

Original Research Article

Asymptomatic carriage of pneumococcus in children under 2 years of age in Libreville: prevalence and associated factors

Steeve Minto'o^{1*}, Chimène Nze-Nkoghe², Fifi C. Loembe¹, Patrice Makouloutou-Nzatsi², Boris Makanga², Diane Ditsoga-Kombila¹, Simon J. Ategbo¹

¹Department of Pediatrics, Faculty of Medicine, Université des Sciences de la Santé, Libreville, Gabon

²Institut de Recherche en Ecologie Tropicale (IRET) (Research Institute in Tropical Ecology), CENAREST, Libreville, Gabon

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*Correspondence:

Dr. Steeve Minto'o,

E-mail: steeve.mintoo@hotmail.fr

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ABSTRACT

Background: The morbidity and mortality attributed to pneumococcus are impressive even in the absence of any problem of antibiotic resistance. The objectives of this study were to determine the prevalence of asymptomatic pneumococcal carriage in children aged between 2 months and 2 years in Libreville and to identify the socio-demographic factors associated with carriage.

Methods: Cross-sectional, descriptive, and analytical study from September 2019 to February 2020, including infants aged 2 months to 2 years, randomly selected, in 8 health centres in Libreville. We collected sociodemographic data from children and parents. Nasopharyngeal swabs were taken from each child and analyzed in the laboratory of institut de recherche en ecologie tropicale (IRET). Categorical data were expressed as frequencies. Univariate analyses (odd ratio-OR) were performed to measure the relationship between the relevant variables and pneumococcal carriage, followed by a multivariate analysis using logistic regression. The threshold of statistical significance was set at $p < 0.05$ for a two-tailed chi-square test.

Results: Of the 434 children included, 51.2% ($n=222$) were girls, with a mean age of 5.4 ± 3.2 months. *Streptococcus pneumoniae* was found in 53 children, giving a prevalence of 12.6% (95% CI [9.5-15.6%]). The prevalence was the same for both sexes. Carriage was associated with more than 2 siblings (OR=2.1; $p=0.01$); an age greater than 6 months (OR=3.6; $p=0.001$); a child's rank higher than the median (OR=2.3; $p=0.006$); a mother's low level of education (OR=4.5; $p=0.001$); a father working in the informal sector (OR=2.4; $p=0.01$). The mother's level of education was the factor found in the multivariate analysis ($p=0.043$).

Conclusions: The data from this survey encourage the serotyping of strains to guide the vaccination strategy.

Keywords: *Streptococcus pneumoniae*, Asymptomatic carriage, Prevalence, Infants, Libreville, Associated factors

INTRODUCTION

Pneumococcus, or *Streptococcus pneumoniae*, is a bacterium responsible for a polymorphism of infections, ranging from benign illnesses to severe invasive pneumococcal diseases such as pneumonia and meningitis. Pneumococcus has always been the germ of greatest concern in common infectious pathology.^{1,2} Invasive pneumococcal infections are particularly serious

because of the mortality and sequelae they cause, especially in children under the age of 2 years, and those with debilitating conditions (sickle cell anemia, asplenia, nephrotic syndrome, congenital heart disease, chronic bronchitis, HIV, etc.).^{1,2} Pneumonia alone has killed more children under the age of 5 than several other diseases combined, namely malaria, measles, and AIDS. Pneumonia is the leading infectious cause of death in children. In 2018, the world health organisation (WHO)

announced alarming figures of 1.8 million deaths, mainly in children under 5 (*S. pneumoniae* is the leading cause of pneumonia).² According to data from a study carried out by Johns-Hopkins university and the NGO save the children, published on 12 November 2018 to mark world pneumonia day, pneumonia will kill almost 11 million children under the age of 5 by 2030 if nothing is done to combat the disease. Naturally sensitive to many antibiotics, *S. pneumoniae* has acquired a great deal of resistance over time. Until 1967, penicillin G was the antibiotic of choice for treating pneumococcal infections. Antibiotic resistance, which emerged as an alarming phenomenon at the end of the 1970s in South Africa, is now widespread throughout the world.²⁻⁴ The pathogenesis of pneumococcal infections is marked by the fact that this bacterium can be present in the nasopharynx of children without causing symptoms. This phenomenon is known as "asymptomatic carriage".^{2,5} Most studies have found asymptomatic carriage to be between 30% and 62% in children under the age of 2. Carriage is generally higher in low- and middle-income countries and among economically disadvantaged populations. For example, higher prevalence has been reported in sub-Saharan African countries, including Ethiopia, Mozambique, Kenya and Ghana.⁵⁻⁷ It should be noted that asymptomatic carriage of pneumococcus in young children is not without consequences. Indeed, it has been shown that nasopharyngeal carriage of pneumococcus is a major risk factor for the development of invasive pneumococcal disease. In addition, asymptomatic carriage plays a key role in the transmission of the bacteria within the community.^{2,5-7} In Gabon, studies carried out among Pygmies in the Ikobé region and among the general population in Lambaréné revealed a prevalence of carriage of between 13.7% and 37%, predominantly in children under 5 years of age.^{8,9} No studies have been carried out in Libreville and the surrounding region, which accounts for 60% of Gabon's total population. The main objective of this survey was to assess the prevalence of asymptomatic pneumococcal carriage in children aged 2 to 23 months in Libreville. The specific objective was to identify factors associated with asymptomatic carriage.

METHODS

This was cross-sectional, descriptive, and analytical study, conducted from September 2019 to February 2020, in Libreville and 2 suburban towns: Akanda and Owendo.

The target population was children under 2 years of age. We included children aged 2 months to 23 months, in good health, seen in crèches and day-care centres, or health centres during vaccination sessions. Children had to be accompanied by at least one parent, who had to give written consent by signing the informed consent form. We did not include subjects aged less than 2 months and more than 23 months; subjects who had had a febrile episode in the 15 days before inclusion; subjects who had received antibiotic therapy in the 3 months before

inclusion; subjects who had received a pneumococcal vaccination; subjects with a chronic pathology (sickle cell disease, HIV, etc.). We excluded all subjects who had presented with an upper or lower respiratory illness in the month following inclusion.

The number of subjects required was calculated using Schwartz's formula, assuming a 95% confidence level; an event frequency of 27.3% in the Lambaréné study; and a margin of error of 5%. At 323 subjects, we applied an attenuation factor of 30% to correct for errors related to our type of study, giving a final minimum number of 420 subjects required.

In health centers, during vaccination or weight monitoring sessions, we included the subjects after obtaining informed consent from the parents. We then took nasal swabs from the children and transferred the breakable part of the swab to a cryotube containing skim-milk tryptone glucose glycerol (STGG), a selective preservation medium for pneumococcus. The cryotubes were first placed in a transport cooler containing dry ice. The coolers had to be transported no later than six hours of the inoculation time to the laboratory of the institut de recherche en Ecologie Tropicale (IRET) of the centre national de recherche scientifique et technique (CENAREST). At the IRET microbiology laboratory, the swabs were vortexed for 10 to 20 seconds to disperse the organisms from the buffer, then frozen at -20°C, prepared for culture on specific media and PCR identification of positive cultures. Isolated strains were stored at IRET under liquid nitrogen freezing for subsequent serotyping.

Independent variable analyzed was pneumococcal carriage. Pneumococcal carriage was defined as isolation of pneumococcal strain after nasal swabbing in included subject. Dependent variables were socio-demographic: age, sex, sibling rank, number of children in household, place of residence and type of housing, parents' level of education, parents'/guardians' occupation, childcare arrangements, passive smoking, and eating habits.

Ethical information

The survey was approved by the Gabonese ministry of health prior to the field work in absence of national ethic committee. Parents gave their written consent by signing an informed consent form on the day of inclusion. Data confidentiality was fully respected.

Quantitative variables were expressed as mean or median, and their trend as standard deviation and quartiles. Qualitative variables were expressed as frequency. The prevalence of asymptomatic carriage was expressed with a 95% confidence interval. Univariate analysis was used to assess the association between a characteristic and asymptomatic carriage of pneumococcus, by calculating the odd ratio with a 95% confidence interval using the Miettinen method. This analysis was used to extract the variables of interest for the multivariate analysis

performed using logistic regression. The p value used for significance was <0.05 for a two-tailed chi-square test.

RESULTS

We included 434 cases, 51.2% (n=222) were girls. Median was 4 months, minimum was 1 month, maximum was 18 months, and the age quartiles were Q1=3 months and Q3=7 months. Children came from families where median number of children at home was 3, minimum 1, the maximum=10, Q1=1, and Q3=3. Subjects included had a median rank of 2^e children. Distribution according to place of recruitment (Table 1). We found that 19.6% (n=85) of subjects had been exposed to passive smoking.

Mothers of children who took part in this study were working women in 32% of cases (n=139), housewives in 38.3% (n=166), and pupils or students in 29.7% (n=129) of cases. These mothers had primary education in 5.1% (n=22), secondary education in 60.4% (n=262), university education in 24.4% (n=106) and no education in 10.1% (n=44). These mothers declared that in 23% of cases (n=98) they had been breastfeeding exclusively. This exclusive breastfeeding lasted an average of 0.2±0.4 months. Median duration of breastfeeding when feeding was mixed 4 months. Fathers had professional activity 29% non-managerial (n=126), 27% informal (n=117), entrepreneur 17.5% (n=76), pupil/student 13.8% (n=60), unemployed 10.6% (n=46), managerial 2.1% (n=9).

A total of 53 subjects/12.6% 95% CI (9.5-15.6%) of infants in sample were asymptomatic carriers of pneumococcus. Univariate analysis showed that asymptomatic carriage of pneumococcus was significantly associated with child's sibling rank, child's age, father's sector of activity and mother's level of education (Table 2).

Multivariate analysis showed that carrier status differed significantly according to the mother's level of education, all classes combined (p=0.043), but also that the mother's level of university education guaranteed a lower carrier status than secondary education OR=0.33 (0.11; 0.80) (p=0.025) (Table 3).

Table 1: Distribution of subjects according to inclusion sites.

Inclusion sites	N	Percentages (%)
Akébé medical centre	52	12
Awendjé medical centre	50	11.5
Glass medical centre	51	11.8
La Peyrie medical centre	55	12.7
London medical centre	54	12.4
Louis medical centre	50	11.5
Nzeng Ayong medical centre	56	12.9
Egypto-Gabonese hospital	66	15.2
Total	434	100

Table 2: Factors associated with asymptomatic carriage.

Facteurs	Odd ratio	IC 95 %	P values
Mother's education level primary/none	4.5	1.6-12.5	0.001
Age≥Q3	3.6	1.8-6.5	0.02
Father working in the min formal sector	2.4	1.2-3.9	0.01
Children's rank ≥median	2.3	1.3-4.1	0.006
Recruited in Akébé medical centre	2.2	1.1-4.6	0.03
Number of kids in household ≥ median	2.1	1.1-3.7	0.01

Table 3: Multivariate analysis of factors associated with asymptomatic carriage of pneumococcus in children under 2 years of age in Libreville.

Facteurs	Odd ratio	IC 95 %	P value
Mother's education level: Reference			
Secondary			0.001
University	0.34	0.11-0.81	0.02
None	1.43	0.58-3.2	0.41
Primary	1.4	0.4-4	0.56
Number of kids in household (+0, 1)	1.4	0.5-3.5	0.55
Sex			
Male	-		
Female	2.1	0.7-2.2	0.52

DISCUSSION

In this sample, women predominated (51.2%). This distribution is the same in the general population, especially the target population of our study in Gabon. In addition, a study of carriage in Ghana also found a female predominance of 54.4%.⁷ The average number of children in the home was 2.6±1.6, which is in line with data from the 2023 demographic and health survey, where the average number of children in households was 4.1.¹⁰ Most of the children in our sample came from low-income families. Around a quarter (27%) of heads of household worked in the informal sector, 30% were non-managers in the public and private sectors, and 24.4% were students, pupils, and the unemployed. The same was true of mothers, only 38% of whom were employed, although most of them worked in the informal sector. This distribution reflects the overall level of education in Libreville revealed by the EDS 2023, i.e. 60.4% of mothers had secondary education.¹⁰ The average duration of exclusive breastfeeding was 0.2±0.4 months, less than the six months recommended by WHO and UNICEF. This duration is very short, or even non-existent, and reflects the general distribution of breastfeeding in the country.¹⁰ This is very important because breastfeeding

has been described as one of the routes of transmission of pneumococcus from the environment to the child.⁴

In this sample of 434 cases, *S. pneumoniae* was found in 12.6% of children sampled in the city of Libreville. This prevalence of pneumococcal colonization is much lower than that observed in many other African countries and Europe. In a previous study of Pygmies in the Ikobé region (central Gabon), the prevalence found was 37%. However, the age group most affected was children aged between two and four (79%).⁷ From the results of the Ikobé study, we can estimate that the under-two age group also had a low prevalence, in line with the dynamic contamination over time already described. This prevalence is low compared with data from other countries. In Egypt, Ethiopia, France, and Finland, the prevalence of pneumococcal carriage in children was 30% and 34% respectively.^{4,5,7} This disparity is difficult to explain. One hypothesis is that it may be due to differences in climate. The equatorial climate, hot and humid throughout the year, could be less favorable to pneumococcal carriage. It could also be due to the time taken to acquire pneumococcal carriage, which varies according to age and region.¹¹ We also note that in all these countries, mothers breastfeed exclusively or for longer than in Gabon.¹²

The parameters associated with carriage were: the existence of siblings with more than one child, age over six months, promiscuity, and low socio-economic status (father working in the informal sector, children recruited in the Akébé district, child rank above the median, low level of education of mothers). In Ethiopia, pneumococcal carriage was also associated with promiscuity and low socio-economic status, but with a focus on specific factors such as being under the age of three, sleeping with parents, and living in a one-room house. These factors increased the incidence of baby carrying by two times compared with those who did not live in these conditions, i.e. did not sleep with their parents and lived in a house with more than one room.¹³

The association between healthy pneumococcal carriage and the existence of siblings of more than one and a child's rank higher than the median could be explained by the fact that there are several people in the home, which would increase the risk of transmission. The data on our patients' siblings included only children under five years of age, and those over five years of age living in the same house were not recorded.

The mother's level of education was found to be the factor determining the prevalence of carriage in our context. A high level of education was protective against asymptomatic carriage. This data sums up all the observations in our context. Mothers with a high level of education breastfeed less often in our country, as they have better social conditions which reduce promiscuity.¹⁰

The principal limitation of our study was the absence of possibility to undertake a specific serotyping of *Pneumococcus* strains. Lack of financial resources and also COVID-19 pandemic are the main reasons of that limitation.

CONCLUSION

This first local study of nasopharyngeal carriage of *S. pneumoniae* in children under two years of age in the city of Libreville showed that carriage is relatively frequent in our context, but lower than in other contexts. Multivariate analysis identified the mother's level of education as a factor explaining asymptomatic carriage in these children. It is essential to identify the serotypes to adapt the pneumococcal vaccine to our region. Therefore, we need to pursue our research by serotyping the strains. With this information hands, the discussion on pneumococcal vaccination can be fine-tuned in terms of which vaccine to choose and which targets to focus on.

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Conflict of interest: None declared

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