Burden of pneumococcal infection in adults in Colombia

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KEYWORDS
Streptococcus pneumoniae;
Cost of illness;
Pneumonia;
Meningitis;
Bacteremia

Abstract
Introduction: The burden of Streptococcus pneumoniae infections is highest in children. Estimates in adult population are uncommon. We determined the burden of disease associated with pneumococcus in adults in Colombia in year 2008.
Methodology: Using different data sources (official mortality records, medical databases, published literature and local epidemiological data) we estimated prevalence, incidence, mortality and disability due to bacterial pneumonia, bacterial meningitis and bacteremia of any cause for year 2008, and the fraction of these that can be attributed to S. pneumoniae.
Results: A total of 63,463 DALYs are lost due to S. pneumoniae in Colombians age 15 or over. Most of this burden (51,848 DALYs, 81.7%) is due to pneumonia, followed by meningitis (9241 DALYs, 14.6%). The three conditions, overall, represent 2.03 DALYs per 1000 Colombians in that age range.
Conclusions: Despite the lower incidence of pneumococcal disease in adults, as compared with children, its burden is still significant, comparable to that of schizophrenia or epilepsy. This study may provide a benchmark for future preventive interventions.
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Introduction
Burden of disease studies provide useful information on the priority setting in public health. This type of study was pioneered in the United States as an initiative of the World Health Organization (WHO). The aim was to prioritize interventions for countries at different stages of development [1,2] and to consider this information in a cost-effectiveness context, establishing the possible impact of individual interventions [3,4].
DALYs (Disability-Adjusted Life Years) were developed as a single-utility measure to determine the burden attributable to a specific disease...
or group of diseases. DALYs combine premature mortality (years of life lost because of premature mortality, or YLLs) with morbidity (years of healthy life lost as a result of disability, or YLDs), which are weighted by the severity of the disability. In contrast with the QALY (Quality-Adjusted Life Year), which provides a measure of health gains, the DALY shows health losses, reflecting the severity of a disease on a scale from 0 (equivalent to perfect health) to 1 (death) [1].

In Table 1, we present the ten most important medical conditions ranked according to their burden of disease per 1000 Colombians of all ages in 2005 [5].

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Condition</th>
<th>DALYs</th>
<th>YLD</th>
<th>YLL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hypertension</td>
<td>53.521</td>
<td>52.627</td>
<td>0.895</td>
</tr>
<tr>
<td>2</td>
<td>Major depression</td>
<td>47.304</td>
<td>47.302</td>
<td>0.001</td>
</tr>
<tr>
<td>3</td>
<td>Dental caries</td>
<td>26.277</td>
<td>26.277</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Birth trauma</td>
<td>15.506</td>
<td>12.219</td>
<td>3.287</td>
</tr>
<tr>
<td>5</td>
<td>Violence</td>
<td>14.795</td>
<td>0.082</td>
<td>14.713</td>
</tr>
<tr>
<td>6</td>
<td>Low birth-weight</td>
<td>11.218</td>
<td>11.055</td>
<td>0.162</td>
</tr>
<tr>
<td>7</td>
<td>COPD</td>
<td>9.812</td>
<td>8.469</td>
<td>1.344</td>
</tr>
<tr>
<td>8</td>
<td>Asthma</td>
<td>9.223</td>
<td>9.041</td>
<td>0.182</td>
</tr>
<tr>
<td>9</td>
<td>Glaucoma</td>
<td>7.001</td>
<td>7.001</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Ischemic heart disease</td>
<td>6.008</td>
<td>0.350</td>
<td>5.659</td>
</tr>
</tbody>
</table>

YLD, years lost to disability; YLL, years of life lost; COPD, chronic obstructive pulmonary disease.

**Table 1** The ten most important medical conditions in Colombia, ranked according to their burden in DALYs per 1000 Colombians of all ages (adapted from [5]).

**Methods**

We estimated the incidence of pneumococcal disease in the Colombian population age 15 or older for 2008 using different sources. Colombia has a nationwide mandatory registry of health interventions called RIPS (Spanish for Individual Registry of Health Services), which was created in 2000. RIPS currently contains data on age, gender, and medical diagnosis (codified according to the International Statistical Classification of Diseases and Related Health Problems version 10 [ICD-10]) for patients treated by the Colombian health system in each calendar year by both public and private providers. The ICD-10 codes used were as follows: G00, G01, G03.9, G04.2, G04.8, and G04.9 for meningitis; A40 and A41 for bacteremia; and J13-J16 and J18 for pneumonia. An adjustment was performed to correct for underreporting (a statistical analysis by Rodriguez-Garcia [13] estimated that RIPS reported 35% of actual cases). One assumption was that underreporting affects all age groups equally. Because underreporting is higher in local, rural and small hospitals, we assumed that pneumonia data would be more uncertain than bacteremia and meningitis, which are generally treated in larger, more complex hospitals. Therefore, we also performed estimations in a second scenario assuming that the incidence and prevalence data for pneumonia in Colombia were similar to the incidence and prevalence estimated by Murray and Lopez for the whole of Latin America, based on Argentinian, Brazilian and Chilean information sources [2].

To estimate mortality, we searched the 2008 database of the Colombian National Statistics Agency (DANE), which contains general population mortality rates and specific mortality rates for bacteremia, meningitis, and pneumonia. The cause of death is determined by the physician, who signs the death certificate, and is classified using ICD-10 codes. For convenience, the information was grouped into the same five age intervals used by DANE: 15—44, 45—64, 65—74, 75—80, and >80 years. The 2008 Colombian population for each age group was estimated by interpolating data from the 2005 population census and official projections for 2010 (see Table 2).
Table 2  Crude Colombian mortality for each of the conditions of interest.

<table>
<thead>
<tr>
<th>Age</th>
<th>Population</th>
<th>Total deaths</th>
<th>Bacteremia</th>
<th>Meningitis</th>
<th>Pneumonia</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-44</td>
<td>20,756,067</td>
<td>34,770</td>
<td>135</td>
<td>161</td>
<td>648</td>
</tr>
<tr>
<td>45-64</td>
<td>7,689,285</td>
<td>37,289</td>
<td>258</td>
<td>137</td>
<td>971</td>
</tr>
<tr>
<td>65-74</td>
<td>1,781,219</td>
<td>67,381</td>
<td>354</td>
<td>63</td>
<td>3124</td>
</tr>
<tr>
<td>75-80</td>
<td>527,843</td>
<td>14,051</td>
<td>178</td>
<td>33</td>
<td>846</td>
</tr>
<tr>
<td>80+</td>
<td>557,334</td>
<td>27,235</td>
<td>351</td>
<td>58</td>
<td>899</td>
</tr>
<tr>
<td>Total</td>
<td>31,311,748</td>
<td>180,726</td>
<td>1276</td>
<td>452</td>
<td>6488</td>
</tr>
</tbody>
</table>

Source. DANE (2008), adjusted for underreporting.

In the DANE figures, mortality rates are reported for persons older than 65 years as a single age group. We assumed a constant proportion of deaths attributable to pneumonia, meningitis or bacteremia for any cause. Mortality rates were also adjusted for underreporting, which has been estimated at 9% by two independent studies [5,14]. This rate was applied equally to all age groups (assumption based on Ruiz and Hincapie [14], who found the highest underreporting for newborns and infants).

DALYs attributable to disability were calculated using the standard method proposed by Murray and Lopez [1]. The final value results from the average weight of disability from the sequelae associated with each disease. Because disability weights specific for Colombia have not been estimated, we assumed weights reported by a Chilean burden of disease study [15], which were 0.521 and 0.920 for the acute phases of pneumonia and bacteremia, respectively, and 0.541 for the sequelae of meningitis (which, in contrast to the other two diseases, was applied to the entire life expectancy). This last weight is compatible with a meta-analysis by Jit [16], who reviewed 63 studies that involved 3408 patients who survived pneumococcal meningitis. In his paper, the following sequelae were identified: hearing loss (20.9%), seizures (6.5%), hydrocephalus (6.8%), spasticity/paresis (8.7%), cranial nerve palsies (12.2%), and visual impairment (2.4%). Based on our panel of experts, we assumed that survivors of pneumonia and bacteremia had no sequelae, so YLDs were estimated during the acute phase of the disease only (which was assumed to last for two weeks for both pneumonia and bacteremia).

To estimate the DALYs attributable to premature death, we used, as is the current practice [1,2], Japanese life-expectancy tables adjusted by age and gender. DALYs are conventionally estimated using the following formulas:

\[ \text{DALYs} = \text{YLLs} + \text{YLDs} \]

where YLLs are years of life lost and YLDs are years lost to disability. The YLL and YLD formulas incorporate three key assumptions: \( r \) is the annual discount rate, and \( K \) and \( \beta \) are parameters for weighting the function of age. To reflect the base case recommended and used by Murray and Lopez [1,2], our calculation assumes \( r = 0.03 \), \( K = 1 \), and \( \beta = 0.004 \), which means that we use an annual discount rate of 3% and differential weight for age.

Because RIPS provides information on bacterial pneumonia, bacterial meningitis and bacteremia of any cause, we estimated the burden of disease attributable to \( S. \ pneumoniae \) for each condition by calculating the proportion of cases caused by this microorganism according to published regional epidemiology records (search strategy: "(Pneumonia, Bacterial/epidemiology)" [Mesh] OR "Meningitis, Bacterial/epidemiology" [Mesh] OR "Bacteremia/epidemiology" [Mesh]) AND ("Latin America" [Mesh]) in PubMed, with equivalent searches for Embase and SciELO). These proportions were broadly assumed to be 80% of all community-acquired pneumonia [17-21], 50% of all bacterial meningitis cases [22,23] and 20% of all bacteremias [24] in adults.

Results

According to official records, in 2008, 7476 deaths were attributable to any of the three diseases of interest (pneumonia, bacteremia and meningitis of presumed or confirmed bacterial origin). After adjusting for 9% underreporting, these figures accounted for 4.5% of all deaths in that period (see Table 2 for adjusted mortality).

During this same period, 55,758 episodes of bacterial pneumonia, 350 cases of bacteremia, and 336 cases of bacterial meningitis were reported nationwide in RIPS. These data were adjusted by assuming that they represented 35% of all cases [13]. Table 3 shows the total DALYs attributable to
pneumococcal pneumonia in Colombia in the two scenarios (adjusting for underreporting and extrapolating data from Murray and Lopez [2]). In both cases, most of the burden for pneumonia is due to premature mortality.

In Table 4, we present our estimations of the burden of bacteremia and meningitis attributable to S. pneumoniae. As shown, most of the burden in bacteremia is due to premature mortality, whereas the impact of meningitis is due to its associated disability. In Tables 3 and 4, we present the results both as the absolute number of DALYs and as a ratio per 1000 inhabitants.

### Discussion

This study has several limitations, which are mainly due to the quality of local information. Colombia is attempting to improve its health-related information systems, and its mortality records are considered quite reliable. The registration of health interventions, however, still underreports morbidity, and the adjustment we performed could be open to discussion, particularly when applied equally to all age groups. A recent paper by Castaneda-Orjuela et al., who used different sources to estimate the incidence of invasive pneumococcal disease in the capital city of Bogota, showed figures similar to ours [25]. The fraction of infections that could be attributable to S. pneumoniae is another limitation of our analysis; crude figures for bacterial pneumonia, meningitis and bacteremia are, no doubt, closer to reality.

With these limitations and based on our data, the burden of pneumococcal disease in adults in Colombia could be expressed as 2.03 DALYs per 1000 inhabitants when we combine pneumonia, meningitis and bacteremia attributable to S. pneumoniae. This result places this group of diseases in a position close to those held by schizophrenia (with 2.65 DALYs per 1000) and epilepsy (2.07 DALYs per 1000) [9].

In this paper, we provide an estimate of pneumococcal disease in a population that has not been seriously considered, even in developed countries. Most of the burden is represented by pneumonia, which has a high incidence and is an important cause of death throughout the entire lifespan. Pneumococcal meningitis causes severe disability,
Despite its relatively low incidence. The total number of DALYs, with more than sixty thousand lost per year, and the relative impact per 1000 Colombian adults can be considered clinically significant and can provide a benchmark to estimate and evaluate future preventive interventions.

Competing interests

None declared.

Ethical approval

Not required.

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References


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