Individual and local level factors and antenatal care use in Colombia: a multilevel analysis

Factores a nivel individual y comunitario y el uso de controles prenatales en Colombia: un análisis multinivel

Fatores individuais e em nível comunitário do uso de cuidados pré-natais na Colômbia: uma análise multinível

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Abstract

This paper examined the association between individual and local level factors and the number of antenatal care visits completed by women in Colombia using data from the 2010 Colombian Demographic and Health Survey *and multilevel logistic regression models. Our findings suggest that, in addition to maternal socioeconomic status, contextual factors influence whether pregnant women complete the minimum recommended number of antenatal care visits. These factors include: level of women's autonomy in the community, regional inequalities and access barriers caused by distance (OR = 0.057), costs of services (OR = 0.035), and/or a lack of confidence in doctors (OR = 0.036). Our results highlight the existence of inequalities in access to antenatal care and the importance of considering the local context in the design of effective maternal care policies in Colombia. Furthermore, our findings regarding individual factors corroborate the evidence from other countries and offer new insights into the association between local level factors and number of antenatal care visits.*

Prenatal Care; Health Services Accessibility; Multilevel Analysis

Resumo

Este trabajo examinó la asociación entre los factores individuales y a nivel de comunidad y el número de visitas prenatales que reciben las mujeres en Colombia. Utilizando datos de la Encuesta Nacional de Demografía y Salud 2010 *para Colombia, se estimaron modelos logísticos multinivel. Nuestros resultados sugieren que, además de la situación socioeconómica de las madres, existen importantes factores contextuales que influyen en la asistencia a un número de controles prenatales óptimo, por ejemplo, el nivel de autonomía de la mujer en la comunidad, las desigualdades regionales y las barreras de acceso causadas por la distancia (OR = 0,057), los costos de los servicios (OR = 0,035), y/o la falta de confianza en los médicos (OR = 0,036). Nuestros resultados destacan la existencia de desigualdades en el acceso a un número adecuado de consultas prenatales y la importancia de incluir el contexto de la comunidad en la formulación de políticas más eficaces de atención materna en Colombia.*

Atención Prenatal; Accesibilidad a los Servicios de Salud; Análisis Multinivel

Introduction

According to the World Health Organization (WHO) [1], every day approximately 800 women die from preventable causes related to pregnancy and childbirth. Around 99% of all maternal deaths occur in developing countries, where socially and economically disadvantaged communities are most affected.

During recent years, the debate about maternal health has highlighted that one of the key factors in reducing maternal and perinatal mortality is access to and utilization of antenatal care services [2]. These services enable early identification of risk and complications that can arise during pregnancy or childbirth, ensure access to educational programs, vaccines, diagnostic tests and treatment of infectious diseases [3], and promote the establishment of a good relationship between pregnant women and health care providers [4]. Moreover, antenatal care visits provide advice and support to pregnant woman and their families regarding healthy behaviors, increase awareness of maternal and newborn health needs and self-care during pregnancy and the postnatal period [5], and lead to an increase in the utilization of emergency care [6,7].

Determinants of antenatal care use

The uptake of antenatal care services is determined by individual factors, such as sociodemographic characteristics, and contextual factors, such as provision of and access to health care services. With regard to individual factors, it has been shown in some countries that women with a higher level of education are more likely to use antenatal care services [8,9,10], while in other countries use of antenatal care is not associated with maternal education [4].

With regard to demographic characteristics, an association has been observed between low level of antenatal care use and a large number of children, higher order pregnancies [11,12] and being a single mother [13]. With respect to the association between women's age and the uptake of antenatal care, studies have revealed greater use of antenatal care among older mothers [14]. An association has also been observed between women's autonomy and use of maternal care services: studies in India [15], Nepal [9] and Kenya [16] showed that women with little autonomy were less likely to use these services.

At the household-level, the use of maternal care services is associated with socioeconomic status [8,17,18] and it has been shown that women from poor households struggle to cover the costs related to health care use [4].

Studies thus far have emphasized the effects of individual and household characteristics on the use of antenatal care in developing countries. However, a large body of literature on health and place [19,20] suggests that context can influence individual health outcomes. Communities, understood as specific localities where individuals reside and where social networks are established, have emerged as important local contexts since they share physical and socioeconomic characteristics that potentially affect an individual's health and help explain the impact of social inequalities on health [19].

Local level contextual factors, such as distance from or time required to reach the nearest health services, maternal education level, and neighborhood poverty, have proved to be important determinants of antenatal care use. With regard to maternal education level, studies have shown that women who have completed secondary education are more likely to use antenatal care and childbirth services [14,21]. Other studies have shown a strong negative association between antenatal care use and neighborhood poverty [22] and distance from antenatal care services [23].

The Colombian context

Although Colombia is an upper middle income country (gross per capita income of US$ 8,315 based on a constant 2005 purchasing power parity), it has one of the most unequal income distributions in the world (Gini index, 58.5) [24]. Approximately 34% of the country's population live in conditions of poverty and 11% in extreme poverty [25].

In recent years, Colombia has made important progress in maternal and infant health. However, regional inequalities continue to be the country's principal challenge. In 2010 the WHO [26] estimated that Colombia had the fourth highest rate of maternal mortality (92 deaths per 100,000 live births) in South America. According to the National Planning Department (DNP) [27], Colombia is unlikely to meet the Millennium Development Goal (MDG) of reducing the maternal mortality rate to 45 deaths per 100,000 live births, by 2015.

The Colombian health care system has two regimes: (i) the contributory regime which covers those who can afford to pay, and (ii) the subsidized regime, for those with low income as defined by the Beneficiary Identification System

(SISBEN, acronym in Spanish). Antenatal care in Columbia is provided by the government and is free to all mothers, irrespective of health insurance status [28] (*Resolution n. 3,384* of 2000).

The Colombian Government has established that the focus of actions to reduce maternal mortality should be the improvement of health care access and the quality of health programs, especially those directed at antenatal care. Furthermore, the government's goal is to ensure that 90% of pregnant women are completing a minimum of four antenatal care visits by 2015 as per the MDG. Although government interventions aim to address inequalities in access to programs, little is known about the effectiveness and coverage of public health programs in Colombia at the local level.

Against this background, this study aims to examine the association between individual factors and local level contextual factors and the number of antenatal care visits completed by pregnant women in Colombia.

Conceptual framework

In this paper we focus on a conceptual framework developed by Aday & Andersen [29] and Andersen [30] to explain the use of health care services. It takes into account individual and local level factors and characteristics of the health care system, both of which have an impact on health care accessibility, availability and acceptability. In this model access to health services occurs within the framework of sanitary policy, based on health system characteristics and the population at risk. Predisposing factors are age, sex, race and beliefs, while facilitating factors are resources, insurance coverage, place of residence and necessity, which promote the use of services (i.e. type, style, purpose and time interval), and consumer satisfaction in the form of individual outcomes.

Data and methods

Data

The data used in the analyses was drawn from the *2010 Colombian Demographic and Health Survey* (DHS). This survey has been conducted in Colombia every five years since 1990 by Profamilia, a private nonprofit organization and the main provider of sexual and reproductive health services in the country. The survey has national coverage and is representative of both urban and rural settings, divided into departments (first administrative subdivisions), regions and subregions.

The DHS sample was selected using stratified multistage cluster sampling and included 51,447 households located in urban and rural areas of 258 municipalities. Within each municipality, an average of 10 households in geographic proximity were grouped to form clusters which represent the local level where the respondents live. Questions were asked about antenatal, childbirth and postpartum care related to the last birth. The sample of eligible individuals consisted of 14,296 women. For all variables, the values "don't know" or "missing" were excluded from the study, giving a final sample of 12,373 women of childbearing age (14 to49 years) residing in 3,672 communities, who had delivered a child in the five years prior to the survey and who had received antenatal care for the most recent birth.

Variables

- **Dependent variable**

We analyzed whether the mother completed a minimum of four antenatal visits as recommended by the WHO [31].

- **Explanatory variables**

A set of maternal characteristics and variables relating to the mother's partner, household and community were included as predictors of completing a minimum of four antenatal visits.

Maternal characteristics included: (i) age (in years); (ii) occupation (farming, unskilled labor, clerical/sales/services/skilled labor, professional/technical/manager); (iii) living with partner or not; (iv) type of participation in the health care system (does not participate, participates in the subsidized regime, and participates in the contributory regime); (v) birth order and interval, combined in just one variable with five categories by merging "birth order" and "preceding birth interval" (first birth, second to third birth order with a less than two year birth interval, second to third birth order with a more than two year birth interval, fourth or more birth order with a less than two year birth interval, and fourth or more birth order with a more than two year birth interval; (vi) a composite index of mother's autonomy, categorized in tertiles (low, intermediate, high). The DHS has no direct measures of autonomy. In line with previous studies [16,32], we used a set of questions as proxies to measure a mother's decision-making power within a household, related to decisions about her own health, household purchases, visits to relatives, use of partner's earnings, cooking, studies and sexual intercourse; and (vii) maternal and paternal

education level (no schooling, primary, secondary and higher education).

Household socioeconomic characteristics included: (i) number of children under the age of five, and (ii) a composite index of household socioeconomic status. Household wealth indices are proxy measures of household socioeconomic status widely used in developing countries which are claimed to be reliable and easier to observe than direct measures of household socioeconomic status, such as income or consumption expenditure, which can be expensive to collect, are often not available and sometimes unreliable [33]. Household wealth is measured using a composite index developed by Filmer & Pritchett [33] which includes a set of durable consumer goods, housing characteristics and access to basic services.

We constructed a similar socioeconomic status index based on ownership of consumer durable goods (radio, TV, fridge, motorcycle and car/truck) and dwelling characteristics (source of drinking water, type of toilet facility, floor and wall material, and electricity). The index is categorized in quintiles (very poor, poor, middle class, rich and very rich).

The household socioeconomic status index and mother's autonomy index were measured using principal components analysis (PCA) with polychoric correlations [34] to take into account the discrete nature of the data and obtain a more accurate estimate of the proportion of explained variance. The indices were rescaled to a range of 0 to 1, where 1 indicates the maximum level of wealth and autonomy.

In order to test the reliability and internal validity of the indicators, associations were compared with other health outcomes, such as stunted growth and underweight. The reliability and internal validity of indicators can also be measured using eigenvalues. A widely used criterion for selecting the number of retained principal components is that proposed by Kaiser [35], which suggests retaining components with an eigenvalue of over 1.0. Given the magnitude of the eigenvalues, the first component was selected in each case. With respect to the composite indicator mother's autonomy, the first component explains 50.96% of the variance with an eigenvalue of 3.56, while for the socioeconomic status index, variance and eigenvalues were 52.3% and 5.23, respectively.

Given the importance of the local context in this study, we evaluated specific local level variables which were constructed as averages or proportions by aggregating individual information and using information gathered from all mothers included in the full sample (53,521 women). In order to avoid an overlap of the measures between the two levels studied (individual and local level), the values of local level variables were derived using the non-self means or proportions method which assigns a value to each subject that represents the average of all other subjects in the community and therefore does not include the subject's own value.

To evaluate the socioeconomic characteristics of the community, we included the average level of women's education and autonomy in the community (categorized as low, intermediate or high). Whether mothers resided in an urban or rural area and the region of residence (Atlantic, Central, Eastern, Pacific, Amazon and Orinoco, and Bogotá) were factors also considered by the analysis.

Finally, to measure the effect of possible barriers to accessing antenatal services, we included the proportion of women in the community who stated that they had not accessed maternal and infant health services due to geographic barriers (the service is too far away), economic barriers (health service costs are very high), the quality of services (they consider the service to be of poor quality), and cultural barriers (they do not trust the doctors).

Some factors such as education and autonomy are measured at both the individual and local level in order to identify possible positive externalities related to the use of antenatal services associated with the level of education and autonomy of other women in the community. For instance, mothers with a lower level of education may be positively influenced by other women with a higher level of education which may lead to the adoption of healthier diets, improve understanding of relevant information about disease and stimulate women to take training in health practices and seek access to health services [36].

Statistical analysis: multilevel models

The role of the local context plays in determining whether a woman completes a minimum of four antenatal visits was examined using multilevel models. Given the hierarchical structure of the DHS and the dichotomous nature of the variable of interest, it was proposed to estimate multilevel logistic regressions at two levels with mothers nested in the communities. These models also allow us explore variations between and within the clusters [37] since when estimating variance in each level it is possible to differentiate between the amount of variation due to individual characteristics and the amount attributed local level variables.

The relationship between variances can be expressed using the variance partition coefficient

(VPC), which measures the proportion of total variance that is attributed to between-group differences. The VPC ranges from 0 to 1, where 0 indicates that there are no between-group differences and 1 indicates there are no within-group differences.

Three sequential models including random intercept were tested: (i) Model 0 (null model) – does not include explanatory variables and observes the effects of the local level variables on the propensity to use antenatal care visits; (ii) Model 1 – controls for maternal characteristics and variables related to her partner and household; and (iii) Model 2, in which the local level variables are added.

Finally, it should be noted that the multilevel models presented here are not weighted by sample size. Like the majority of health surveys, the sampling design of the Colombia survey incorporates a weighting factor in order to reduce estimation bias resulting from the different selection probabilities. Although many authors argue that sampling weights should be included in the context of the multilevel models, this is not a simple task and adequate methods for doing this are yet to be developed [38,39]. To minimize this bias in the estimates, some authors have suggested controlling for variables relevant to the sampling design [38]. Therefore, our analysis included the place of residence (urban-rural) and region as explanatory variables.

Analysis was carried out using Stata 12 (Stata Corp., College Station, USA). All descriptive statistics were created using the command svy, and the multilevel models were fitted using the command xtmelogit. The variables included in the models were selected based on a bivariate analysis (p-value, 0.05).

Results

Descriptive statistics

Figure 1 shows the proportion of women who attended four or more antenatal care visits by department and region. The maps show the significant degree of heterogeneity among departments and regions: on average 90% of women in Colombia reported completing at least four antenatal care visits, while in the departments this percentage ranged from 53 to 96%. Differences were also observed between regions. Women who reported less than the minimum number of visits resided in departments located in peripheral regions.

Table 1 presents the distribution of percentages of women who attended at least four antenatal care visits by selected variables. With socioeconomic variables and the use of antenatal care, the descriptive findings showed that an increase in the proportion of mothers who completed at least four antenatal care visits was associated with increasing maternal educational level and autonomy, increasing educational level of partners and increasing socioeconomic status.

With respect to the local level variables, women who lived in communities where women on the whole have higher levels of education and autonomy were more likely to complete more than four antenatal care visits.

Table 2 shows that women who completed less than three antenatal care visits lived in communities with greater barriers to accessing maternal and child health services.

Multilevel logistic regression models

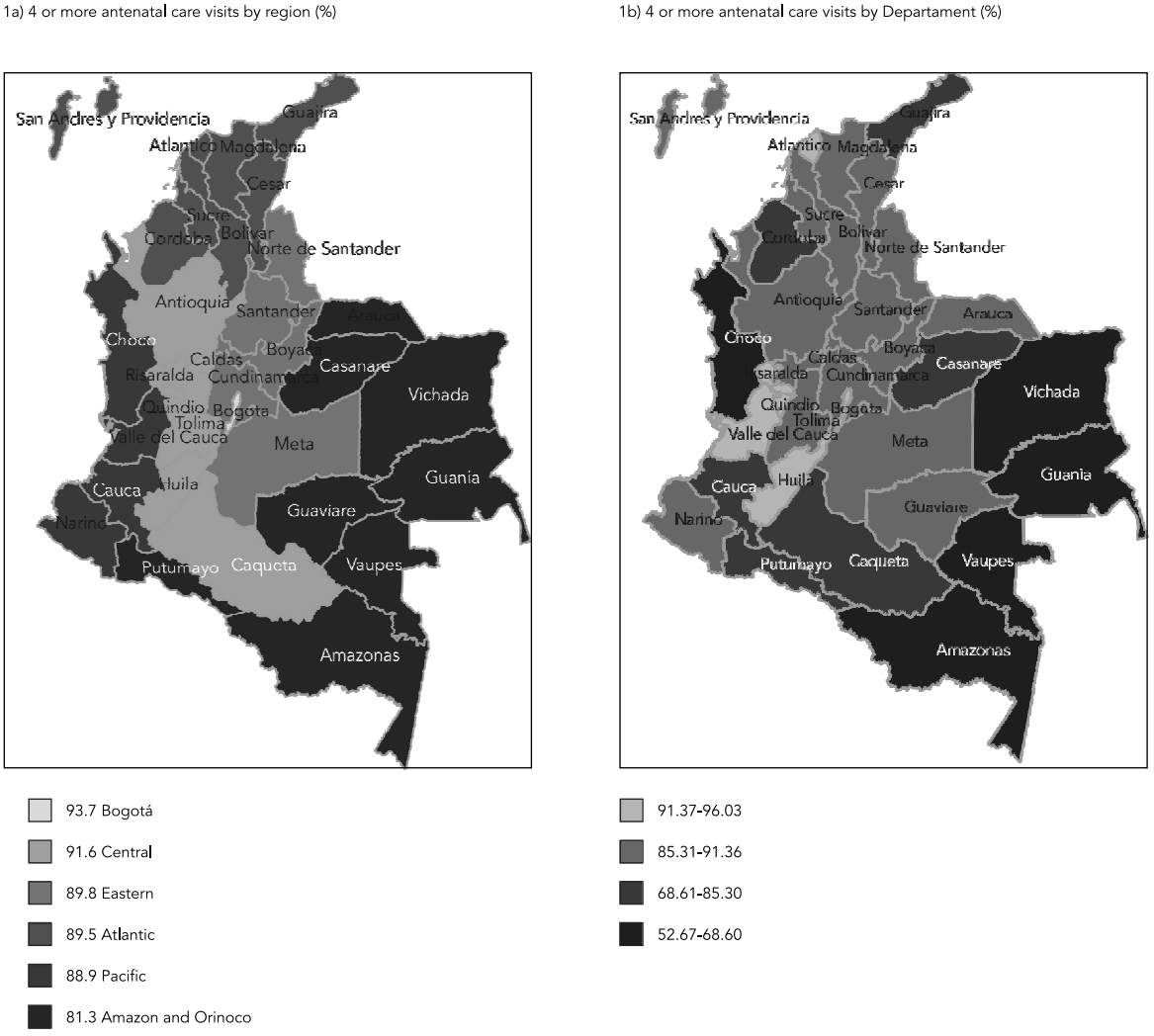
Table 3 shows the variances for each of the random effects models. The null model shows that 34.7% of the variance in the probability of completing four antenatal care visits is due to differences between communities and thus may be explained by local level variables context. When the individual and household characteristics (Model 1) were included, variance decreased by more than half (17.1%). When the local level variables were included (Model 2), variance decreased to 7.2%.

Table 4 shows the results of the multilevel logistic models for a minimum of four antenatal care visits. Model 1 shows the effect of individual and household factors on the propensity to complete four or more antenatal care visits. The results show that older women with a higher level of education and autonomy, participating in the health system, with partners with a higher level of education, and living in households with higher socioeconomic status are more likely to complete at least four antenatal care visits. In contrast, the likelihood of completing the minimum number of antenatal care visits decreases with an increasing number of children under five years in the household. Similarly, mothers with more than one child are less likely to complete the minimum number of visits than those with only one child. Women dedicated to farming activities or unskilled labor are less likely to complete at least four antenatal care visits than women who do not work.

The local level variables are included in Model 2. The findings indicate that the likelihood of completing the minimum number of visits increases with increasing average levels of autonomy. Women living in communities where a greater proportion of women reported not

Figure 1

Proportion of women completing four or more antenatal care visits by state and region. *2010 Colombian Demographic and Health Survey* (N = 12,373) *.



* Compiled by authors.

having access to maternal and infant health care because the services are too far away, costs are very high, or they do not trust the doctors are least likely to complete the minimum number of visits.

After including the local level variables, the effect of the individual and household variables, except for mother's occupation, remained significant. Moreover, when controlled for the local level variables, the odds ratio (OR) for the household socioeconomic status decreased significantly.

Finally, no statistically significant association was found between completing the minimum number of visits and the local level variables place of residence, community maternal education and the proportion of women in the community who reported not accessing antenatal care visits because of poor quality services.

Discussion

This study differs from others carried out in Colombia [12,40] to date, due to its hierarchical data structure and use of multilevel modeling to analyze the relative contribution of individual and

Table 1

Percentage distribution of women completing four or more antenatal care visits, according to selected characteristics. *2010 Colombian Demographic and Health Survey* (N = 12,373).

Variable	4 or more antenatal care visits (%)
Mother's educational level	
No education	62.0
Primary	81.9
Secondary	92.2
Higher	97.0
Mother's occupation	
Not working	85.2
Agricultural, unskilled manual	81.6
Clerical, sales, services, skilled manual	91.3
Professional, technical, manager	97.9
Mother's participation in health system	
Does not participate	85.1
Participates in the subsidized regime	87.3
Participates in the contributory regime	95.4
Mother's level of autonomy	
Low	84.8
Intermediate	91.5
High	92.9
Child's birth order and preceding birth interval	
First birth	93.6
2nd-3rd and < 2 years	79.8
2nd-3rd and > 2 years	92.1
4th + and < 2 years	70.8
4th + and > 2 years	80.4
Mother's cohabitating with partner	
No	88.0
Yes	90.9
Partner's educational level	
No education	73.2
Primary	85.5
Secondary	92.3
Higher	97.1
Household socioeconomic status	
Very poor	72.3
Poor	85.6
Middle class	90.2
Rich	94.4
Very rich	96.3
Place of residence	
Rural	83.0
Urban	93.0

contextual factors as predictors of antenatal care. In addition, it explores the role played by factors which reflect the local context, such as level of women's autonomy and cultural barriers to accessing services, which are rarely taken into consideration by other studies. The benefits of this analysis are twofold: first, knowledge of the effects of the local context on antenatal care

Table 2

Percentage of women reporting access barriers to maternal and child health services in the community, by region and number of antenatal care visits. *2010 Colombian Demographic and Health Survey* (N = 12,373).

Barrier to access	Regions						Colombia		
	Pacific	Atlantic	Eastern	Central	Bogotá	Amazon and Orinoco	Mean	0-3 visits	4 or more visits
Service is too far	5.2	3.4	3.1	3.2	0.5	8.1	3.2	9.0	2.6
Service is of poor quality	0.9	0.9	1.2	1.1	0.6	1.7	1.0	1.5	0.9
Service is too expensive	1.1	1.4	0.8	0.7	0.2	0.9	0.9	2.4	0.7
They do not trust doctors	0.9	0.9	0.8	0.7	0.7	1.4	0.8	1.8	0.7

Table 3

Random effect variances.

	Model 0 Null model	Model 1 Individual	Model 2 Local
Variance at local level	1.751 *	0.679 *	0.256 *
Variance partition coefficient (VPC) [%] **	34.7	17.1	7.2
Likelihood ratio test	Reference	1360.43	383.44

* $p < 0.001$;

** Measures the proportion of total variance that is due to differences $\sigma_{\mu}^{2} / \sigma_{\varepsilon}^{2} + \sigma_{\mu}^{2}$.

Table 4

Multilevel logistic regression models for completing four or more antenatal care visits. *2010 Colombian Demographic and Health Survey* (N = 12,373).

	Model 1 Individual		Model 2 Community	
	OR	95%CI	OR	95%CI
Individual factors				
Age (years)	1.057 *	1.04; 1.07	1.053 *	1.04; 1.07
Age (squared)	0.997 *	1.00; 1.00	0.997 *	1.00; 1.00
Mother's educational level [reference = no education]				
Primary	1.612 **	1.20; 2.17	1.547 **	1.15; 2.08
Secondary	2.368 *	1.72; 3.25	2.088 *	1.52; 2.86
Higher	2.833 *	1.84; 4.36	2.428 *	1.58; 3.72
Mother's occupation [reference = not working]				
Agricultural, unskilled manual	0.670 *	0.54; 0.84	0.902	0.72; 1.12
Clerical, sales, services, skilled manual	1.162	0.98; 1.37	1.171	1.00; 1.38
Professional, technical, manager	1.198	0.72; 2.00	1.200	0.72; 2.00
Participation in the health system [reference = no participation]				
Subsidized regime	1.536 *	1.29; 1.83	1.602 *	1.35; 1.91
Contributory regime	1.591 *	1.26; 2.01	1.594 *	1.27; 2.00

(continues)

Table 4 (continued)

	Model 1 Individual		Model 2 Community	
	OR	95%CI	OR	95%CI
Individual factors				
Mother's autonomy level [reference = low]				
Intermediate	1.397 *	1.20; 1.62	1.329 *	1.15; 1.54
High	1.537 *	1.32; 1.79	1.430 *	1.22; 1.67
Child's birth order and preceding birth interval [reference = first-birth]				
2nd-3rd and < 2 years	0.412 *	0.31; 0.55	0.397 *	0.30; 0.52
2nd-3rd and > 2 years	0.588 *	0.48; 0.72	0.605 *	0.50; 0.73
4th + and < 2 years	0.239 *	0.17; 0.34	0.241 *	0.17; 0.34
4th + and > 2 years	0.297 *	0.23; 0.39	0.334 *	0.26; 0.43
Cohabitating with partner [reference = no]				
Yes	1.137	0.97; 1.34	1.235 ***	1.05; 1.45
Partner's educational level [reference = no education]				
Primary	1.212	0.94; 1.57	1.231	0.96; 1.59
Secondary	1.372 ***	1.05; 1.80	1.419 ***	1.09; 1.85
Higher	1.641 ***	1.12; 2.40	1.803 **	1.24; 2.62
Household's number of children under five	0.815 *	0.75; 0.88	0.839 *	0.78; 0.91
Household socioeconomic status [reference = very poor]				
Poor	1.862 *	1.58; 2.20	1.290 **	1.09; 1.53
Middle class	2.855 *	2.35; 3.47	1.759 *	1.44; 2.15
Rich	3.973 *	3.23; 4.88	2.085 *	1.67; 2.60
Very rich	5.043 *	3.59; 7.08	2.570 *	1.81; 3.64
Community-level characteristics				
Mean level of mother's education [reference = low]				
Intermediate			0.946	0.77; 1.16
High			1.125	0.76; 1.67
Mean level of women's autonomy				
Intermediate			1.181 ***	1.01; 1.38
High			1.367 *	1.15; 1.62
Access barrier: service is too far			0.0566 *	0.03; 0.11
Access barrier: service of poor quality			0.331	0.06; 1.68
Access barrier: service too expensive			0.0346 *	0.01; 0.19
Access barrier: does not trust doctors			0.0360 *	0.01; 0.17
Place of residence [reference = rural]				
Urban			0.870	0.74; 1.02
Region [reference = Pacific]				
Atlantic			1.823 **	1.25; 2.66
Eastern			1.210	0.83; 1.76
Central			1.735 **	1.19; 2.53
Bogotá			1.516 ***	1.03; 2.24
Amazon and Orinoco			0.660 ***	0.46; 0.95

OR: odds ratio, 95%CI: 95% of confidence interval.

* p < 0.001;

** p < 0.01;

*** p < 0.05.

use can contribute to the design of more effective policies and help define appropriate levels of intervention; and second, the results of this study may help to identify necessary improvements to health services that contribute to reducing place-based inequalities in health care.

Woman's autonomy appears to be one of the greatest contributing local factors for completing four antenatal care visits. The importance of this factor's role highlights the importance of women's empowerment, not only within the household, but also in the community. This leads to greater decision-making power with respect to maternal health and allows women to be positively influenced by the practices and attitudes of other women in the community. With respect to individual factors, our findings are consistent with those of previous research studies, which revealed that women who decided about their own medical care were more likely to receive professional antenatal care [16,12].

As in other developing countries [4,8], we found regional inequalities in access to antenatal care services. Although Colombia is likely to achieve the MDG regarding antenatal care visits by 2015 [27], regional inequalities still exist, particularly in the Pacific and Amazon and Orinoco Regions. A large part of the population of these regions do not have access to health services, due to low levels of economic development, lack of government presence, hostile and isolated environments, and the large number of ethnic minorities [41,42].

Access barriers due to distance also have a negative impact on the likelihood of completing the minimum number of antenatal care visits. Similar results have been found in Cambodia [11] and Kenya [4], while in Indonesia a quantitative study showed that distance and travel costs are barriers to accessing antenatal services, especially in rural areas [43]. Similar results were also found in rural areas of Mali [18]. Our analysis also revealed other barriers to accessing antenatal services, such as the cost of health services and the lack of confidence in doctors.

Our results are also consistent with findings from other national [40] and international [4,11] studies. We did not find any association between place of residence (urban-rural) and the number of antenatal care visits. It is possible that the effect of place of residence is reflected in other variables such as household socioeconomic status. Authors have found a strong association between household poverty [18] or neighborhood poverty [22] and a lower likelihood of accessing antenatal care in rural areas in Mali and Haiti. In other countries, studies revealed that mothers were less likely to receive visits or complete the minimum number of visits in rural areas [44,45].

Previous studies have shown an association between antenatal care visits and the average level of education in a community [11]. When we controlled for individual and local level variables (Model 2), level of education in a community was not significantly related to outcome. However, we found a positive and statistically significant association between average level of education in a community (unreported results) and access which disappears only when the mother's education level is introduced into the model. These findings suggest that although the average level of education in a community may influence the likelihood of completing four or more antenatal care visits, the most important determinant in Colombia is the mother's level of education

The findings related to individual variables are similar to findings of other international studies and other studies in Colombia [4,11,12,40,46]. Characteristics such as being an older mother, having fewer children and a greater time interval between births, higher level of education, health coverage and greater autonomy were associated with a greater likelihood of completing the minimum number of visits.

An earlier study in Colombia [40] found that there was no association between likelihood of completing at least one antenatal care visit and paternal education level. We found however that mothers with partners with a higher level of education were more likely to complete four or more antenatal care visits. Our findings are consistent with studies carried out in other countries [11,46,47]. Higher levels of education are reflected in greater awareness of and access to adequate practices during pregnancy, strengthens the empowerment of women, and is associated with income level. In addition, partners with a higher level of education may be more efficient in the use of available information on maternal and child care and more persuasive about healthy practices promoting safe motherhood.

Our results also showed that women in unskilled labor or farming occupations were less likely to complete antenatal care visits than those who did not work. However, this association lost statistical significance when we controlled for local level variables. Similar results were found in a study carried out in Nepal when controlling for sociodemographic characteristics [44]. In other studies conducted in Colombia, being employed was not a significant determinant of receiving antenatal care [12].

Our findings also show that poorer and socially and economically disadvantaged women are least likely to complete the minimum number of antenatal care visits, indicating that there is a social gradient in antenatal health care. Other studies show inequalities in access to or use of antenatal care in metropolitan areas of European countries [48] and developing countries [18,46].

This lack of capacity of certain groups of society to access health services has a negative im-

pact, not only on maternal well-being, but also on the economic development of the country, given the harmful effect this situation can have on maternal morbi-mortality and perinatal mortality. Thus, in order to increase the capacities of these groups of vulnerable women, the Government must concentrate on removing some of the key barriers to accessing the health system through improvements in education and reduction in poverty.

Limitations

Given the nature of data collection, this study is not exempt from response bias. We suggest that future studies explore the possibility of including objective local level variables. In addition, the cross-sectional nature of this study does not allow us to establish causal relationships.

Our results highlight the importance of considering the local context in the design of effective maternal care policies. We found significant variance in local level variables even after controlling for individual and local level variables, which suggests that other factors that could determine the likelihood of completing a minimum of four antenatal care visits were not taken into, such as appropriate maternal behaviors and practices and levels of violence and safety in the mother's place of residence.

Although the proportion of women that completed a minimum of four antenatal care visits is an indicator for monitoring progress in maternal health, this study did not take into account other relevant factors associated with the quality of antenatal care and good maternal health, such as timing of visits and care practice during the visits.

Conclusions

Despite the fact that women in Colombia have the right to free access to antenatal care, the findings of this research reveal inequalities in access to care and deficiencies in ensuring the completion of a minimum of four antenatal care visits, highlighting the need to make a concerted effort to improve monitoring of mothers who begin antenatal care in order to guarantee continuity. Furthermore, the existence of access barriers associated with the cost of services is an indication that problems still exist in fulfilling this government commitment.

Women's autonomy, at both the individual and local level, is a key factor for increasing antenatal care use. However, greater empirical research of the Colombian and Latin American context is required to broaden understanding of the positive externalities of women's autonomy at local level and how this can influence maternal health outcomes.

This study provides evidence that inequality in access to antenatal care is still a challenge for many Colombian mothers and sheds light on crucial policy elements to redress this situation: (i) give due consideration to the local context as a determinant of antenatal care and in the design of maternal and infant health policies; (ii) design and implement strategies to improve access to antenatal care among women from the poorest sector of society, who have a lower level of education, who live in underdeveloped regions and who live in communities with significant geographic and cultural barriers (the Pacific and the Amazon and Orinoco Regions); and (iii) invest in programs designed to strengthen women's autonomy and empowerment, taking into account the resulting positive knock-on effects.

Resumo

Este trabalho examinou a associação entre os fatores individuais e de comunidade e o número de consultas pré-natais recebidas por mulheres na Colômbia. Utilizando-se dados da Pesquisa Nacional de Demografia e Saúde 2010 *e foram estimados modelos logísticos multiníveis. Nossos resultados sugerem que, além do nível socioeconômico das mães, há importantes fatores contextuais que exercem influência quanto ao recebimento de um número ideal de exames pré-natal, por exemplo, a autonomia das mulheres, as desigualdades regionais e as barreiras de acesso devido à distância (OR = 0,057), os custos dos serviços (OR = 0,035), e/ou a falta de confiança nos médicos (OR = 0,036). Nossos resultados destacam a existência de desigualdades no acesso a um número adequado de consultas pré-natais e a importância de incluir o contexto da comunidade na elaboração de políticas mais eficazes de cuidados maternos na Colômbia.*

Cuidado Pré-Natal; Acesso aos Serviços de Saúde; Análise Multinível

Contributors

A. M. Osorio participated in data processing, analysis and as lead author in the preparation and elaboration of this manuscript. L. M. Tovar and K. Rathmann contributed to the preparation and elaboration of this manuscript.

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