



Original Research

Factors associated with tetanus vaccination in pregnant women living in Minas Gerais State, Brazil: A cross-sectional study

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ABSTRACT

Background: Immunization in pregnant women is essential to help controlling and avoiding preventable diseases.
Aim: Analyzing some factors associated with non-vaccination against tetanus in pregnant women who gave birth in maternity hospitals in Belo Horizonte City, Minas Gerais State, Brazil.

Methods: Cross-sectional study carried out with database deriving from the research titled “Born in Belo Horizonte: Survey on childbirth”, which was developed in public and private hospitals. Sample was calculated by taking into consideration the total number of births recorded in each investigated maternity hospital - the final sample comprised 481 mothers. Descriptive population statistics were used for data analysis purposes, whereas Poisson regression model was used to estimate factors associated with non-vaccination against tetanus during pregnancy.

Results: The prevalence of puerperal women subjected to at least 2 doses of tetanus vaccine reached 59.2%. Adjusted analyses have shown that not living with a partner has increased by 1.58 times the prevalence of women who did not take tetanus vaccine, on average; that the prevalence of women who were not vaccinated has decreased by 0.65 times after each prenatal consultation, on average; that prenatal consultations with nurses have reduced by 0.52 times the prevalence of women who did not take the tetanus vaccine, on average.

Conclusion: Almost half of puerperal women were not vaccinated against tetanus during pregnancy. It is essential identifying specific groups to help implementing and expanding preventive actions, such as immunization for pregnant women. Despite advances in public health policies, authorities still face challenges to expand vaccination coverage in the investigated state, as well as to strengthen the national immunization program to help increasing tetanus vaccination rates among pregnant women.

1. Introduction

Pregnancy is a stage in women’s lives that requires special care to ensure a healthy pregnancy, with proper fetal development and growth (PSARRIS et al., 2019). Mothers’ immunization stands out among these precautions, since the emergence of preventable diseases during

pregnancy can lead to negative neonatal and maternal outcomes [1].

Vaccine application is a promising strategy to prevent some infections, such as neonatal and maternal tetanus (NMT), which is a highly lethal disease that harms the central nervous system and mainly affects populations living in low- and middle-income countries [2]. The inactivated vaccine containing tetanus toxoid provides effective and safe

Abbreviations: NMT, neonatal and maternal tetanus; NDIS, Notifiable Diseases Information System; WHO, World Health Organization; dT, diphtheria and tetanus; DTpa, diphtheria, tetanus and acellular pertussis; CI, confidence intervals; QI, interquartile range.

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protection against the disease; however, despite the advances in its elimination process through immunization programs, it remains a severe public health issue and a social inequality marker [3].

Several countries have already eliminated this disease. Overall, there has been decrease by 85% in neonatal tetanus cases worldwide, in the last 20 years [4]. Data recorded in Brazil have also shown decreased incidence of the disease in the country [5]. According to the Notifiable Diseases Information System (NDIS), 35 neonatal tetanus cases were confirmed in the country from 2007 to 2017; most of them were recorded in Northern and Northeastern Brazil [5]. Data on maternal tetanus are scarce, mainly because it happens after miscarriages, which makes surveillance ever harder [6,7].

Nowadays, most tetanus cases are associated with lack of vaccination in pregnant women [8]. It is estimated that 47 million women worldwide remain unprotected from tetanus [8], and it indicates that despite advances in vaccination coverage, there are still several challenges to be overcome before fully eradicating this disease. In case of lack of vaccine proof, pregnant women should take 3 vaccine doses, by respecting the intervals between doses to enable antibody levels to remain above the protection threshold [9].

Tetanus vaccination coverage in Brazil, from 2010 to 2014, has only accounted for 52.3% of pregnant women – this rate is much lower than the 95% rate recommended by WHO [10] [[11]]. Such a low coverage may have been determined by issues associated with poor Health System efficiency, as well as with limitations in women's access to the vaccine and with individual factors related to women [8,12,13]. There is evidence that higher schooling, larger number of prenatal consultations and older mothers are positive factors for pregnant women's vaccination [14,15]. On the other hand, newborn prematurity and pregnant women's multiparity can be negative predictors of it [16].

The aim of the current study was to analyze potential factors associated with non-vaccination against tetanus among pregnant women who gave birth in maternity hospitals in Belo Horizonte City, Minas Gerais State. Results in the present research will contribute to identify risk groups who require intervention, in addition to help developing health policies focused on improving vaccination coverage rates among pregnant women.

2. Methods

Cross-sectional study carried out with data deriving from the research titled "Born in Belo Horizonte: Survey on delivery and birth", which was developed in public and private maternity hospitals of Belo Horizonte City, Minas Gerais State, Brazil. It was carried out in 2011, based on the same theoretical-methodology adopted for the aforementioned research [17]. Despite the time elapsed since the survey was conducted, its data remain up-to-date if one takes into consideration the context inherent to tetanus vaccination in pregnant women.

2.1. Study sample

The study sample was calculated by taking into consideration the total number of births in each investigated maternity hospital; minimum sample size was defined as 450 mothers per stratum, strata were selected based on hospital type (public, mixed and private), as well as on macro-region -, selection process comprised at least 5 maternity units per stratum, and 90 puerperal women per maternity hospital. Further details on the sampling process can be found in another publication [17].

2.2. Study population

Postpartum women who gave birth in 11 different maternity hospitals were selected for the current study: 7 of them gave birth in the public health network and 4, in the private health network. Inclusion criteria comprised women hospitalized at delivery time, who presented their Pregnancy Booklet at hospitalization time, regardless of gestational

age and newborn weight, or stillborn weighing more than 500 g and gestational age longer than 22 weeks. Pregnancy Booklets are an important instrument set by the National Obstetric and Neonatal Care Policy; they are used to monitor pregnancy and include vaccine registrations [18]. Postpartum women with severe mental disorders, homeless, foreigners who were not capable of communicating in Portuguese, who presented impaired hearing and speech, and who were convicted by court order were excluded from the study.

After the inclusion and exclusion criteria application was over, the herein investigated population comprised 481 puerperal women. It is noteworthy that sensitivity analysis was carried out to rule out statistically significant differences in schooling, marital status, race or color, number of prenatal consultations, gestational history and risk of miscarriage between total research population and study sample.

2.3. Data collection

Data were collected based on interviews conducted with puerperal women, at least 6 h after delivery, as well as on information about them available in their medical records. Standardized questionnaire comprising patients' identification, sociodemographic and obstetric background variables was applied. During the process, Pregnancy Booklets were photographed to collect information about vaccination: immunobiological drug taken and number of doses. Data collection was performed by nurses who worked in health institutions and by graduate students trained for this purpose. Collection was continuously carried out in each maternity hospital until the planned sample size was achieved.

2.4. Variables

Vaccination status against tetanus was used as dependent variable, i. e., whether, or not, women received adequate (sufficient) immunization in the last pregnancy. According to WHO, the record of two, or more, tetanus vaccine doses is the minimum necessary to ensure protection from the disease in women with unknown or delayed vaccination history [2] – this recommendation was herein used to measure women's vaccination status. It is noteworthy that the vaccination schedule has changed between the data collection period and the present day. Back in 2011, pregnant women without proof of vaccination, or with incomplete schedule, were subjected to three doses of dT vaccine (diphtheria and tetanus), by respecting the recommended interval between applications. On the other hand, pregnant women who completed their vaccination schedule, and took the last dose more than 5 years ago, were subjected to a booster dose of dT vaccine [19]. However, diphtheria, tetanus and acellular pertussis (dTpa) vaccine was introduced in pregnant women's vaccination schedule in 2014, a fact that changed the recommendations. Since then, a dTpa dose is administered to pregnant women after the 27th pregnancy week, regardless of their vaccination history. According to the scheme described above, dTpa could replace the dT dose in cases of pregnant women with incomplete vaccination schedule [20].

The herein investigated independent individual variables comprised patients' age, race or color (the most frequent color or race categories spontaneously declared, based on self-classification, were aggregated), schooling, marital status and paid job status. Variables associated with gestational context comprised history of miscarriage, primiparity, gestational risk (self-report), number of consultations during the last prenatal period, service where she received prenatal care (public or private) and professional category accounting for most prenatal consultations.

2.5. Data analysis

Statistical package *Statistical Software for Professional (Stata)*, version 14.0, was used for data analysis. Population description was performed and estimates were expressed as percentage (%), at 95% Confidence

Interval (95% CI). After quantitative variables' asymmetry was checked through Shapiro-Wilk test, data were expressed as median and interquartile range (IQR). Poisson regression was used to estimate factors associated with non-vaccination against tetanus during pregnancy - gross and adjusted were recorded for variables such as age, schooling, marital status, race or color, paid job, professional accounting for performing most prenatal consultations, primiparity, number of prenatal consultations, history of miscarriage, prenatal consultations' network type (private or public) and pregnancy-risk classification report. It is noteworthy that the error for relative risk can be overestimated when this regression model is applied to binomial data, since Poisson distribution variance progressively increases, whereas binomial distribution variance reaches maximum value when prevalence reaches 0.5. Robust variance estimator was used to fix this problem. It was done to obtain results similar to those observed after Mantel-Haenszel statistics was used, because the covariate of interest was categorical [21]. The backward method was applied to the multivariate regression model, and all variables of interest presenting statistical significance level lower than 20% were included in the bivariate analysis. Theoretical (technical) criteria were also taken into consideration at the time to include variables in the model, since socio-demographic aspects, as well as obstetric history, may be associated with non-vaccination against tetanus in pregnant women [22,23]. Hosmer & Lemeshow test was used to check the fit of the final model. Gross and adjusted prevalence ratios were presented, and 95% confidence intervals (95% CI) were calculated at significance level of 0.05, in all analytical procedures.

2.6. Ethical considerations

The study referring to "Vaccination of pregnant women: assessment of epidemiological and clinical aspects in the city of Belo Horizonte" was approved by the Ethics Committee of Federal University of Minas Gerais, under CAAE protocol n, 53843716.0.0000.5149.

3. Results

In total, 59.2% (95% CI: 54.78–63.57) of the 481 investigated women received at least two tetanus vaccine doses. Table 1 shows the demographic, socioeconomic and obstetric features of the sample. Patients' median age was 27 years (IQR: 22–32). Most puerperal women were married, of non-white race or color, had paid jobs at the time and attended high school. With respect to obstetric features, most women were not primiparous, had no history of miscarriage, and presented median number of 8 prenatal consultations, which were mostly performed by doctors in the public network. As for the degree of pregnancy risk, most women were classified as usual risk.

Table 2 shows gross and adjusted analyses applied to factors associated with non-vaccination against tetanus in pregnant women. Gross analyses have shown association between the number of prenatal visits and history of miscarriage ($p < 0.05$).

Based on the adjusted analyses, after the other variables were adjusted, it was possible observing that being single, widowed or divorced has increased by 1.58 times the prevalence of women who did not take the tetanus vaccine in comparison to that of married women ($p = 0.028$), on average. Having most prenatal consultations with nurses reduced by 0.52 times the prevalence of women who did not take the tetanus vaccine ($p = 0.039$), on average. Finally, the mean prevalence of women who did not take the tetanus vaccine has decreased by 0.65 times after each prenatal consultation ($p = 0.044$).

4. Discussion

The tetanus vaccination rate recorded for pregnant women in the current study was lower than that recommended by WHO (>95% to eradicate or control the disease). Similar results have been reported in other studies. A study conducted in Egypt recorded vaccination rate of

Table 1

Demographic, socioeconomic and obstetric profile of the sample of recent mothers. Belo Horizonte, 2011 (n = 481).

	n (%)	CI95%
Age¹	27 (22–32)	
Marital status		
Married/Stable union	338 (70,27)	66,01–74,20
Single/Widow/Divorced	143 (29,73)	25,79 - 33,98
Race or color²		
White	125 (25,99)	22,25–30,10
Non-white ³	356 (74,01)	69,89 - 77,74
Scholarship		
Up to complete elementary school	164 (34,17)	30,04–38,54
High School	247 (51,46)	42,97 - 55,92
Incomplete higher education or more	69 (14,38)	11,50 - 17,82
Paid employment		
No	232 (48,23)	43,77 - 52,71
Yes	249 (51,77)	17,28–56,22
Obstetric Profile		
N° of prenatal consultations¹ 8 (7–10)		
Primiparous		
Yes	202 (42,08)	37,72 - 46,56
No	278 (57,92)	53,43–62,27
Abortion history		
No	190 (66,20)	60,49–71,47
Yes	97 (33,80)	28,52 - 39,50
Professional who performed most prenatal consultations		
Physician	398 (83,09)	79,44–86,19
Nurse	83 (16,91)	13,80 - 20,55
Type of service where prenatal care was performed		
Public	327 (67,98)	63,66–72,01
Private	154 (32,02)	27,98 - 36,33
High-risk pregnancy		
No	222 (70,70)	65,39–75,49
Yes	92 (29,30)	24,50 - 34,60

Notes: ¹Median (IQ); ²The most frequent categories of color or race declared spontaneously (self-classification) were aggregated. Ethnic-racial characteristics of the population: a study of color or race classification categories 2008. Rio de Janeiro: IBGE, 2011. Available at: <http://www.ibge.gov.br/home/estatistica/populacao/caracteristicas_raciais/PCERP2008.pdf>. Accessed on: July 2021. ³Non-white includes: Indigenous, brown and black; CI95% = Confidence interval of 95%.

52% [12]. Research conducted in the United States has shown vaccination coverage lower than 45% [24].

These data have reinforced the need of identifying barriers capable of hindering patients' adherence to tetanus vaccination and the consequent increase in its coverage [25]. This vaccine plays essential role in preventing maternal disease, mainly in transferring transplacental IgG to the fetus, a fact that helps decreasing the incidence of neonatal tetanus [26].

Although the effectiveness and safety of tetanus vaccines are well established in the literature [1], barriers to satisfactory vaccination coverage remain. Thus, besides individual aspects, maternal immunization programs must take into consideration other aspects, such as training health professionals, guaranteeing women's access to prenatal care and making immunobiological drugs available in health services - in addition to promoting effective vaccination campaigns to strengthen adherence to immunobiologicals [27].

The current study has shown that single pregnant women recorded higher prevalence of non-vaccination against tetanus. This result corroborated some studies that have advocated that women who do not receive support from their partners are lesser likely to be vaccinated [15]. Therefore, the partner's presence can be associated with better women adherence to maternal health care [28], which can provide them with greater security in decision-making processes [29].

The current research has also shown that the prevalence of pregnant women who took the tetanus vaccine has increased after each prenatal consultation. Prenatal consultations are essential to enable educational activities, since they are an opportunity to welcome and provide information about immunobiological drugs [15] to women - this procedure

Table 2
Crude and adjusted analyses of factors associated with non-vaccination against tetanus in pregnant women. Belo Horizonte, 2011 (n:481).

	Crude Analysis		Adjusted Analysis ²	
	PR ¹ (IC95%)	p-value	PR ² (IC95%)	p-value
Age	0,99 (0,980–1014)	0,756		
Scholarship				
Elementary School	1			
High School	1,02 (0,808 - 1302)	0,832		
Higher education	1,00 (0,716–1418)	0,962		
Marital status				
Married/Stable union	1		1	
Single/Widow/ Divorced	1,14 (0, 914 - 1436)	0,237	1,58 (1051–2400)	0,028
Race or color ³				
White	1			
Non-white ⁴	0,99 (0,780 - 1276)	0,989		
Paid work				
No	1			
Yes	1,03 (0,831 - 1280)	0,776		
Professional who performed most prenatal consultations				
Physician	1		1	
Nurse	0,92 (0,683 - 1246)	0,602	0,52 (0,284–0,966)	0,039
Primiparous				
Yes	1			
No	0,87 (0,704 - 1083)	0,218		
Number of prenatal consultations	0,94 (0,903 - 0,986)	0,010	0,92 (0,863–0,998)	0,044
Abortion history				
No	1			
Yes	1,41 (1064–1883)	0,017		
Type of service where prenatal care was performed				
Public	1			
Private	1,07 (0,859 - 1351)	0,515		
High-risk pregnancy				
No	1			
Yes	1,19 (0,907 - 1567)	0,206		

Notes: ¹PR: Prevalence ratio; ²Adjusted, according to p-value or technical criteria, for age, education, abortion history, paid work, primiparity, high-risk pregnancy report and self-reported race or color. 95% CI: 95% confidence interval; ³The most frequent categories of color or race declared spontaneously (self-classification) were aggregated. Ethnic-racial characteristics of the population: a study of color or race classification categories 2008. Rio de Janeiro: IBGE, 2011. Available at: <http://www.ibge.gov.br/home/estatistica/populacao/caracteristicas_raciais/PCERP2008.pdf>. Accessed on: July 2021. ⁴Non-white includes: brown, indigenous and black; p-value <0.05 in bold. Hosmer & Lemeshow test = 0.9945.

can contribute to increase patients' adherence to vaccines.

In addition to pointing out the importance of carrying out prenatal consultations, the current study has observed higher prevalence of tetanus vaccination in pregnant women whose consultations were carried out by nurses. It is well-documented in the literature that pregnant women who had consultations with nurses presented better satisfaction with the guidelines, since these professionals provide a more holistic care by taking into consideration the emotional, cultural and physical aspects of pregnant women, a fact that enables better professional-patient bond to favor adherence to prenatal care [30].

Research conducted in England has shown that nurses receive constant training, which provides them important knowledge about maternal immunization. This training favors the qualification of care

provided to pregnant women and increases nurses confidence in recommending the vaccine to them, in comparison to other health professionals [31]. Study conducted in Australia has emphasized the importance of educating health professionals who perform prenatal care, since it can lead to increased maternal vaccination coverage [32]. In addition, health services should train professionals about the importance of administering immunobiological drugs and about providing proper guidance on the benefits of immunization to women in health services, mainly during pregnancy [33].

4.1. Strengths and limitations

Some limitations of the current study must be acknowledged. Firstly, it is a cross-sectional study, which makes it impossible identifying and/or interpreting the temporality of associations shown in the recorded results. Secondly, although other methodological approaches (such as multilevel approach and spatial analysis) have been tested to investigate the association of other aspects - in addition to the individual ones - with tetanus vaccination in pregnant women, associations were not found. Finally, it is noteworthy that vaccine records in pregnant women's booklets may be underestimated, due to likely lack of records about doses administered before, or during, pregnancy.

The strength of the present study lies on the fact that the investigated population was representative in most of the analyzed variables. It is noteworthy that results found in the current study corroborated previous studies conducted in other countries [34]. In addition, the herein analyzed data about vaccination did not depend on mothers' memory, since it was possible extracting information about vaccination from their booklets, and it enabled reducing bias likelihood.

5. Conclusions

The study has advanced in the vaccination perspective, since the knowledge deriving from it has practical and political implications, and it can be used to guide further in-depth research focused on investigating public health aspects associated with pregnant women vaccination in Brazil.

Achieving satisfactory tetanus vaccination coverage among pregnant women, mainly among those living in socially deprived regions, remains a challenge, despite the advances in tetanus vaccination coverage, as well as the progress in disease eradication processes worldwide. The current study has outlined some factors associated with tetanus vaccination in pregnant women, with emphasis on high-risk groups or regions. The present findings can be used as guide to develop public health strategies aimed at improving vaccination coverage among pregnant women. In addition, it can provide important epidemiological information and have significant implications in the development of strategies aimed at improving immunization coverage among pregnant women and in groups presenting specific features.

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Availability of data and materials

The data sets used and/or analyzed during the present study are available with the corresponding author, upon reasonable request.

Contribution

Study design, literature review, conceptualization of the study preparation of the manuscript, data analysis and critical review of the manuscript, and sending it for publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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