Article

Transmission of rubella and risk of congenital rubella syndrome (CRS) in pregnant women during prenatal consultation at the Sino - Gabonese Friendship Hospital in Franceville.

Adelaïde Niéguitsila[1] ; Cédric Sima Obiang[2] ; Thiéry Ndong Mba[2,3*] ; Kervaly Pierre Bithegue Mba[2]; Ulrich Nzamba[5] ; Aimé Parfait Rapona[5] ; Hilaire Moundounga Kenguele[1] ; Arnaud Brice Pambo Pambo[6] ; Cyrille Bisseye[2] ; Patrick Mickala [2] and [6]

1- Laboratory of Multidisciplinary Environmental Research (LARME), University of Science and Technology of Masuku (USTM) Franceville, Gabon
2- Laboratory of Molecular and Cellular Biology (LABMC) University of Science and Technology of Masuku (USTM), Franceville, Gabon
3- Biochemistry Research Laboratory (LAREBIO), University of Science and Technology of Masuku (USTM) Franceville, Gabon
5- Medical analysis laboratory of the Sino-Gabonese friendship hospital in Franceville, Gabon
6- Laboratory of Animal Physiology, University of Science and Technology of Masuku (USTM), Franceville, Gabon
***Corresponding author**: Dr Thiéry Ndong Mba, e-mail: tndongmba2021@gmail.com

ABSTRACT: Objectives: Pregnant women represent a population category at high risk of severe rubella infection, capable of adversely affecting their fetus. This study was conducted to determine the seroprevalence of anti-rubella antibodies in pregnant women seen in prenatal consultations at the Sino-Gabonese Friendship Hospital in Franceville**. Patients and Methods**: A prospective, cross-sectional study was conducted at the Sino-Gabonese Friendship Hospital in Franceville, from April 3 to July 27, 2023. Using a structured and pre-established questionnaire, sociodemographic and obstetrical characteristics were obtained... Three milliliters of blood were collected from participants to measure rubella-specific IgG antibody levels using the **OnSite Rapid Test Rubella IgG/IgM COMBO** lateral flow immunochromatographic assay. Results were considered significant at p≤0.05. **Results:** The study included 107 pregnant women seen in prenatal consultations. With a mean age of 27.9±7.1 years, anti-Rubella IgG antibodies were found in 87 pregnant women, indicating an overall seroprevalence of 81.30% (95% CI: [0.72 - 0.87). Of these, 6.9% (n = 6) of the women were serum anti-Rubivirus IgM carriers. In univariate analysis, it was indicated that pregnant women in the study aged between 21-30 years (OR =0.33; 95% CI: [0.12-0.9] p=0.0027), student (OR =6.35; 95% CI: [1.39-29.09] p=0.001), or without professional status (OR =0.05; 95% CI: [0.01- 0.27] p<0.001), high school education (OR =8.24; 95% CI: [2.83-23.96] p<0.001), single (OR =0.3; 95% CI: [0.11-0.85] p=0.0021) or cohabiting OR =3.91; 95% CI: [1.21-12.64] p=0.0017) Residing in an urban area (OR =49; 95% CI: [1.43-16.75] p=0.006), in the first trimester of their pregnancy (OR = 0.29; 95% CI: [0.09-0.94] p= 0.033), with a history of spontaneous abortion (OR = 0.09; 95% CI: [1.04; 11.30] p= 0. 037), and unvaccinated (OR = 0.13; 95% CI: [0.05; 0.13] p<0.000), had an elevated risk of Rubella, After adjusting for risk factors by logistic regression, residence in a rural area (ORA = 139.87 95% CI : [1.74 -11236.216] p=0.027),and no vaccination (ORA = 43.3 95% CI: [1.13 -1662.7] p= 0.043), were identified as the only significant risk factors for Rubella for the present study population**. Conclusion**: The high rate of susceptibility to rubella among pregnant women in the present study indicates that any short-term vaccination strategy aimed at reducing the number of susceptible women of childbearing age is imperative

Keywords: Transmission; Rubella; Pregnant women; Friendship Sino-Gabonese Hospital; Franceville; Gabon

 doi:10.20944/preprints202306.0481.v1

I. INTRODUCTION

Nowadays, viral infections are increasingly common worldwide **(Morse S et al., 2001).** One of these is rubella. Although this disease is benign, it affects both children and adults. It is responsible for numerous intrauterine complications in pregnancy, which can cause a series of malformations of the embryo, death of the fetus, and premature delivery in the case of primary infection in pregnant women (**Camejo Leonor M et al., 2023**). In the world, the major epidemics of the disease have occurred in developed countries. This is the case of Great Britain in 1940, Sweden in 1951 and the United Kingdom in 2006, Sweden in 1951 and the United States of America in 1964. In developing countries, an epidemic occurred in Panama in the mid-1980s. In the United States alone, more than 20,000 cases of congenital rubella syndrome (CRS) have been reported (**Berg AH et al., 2022**). As the public health burden of rubella is related to the risk of infection in pregnant women, many countries have developed a vaccine, to eradicate rubella and congenital rubella syndrome (**WHO, 2018**). This is the case of the USA which, have not reported cases of naturally transmitted rubella since 2004 (**Wallin T, et al 1017**), and Canada where the average incident rate has decreased from 0.2000 in 98 to 0.0003 in 2011 (**Public Health Agency of Canada. 2014**) and have conducted serological surveys to determine the proportion of women of childbearing age who are susceptible to rubella. (**Kassa ZY et al., 2020**). Rubella is a public health problem that results in the birth of approximately 110,000 children with congenital rubella syndrome (CRS) (**Duszak, RS et al., 2009**). In contrast to these countries, rubella remains a real public health problem in developing countries (countries in Africa, Southeast Asia and the Middle East (**Lambert N et al., 2015**). Moreover, it is estimated that the magnitude of congenital rubella syndrome for countries without rubella vaccine policy can be very large (**Su Q et al.,2021**)... For example in 1996, there were nearly 22,000 congenital rubella cases in Africa and nearly 46,000 in Southeast Asia (**Masresha B, et al., 2018**). Gabon, a central African country is not immune to the antics of this rubella burden. Despite the integration of the Expanded Program on Immunization (EPI) in primary health care centers, the integration of vaccination outside the EPI (**Ategbo S, et al., 2010**), there are no rubella screening programs in pregnant women but rather a detection of immunity in them, towards the disease. Thus, the magnitude of the problem is unknown. . The lack of data on the seroprevalence of the virus responsible for the disease among pregnant women in this country therefore prompted the setting up of this study, with the general objective of assessing the seroprevalence of rubella virus among pregnant women receiving antenatal care at the Sino-Gabonese Friendship Hospital in Franceville.

II. MATERIALS AND METHODS

II.1 Study setting

The study was conducted in the medical analysis laboratory of the Sino-Gabonese Friendship Hospital in Franceville, the capital of the second province (Haut-Ogooué) of Gabon in terms of population. This city is divided into four districts. Located in the 2nd district, the Sino-Gabonese Friendship Hospital of Franceville is a support hospital for the Amissa Bongo University Hospital of Franceville, another public health structure, and receives patients from all walks of life.

II. 2. Type and period Study population

This is a prospective and cross-sectional study with descriptive and analytical purposes, which was conducted from April 11 to July 2023, and focused on pregnant women who came for prenatal consultation during the study period to the Sino-Gabonese Friendship Hospital in Franceville**.**

II.3 Inclusion and exclusion criteria

Only pregnant women were included in the study who were undergoing prenatal consultations at the Sino-Gabonese Friendship Hospital and who had consented to participate in the study. Non-pregnant women and pregnant women who refused to participate in the study were excluded**.**

II.4. Sampling method and sample size

To select the pregnant women seen at the Sino-Gabonese Friendship Hospital from April to July 2023, a systematic, random and simple sampling technique was used, and our study population size was 107 participants.

II.5. Questionnaire

A pre-established and structured questionnaire (see appendix) was submitted to the participants to collect socio-demographic characteristics (age, marital status, professional status, level of education, area of residence), and obstetrical characteristics such as pregnacies number, age of pregnancy, history of spontaneous abortion, stillbirth, and immunization status

II. 6. Definitions

Stillbirth: delivery of a fetus showing no signs of life after 20 completed weeks of gestation.

Fetal death: fetal death in utero after 28 completed weeks of gestation.

Spontaneous abortion: a clinically recognized spontaneous miscarriage prior to 20 weeks gestation.

Previous exposure to rubella virus infection: pregnant women whose blood tests positive for IgG antibodies, thus protective immunity against infection.

Recent rubella virus infection: pregnant women testing positive for IgM antibodies.

II.7 Sample collection and storage

After the participants signed the informed consent form, 5 ml of venous blood was collected aseptically at the HASG laboratory in Franceville from each pregnant woman in one EDTA-coated tube and one dry tube. Each tube was centrifuged at 3000 rpm for 10 min to remove the plasma, which was frozen at -20°C until use. .

II. 8. Serological diagnosis of rubella

Using the rapid test: OnSite Rapid Test Rubella IgG/IgM COMBO, the diagnosis of Rubella, was made from 3ml of venous blood sample taken from each study participant and the sera separated by centrifugation were stored at 2°C to 8°C until the day of diagnosis. This diagnostic guidance test used is manufactured in the United States by CTK Biotech, inc, located in California.

Interpretation of the result:

Negative result: If only the C line develops, this indicates that anti-Rubella antibodies are not detected in the sample. The result is negative or non-reactive.

- Positive result: In addition to the presence of the C line, if only the M line develops, the test indicates the presence of anti-Rubella IgM. The result is anti-Rubella IgM positive or reactive and anti-Rubella IgG negative or non-reactive.

In addition to the presence of the C line, if only the G line develops, the test indicates the presence of anti-Rubella IgG. The result is positive or reactive anti-Rubella IgG and negative or non-reactive anti-Rubella IgM.

In addition to the presence of the C line, if the M and G lines develop, the test indicates the presence of both anti-Rubella IgM and IgG. The result is anti-Rubella IgM and IgG positive.

- Invalid Test: If no C line develops, the test is invalid regardless of color development on the test lines (G and M) as indicated below. Repeat the test with a new cassette.

II. 9 Data Quality Assurance

To assess its validity and completeness, a questionnaire was pretested with 5% of the study subjects, prior to the actual data collection. This process was methodically and rigorously followed. To verify the accuracy and completeness of the questionnaire data obtained from each study

participant, the data were reviewed immediately. The samples were processed and tested by an experienced laboratory professional and according to the recommendations of the supplier and manufacturer. Sensitivity and specificity were 98% and 97.3%, respectively, for the OnSite Rubella IgG/IgM rapid test.

II. 10 Ethical considerations

The authorization to conduct the study was granted by the hospital administration and the sampling was designed on the basis of the voluntary participation of the pregnant women in the study, after explaining the rationale, benefits, and ensuring the confidentiality of the study, Participation in the study was finalized by written and informed consent of each participant. To maintain anonymity, code numbers were used instead of nominal identifiers.

II. 11. Statistical Analysis of Data

The collected data were entered into a Microsoft Excel 2013 spreadsheet, cleaned, and then analyzed using R software version 4.2.1. To assess the association between rubella seroprevalence and various sociodemographic and obstetric characteristics of pregnant women, univariate and then binary logistic regression analyses were performed. Odds ratios and their 95% confidence intervals were used to measure the strength of the association. The p-values were determined and considered significant when they were less than or equal to 0.05.

III. RESULTS

III.1 Rubella seroprevalence among pregnant women in the study (n = 107).

A total of 107 pregnant women seen for prenatal consultation at the Sino-Gabonese Friendship Hospital met the inclusion criteria and responded to the survey. This indicated a 100% response rate for the present study. With a mean age of 27.9 ±7.1 years for all participants, an overall seroprevalence of 81.30% (95% CI:0.72 - 0.87) (n=87), of specific anti-Rubivirus IgG was revealed in these women. Among the latter, 6.9% (n=6) of the women were serum anti-Rubivirus IgM carriers.

III.2 Seroprevalence of Rubella virus infection according to sociodemographic characteristics of pregnant women in the study (N = 107).

A univariate analysis of rubella seroprevalence according to sociodemographic characteristics of the pregnant study women indicated that, those who were aged between 21-30 years (OR =0.33; 95% CI: [0.12-0.9] p=0.0027), student (OR =6.35; 95% CI: [1.39-29.09] p=0.001), or with no occupational status (OR =0.05; 95% CI: [0.01- 0.27] p<0.001), secondary school education (OR =8.24; 95% CI: [2.83-23.96] p<0.001), single (OR =0.3; 95% CI: [0.11-0.85] p=0.0021), or cohabiting OR =3.91; 95% CI: [1.21-12.64] p=0.0017) and residing in a rural area OR =49; 95% CI: [1.43-16.75] p=0.006) were at high risk for rubella virus infection (Table 1).

Table 1. Univariate analysis of seroprevalence of rubella virus infection according to sociodemographic characteristics of pregnant women in the study.

Variables	Rubella seroprevalence % (n/N)	Crude OR, 95% CI	p-value
Age groups of pregnant woman (years)			
≤20	80 (12/15)	0.91 [0.23–3.58]	0.89
21–30	70.73 (29/41)	0 .33 [0.12–0.9]	**0.027***
31–40	88.89 (40/45)	2.55 [0.85–7.63]	0.09
41–43	100 (6/6)	Référence	-
Professional status of the pregnant woman			
Pupil/student	94.74 (36/38)	6.35 [1.39–29.09]	**0.001***
Small job	76.92 (10/13)	0.74 [0.18–2.98]	0.67
Public official	81.25 (39/48)	Reference	-
Without	25 (2/8)	0.05 [0.01–0.27]	**< 0.001***

Education level of the pregnant woman			
Primary	92 (23/25)	3.23 [0.69– 15.02]	0.12
Secondary	91.02 (71/78)	8.24 [2.83–23.95]	**< 0.001***
University	75 (3/4)	Reference	-
Marital status of pregnant woman			
Single	72 (36/50)	0.3 [0.11–0.85]	**0.021***
Cohabiting	81.49 (43/47)	3.91 [1.21–12.64]	**0.017***
Engaged	8.33 (5/6)	1.16 [0.13–10.51]	0.90
Married	75 (3/4)	Référence	-
Residence Area of the pregnant woman			
Franceville (Urban)	85.10 (80/94)	Référence	-
Other (Rural)	53.85 (7/13)	4.9 [1.43–16.75]	**0.006***

*= Significant result, OR = Odds ratio, CI = Confidence interval

III.3. Rubella seroprevalence by obstetric characteristics of pregnant women in the study (N = 107)

A univariate analysis of rubella seroprevalence by obstetric characteristics of the pregnant study women indicated that, unlike risk factors that may be associated with rubella such as stillbirth or gestational age, only pregnant women who were in the first quater of pregnancy (OR = 0.29; 95% CI : [0.09-0.94] p=0.033), with a history of spontaneous abortion (OR = 0.09; 95% CI: [1.04; 11.30] p= 0.037), and unvaccinated (OR = 0.13; 95% CI: [0.05; 0.13] p<0.000), had a very high likelihood of being infected with rubella virus. These risk factors were significantly associated with rubella seroprevalence Table 2.

Table 2. Univariate analysis of Rubella seroprevalence according to obstetric characteristics of pregnant women in the study.

Variables	Rubella Seroprévalence % (n/N)	Crude OR, 95 % CI	Valeur p-value
Age of pregnancy (Quater)			
1st Quater	77.05 (47/61)	0.29 [0,09–0.94]	**0.033***
2nd Quater	87.5 (28/32)	1.9 [0.58–6.21]	0.28
3rd Trimestre	85.71 (12/14)	Reference	-
Pregnacies number			
Primigeste	82.9 (63/76)	1.41 [0.5–3.96]	0.51
Multiigeste	77.42 (24/31)	Reference	-
Number of deliveries after 20 weeks of pregnancy			
≤ 2	95.12 (37/41)	Reference	-
≥3	72.73 (50/66)	0.29 [0.09–0.94]	0.061
History of spontaneous abortion			
Yes	33.33 (2/6)	0.09 [0.02– 0.53]	**0.002***
No	82.33 (85/101)	Reference	
Stillbirth			
Yes	80 (4/5)	0,92 [0.1–0.71]	0.62
No	81.37 (83/102)	Reference	-
Vaccination status against rubella			
Vaccinated	90.91 (70/77)	Reference	
Not Vaccinated	56.67 (17/30)	0.13 [0.05–0.13]	**< 0.001***

*= Significant result, OR = Odds ratio, CI = Confidence interval

III-4- Multivariate logistic regression analysis of risk factors associated with rubella seroprevalence among pregnant women (n = 107) in the study.

Finally, the result of the multivariate logistic regression analysis indicated that pregnant women in the study residing in rural areas (Adjusted OR = 139.87 95% CI: [1.74 -11236.216] p=0.027), and unvaccinated (Adjusted OR = 43.3 95% CI: [1.13 -1662.7] p= 0.043), were at higher risk of Rubella than other participants. Table 3.

Table 3. Multivariate logistic regression analysis of risk factors for Rubella seroprevalence among pregnant women (n = 97) in the study.

 doi:10.20944/preprints202306.0481.v1

Variables	Rubella séroprévalence % (n/N)	Ajusted OR, 95 %CI	Valeur p
Age groups of pregnant woman (years)			
≤20	80 (12/15)	-	-
21–30	70.73 (29/41)	-	-
31–40	88.89(40/45)	-	-
41–43	100 (6/6)	-	-
Professional status of the pregnant woman			
Pupil/student	94.74 (36/38)	-	-
Small job	76.92 (10/13)	-	-
Public official	81.25 (39/48)	-	-
Without	25 (2/8)	-	-
Education level of the pregnant woman			
Primary	92 (23/25)	-	-
Secondary	91.02 (71/78)	-	-
University	75 (3/4)	-	-
Marital status of pregnant woman			
Single	72 (36/50)	0.48 [0.02 –11.93]	0.65
Cohabiting	81.49 (43/47)	-	-
Engaged	8.33 (5/6)	-	-
Married	75 (3/4)	1	-
Residence Area of the pregnant woman			
Franceville (Urbain)	85.10 (80/94)	1	-
Other (Rurale)	53.85 (7/13)	139.87 [1.74 – 11236.22]	**0.027***
Age of pregnancy (Quater)			
1st Quater	77.05 (47/61)	0.064 [0.02 –2.41]	0.064
2nd Quater	87.5 (28/32)	0.046 [0.00 –5.00]	0.2
3rd Quater	85.71 (12/14)	1	
History of spontaneous abortion			
Yes	33.33 (2/6)	-	-
No	82.33 (85/101)	-	-
Vaccination status against rubella			
Vaccinated	90.91 (70/77)	1	
Not Vaccinated	56.67 (17/30)	43.3 [1.13 –1662.7]	**0.043***

*= Significant result, ORA = Odd ratio = adjusted odds ratio, CI = Confidence interval.

 doi:10.20944/preprints202306.0481.v1

IV-DISCUSSION

Contrary to the results obtained in previous studies, which noted that none of the sera tested had IgM (**haabouni, F. et al., 2012**), the majority of studies conducted elsewhere indicate that the detection of IgM is a better indicator to assess the seroprevalence of rubella in pregnant women (**Sampedro, A. et al., 2013**). This is the case in the present study in which, n = 6 i.e., 6.9% of women carried serum anti-rubella IgM. The presence of IgM, compatible with the existence of a recent and evolving rubella, can be responsible for serious complications on the evolution of the fetus, or even abortions and premature birth. In total, 81.30% (n=87) of pregnant women in our study were seropositive for anti-rubella IgG antibodies indicating a sustained infection in the population and indicating endemicity, in an underpopulated country like Gabon, likely to be controlled by setting up regular monitoring of at-risk pregnancies.This result although lower than that reported elsewhere (93.1%) (**Olajide OM et al., 2015**), it is close to those obtained in studies in China (83.3%) (**Meng Q, et al. 2018**), India (83.4 and 82.3%) (**Muliyil DE, et al., 2018**), (**Shanmugasundaram D, et al., 2017**), Cameroon (88.6%) (**Fokunang CN et al., 2010**). However, contrasting lower rates were reported in Western Sudan (65.3%) (**Hamdan HZ et al., 2011**) and Algeria (68.6%) (**Oyinloye SO et al., 2017**). This variability of results could be justified not only by the different serological diagnostic methods used in the different studies, but also, by differences that exist in the study sample sizes, geographical and environmental characteristics (climate, rainfall, temperature, soil type, altitude...) and everyday behavioral characteristics, of pregnant women such as education level, hygiene practices and dietary habits (**Ang, LW et al., 2022**). As noted elsewhere, the majority of IgG antibody-positive pregnant women in the present study indicated either prior rubella or acquired immunity. And thus, they were unlikely to infect their fetus outside of a strong immunosuppressed setting (**Kolawole OM et al., 2014**). On the other hand, it was shown that in the overall rubella seroprevalence among pregnant women in the study, the proportion of IgM positivity was 6.9%. Higher than that reported in Ethiopia (2.1%) (**Tamirat B et al., 2017**), This prevalence was consistent with the combined prevalence of recent rubella infection in sub-Saharan Africa (5.1%) (**Mirambo MM et al., 2015**), as also recently reported in Cameroon (5.5%) (**Michel N, et al., 2018**). In contrast, the proportion of IgM positivity in the present study ((6.9%), was lower than those reported in Northern Ethiopia (9.5%) (**Wondimeneh Y, et al., 2018**). This diversity of results in different studies, could be due to the difference in endemicity of rubella virus, variability in sample size of the studies, laboratory methods used, and differences in thresholds of tests used.

The results of the univariate analysis of rubella seroprevalence according to the socio-demographic characteristics of the pregnant women in our study revealed that those who were between 21-30 years of age, student, or without professional status, with a high school education, single or cohabiting, and residing in rural areas, were at high risk of rubella. Contrary to other studies (**Ekuma UO et al., 2022**), it is noted that women with a low professional status, and single people, probably due to their low income, hygiene practices and eating habits, or living in lower socio-economic conditions, are susceptible to contracting the disease (**Ramos-Morcillo AJ et al.,2019**). Indeed, as in all cities in Gabon, precisely in Franceville, a semi-urban area, populations tend to eat more and more outside their homes. So, with the resurgence of food shops on the public highway (grilled meats, fruits and vegetables, fermented beverages, cakes ...) and even the water that is served to drink, is of questionable origin, quality and hygiene. It could be predicted that the rate of rubella cases in the coming years could be higher, if measures were not put in place to deal with it. This is perhaps why the Gabonese Food Security Agency (**GFSA**) has undertaken to launch a campaign with the slogan "Eat Out, Eat Clean" to sensitize street food actors on good hygiene practices (**Loïc Ntoutoum; 2019**).

In addition, a univariate analysis of rubella prevalence according to obstetrical characteristics of the pregnant women in this study indicated that those who were in the first trimester of pregnancy, had a history of spontaneous abortion, and were unvaccinated, had a very high probability of being infected with the rubella virus. This result is in agreement with a study conducted in Ethiopia that found a higher proportion of IgM positivity in pregnant women who were in their first trimester (**Tulu B et al., 2018**). , in Tanzania (**Lulandala L et al., 2017**). Unlike some studies that found a

significant association between rubella prevalence and urban settings (**Jahromi AS et al., 2011**), further multivariate logistic regression analysis of variables in the present study, showed that rubella seropositivity was significantly associated with rural residence and non-vaccination. These results, similar to those obtained in a study conducted in Canada (**Prevention of Congenital Rubella Syndrome. 1999**), can be explained by the fact that rubella vaccine is not always administered to unprotected women after delivery, and not all women are tested during pregnancy. Second, in countries in the sub-Saharan region, populations living in the hinterland do not have sufficient information about the appropriateness of vaccination. And the vaccination status of women in Gabon is not checked regularly. Yet, the elimination of congenital rubella syndrome depends not only on effective vaccination in childhood, but also on identifying and vaccinating unprotected women of childbearing age (**Dixon MG et al., 2022**)

Study strengths and limitations

Although this study provides preliminary data that can support future research, some limitations are recognized. First, the time frame for this study did not allow for a large enough sample size. Second, the OnSite Rapid Test Rubella IgG/IgM COMBO lateral flow chromatography immunoassay, used for the simultaneous and rapid detection and differentiation of IgG and IgM rubella antibodies, should be complemented by IgG sensitivity, specificity and avidity tests such as ELISA. In addition, the molecular biology method (qPCR), which detects Rubivirus RNA, could strengthen the diagnosis and reflect the true burden of rubella in the study population. Third, because the risk factor assessment was conducted on the basis of self-reports by study participants, the study may suffer from recall bias. Finally, because it was conducted only in a hospital setting, this study may not be representative of the general population.

V. CONCLUSION

The present study, which has the strength of being one of the few surveys of its kind on rubella infection in pregnant women in Gabon, and particularly in the province of Haut-Ogooué, has provided a comprehensive understanding of the seroprevalence and risk factors of rubella in pregnant women in Franceville and its surroundings. It established that some pregnant women were still at risk of infection during pregnancy, with potential complications for their fetus in case of congenital rubella. The risk of parasitic transmission to the fetus is higher the later in pregnancy the maternal primary infection with rubella virus occurs, conversely to the clinical signs that are more deleterious to the fetus in case of early maternal infection (**Mawson AR et al., 2019**). The risk factors revealed in the present study, were residence in rural areas and non-vaccination. To limit this risk of congenital rubella, preventive measures should be taken by health authorities in Gabon. In addition, awareness campaigns on rubella and the modes of contamination among pregnant women, training of health professionals in the diagnosis of prenatal infection, as well as lowering the cost or even providing free laboratory diagnosis should be planned by public health authorities to better prevent and control congenital rubella transmission in Gabon.

Acknowledgements: The authors would like to thank the General Management of the Sino Gabonese Friendship Hospital in Franceville for allowing this study to be conducted and the laboratory technicians who helped perform the laboratory tests for all the patients in the study.

Data Availability: In order to preserve the confidentiality of the participants, all data generated and analyzed during this study are not publicly available. However, they are available from the corresponding author upon reasonable request.

Contributors: TNM and CSO designed the study; UN and APR performed the laboratory work; all authors performed the statistical analyses, interpretation, contributed to the writing and approved the final version of the manuscript.

Funding: No funding was obtained.

Competing Interests: The authors declare that there are no conflicts of interest regarding the publication of this article.

Data sharing statement: No additional data are available.

REFERENCES

ANG, LW, GAO, Q., CUI, L. et al. Prevalence of measles antibodies among migrant workers in Singapore: a serological study to identify susceptible population subgroups. BMC Infect Dis 22 , 88 (2022). https://doi.org/10.1186/s12879-022-07066-2

ATEGBO, S., NGOUNGOU, E. B., KOKO, J., VIERIN, Y., ZANG NDONG, C. E. & MOUSSAVOU MOUYAMA, A. 2010. [Immunization coverage of children aged 0 to 5 years in Libreville (Gabon)]. Sante, 20, 215-9

BERG, AH .2022. . Fighting rubella without vaccines: the Danish exception, 1941-1987. Social history of medicine, 35 (3), 888-909

CAMEJO LEONOR M, MENDEZ MD, Rubella. [Updated 2023 Jan 31]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan.-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK559040/.

CURTI SP, FIGUEIREDO CA, DE OLIVEIRA MI, ANDRADE JQ, ZUGAIB M, FRUGIS YU AL, et al.,. Molecular epidemiology of rubella viruses involved in congenital rubella infections in São Paulo, Brazil, between 1996 and 2009. J Med Virol. 2013 November;85(11):2034-41. doi: 10.1002/jmv.23675. Epub 16 July 2013. PMID: 23861141; PMCID: PMC7167121

DIXON MG, REEF SE, ZIMMERMAN LA, GRANT GB. Past as prologue - Using lessons from the rubella vaccination program to inform COVID-19 vaccination. Emergency Infect Dis. 2022 December;28(13):S225-S231. doi: 10.3201/eid2813.220604. PMID: 36502405; PMCID: PMC9745252.

DUSZAK RS. 2009. Congenital rubella syndrome-major review. Optometry-Journal of the American Optometric Association, 80 (1), 36-43.

EKUMA UO, OGBU O, OLI AN, OKOLO MO, EDEH PA, AL-DAHMOSHI HOM, et al. The burden of probable rubella infection among healthy pregnant women in Abakaliki, Ebonyi State, Nigeria. Interdiscip Perspect Infect Dis. January 31, 2022;2022:5743106. doi: 10.1155/2022/5743106. PMID: 35140784; PMCID: PMC8820899

FOKUNANG CN, CHIA J, NDUMBE P, et al. Clinical studies on rubella virus seroprevalence in pregnant women in the regions of Cameroon. African Journal of Clinical and Experimental Microbiology 2010; 11: 79-92. 10.4314/ajcem.v11i2.53913

HAABOUNI F, MESSADI L, FKI ZRIBI M, A HAMMAMI, H KARRAY, Seroprevalence of rubella in women of reproductive age two years after the introduction of vaccination in Tunisia Pathology Biology,Volume 60, Issue 3,2012,Pages 170-173,ISSN 0369-8114

HAMDAN HZ, ABDELBAGI IE, NASSER NM, et al. Seroprevalence of cytomegalovirus and rubella in pregnant women in western Sudan. Virol J 2011; 8 :217 10.1186/1743-422X-8-217

JAHROMI AS, KAZEMI A, MANSHOORI G, MADANI A, MOOSAVY SH, SEDDIGH B. Rubella virus seroprevalence in women with spontaneous abortion. American J Infect Dis. 2011; 7 (1):16

KASSA ZY, HUSSEN S, ASNAKE S. Sero-prevalence of rubella among pregnant women in Sub-Saharan Africa: a meta-analysis. Hum Vaccin Immunother. 2020 Oct 2;16(10):2472-2478. doi: 10.1080/21645515.2020.1729027. Epub 2020 Mar 20. PMID: 32195620; PMCID: PMC7644194.

KOLAWOLE OM, ANJORIN EO, ADEKANLE DA, KOLAWOLE CF, DUROWADE KA. Seroprevalence of rubella IgG antibody in pregnant women in osogbo, Nigeria. Int J Prev Med. 2014 Mar;5(3):287-92. PMID: 24829712; PMCID: PMC4018637.

LAMBERT N, STREBEL P, ORENSTEIN W, ICENOGLE J, POLAND GA. Rubella. Lancet. June 6, 2015;385(9984):2297-307. doi: 10.1016/S0140-6736(14)60539-0. Published online January 8, 2015. PMID: 25576992; PMCID: PMC4514442.

LOÏC NTOUTOUM; 2019: Food hygiene: AGASA looks at "street food."

LULANDALA L, MIRAMBO MM, MATOVELO D, GUMODOKA B, MSHANA SE. Acute rubella virus infection in spontaneously aborted women in Mwanza City, Tanzania. J Clin Diagn Res. 2017 Mar;11(3):QC25-QC27. doi: 10.7860/JCDR/2017/22634.9544. Published online March 1, 2017. PMID: 28511456; PMCID: PMC5427382

MASRESHA B, SHIBESHI M, KAISER R, LUCE R, KATSANDE R, MIHIGO R. Congenital rubella syndrome in the African region - Sentinel surveillance data. J Immunol Sci. 2018 Aug 2; Suppl:146-150. PMID: 30957103; PMCID: PMC6446990.

MAWSON AR, CROFT AM. Rubella Virus Infection, the Congenital Rubella Syndrome, and the Link to Autism. Int J Environ Res Public Health. 2019 Sep 22;16(19):3543. doi: 10.3390/ijerph16193543. PMID: 31546693; PMCID: PMC6801530.

MENG Q, et al. Rubella seroprevalence among pregnant women in Beijing, China. BMC Infect. Dis. 2018; 18:130-130. doi: 10.1186/s12879-018-3032-x.

MICHEL N, et al. Seroprevalence of IgM and IgG antibodies to rubella and associated risk factors in pregnant women attending the antenatal clinic of Bafoussam regional hospital, western region of Cameroon. J. Trop. Dis. 2018 doi: 10.4172/2329-891X.1000279.

MIRAMBO MM, MAJIGO M, ABOUD S, GROß U, MSHANA SE. Serological culprits of rubella infection in Africa in the pre-vaccination era: a systematic review . BMC Resolution Notes. 2015; 8 (1):716. doi: 10.1186/s13104-015-1711-x.

MORSE, S. S. (2001). Factors in the emergence of infectious diseases (pp. 8-26). Palgrave Macmillan UK

MULIYIL DE, et al. Rubella seroprevalence among pregnant women in India, 2017. Vaccine. 2018; 36:7909-7912. doi: 10.1016/j.vaccine.2018.11.013..

OLAJIDE OM, AMINU M, RANDAWA AJ, ADEJO DS. Seroprevalence of rubella-specific IgM and IgG antibodies among pregnant women seen in a tertiary hospital in Nigeria. Int J Womens Health. 2015 Jan 6;7:75-83. doi: 10.2147/IJWH.S68667. PMID: 25610003; PMCID: PMC4294645

OYINLOYE SO, AMAMA CA, DANIEL R, et al.. Rubella antibody seroprevalence survey among pregnant women in Maiduguri, Borno State, Nigeria . African Journal of Clinical and Experimental Microbiology 2014; 15:151-7

PREVENTION OF CONGENITAL RUBEOLA SYNDROME. Paediatr Child Health. 1999 Mar;4(2):158-60. French. PMCID: PMC2828211.

PUBLIC HEALTH AGENCY OF CANADA. (2014). Elimination of measles, rubella and congenital rubella syndrome in Canada: documentation and verification report. Public Health Agency of Canada.

RAMOS-MORCILLO AJ, MORENO-MARTÍNEZ FJ, SUSARTE AMH, HUESO-MONTORO C, RUZAFA-MARTÍNEZ M. Social determinants of children's health, family and personal hygiene: a comparative study. Int J Environ Res Public Health. 2019 Nov 26;16(23):4713. doi: 10.3390/ijerph16234713. PMID: 31779283; PMCID: PMC6926531

SAMPEDRO, A., RODRÍGUEZ-GRANGER, J., GÓMEZ, C., LARA, A., GUTIERREZ, J., & OTERO, A. (2013). Comparative evaluation of a new chemiluminescent test and ELISA for the detection of measles IgM. Clinical laboratory analysis journal , 27 (6), 477-480

SHANMUGASUNDARAM D, et al. Burden of congenital rubella syndrome (CRS) in India based on cross-sectional serological survey data, 2017 and 2019-2020. PLoS Negl. Trop. Dis. 2021; 15:e0009608. doi: 10.1371/journal.pntd.0009608

SU Q, FENG Z, HAO L, MA C, HAGAN JE, GRANT GB, et al.,. Assessment of the burden of congenital rubella syndrome in China and evaluation of mitigation strategies: a metapopulation modeling study. Lancet Infect Dis. Jul 2021;21(7):1004-1013. doi: 10.1016/S1473-3099(20)30475-8. Published online January 27, 2021. PMID: 33515508; PMCID: PMC9102636

TAMIRAT B, HUSSEN S, SHIMELIS T. Rubella virus infection and associated factors among pregnant women attending antenatal clinics at public hospitals in Hawassa city, southern Ethiopia: a cross-sectional study. BMJ open. 2017; 7:e016824. doi: 10.1136/bmjopen-2017-016824

TULU B, MEKONNEN D, AMSALU E, ZENEBE Y, GETAHUN M. Rubella virus seroprevalence and associated factors among unvaccinated pregnant women in northwestern Ethiopia. Ethiopia. J. Health Dev. 2018;

WORLD HEALTH ORGANIZATION Sep 4, 2018 Congenital rubella syndrome: standards for vaccine-preventable disease surveillance.

WONDIMENEH Y, et al. Rubella virus infections and immune status among pregnant women before rubella vaccine introduction in Amhara Regional State, Ethiopia. Int. J. Infect. Dis. 2018; 76: 14-22. doi: 10.1016/j.ijid.2018.07.024.