



## Early View

Research letter

### **Geographic distribution of COPD prevalence in the World displayed by Geographic Information System maps**

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**TITLE: Geographic distribution of COPD prevalence in the World displayed by Geographic Information System maps**

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To the editor:

Existing data on COPD prevalence are irregularly distributed around the world, and in many geographic regions data are scarce or even non-existent. This fact hinders the implementation of adequate preventive and therapeutic interventions in order to reduce the high burden and costs of COPD [1]. In the current study, we have used the Geographic Information System (GIS) inverse distance weighted (IDW) interpolation technique with the objective of visualizing spatial data of COPD prevalence in the world and obtain a visual impression of the magnitude of this global health problem. GIS has been recognised as an effective tool to display the geographical distribution of data, even when they are few and widely separated, as is the case with the prevalence of COPD [2-4].

We have conducted a systematic literature search of Medline, EMBASE (via Ovid) and Google Scholar, from January 1995 to March 2019. The search focused on the identification of population-based surveys on COPD prevalence rates, conducted in samples representative of the general population on individuals aged 40 and older, and airflow limitation compatible with a COPD diagnosis using validated spirometric criteria. The process of articles selection and the results of the selected papers has been described in detail in recent publications [5-7]. To complete the original database, data from five other studies published throughout 2018-19 were added to the previous selected ones [8-12]. Data obtained from the search were analysed using GIS. GIS is a computerised mathematical approach able to extract new information from the available data, using points with known prevalence values to estimate prevalence at other unknown points, finally covering a whole area [3]. The methodology used to develop the GIS maps has been described in detail previously by the authors [5-7]. In brief, the GIS-IDW interpolation computer program uses the prevalence rates obtained from the surveys combined with the geographical coordinates of the places where they were conducted in order to create raster images with data encoded by pixel values and locations. In the resulting map blue and green tones represent low values ( $\leq 8\%$ ); yellow, intermediate (9-15%); orange, high (16-20%);

red, very high (>20%), and the sparsely populated areas with less than 1 inhabitant / km<sup>2</sup> appear shaded in white.

The results of the search produced a total of 147 surveys (64 from Europe, 10 from Africa, 17 from the Americas, 53 from Asia, and 3 from Oceania). Eighteen (12.2%) surveys used the lower limit of normal and the remaining 129 used the GOLD criteria of fixed ratio of forced expiratory volume in one second (FEV1)/ forced vital capacity (FVC) <0.7. The estimated worldwide COPD mean prevalence (expressed in percent and 95% confidence intervals) was 13.1% (10.2%-15.6%), with the following distribution by continents: Europe 12.4% (8.8%-16.0%), Africa 13.9% (12.0%-15.9%), America 13.2% (10.5%-15.9%), Asia 13.5% (10.0%-16.0%) and Oceania 11.6% (9.8%-13.1%).

The areas of very high COPD prevalence, represented by intense red shadows were found in the South-Western extremity of the African continent, with 23% in Cape Town. In the Russian regions of the East European Plain and the Central Siberian Plateau bordering Ukraine, Kazakhstan and Mongolia the mean prevalence was 21.8%. Finally, the center of Iran (prevalences ranging from 16.9% to 22.2%), the region of Nueva Ecija in Philippines (20.8%), and some areas of central Europe, such as the Po Delta Area (23%), Salzburg (26%) Munich (21%) and North of England and Scotland (Ashington 25% and Glasgow 24%), among others, were also shaded in red (Figure 1).

Orange shades, indicative of COPD prevalence between 16% and 20%, covered a large part of Europe and Russia; large regions of Central and Western Asia, North-Eastern China, and the Malay Archipelago of Southeast Asia. Large areas of Africa and North and South America were also shaded in orange.

Most of the remaining regions of the world were shaded in yellowish tone, indicative of intermediate prevalence (9%-15%). There were several relatively small territories, scattered across all continents, with low COPD prevalence shaded in bluish or greenish tones, including the Easternmost regions of North Asia, South India (Bangalore 4.4%), some areas of the

Arabian and the Anatolian peninsulas (Abu Dhabi 3.7%, Riyadh 4.2% Erzurum 5%), and some coastal regions of the North-Western South America (Temuco 6.4%, Peru 6%). Finally, the sparsely populated areas around the world (including Antarctica, Northwest Alaska, the great North of Canada, the Labrador Peninsula, Greenland, the Amazon basins and their tributary rivers, some areas of the Andean Altiplano and Patagonia, and the various desert and semi-desert lands from all continents) appeared without shading indicating the lack of reliable epidemiological information.

In a systematic review and meta-analysis published in 2015, Adeloye et al [13], using the same criteria as in the current study, identified 123 surveys with a global prevalence of COPD in 2010 of 11.7% (95%CI: 8.4%-15.0%). Interestingly, they observed an increase in prevalence from 1990, when the prevalence observed was 10.7% (95%CI: 7.3%-14.0%). Our study, including 24 more recent studies, suggests an increase in prevalence up to 13.1% and confirms the tendency towards a global increase in prevalence of COPD.

Complementing the numbers obtained in our analysis of prevalence, the GIS methodology provides a complete map of all regions of the world, including those without real data. This analysis has limitations related to the epidemiological methods used in the original prevalence studies, and to the GIS technique. For example, the data used to compile the database of the GIS program were derived from studies conducted from the 1990s to more recent years [13].

GIS is a highly accurate computerized statistical system with mathematical precision [14]. In our study, owing to scarcity of epidemiological surveys, many geographical regions were shaded by data interpolation using the nearest four values of the neighbouring regions of the same country, or in some cases using values of nearby countries. This may have resulted in loss of precision of prevalence estimates for those regions. GIS method does not take into account ethnic, racial, cultural or political boundaries within and across countries. These factors may be associated with different social habits, languages, inbreeding, feeding, smoking, occupational

and environmental pollutants exposure, and quality of public health services and accessibility to care providers, that may modify the prevalence of COPD.

In summary, the present study indicates a global increase in COPD. Because of its ability to present complex data in visually appealing fashion, GIS is a powerful epidemiological tool to convey the current and future epidemiology of COPD and other respiratory diseases [15].

### **CONFLICT OF INTEREST**

Marc Miravittles has received speaker fees from AstraZeneca, Boehringer Ingelheim, Chiesi, Cipla, AstraZeneca, Menarini, Rovi, Bial, Zambon, CSL Behring, Grifols and Novartis, consulting fees from AstraZeneca, Boehringer Ingelheim, Chiesi, GlaxoSmithKline, Bial, Gebro Pharma, CSL Behring, Laboratorios Esteve, Ferrer, Mereo Biopharma, Verona Pharma, TEVA, pH Pharma, Novartis and Grifols and research grants from GlaxoSmithKline and Grifols, outside the submitted work. The remaining authors have no conflicts of interest related to this manuscript.

**CONTRIBUTIONS OF AUTHORS:** All the authors have contributed to the elaboration of the manuscript, and have approved its final version. IB, ID, and MM are the guarantors of the paper.

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**Figure 1.** IDW interpolation map of COPD prevalence in the World.

Orange and red shadows, indicative of high/very high COPD prevalence, appear in extensive regions of Northern and Southern Asia; Eastern and Southern Africa; most regions of Europe; southeast and southwest Canada bordering the US; in the American regions surrounding the Great lakes, and the Ohio and the upper Mississippi rivers; and in several coastal areas of Brazil, Uruguay and Argentine bordering the South Atlantic Ocean. Most of the rest of the world regions are shaded in yellow tones indicative of intermediate prevalence. In addition, there are some small areas shaded green and blue due to their low COPD prevalence, as well as several sparsely populated or depopulated areas, scattered across all continents, shaded in white due to lack of data.



