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Analyzing the relationship between prenatal checkups and infant morbidity and mortality: What happens in developing countries such as Ecuador?

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Abstract:
Background: *Prenatal care reduces maternal and perinatal morbidity and mortality, premature births, and the number of low birth weight babies; it also makes it possible to identify risk factors, which makes it possible to establish timely preventive and therapeutic actions during pregnancy. Prenatal care involves not only the number of visits but also when they were made during the course of the pregnancy and with what quality.*
Materials and Methods: *We used a representative sample of Ecuador taken from the data of the National Health and Nutrition Survey 2018 (ENSANUT), a database collected by the National Institute of Statistics and Census (INEC). We took into account women of childbearing age who have been pregnant. To answer our research questions we used descriptive statistics to analyze the sample and binary logistic linear regression models to analyze the relationship between prenatal controls and mortality/morbidity of their children. We used a Principal Component Analysis (PCA) analysis to create a more robust child morbidity variable. This variable better captures the multidimensionality of child morbidity. In the linear regression models, Odds Ratios (OR) with their 95% confidence intervals (95% CI) were estimated for each of the independent variables.*
Results: *Our results show that women who had more prenatal checkups have twice the risk (OR= -2.00; CI=-1.981;-2.055) of having infants with morbidity. In addition, these women also have almost three times less risk (OR= -2.81; CI=-1.989; -2.962) of having infant mortality during childbirth. These results were statistically significant at a p<0.05 level. It was also demonstrated that women in rural areas, with lower income, of indigenous ethnicity, single and with low levels of schooling are more susceptible to not having prenatal check-ups and, therefore, to having higher risks of mortality and morbidity of their children. Other factors, such as micronutrient consumption and frequency of consumption, are significant factors that explain the levels of infant morbidity and mortality.*
Conclusion*: It is proved that adequate prenatal control modifies the incidence of acute respiratory disease, acute diarrheal disease, low birth weight, prematurity in neonates (morbidity indicators) and a considerable reduction in infant mortality was evidenced. Based on our findings, we recommend that health policy makers and medical professionals consider the promotion of prenatal care as an effective preventive method to detect perinatal diseases and therefore reduce maternal and infant mortality in the Ecuadorian population.*
Key Word: *Prenatal control, morbidity, mortality, birthweight. Respiratory infection, diarrhealdisease.*

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I. Introduction

Prenatal care reduces maternal and perinatal morbidity and mortality, premature births and the number of low birth weight babies; it also makes it possible to identify risk factors, which makes it possible to establish timely preventive and therapeutic actions during pregnancy.[1]. Mortality and complications of the maternal-infant binomial occurring in childbirth, puerperium and their care processes are currently considered avoidable with the advances and resources of current medicine.[2].

Reducing maternal and infant mortality and morbidity is currently considered a health priority worldwide, so that in the year 2000 it was proposed to achieve a 75% reduction in maternal mortality indicators by the year 2015. However, this objective is far from being achieved, since, according to the World Health Organization (WHO), it shows an annual reduction of only 1%.[3]. In 2015, 303,000 women worldwide died of obstetric causes, 2.7 million newborns died in the first 28 days of life, and the number of stillbirths reached 2.6 million.[4]. In the Latin American context, 7600 maternal deaths have been registered in 2015 due to obstetric causes such as postpartum hemorrhage and hypertension, at present, it is still possible to evidence the death of thousands of women due to preventable causes related to pregnancy and childbirth. In addition, with regard to the high rates of perinatal mortality, causes such as prematurity, low birth weight, hypertension in pregnancy, maternal-fetal isoimmunization, infectious processes, diabetes, low fetal reserve, birth complications, etc.; and in the neonate, respiratory diseases, asphyxia, hemolytic disease, among others, are evident.[5].

Therefore, prenatal care (PCN) is a set of actions that involves a series of visits by the pregnant woman to the doctor's office, with the objective of monitoring the evolution of the pregnancy, detecting risks early and preventing complications, based on a series of interventions aimed at identifying and modifying medical, behavioral and psychosocial risks, with the sole objective of taking care of the woman's health and obtaining a perinatal outcome without morbidities.[6]It is based on a series of interventions aimed at identifying and modifying medical, behavioral and psychosocial risks, with the sole objective of taking care of the woman's health and obtaining a morbidity-free perinatal outcome.[7]A quality health care approach during pregnancy and childbirth can prevent maternal and infant mortality to a large extent; however, worldwide it has been recorded that only 64% of women receive prenatal care four or more times during their pregnancy.[8]. There is a wide gap in development conditions, which predisposes to a limitation of access to quality health services mainly in groups of vulnerability or greater social exclusion. Thus, it is evident that indigenous and Afro-descendant women, as well as women with low income and fewer years of formal education are three times more likely to die from causes related to pregnancy and childbirth than non-indigenous women due to lack of health services (prenatal and perinatal care) or personal beliefs.[9]. This situation is alarming, as studies have estimated that women who do not receive prenatal care and give birth at home are 19 times more likely to die than those who receive prenatal care and give birth in a health facility.[10].

On the other hand, prenatal care involves not only the number of visits, but also the time they were made during the course of the pregnancy and the quality of the visits.[1]. Adequate coverage of pregnant women is necessary to generate a positive impact on morbidity and mortality, in addition, care with minimum quality standards is required, such as generating an atmosphere of trust between the doctor and the patient, as well as guaranteeing the privacy of the pregnant women.[5].

The prenatal care program, starting with a first visit before 12 weeks gestation, is accompanied by better perinatal outcomes, followed by two visits in the second trimester and three in the third trimester.[11]. The earlier you receive care, the better the opportunity to prevent, identify and correct problems that may affect your health or that of the infant, and early initiation of prenatal care is considered a positive predictor of adherence to the program.[12]. However, despite this, there are negative factors that influence the mother to start prenatal care late, including: not having a stable partner, low educational level, unwanted pregnancy, not having health insurance or a regular care institution, being under 20 years old or over 35, multiparity, unemployment, living in socially depressed areas or having low income levels.[13]. The World Health Organization (WHO) has shown a strong association between a decrease in the probability of prenatal deaths and prenatal checkups. This is because there are more opportunities to detect and manage potential problems. Antenatal care with a minimum of eight contacts can reduce perinatal deaths by as much as 8 per 1000 births, compared to a minimum of four visits.[4].

It is necessary to identify, analyze and detect all risk factors that influence the lack of prenatal care by pregnant women, since the identification of risk factors prior to birth is essential to identify the main problems that contribute to perinatal and maternal mortality at different levels of care and thus distribute the resources required, in addition, to propose strategies that benefit the obstetric population, and achieve a decrease in morbidity and perinatal mortality.[14]. Therefore, prenatal care is a factor for health professionals to provide care, support and information to pregnant women. This includes promoting a healthy lifestyle, including good nutrition, screening and disease prevention, providing family planning counseling, and supporting women who may be experiencing intimate partner violence.[15]. In this sense, the present research aims to analyze the impact of prenatal checkups on neonatal morbidity and mortality.

II. Material And Methods

Study design and population: A cross-sectional study was conducted using data from the National Health and Nutrition Survey of Ecuador (ENSANUT) 2018, whose data were obtained by the National Institute of Statistics and Census (INEC). After database cleaning, a total of 12489 observations were obtained. Data from prenatal checkups performed by women who reported a pregnancy in the last 5 years were included.

Inclusion and Exclusion Criteria: All children of women who responded to the questions in section IV Child Health of the ENSANUT survey, referring to Prenatal Control and Newborn Care, were included. Missing data values were excluded.

Source of Information: ENSANUT 2018 is a survey included in the National Statistical Program that employs probability sampling applied every 5 years and whose target population is all household members in the 24 provinces of Ecuador. ENSANUT 2018 includes the form Women of childbearing age, in section IV called Childhood Health (Children under 5 years old).

Statistical Analysis. The ENSANUT 2018 survey database was analyzed with the statistical package Stata v15 (Stata Corporation, College Station, Texas, USA). A value of $p<0.05$ was considered to determine statistical significance between variables. The Chi-square test was used to determine the overall correlation between the variables of interest. The association was evaluated by prevalence ratios with their respective 95% confidence intervals with an analysis for each of the variables included in the study.

Study Variables. Therefore, in order to estimate a discrete choice model that estimates the probability of morbidity and mortality:

$$Morbidity_i = \beta_0 + \beta_1 X_i + \sum_{j=2}^{12} \beta_j Z_i + \varepsilon_i \qquad (1).$$

Where $Morbidity_i$ represents morbidity (measured through a weighted composite index, which is subsequently dichotomized), X_i represents a set of control variables and Z_i represents a set of territorial control variables. Finally, ε_i represents the stochastic error term.

$$Mortality_i = \beta_0 + \beta_1 X_i + \sum_{j=2}^{12} \beta_j Z_i + \varepsilon_i \qquad (2).$$

Where $Mortality_i$ represents mortality (which is a dichotomous variable taking values of 1 and 0), X_i represents a set of control variables and Z_i represents a set of territorial control variables. Finally, ε_i represents the stochastic error term.

III. Result

To construct a composite measure of morbidity, within our research we specifically used 4 items from the questionnaires and considered that child morbidity is a multidimensional concept, thus the traditional literature, and used a principal component factor analysis (PCA) to ensure that the items can be grouped into a factor dimension. Through PCA with a varimax rotation, we obtained 1 eigenvalue greater than 1. Therefore, we confirmed that we can explain the morbidity index through a single dimension index, where the factor loadings of each variable have the highest weight in their respective dimension and these explain 80% of the variance. The questionnaire questions and their initial coding in the questionnaires are presented in **Table 1**. Our morbidity index was standardized such that we obtained a number between 0-1 where a number closer to 1 means higher child morbidity. To standardize our index to a number between 0-1 we followed the following procedure:

$$Standarized\ index = \frac{(X_i - X_i min^{sample})}{(X_i max^{sample} - X_i min^{sample})}$$

Where X_i is the factor value for individual i, $X_i min^{sample}$ is the minimum factor value for individual i in the entire sample and $X_i max^{sample}$ is the maximum factor value for individual i in the entire sample.

Subsequently, we dichotomized our morbidity index so that we could simplify our analyses. All children with a morbidity index ≤ 0.71 (median index) were considered as children with a low morbidity risk, while children with an index >0.71 were considered as children with a high morbidity risk. We coded all children with a high morbidity risk as 1 and all children with a low morbidity risk as 0.

Table 1. ENSANUT questions and coding

ENSANUT question	Codification
Weighed less than 2.5 kilograms (low birth weight)?	0=No/1=Yes
Birth before 9 months (Born premature)?	0=No/1=Yes
In the last two weeks have you had diarrhea in the last two weeks?	0=No/1=Yes
In the last two weeks have you had any respiratory symptoms?	0=No/1=Yes

Table 2 shows the results of the validity and reliability tests. Here we observe that the total number of items is 4, in addition, the average inter-item correlation is 0.833. That is, we observe that there is a high correlation between the 4 items, so that we can see that the items are highly correlated and explain our index in a good way. Crombach's alpha also shows an acceptable level, since it presents a value of 0.818. The Kayser Meyer Olin (KMO) statistic shows a high level. The KMO takes values between 0 and 1, and small values indicate that, in general, the variables have too little in common to justify a PCA analysis. In our case, we observed that our 4 items considered for analysis have a lot in common. We also note that Barlet's test is significant, indicating that the items are good measures for constructing the child morbidity index.

Table 2. Results of the sample reliability and validity test.

Test		Morbidity index
Number of items		
Average interitem correlation		0.833
Cronbach's alpha		0.818
Kayser Meyer Olin measure (KMO)		0.853
Bartlett's test	Chi square	3.65e+05
	df	
	Sig.	0.000

Table 3 shows the results of the factor loadings from principal component analysis. Here we can observe each of the items used to construct our morbidity index. We observe that the factor loadings are high, which means that each item contributes significantly to the constructed index. Furthermore, we observe that all our 4 items explain 81% of the variance, suggesting that our index has a large variance explained through each item used to construct it.

Table 3. Results of the principal component analysis.

KMO= 0.853 Variable	Morbidity index
Weighed less than 2.5 kilograms (low birth weight)?	0.850
Birth before 9 months (Born premature)?	0.825
In the last two weeks have you had diarrhea in the last two weeks?	0.745
In the last two weeks have you had any respiratory symptoms?	0.882
Variance explained	*81%*

Table 4 presents the descriptive statistics of the variables used in this study. Here we observe that 23.17% (with a CI 22.33-23.55) of children in the sample are at high risk of morbidity. In addition, there is an 18.57% infant mortality rate (mothers who reported that their children died). Regarding our independent variable of interest, we observed that the number of prenatal controls reported by the mothers is 7.36 prenatal controls. Regarding the characteristics of the mother, 42.7% were women from the coastal region and 81.03% were of mixed race. It is also reported that 43.4% of the mothers have a high school education and 71.3% are women from the urban area. In addition, 70.4% of the mothers reported that they had prenatal checkups in the health facilities of the Ministry of Public Health (MSP). 88.5% of the mothers report that they consume micronutrients daily and 80.3% report that they consume micronutrients such as iron plus folic acid. Interestingly, 80.5% and 78.9% of mothers reported that they received micronutrient intake counseling and counseling on risk signs, respectively. Also, 53.1% of the mothers reported that they had a normal delivery. Likewise, when looking at the territorial variables we observe that on average there are 151 inhabitants per square kilometer, the average per capita production (GVA) is $1297 USD and 59.33% live in the urban area. These descriptive statistics reveal important patterns of the individuals considered in this study.

Table 4. Descriptive statistics of the variables used in this study**.**

Variable	Mean-Percent	Min	Max	95% CI
Infant Morbidity				
Low risk of morbidity	76.83%	0	1	76.05-77.66
High risk of morbidity	23.17%	0	1	22.33-23.55
Infant mortality				
Live child	81.43%	0	1	80.05-82,66
Deceased child	18.57%	0	1	17.97-19.12
Prenatal checkups				
Number of prenatal checkups	7.36	0		7.27 -7.45
Sex of newborn				
Woman	48.2%	0	1	47.1-48.9
Man	51.1%	0	1	50.2-52.1
Frequency of micronutrient consumption				
Frequency of micronutrient intake (daily=1)	88.5%	0	1	88-89.3
Frequency of micronutrient consumption (passing a day=2)	7.6%	0	1	7.01-8.41
Frequency of micronutrient consumption (passing two days=3)	4.81%	0	1	3.98-5.10
Frequency of micronutrient consumption (more than two days=4)	0.42%	0	1	0.32-0.51
Micronutrientintake				
Consumed micronutrients micronutrientsmicronutrients (iron=1)	13.2%	0	1	13-13.5
Consumed micronutrients micronutrientsmicronutrients (Folic acid=1)	6.13%	0	1	5.15-6.29
Ingested micronutrients micronutrients (iron plus folic acid=1)	80.3%	0	1	79.2-80.5
Mother'sregion of origin				
Sierra	38.5%	0	1	38-39
Costa	42.7%	0	1	41.21-43.09
Amazon	16.3%	0	1	15.98-17.01
Galapagos		0	1	1.96-2.51
Mother's ethnicity				
Indigenous	7.1%	0	1	6.6-7.28
Afro-Ecuadorian	5.3%	0	1	4.90-5.98
Mongrel	81.03%	0	1	80.22-81.86
White	1.4%	0	1	1.2-1.9
Montubio or Others	4.6%	0	1	4-5.1
Mother'seducationallevel				
None	0.7%	0	1	0.3-1.1
Basic Education	27.3%	0	1	27.1-28.3
Middle/High School Education	43.4%	0	1	43.41-44.12
Higher Education	27.1%	0	1	26.87-27.98
Residential area				
Urban Area	71.3%	0	1	70.3-72.1
Place where prenatal checkups were performed				
Place where prenatal check-ups were performed (HPM health facilities)	70.4%	0	1	69.76-71.92
Did you receive advice on micronutrients?				
Did you receive advice on micronutrients? (yes=1)	80.5%	0		79.87-81.72
Did you receive advice on risk signs?				

Did you receive advice on micronutrients? (yes=1)	78.9%	0		77.3-79.1
Week of the first prenatal checkup				
Weeksfirst control	7.32	1		7.16 -7.48
Type of delivery				
Normal delivery	53.1%	0	1	52.1-53.5
Urban density				
Inhabitants per squarekilometer	151.01	1152.5	321	146.32-160.33
Economic development of the province				
Provincial GVA per capita	1297.65	540.5	321	836.43-1456.67
Area				
Urbana	59.33%	0.54	0	55.51-61.51
Rural	44.49%	0.36	0	41.49-46.49

Table 5 shows the average birth weight of boys and girls. We observe that as the number of controls increases, the average birth weight of boys and girls increases. An interesting pattern stands out here, for example, we see a higher frequency of mothers who performed a greater number of prenatal checkups and here we observe that the average birth weight is also higher. In general, we observe that a greater number of prenatal checkups is associated with a higher birth weight.

Table 5. Average birth weight and number of prenatal check-ups

Number of prenatal checkups	Average birth weight of girls	Average birth weight of infants
0	2297.95	2025.84
1	2076.32	2514.25
2	1927.99	2460.67
3	2133.01	2609.86
4	2124.70	3197.36
5	2049.88	3200.22
6	3069.42	3185.33
7	3128.66	3445.71
8	3145.37	3439.78
9 or more	3124.56	321.55

Next, we performed a formal test to rule out the presence of multicollinearity among our independent variables. In **Table 6** we present a multicollinearity analysis. We use the Variance Inflator Factor (VIF) to perform this test. Previous literature indicates that a VIF greater than 5 can demonstrate that multicollinearity exists in our data. As we can see, no variable has a VIF greater than 5 and therefore we rule out multicollinearity problems in our independent variables. This analysis is important since multicollinearity problems cause instability of the parameters of a regression, incorrect signs and higher standard errors, which translates into statistical insignificance of the parameters.

Table 6. Multicollinearity test of the variables

Variable	VIF	SQRT VIF	Tolerance	R-Squared
Number of prenatal checkups	1.22	2.81	0.9913	0.0032
Sex of newborn	1.33	1.86	0.6125	0.3355
Frequency of micronutrient consumption	1.98	1.65	0.9862	0.0236
Micronutrientintake	1.25	1.33	0.3321	0.1189
Mother'sregion of origin	1.98	1.65	0.9862	0.0236
Mother'sethnicity	1.66	1.23	0.3312	0.1133
Mother'seducationallevel	1.22	1.85	0.6310	0.3690
Residential area	1.12	1.36	0.9126	0.0352
Place where prenatal checkups were performed	1.33	1.68	0.8826	0.2252
Did you receive advice on micronutrients?	1.22	1.85	0.6310	0.3690

Did you receive advice on risk signs?	1.57	1.85	0.6310	0.3690
Week of the first prenatal checkup	1.44	1.75	0.9653	0.0352
Type of delivery	1.63	1.11	0.8865	0.2097
Urban density	1.68	1.09	0.3533	0.1218
Economic development of the province	1.33	1.68	0.8826	0.2252
Urban area	1.05	1.32	0.9538	0.0263
Mean VIF	1.86			

Then, the confusion matrix of the model is shown. **Table 7** shows that the models we estimated are correctly specified. In the first model we use morbidity as the dependent variable, which is 71.22% specified by the independent variables. That is, the independent variables predict child morbidity in 71.22% of the cases. Next, in the second model we use infant mortality as the dependent variable, which is 80.42% specified by the independent variables. It is worth mentioning that this percentage is relatively high, being an acceptable level higher than 60%.

Table 7. Confusion matrix of the estimated models

	MorbidityModel		
	True		
Classified	D	~D	Total
	1281	523	4736
	1115		2518
Total	4288	2966	7254
Correctlyclassified			71.22%
	MortalityModel		
	True		
Classified	D	~D	Total
	1198	763	4736
	1102	1344	2518
Total	4288	2966	7254
Correctlyclassified			80.42%

Next, to further explore this proposed relationship, we dichotomized the dependent variable to expand our analysis using a logistic model as shown in **Table 8**. In the table, the dependent variable is the dichotomous morbidity risk variable that takes a value of 1 if the newborn is at high risk of morbidity and takes a value of 0 if the newborn is at low risk of mortality. Here we observe that, as expected, the odd ratio (OR) is positive (greater than 1) and significant, showing us that an increase of one additional prenatal checkup reduces the risk of high infant morbidity by 2 times (CI= 1.981-2.055) compared to those women who did not have any prenatal checkup. Other factors are negative odds ratios are the mother's education, which increase as the mother's level of schooling increases, with a mother with higher education (OR= -2.783, CI= -2.83--2.832) being the category with the highest magnitude. Another factor with a negative odds ratio is micronutrient intake, which has an OR= -2.45 (CI= -1.023--2.154).

Table 8. Logistic regression analysis between the number of prenatal controls and morbidity.

	OR	P-value	95% CI
Var. dep.: High risk of morbidity =1, 0 otherwise			
Number of times of prenatal checkups			
Prenatal checkups	-2.005^{***}	0.004	1.981-2.055
Sex of childborn			
Woman	Ref.		
Man	1.522^{***}	0.001	1.162-1.678
Mother'sregion of origin			
Sierra	Ref.		
Costa	1.083	0.590	1.010-1.369
Amazon	1.511^{**}	0.049	1.002-1.824
Galapagos	2.402	0.152	2.322-2.575
Mother's ethnicity			
Indigenous	Ref.		

Afro-Ecuadorian	1.035	0.932	1.003-1.056
Mongrel	0.933	0.806	0.626-2.086
White	0.903	0.864	0.276-1.071
Montubio or Others	0.818	0.620	0.692-0.991
Mother'seducationallevel			
None	Ref.		
Basic Education	2.262	0.125	2.221-2.860
Middle/High School Education	-2.337	0.109	2.191-2.889
Higher Education	-2.783*	0.060	-2.042--2.889
Residential area			
Rural	Ref.		
Urban	-1.078	0.635	-1.035--1.086
Place where prenatal checkups are performed			
Other establishment	Ref.		
HPM health facilities	0.822	0.235	0.521-1.128
Consumedmicronutrientsduringpregnancy			
iron?	Ref.		
Folic acid	-1.496	0.188	1.197-1.903
iron plus FolicAcid?	-2.099**	0.023	1.055-2.155
Frequency of micronutrientintake			
daily	Ref.		
spending a day	0.652*	0.050	0.058-1.001
spending two days	-0.693	0.799	0.593-1.770
More than two days	-0.976	0.981	0.083-2.034
Did you receive advice on micronutrients?			
No	Ref.		
Yes	-1.099	0.634	1.0093-1.482
Did you receive advice about alarming signs?			
No	Ref.		
Yes	-1.715*	0.092	1.027-1.955
Week of the first prenatal checkup			
Weeksfirst control	-0.985	0.246	0.040-1.010
Type of delivery			
Cesaria	Ref.		
normal (vaginal)	-1.233	0.125	1.058-1.478
Urban density			
Inhabitants per squarekilometer	-1.654**	0.023	1.570-7.242
Economic development of the province			
Provincial GVA per capita	-1.092**		1.017-2.097
Constant	5.790***	0.007	5.472-5.940
Observations	12489		
AIC	1848.35		
BIC	2011.41		
Chi^2	152.4		
Chi^2 *p-value*	0.000		
Log-likehood	-898.174		

Notes: Asterisks mean: *p <0.10,**p < 0.05, ***p < 0.01.

Next, to explore the relationship between prenatal controls and infant mortality, we used a logistic model as shown in **Table 9**. In the table, the dependent variable is the dichotomous variable of live-born child that takes a value of 0 if the newborn is still alive and takes a value of 1 if the newborn died. Here we observe that, as expected, the odd ratio (OR) is positive (greater than 1) and significant, showing us that an increase of one additional prenatal checkup reduces the probability of a stillborn child by 2 times (CI= 1.989-2.026) compared to those women who did not have any prenatal checkup. Other factors are negative odds ratios are the mother's education, which increase as the mother's level of schooling increases, with a mother with higher education (OR= -2.783, CI= -2.042--2.889) being the category with the highest magnitude. Another factor with a negative odds ratio is micronutrient intake, which has an OR= -2.099 (CI= -1.055--2.155). These results are very similar to those shown in **Table 8**, so we conclude that prenatal controls increase the probability of having a lower level of infant morbidity and a higher probability of having a live birth.

Table 9. Logistic regression analysis between the number of prenatal controls and mortality.

	OR	P-value	95% CI
Var. dep.: Stillborn=1, 0 otherwise			
Number of times of prenatal checkups			
Prenatal checkups	-2.81***	0.000	-1.989 - -2.962
Sex of childborn			
Woman	Ref.		
Man	1.511***	0.000	1.162-1.678
Mother'sregion of origin			
Sierra	Ref.		

Costa	1.021	0.76	1.010-1.369
Amazon	1.511*	0.049	1.002-1.824
Galapagos	2.134	0.152	2.322-2.575
Mother's ethnicity			
Indigenous	Ref.		
Afro-Ecuadorian	1.035	0.932	1.003-1.056
Mongrel	0.933	0.806	0.626-2.086
White	0.903	0.864	0.276-1.071
Montubio or Others	0.818	0.620	0.692-0.991
Mother'seducationallevel			
None	Ref.		
Basic Education	2.262	0.125	2.221-2.860
Middle/High School Education	-2.337	0.109	-2.191--2.889
Higher Education	-2.783*	0.060	-2.042--2.889
Residential area			
Rural	Ref.		
Urban	-1.078	0.635	-1.035--1.086
Place where prenatal checkups are performed			
Other establishment	Ref.		
HPM health facilities	0.822	0.235	0.521-1.128
Consumedmicronutrientsduringpregnancy			
iron?	Ref.		
Folic acid	-1.496	0.188	-1.197--1.903
iron plus FolicAcid?	-2.099**	0.023	-1.055--2.155
Frequency of micronutrientintake			
daily	Ref.		
spending a day	0.512*	0.050	0.058-1.001
spending two days	-0.693	0.799	-0.593--1.770
More than two days	-0.976	0.981	-0.083--2.034
Did you receive advice on micronutrients?			
No	Ref.		
Yes	-1.099	0.634	-1.0093--1.482
Did you receive advice about alarming signs?			
No	Ref.		
Yes	-1.715*	0.092	-1.027--1.955
Week of the first prenatal checkup			
Weeksfirst control	-0.985	0.246	-0.040--1.010
Type of delivery			
Cesaria	Ref.		
normal (vaginal)	-1.233	0.125	-1.058--1.478
Urban density			
Inhabitants per squarekilometer	-1.654**	0.023	-1.570--7.242
Economic development of the province			
Provincial GVA per capita	-1.092**		-1.017--2.097
Constant	5.790***	0.007	5.472-5.940
Observations	12489		
AIC	1848.35		
BIC	2011.41		
Chi^2	152.4		
Chi^2 *p-value*	0.000		
Log-likehood	-898.174		

Notes: Asterisks mean: *p < 0.10, **p < 0.05, ***p < 0.01.

After estimating the logit model, we can estimate the marginal impacts (MI) of the independent variable on the probability of low morbidity and mortality. **Figure 1** shows that as prenatal controls increase, there is a lower probability of infant morbidity and mortality. Specifically, we observe that with each additional prenatal checkup the health and life of the newborn is better.

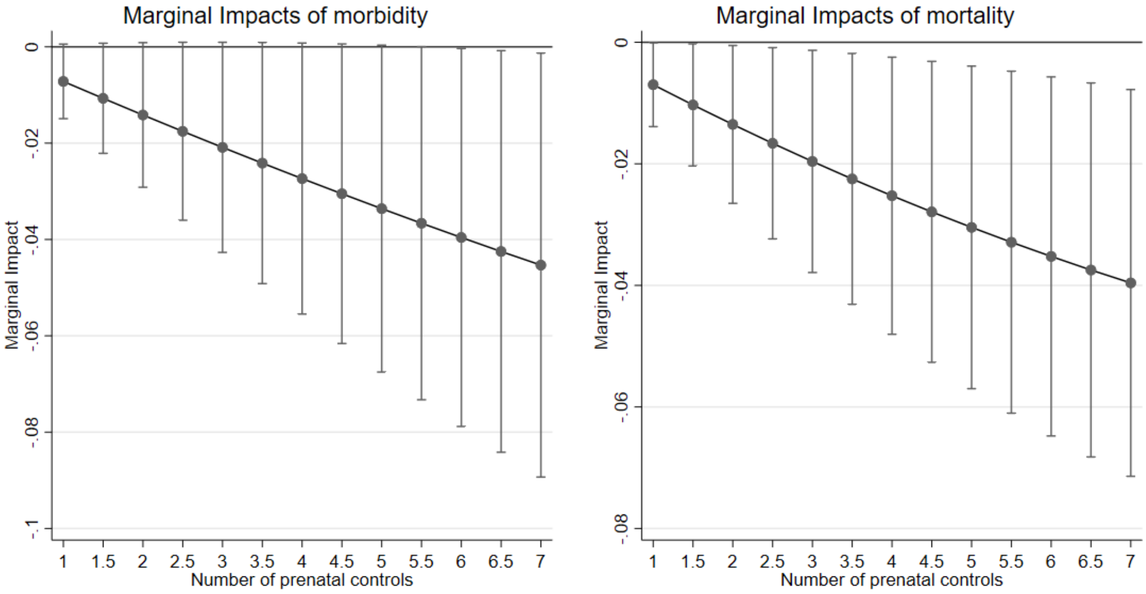

Figure 1. Marginal impacts of prenatal care on infant morbidity and mortality and their respective 95% confidence intervals.

IV. Discussion

Currently, medical research is mainly aimed at reducing maternal and infant mortality and morbidity through access to quality obstetric and perinatal medical care. In the present study, a positive association was found between having a greater number of prenatal check-ups, the mother having a higher level of education, consuming iron and folic acid more frequently and with a daily frequency with a considerable reduction in neonatal morbidity and mortality. We conclude that prenatal consultations are an essential means of bringing health professionals closer to mothers, and with adequately trained health personnel, preventive activities during pregnancy can be promoted and healthy diets can be encouraged.[16]. Our results show that 70.4% of the mothers reported that they had prenatal check-ups in the health facilities of the Ministry of Public Health (MOH). 88.5% of the mothers report that they consume micronutrients daily and 80.3% report that they consume micronutrients such as iron plus folic acid. Interestingly, 80.5% and 78.9% of mothers reported that they received micronutrient intake counseling and counseling on risk signs, respectively. Also, 53.1% of the mothers reported that they had a normal delivery. Thus, territorial variables show that there are 151 inhabitants per square kilometer, the average per capita production (GVA) is $1297 USD and 59.33% live in the urban area. These descriptive statistics reveal important patterns of the individuals considered in this study.

Rivera et al., that some factors that have been described in the literature in relation to inadequate use of prenatal care are age, schooling and distance from home. In this study, there were no significant differences in the access of adolescents, neither in their schooling nor in the distance they had to travel from their home to the health center, probably because more than 70% of the respondents were between 15 and 29 years of age and lived near the health services.[17]These results coincide with our research, in which prenatal checkups are more consecutive for factors such as the mother's education, which increase as the mother's level of schooling increases, with a mother with higher education (OR= 2.783, CI= 2.042-2.889) being the category with the greatest magnitude. Another factor with a positive odds ratio is micronutrient intake, which has an OR= 2.099 (CI= 1.055-2.155).

In our results we can observe that a greater number of prenatal controls is associated with a higher birth weight, results that agree with another study in our same line of research, where they were able to identify that the implementation of health services in the United States led to a reduction in the number of birth weights less than 2500 g and prematurity.[18]. Similar results were found by Alfaro et al., where they emphasize the timeliness and effectiveness of prenatal care and point out the impact on complications such as type of delivery and low birth weight.[19]. Another interesting result we were able to find is that we observed that, as expected, the odd ratio (OR) is positive (greater than 1) and significant, which shows that an increase of an additional prenatal check-up increases by 2 times a lower risk of infant morbidity (CI= 1.981-2.055) compared to those women who did not have any prenatal check-up. The importance of prematurity and low birth weight stems from the fact that they are responsible for 85% of perinatal morbidity and mortality.[20].

Regarding infant mortality, it was observed that, as expected, the odd ratio (OR) is positive (greater than 1) and significant, which shows that an additional prenatal check-up increases the probability of a live birth by 2 times (CI= 1.989-2.026) compared to those women who did not have any prenatal check-up.026) compared to those women who did not undergo any prenatal care. Similarly, a Colombian study showed that complications such as preterm delivery (13.8%), abortion (22.8%), maternal deaths generally due to infections and hemorrhage, as well as approximately 75% of neonatal deaths, can be avoided with timely gestational care.[21]. The decrease in perinatal mortality observed in the present study, which confirms the results of previous research in which there was evidence of a decrease in the number of perinatal deaths whose number was reduced from an initial rate of 24.3 per thousand births to 13.0, with statistically significant linear correlation coefficients, in a health institution in Colombia, thus demonstrating the effect of a reduction in the number of perinatal deaths.[22]Therefore, the effect of better prenatal care, better identification of risk factors and better detection of pregnancy pathology drastically reduces the risk of morbidity and mortality in the mother-child binomial.

We consider that having a greater number of prenatal check-ups, the mother having a higher educational level, consuming iron plus folic acid and with a daily frequency, in addition to receiving advice on how to consume it and counseling on risk signs during pregnancy, are predictors of normal birth weight and should be part, together, of the training, prevention and follow-up processes for pregnant women; these four factors, which in the proposed model adequately predict the event, their probabilities are predictive as well. Therefore, the factors that can be managed by the health system would be those corresponding to: prenatal controls, they should have clear objectives in each control, especially in pregnant women with low birth weight; iron and folic acid consumption and adequate counseling, because this event is a function of the gestation planning of hospitals (or health centers) and also the factor of counseling on warning signs would be associated in the same sense.

V. Conclusión

Prenatal care is the international strategy that seeks to provide adequate care to pregnant women and thereby reduce morbidity and mortality of mothers and children. However, although prenatal care for pregnant women is a priority in all health plans and programs worldwide, not all women have access to this service or simply do not attend: and those who do, show dissatisfaction with the service. Thus, we can conclude that quality prenatal care leads to improved perinatal outcomes. Therefore, the number of prenatal check-ups influences obstetric gestational outcomes, showing that an increase of one additional prenatal check-up reduces the risk of high infant morbidity by 2 times (CI= 1.981-2.055) compared to those women who did not have any prenatal check-up. Likewise, we found that an increase of one additional prenatal checkup reduces by 2 times the probability of a stillborn child (CI= 1.989-2.026) compared to those women who did not have any prenatal checkup. Other factors are negative odds ratios are the mother's education, which increase as the mother's level of schooling increases, with a mother with higher education (OR= -2.783, CI= -2.042--2.889) being the category with the highest magnitude. Another factor with a negative odds ratio is micronutrient intake, which has an OR= -2.099 (CI= -1.055--2.155). This is why it should exceed the 5 controls established as a minimum by current regulations. Since the lack of attendance is influenced by many factors, with personal factors standing out as the main reason, it is necessary to address both physiological and psychosocial aspects during prenatal care, which favor the early detection of alterations and prevention of complications in the mother and the product.

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