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Brief report

Streptococcus pneumoniae: prevalence in nasopharyngeal carriers of more than 50-years-old, in a Mexican rural community

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ABSTRACT

Introduction: Streptococcus pneumoniae (Sp) is the main cause of community-acquired pneumonia in the elderly, hence the importance to establish the prevalence of nasopharyngeal colonization by different Sp serotypes in adults.
Methods: from December 2009 to June 2010, nasopharyngeal cultures were taken from adults living in rural communities in Mexico for the isolation and serotyping of Sp by the Quellung reaction. Penicillin and ceftriaxone susceptibility tests were performed by the microdilution method.
Results: two hundred and thirty-six adults over 50 years old, were included. The prevalence of colonization by Sp was 21.6%. The most frequent serotypes were 19A (21%), 6A (13%), 6B and 11A (11%). All isolates were susceptible to ceftriaxone, and 52.8% of the isolates showed penicillin minimal inhibitory concentrations ≥0.12 mg/L.
Conclusion: this is the first study analyzing the nasopharyngeal colonization by Sp in adults in Mexico. Serotypes not included in any of the pneumococcal vaccines were frequently identified.

Prevalencia de colonización nasofaríngea por *Streptococcus pneumoniae*, en adultos mayores de 50 años, en comunidades rurales de México

Palabras clave:
Streptococcus pneumoniae
Portador nasofaríngeo
Adultos
Serotipos
Susceptibilidad antimicrobiana
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RESUMEN

Introducción: Streptococcus pneumoniae (Sp) es la principal causa de neumonía adquirida en la comunidad en ancianos, de ahí la importancia de conocer la prevalencia de colonización nasofaríngea y los serotipos de Sp.
Métodos: De diciembre de 2009 a junio de 2010 se realizaron cultivos nasofaríngeos en mayores de 50 años de comunidades rurales de México para la detección y serotipificación de Sp (reacción de Quellung). Se determinó la sensibilidad a penicilina y ceftriaxona mediante la técnica de microdilución.
Resultados: Se incluyeron 236 sujetos. La prevalencia de colonización por Sp fue del 21,6%. Los serotipos más frecuentes fueron 19A (21%), 6A (13%), 6B y 11A (11%). El 100% eran sensibles a ceftriaxona y en el 52,8% la concentración mínima inhibitoria de penicilina fue ≥ 0,12 mg/l.
Conclusión: Este es el primer estudio de colonización nasofaríngea por Sp en adultos realizado en México. Se identificaron con frecuencia serotipos circulantes no incluidos en ninguna de las vacunas neumocócicas.

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Introduction

Airway mucosa is colonized by various bacteria through host dependent mechanisms and microorganisms present in a certain moment.[1] Colonization by *Streptococcus pneumoniae* is usually associated with a specific number of serotypes which commonly cause invasive and localized infections.[2]

S. pneumoniae is considered the main pathogen affecting pediatric patients, young children and adults; it might be manifested as invasive pneumococcal disease (IPD), and is associated with high morbidity and mortality rates in adults older than 65 years and subjects with underlying diseases, which increases substantially with age.[3]

Epidemiological studies have shown that one of the major risk factors for colonization in adults is the coexistence with children of less than 5 years old[4]; it has already been observed that this tendency decreases with polysaccharide conjugate vaccine (PCV) administration, by herd effect.

Currently in Mexico, two available pneumococcal vaccines exist for adults; the polysaccharide vaccine of 23 serotypes (PPV23) and the conjugate vaccine of 13 serotypes (PCV13).[5]

In Mexico, PPV23 was included in the vaccination scheme in 1993, targeting population with risk factors: 60 to 64 years old as well as 65 or older. However, PPV23 does not impact on nasopharyngeal colonization, an important factor in the epidemiology of pneumococcal infections; thus, it does not confer significant protection against these mucosa infections or against a decrease of pneumococcal antimicrobial resistant strains.

At the moment of the present study only PCV7 and PPV23 existed. There are few data available on *S. pneumoniae* serotypes that cause IPD in Mexican population. From 2014 to 2017, the Dirección General de Epidemiología has reported an annual average of approximately 40 IPD cases.[6]

In addition, adult populations are not as studied as pediatric ones, although it is important to understand that PCV introduction impacts in adults, specially in the high-risk age group of 65 years and older.[3] So, it is noteworthy to know the prevalence of nasopharyngeal colonization as a surrogate indicator of *S. pneumoniae* serotypes in adults in Mexican rural communities as well as the resistance to penicillin in these strains, in order to implement preventive programs that could impact the burden of disease in these groups.

Methods

Cross sectional epidemiological, descriptive study; carried out from December 2009 to June 2010 in rural communities of Tequisquiapan, Amealco and Colon in Queretaro, México, an area with 1,840,000 inhabitants and 18 municipalities. Data recorded were: active and passive smoking, previous respiratory infection, use of antibiotics 1–3 months prior to the sample collection, cohabitation with children less than 5 years old and previous immunization within the last 5 years, with the 23-valent polysaccharide vaccine. Ethics committees of participating institutions approved the study; all participants signed an informed consent. A nasopharyngeal specimen was obtained from each participant; *S. pneumoniae* was identified by standardized microbiological methods.[7] The serotyping was conducted using the Quellung reaction with serum produced by the Statens Serum Institute (Copenhagen, Denmark); the serogroup and serotype were identified according to Danish nomenclature.[8]

Penicillin and ceftriaxone susceptibility tests were performed by the microdilution method following the Clinical and Laboratory Standards Institute procedures.[9] Isolates with penicillin minimal inhibitory concentrations (MICs) of ≤0.06 mg/L, 0.12–1 mg/L, and ≥2 mg/L were considered susceptible, intermediate, and resistant, respectively. For the purpose of this study strains with intermediate susceptibility to penicillin were clustered into the resistant strains.

Table 1
General characteristics of 236 subjects over 50 years in a Mexican rural community in Querétaro, México (2009–2010).

Characteristics	
Women, n (%)	184 (77.9)
Age, average (SD)	64.1 (10.0)
Community, n (%)	
Amealco	45 (19.0)
Colon	71 (30.0)
Tequisquiapan	120 (50.8)
Previous disease, n (%)	159 (70.3)
Previous ARI, n (%)	45 (19.0)
Previous ABP (3 months), n (%)	31 (13.0)
Coexistence with children less than 5 years old, n (%)	51 (13.1)
PPV 23V vaccination, n (%)	60 (25.4)
Daycare center residents, n (%)	1 (0.4)

ARI: acute respiratory tract infection; ABP: antibiotic prescription; PPV 23V: polysaccharide pneumococcal vaccine of 23 serotypes.

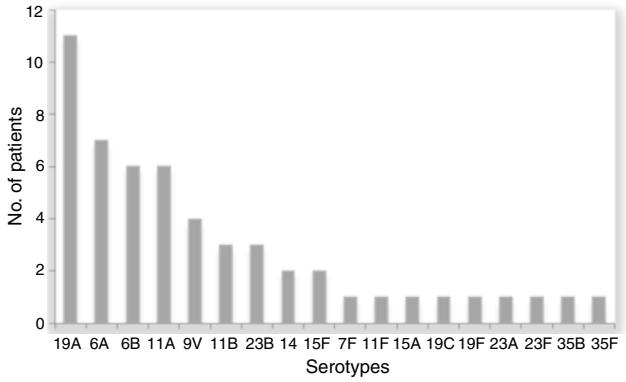

Fig. 1. Distribution of serotypes of *Streptococcus pneumoniae* nasopharyngeal isolates from 236 subjects over 50 years in a rural population of Querétaro, Mexico (2009–2010).

Statistical analysis

Statistical analysis was performed with the SPSS 16.0 software. Data were reported with measures of central tendency and dispersion. An association between *S. pneumoniae* colonization and nominal variables of interest by means of Xi-squared or Fisher's exact test was considered as more convenient, the odds ratio and its 95% confidence interval were calculated.

Results

Two hundred and thirty-six adults over 50 years old were included: 184 (77.9%) were women and 159 (67.4%) subjects had comorbidities, their general characteristics are shown in Table 1.

The prevalence of colonization by *S. pneumoniae* in the studied population was 21.6% (51/236) 95% CI 16.35–26.85. Two subjects were colonized by two different serotypes and we recovered a total 53 *S. pneumoniae* isolates. The most frequent serotypes were 19A (11), 6A (7), 6B (6) and 11A (6). The distribution of serotypes is shown in Fig. 1.

Twenty-five percent (13/53) of the serotypes were included in the PCV7, 26% (14/53) in the PCV1O, 62% (33/53) in the PCV13, and 60% (32/53) in the PPV23.

Penicillin resistance (intermediate plus resistant isolates) was detected in 52.8% (28/53). All isolates were susceptible to ceftriaxone.

There was no association between any of the variables studied with *S. pneumoniae* colonization or with penicillin-resistant isolates.

Discussion

The studied population was mestizo from rural environment, living in communities with few day care centers for adults. It should be noted that only 13.5% (32/236) of the subjects had contact with children less than 5 years.

Despite of the absence of risk factors for *S. pneumoniae* carriage in our population, 21.6% (51/236) of adults with nasopharyngeal colonization represents a prevalence among the highest described in the world[3] and indirectly shows the *S. pneumoniae* serotypes that circulate in the community.

Previous reports have indicated a prevalence between 3.7% and 38%,[10–13] with differences attributed to ethnic, geographical and social development situations. The lowest prevalence has been found in the Jewish population in Israel and the highest in Australian aborigines, who have been described with a higher risk of colonization and invasive pneumococcal disease. In addition, a study performed in Nigeria shows a 26% prevalence of nasopharyngeal colonization prior to the introduction of PCV7.[12]

In Mexico, it is not mandatory to report cases of *S. pneumoniae* invasive disease, so, nowadays its incidence is unknown in all age groups. Since 2009, Mexico adopted a vaccination scheme of 3 doses of PCV7 in children less than one year old, however, in 2011 it was replaced with the PCV13.[6]

In previous reports from other municipalities, the proportion of PCV7 vaccination with 3 doses was approximately 60%,[14] and as expected, circulating serotypes were not included in the vaccine. This possibility was confirmed with our results, finding that serotype 19A showed the highest prevalence, also reported by Carnalla-Barajas et al.[15] as the main IPD agent in the USA. The proportion of 19A serotype, isolated from invasive and non-invasive pneumococcal disease in Mexican population, has increased with time.

In regard to bacterial resistance, Mexico has recently applied a policy on antibiotic selling restriction that started prior to the recruitment of our research subjects. The rate of bacterial resistance was similar to that found in strains colonizing the nasopharynx of young children immunized with PCV7 in rural communities.[16] However, in a previous study in daycare centers, a higher rate of resistance to penicillin was found (64%).[17]

In the present study, we did not found antimicrobial resistance associated factors, and there were no ceftriaxone resistant strains, possibly because at rural communities in Mexico the use of third generation cephalosporins at outpatient level is still limited.

To our knowledge, this is the first study that analyzes the nasopharyngeal colonization by *S. pneumoniae* in adults in Mexico (21.6%). At the time of the study, there was approximately a 60% vaccination rate (PCV7) in the pediatric population and 25% of the identified serotypes are present in the PCV7. Children are the main reservoirs for the transmission of pneumococcal serotypes responsible of invasive disease in adults, but epidemiological changes observed among them should not only be attributed to the use of PCV7 or PCV13 among children, since other factors might also play an important role, for example, PPV23 vaccination in adults. However, it is unknown whether this herd effect will be similar across all serotypes and subgroups in the population. These effects might differ in populations with different serotype distributions and with higher or lower prevalence of chronic diseases among older adults. In order to choose the best prevention option, it is important to know exactly the serotypes that colonize the adult population, as well as the serotypes causing invasive and noninvasive diseases in our country.

There are several limitations in this study, it was performed during winter, thus, it was not possible to assess the seasonal variation in the colonization rate, and we did not performed molecular analysis. An analysis of a larger sample size and molecular analysis will improve our knowledge of invasive pneumococcal disease in our population.

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Conflict of interests

The authors declare no conflict of interests.

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References

1. Granato Paul A. Pathogenic and indigenous microorganisms of humans. In: Murray PR, Baron EJ, Jorgensen JH, Pfaller MA, Yolken RH, editors. Manual of clinical microbiology. 8th ed. Washington, DC: ASM Press; 2003. p. 44 [Cap. 5].
2. Hausdorff WP, Bryant J, Paradiso PR, Siber GR. Which pneumococcal serogroups cause the most invasive disease: implications for conjugate vaccine formulation and use, part I. Clin Infect Dis. 2000;30:100–21.
3. Cui YA, Patel H, O'Neil WN, Li S, Saddier P. Pneumococcal serotype distribution: a snapshot of recent data in pediatric and adult populations around the world. Hum Vaccin Immunother. 2017;13:1–13.
4. Metlay JP, Fishman NO, Joffe M, Edelstein PH. Impact of pediatric vaccination with pneumococcal conjugate vaccine on the risk of bacteremic pneumococcal pneumonia in adults. Vaccine. 2006;24:468–75.
5. Subsecretaria de Prevención y promoción de la Salud, Centro Nacional para la Salud de la Infancia y la Adolescencia. Programa de Acción Específico Vacunación Universal 2013-2018. Secretaria de Salud. México. http://www.censia.salud.gob.mx/contenidos/descargas/transparencia/especiales/PAE_Vacunacion_Universal_PAE_final_final.pdf.
6. Sistema Nacional de Vigilancia Epidemiológica Sistema Único de Información. Boletín Epidemiológico. Dirección General de Epidemiologia Mexico. 2017;44:12.
7. O'Brien KL, Nohynek H, The WHO Pneumococcal Vaccine Trials Carriage Working Group. Report from a WHO Working Group: standard method for detecting upper respiratory carriage of *Streptococcus pneumoniae*. Pediatr Infect Dis J. 2003;22:e1–11.
8. Austrian R. The Quellung reaction, a neglected microbiologic technique. Mt Sinai J Med. 1976;43:699–709.
9. CLSI. Performance Standards for Antimicrobial Susceptibility Testing; Twenty-First. Informational Supplement. CLSI document M100-S181, vol. 27. Wayne, PA: Clinical and Laboratory Standards Institute; 2008.
10. Ituzarra RH, Valenzuela MT, Trucco OA, Inostroza JS, Granata PS, Fleiderman JV. Portación nasal de *Streptococcus pneumoniae* en adulto mayor y su respuesta frente a la vacunación antineumocócica. Rev Med Chile. 2007;135:160–6.
11. Regev-Yochay G, Raz M, Dagan R, Porat N, Shainberg B, Pinco E, et al. Nasopharyngeal carriage of *Streptococcus pneumoniae* by adults and children in community and family settings. Clin Infect Dis. 2004;38:632–9.
12. Adetifa IM, Antonio M, Okoromah CA, Ebruke C, Inem V, Nsekpong D, et al. Pre-vaccination nasopharyngeal pneumococcal carriage in a Nigerian population: epidemiology and population biology. PLoS ONE. 2012;7:e30548.
13. Hammitt LL, Bruden DL, Butler JC, Baggett HC, Hurlburt DA, Reasonover A, et al. Indirect effect of conjugate vaccine on adult carriage of *Streptococcus pneumoniae*: an explanation of trends in invasive pneumococcal disease. J Infect Dis. 2006;193:487–94.
14. Díaz-Ortega JL, Ferreira-Guerrero E, Trejo-Valdivia B, Téllez-Rojo MM, Ferreyra-Reyes L, Hernández-Serrato M, et al. Cobertura de vacunación en niños y adolescentes en México: esquema completo, incompleto y no vacunación. Salud Publica Mex. 2013;55 Suppl 2:S289–99.

15. Carnalla-Barajas MN, Soto-Noguerón A, Sanchez-Aleman MA, Solorzano-Santos F, Velazquez-Meza ME, Echaniz-Aviles G. Changing trends in serotypes of *S. pneumoniae* isolates causing invasive and non-invasive diseases in unvaccinated population in Mexico (2000–2014). Int J Infect Dis. 2017, http://dx.doi.org/10.1016/j.ijid.2017.02.005.
16. Espinosa de los Monteros LE, Aguilar F, Jiménez RN, Rodríguez RS, Gómez D. *Streptococcus pneumoniae* serotype replacement in nasopharyngeal colonization in children vaccinated with PCV7 in Mexico. Salud Publica Mexico. 2010;52:4–13.
17. Espinosa de los Monteros LE, Jiménez V, Aguilar F, Cashat M, Reyes A, Rodríguez R, et al. *Streptococcus pneumoniae* isolates in healthy children attending day-care centers in 12 states in Mexico. Salud Publica Mexico. 2007;49:249–55.