Table 2, only four covariates; employment status (X_4), obstetric history (X_6), nutritional condition (X_8) and anemia (X_9) are significant ($P \leq .05$). These four covariates suggest that there are sociodemographic-obstetric and nutritional factors associated with Covid-19 in pregnant women at a Hospital II-1 in Trujillo, Peru. In Table 3, the results of the reduced multiple logistic regression model suggest a decrease in the entropy of the model (AIC = 224,61 and Deviance = 214,61) that shows a better fit of the reduced model compared to the full model. Similarly, in Table 4, the results of the classification show that, with the reduced model, 71.68% of the pregnant women during Covid-19 in a Hospital II-1 in Trujillo, Peru were correctly classified. Finally, Table 5 shows significant differences ($P < 0.05$) between pregnant women, related to sociodemographic-obstetric factors, nutritional status and anemia during Covid-19, which shows the findings found with the logistic region model, which links Covid-19 with sociodemographic factors in pregnant women in a Hospital in Trujillo, Perú.

Table 2. Multiple logistic regression model based on sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19 at a Hospital II-1 in Trujillo, Peru

Covariate	$\widehat{\text{Î}}^{2}_{p}$	Standard error	*Z* value	*P* value
Age (X_1)	-0,13261	0,32982	-0,402	0,687631
Education (X_2)	0,05856	0,35429	0,165	0,868724
Maritl status (X_3)	-0,33795	0,31175	-1,084	0,278351
Employment status (X_4)	1,14545	0,26909	4,257	0,0000207
Parity (X_{45})	-0,18494	0,20849	-0,887	0,375039
Obstetric history (X_6)	-0,83792	0,42146	-1,988	0,046796
Intergenesis period (X_7)	-0,25788	0,42838	-0,602	0,547327
Nutritional condition (X_8)	0,96589	0,42838	-0,602	0,000108
Anemia (X_9)	0,67710	0,23670	2,861	0,004228
Residual Deviance	248,98			
AIC	268,98			

Table 3. Reduced multiple logistic regression model based on sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19 in a Hospital II-1 in Trujillo, Peru

Covariate	$\widehat{\text{Î}}^{2}_{p}$	Standard error	*Z* value	*P* value	Ï ‡^{2} value	*P* value
Employment status (X_4)	0,8919	0,2758	3,234	0,00122	32,75	0,00002
Obstetric history (X_6)	-0,7721	0,4719	-1,636	0,10178	229,46	0,069617
Nutritional condition (X_8)	0,7636	0,2430	3,143	0,00167	217,8	0,000633
Anemia (X_9)	0,4486	0,2545	1,763	0,07794	214,61	0,074153
Residual Deviance	214,61					
AIC	224,61					

Table 4. Classification of pregnant women before and during Covid-19 in a Hospital II-1 in Trujillo, Peru based on a multiple logistic regression model

	Fitted		Correct percentage
Observed	Before Covid-19	During Covid-19	
Before Covid-19	88	39	69,29%
During Covid-19	25	74	74,74%

Overall correct percentage	71,68%

Table 5. Comparison (Mann-Whitney *U* test) of sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19 in a Hospital II-1 in Trujillo, Peru

Factor	Covariate	*U* value	*P* value
Sociodemographic	Employment status (X_4)	4602	0,0000001
Obstetric	Obstetric history (X_6)	7232	0.0098240
Nutritional	Nutritional condition (X_8)	4529	0.0000456
Anemia	Anemia (X_9)	4837	0.0002088

DISCUSSION

The results can be explained to the extent that, in normal times, sociodemographic factors can determine by themselves the changes in the nutritional states of pregnant women and that, if they can suffer greater alterations when sociopathic or psychological problems derived from your age, educational level, marital status or employment status. This is that before Covid-19 it was seen as states of normal alterations in pregnant women or with conditions of social confinement, the very relationships of the family and society have changed, and it is in itself an unknown process, since it has broken with their routine or methods and styles of family, social and work life (WHO, 2020; Wang et al. 2020). These processes are suffered more on a psychological level because we are talking about insured populations that mostly had a job before Covid -19 and who may have already lost it or are about to do so. This generates insecurities and changes in the ways of eating or nourishing, hence the changes in their nutritional states before and during Covid -19 (BMJ, 2020; Rothe et al. 2020) can be explained. On the other hand, the drastic changes suffered by pregnant women in their eating and nutritional habits that cross all ages, educational degrees, marital status or employment status. To get to this point we must say that the pregnant woman would be going from a state of comfort, planned and ordered to a state of disorientation and uncertainty, just by thinking about the fetal maternal complications that they may have from being infected with Covid -19 and being asymptomatic (Qiao, 2020; Ota et al. 2012). The results would indicate that the impact of Covid -19 on the relationships between obstetric factors with anemia before and during Covid -19 would be due to the way in which this disease would disrupt the processes of change that the body of the pregnant woman undergoes during the pregnancy. Covid -19 would mainly affect the immunological and structural changes of the pregnant woman, placing them at greater risk of suffering even other viral infections (Chen H et al., 2020; Li Y et al., 2020).

CONCLUSIONS

Multiple logistic regression model based on sociodemographic-obstetric factors, nutritional status and anemia in pregnant women before and during Covid-19 in a Hospital II-1 in Trujillo, Peru showed a good fit and allowed to correctly classify most of pregnant women. Only four covariates were significant; employment situation, obstetric history, nutritional condition and anemia. Differences were observed between sociodemographic factors such as employment status, obstetric factors such as obstetric history, and factors related to nutritional status and clinical symptoms of anemia. Finally, the impact of COVID-19 reflected in the relationships between sociodemographic and obstetric factors with nutritional status and the anemia diagnosed in pregnant women treated in a Hospital II-1 in Trujillo, Peru, was evidenced.

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ETHICAL APPROVAL

As per international standard or university standard ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.