Title: The Global Inverse Care Law: A Distorted Map of Blindness

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Statistical analysis can be used to interpret and give meaning to data, however, the ability to interpret large quantities of data and it's resulting statistical reporting is not always straightforward. Graphical representations such as graphs and maps are a way of translating or converting data in to a visual interpretation.

Commonly used world maps are imperfect and contain distortions to allow a spherical reality to be represented in 2-dimensions. This distortion can be manipulated to produce a world map that gives each defined area (country or region) a size proportional to its population.[1]

Cartograms are used to effectively map socio-economic data and can be effective means of mapping disease. In keeping with the phrase "a picture equals a thousand words" cartograms can be used to analyse spatial data in an easily comprehensible style.

In 1971, Hart[2] described the, "Inverse Care Law" as the availability of good medical care varying inversely with the need for it in the population served. Hart was describing the situation in the National Health Service in Great Britain at the time in which he practiced as both a General Practitioner and an epidemiologist.

Two recently published articles demonstrate the “Inverse Care Law” on a global level. The prevalence of blindness worldwide in 2010[3] was reported by the World Health Organisation and verified that low- and middle-income countries, as expected, have the highest prevalence of blindness and visual impairment. In stark contrast to this, a more recent report describes the, “Number of ophthalmologists in training and practice worldwide”[4] providing global data for the number of ophthalmologists per county and demonstrates that despite a growing number in practice the gap between need and supply is widening.

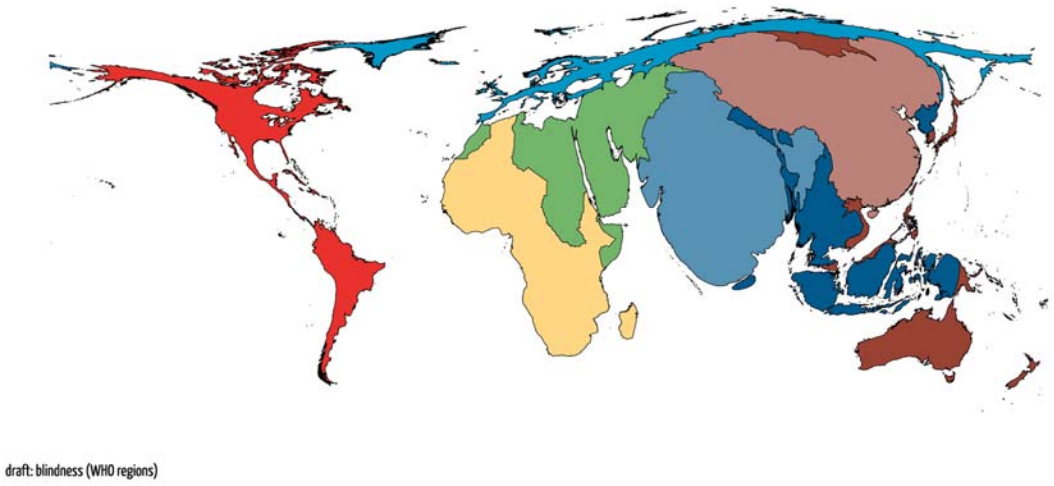
The situation is also magnified within individual countries of high, middle and low-income. For example, in France, an inverse correlation was found between the number of ophthalmologists and the prevalence of low vision for subjects of similar age and socio-professional category[5] and another example is in Kenya where of the 86 practicing ophthalmologists, 43 are based in Nairobi [personal correspondence]. That equates to 50% of the countries ophthalmologists serving 8% of an already underserved population.

We have developed two cartograms to depict the data from these two papers [3 4] using ESRI’s ArcGIS 10 software with the Cartogram Creator. These tools apply the Gastner & Newman diffusion-based method [6]. This allowed us to create density-equalised maps based on the absolute values provided in the papers. In the maps, each of the reference areas (WHO regions and countries) is resized according to these values. Larger areas represent higher numbers and smaller areas proportionally smaller data values (see figures 1 and 2).

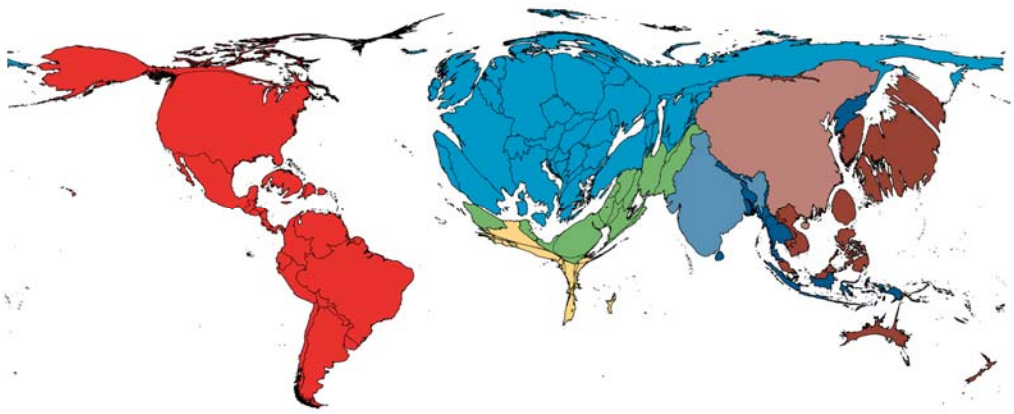
We believe these maps can be used to share masses of data in a visual, intuitive and comprehensible way, which will be understood by policy makers and can be used by advocates for global health.

Figure 1 Legend: A Cartogram showing the prevalence of blindness by WHO region (using WHO region colours).

Figure 2 Legend: A Cartogram showing the number of practicing ophthalmologists worldwide by country.



draft: blindness (WHO regions)



draft: ophthalmologists (coloured by WHO regions)

References: (Output Style: BMJ EndNote)

1. Dorling D, Barford A, Newman M. WORLDMAPPER: the world as you've never seen it before. IEEE Trans Vis Comput Graph 2006;**12**(5):757-64 doi: 10.1109/TVCG.2006.202[published Online First: Epub Date]|.
2. Hart JT. The inverse care law. Lancet 1971;**1**(7696):405-12
3. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. The British journal of ophthalmology 2011 doi: 10.1136/bjophthalmol-2011-300539[published Online First: Epub Date]|.
4. Resnikoff S, Felch W, Gauthier TM, et al. The number of ophthalmologists in practice and training worldwide: a growing gap despite more than 200 000 practitioners. The British journal of ophthalmology 2012 doi: 10.1136/bjophthalmol-2011-301378[published Online First: Epub Date]|.
5. Lafuma AJ, Brezin AP, Fagnani FL, et al. Prevalence of visual impairment in relation to the number of ophthalmologists in a given area: a nationwide approach. Health Qual Life Outcomes 2006;**4**:34 doi: 10.1186/1477-7525-4-34[published Online First: Epub Date]|.
6. Gastner MT, Newman ME. From The Cover: Diffusion-based method for producing density-equalizing maps. Proceedings of the National Academy of Sciences of the United States of America 2004;**101**(20):7499-504 doi: 10.1073/pnas.0400280101[published Online First: Epub Date]|.