Epidemiological study of enteric infections in children by comparing different countries

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RESUMEN

Correlaciones entre muertes por diarrea en niños y parámetros tanto socioeconómicos como ambientales, son estudiadas aquí para 10 países, mostrando asociaciones entre casos y población, lluvia y producto interno bruto (PIB). Las variables correlacionadas incluyen: casos de muerte, población (total y densidad), área (tierra y agua), temperatura promedio, lluvia, productividad, desigualdad de ingreso (índice Gini), indicador de alta tecnología (tecnología de desarrollo de armas nucleares). Cuando se divide en 2 grupos la base de datos: países desarrollados y en desarrollo, algunas asociaciones crecen para los países en desarrollo (R más grandes, p-values <0.05). Las correlaciones encontradas aquí apoyan que el exceso de lluvias y los asentamientos atestados contribuyen a la transmisión de las infecciones; dando a entender que la densidad de población impone un límite práctico en el control de las infecciones entéricas en los países en desarrollo.

Palabras clave: diarrea, niños, países en desarrollo, infecciones entéricas.

ABSTRACT

Correlates among diarrhea-deaths in children, and social and environmental parameters, are studied here for 10 countries, showing significant associations among cases and population, rainfall, and gross domestic product (GDP). The variables correlated include: cases, population (total and density), area (land and water), average temperature, rainfall, productivity (GDP), income inequality (Gini index), and hi-technology indicator (by nuclear weapons technology). When the dataset is split in two sets: developed and developing countries, some of the associations for developing countries grow up (larger R, p-values < 0.05). Correlations found here support that excessive rainfall and crowded settlements contribute to the transmission of infections; hinting that population density imposes a practical boundary in controlling enteric infections in developing countries.

Key words: diarrhea, children, developing countries, enteric infections.

INTRODUCTION

The World Health Organization WHO, estimated that 35% of deaths in children are associated with malnutrition (WHO UNICEF 2013), being pneumonia and diarrhea the two leading killers. The enteric infections overt diarrhea and are estimated to cause 760,000 deaths in children of developing countries where about 1.1 billion people have no safe drinking water and 2.6 billion lack of pit latrines (Petri *et al.,* 2008, Viau *et al.,* 2011). Advances in fighting diarrhea, include the use of glucose electrolyte ORT, vaccination when possible, and application of antibiotics and antiviral drugs, these have greatly diminished the amount of deaths, from 4.6 million per year in 1980's, to 0.76 million in 2013; however the morbidity of enteric infections has not decreased, adding up to 1.7 billion cases worldwide, potentially impairing the hosts for life, and shortening their life expectancy (Petri *et al.*, 2008, WHO 2013b).

The transmission and spreading of enteric infections are strongly associated to hygiene when preparing and eating food, and to keeping separate the human and domestic animal excretions. Here we observe variables as indirect indicators of inadequate domestic hygiene, such as population density as indicator of crowded towns, and probably not clean, GDP as measurement of wealth/productivity per capita, indirectly indicating existence of sewage, latrines or WC in houses, and adequate disposal of biologic trash, Gini as indicator of income inequity or poverty, number of nuclear weapons as indirectly signaling hi-technology and infrastructure available in the country. Temperature, rainfall and water area (km of total area), may be good indicators of pathogens survival and spreading by being carried in streams to surface or to groundwater, and far away locations. However all these are indirect indicators, careful interpretation is needed to better understand spreading of infections.

This study looks for the possibility of find interesting “external” factors to the spreading and transmission of enteric infections, here are neither considered host's nor germ’s parameters.

METHODS

This is a statistical analyzes of correlates among number of diarrhea-deaths in children (or cases), and social and environmental parameters: population (total and per square kilometer), productivity (GDP per capita), wealth inequity % (Gini index), rain precipitation per year (mm/year), annual average temperature (Celsius), and total water area (km^2) in different countries. The inclusion of nuclear weapons here, serves because the technology to develop the nuclear weapons and the infrastructure needed in that, tell that the country have those human, software and hardware resources. By the end of this manuscript, May 2015, the data collected was analyzed and reported, however notice this is a continued effort.

DATA BASE: Petri *et al.*, (2008) reported that China and Pakistan had about 120,000 deaths caused by diarrhea in children under 5 yo. in the year 2000, India had more than 450,000 deaths, Mexico had 12,500 deaths, Myanmar 35,000 deaths. The USA Center of Disease Control and Prevention CDC, reported 400 deaths due to diarrhea for 1992, dropping to about 50 by 2012 (CDC 1992; CDC 2012), The population, population density, GNP and Gini indexes, rain fall, temperatures averages, and nuclear capabilities were acquired from Wikipedia.org* by searching for: “Climate of *country”* and “*Country*”. Notice that for Myanmar (previously Burma) was not found the Gini index, and the rainfall amounts were neither found for Colombia nor Cameroon with the precision required by the end of this report. (*Note that Wikipedia collects information from accredited international databases such as: International Monetary Fund, Britannica Encyclopedia, CIA, United Nations, etc.)

Statistical analyses and graphs by SPSS 16.0 (2007).

RESULTS AND DISCUSSION

The number of death cases is significantly associated with the population, total (R=.742, p-value=.014, N=10) and density (R=.801, p=value=.005), and with rain fall per year (R=0.77, p-value=.024, N=8). The cases per million inhabitants per square kilometer, are significantly correlated with GDP, Gini indexes, and rain (R=-.636, p-value=.048, N=10; R=- 0.635, p-val=.066 N=9; R=.669, p-val=.07) and cases per population density are associated with GDP, rain (R=-.62, p-v=.057, N=10, and R=.794, p-v=.019, N=8), some associations shown in Figures 1 and 2. If the dataset is split in developed and developing countries, cases per million habitants is strongly associated with GDP index (R= -0.922, p-value=.001, N=8) as graphically shown by Scatter plot in figure 2. Some complicated variables may help to understand infections, but need for more analyses on them should be done, for example GDP*Gini vs. cases/pop (R= - .811, p-value < 0.027, N=7). The factorization of GDP by Gini index magnified, as expected, the correlations, highlighting that income inequality is associated with infective diseases.

The larger countries in respect to inhabitants are China (1.3 billion people) and India (1.2), but China extends in almost three times the area of India, resulting in 0.38 times the India's population density, explaining partially, why are fewer cases in China and more than expected in the UK.

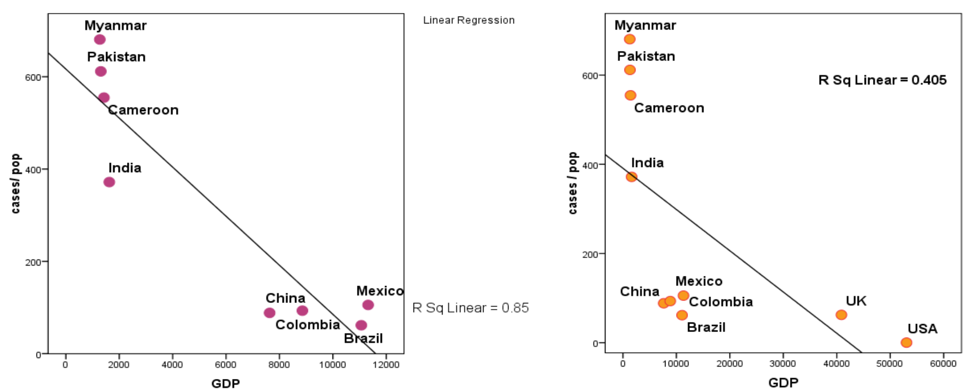

Figure 1. *Association between child death cases per million of population, and GDP. Left Scatter plot for 3rd world countries (R= - 0.922 p-value=0.001, N=8), right plot includes USA and UK which decreases the correlation and its significance (R= - 0.636, p-value=0.048, N=10)*

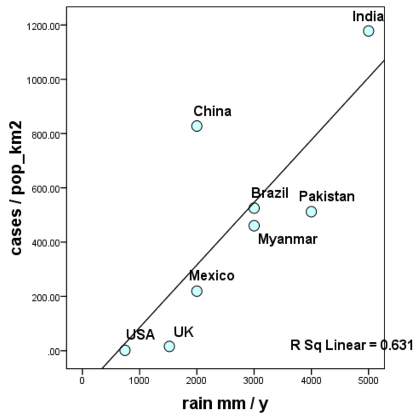

Figure 2. *Association between child death cases per population density and total rain fall per year in millimeters (averages),*R=.794, p-value=0.019, N=8. *The Southern Asia Monsoon affects to India, Pakistan and Myanmar (of the studied here). (rain data only for 8 countries).*

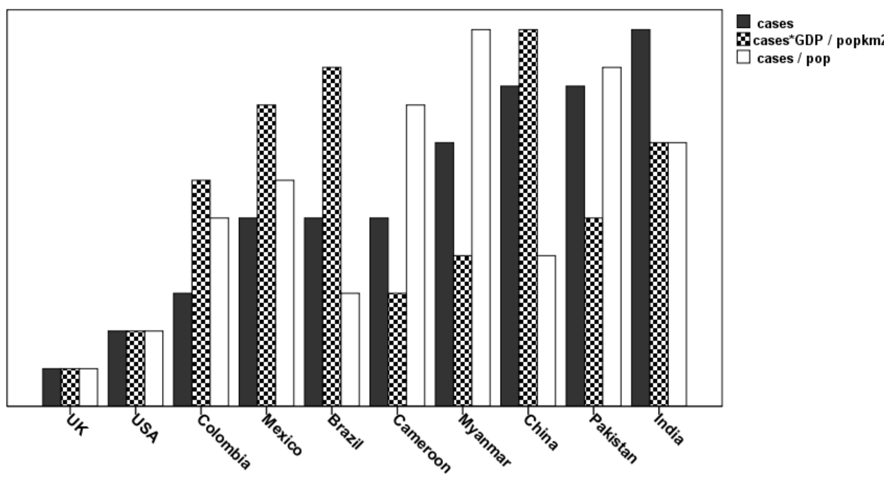

Figure 3. *Comparison of ranks: cases of death in children (black), deaths per population (clear), and deaths per population density times GDP (chess pattern), which also can be interpreted as some kind of cost in $US dollar of diarrhea-deaths in children. India change place comparing cases vs. cases* GDP/popkm2 (cases*GDP/pop/km^2), and cases vs. cases/population.*

To consider the productivity in the analysis, we test if GDP (productivity) is linked to deaths of children by enteric infections. When the number of child deaths are divided by population-density, and multiplied by GDP, the pattern changes. Figure 1 shows some differences between 1st and 3rd worlds. The Figure 2 shows rainfall associations (detailed rain data were found only for 8 countries by the end of this report), and Figure 3 add the wealth of every country as GDP. The three BRIC countries studied here (Brazil, India and China) show, as a group, the smallest average value of deaths in the 3rd world studied, however these individual countries of BRIC, have very high absolute number of cases. (By the time this report was produced, could not find enough precise data for Russia). Considering population and GDP, India ranks as more advanced country than it ranks for cases, moving from the country with more cases, to ahead of Mexico, Brazil, and China; and in other hand Mexico falls among the worst cases*GDP/pop/km2, despite of wealth, see Figure 3. Therefore the wealth appears not such an important factor, in Mexico, for helping to prevent child death by diarrhea.

CONCLUSIONS

The most important associations among the social and environmental variables studied here, with cases of deaths in children caused by enteric pathogens, suggest that population density and rain are factors helping infections to constantly spread throughout the population, despite of GDP, Gini or Hi-Tech (nuclear) capabilities. Most of the enteric pathogens have smaller decay times in water than in dry environments; notice that India, Pakistan and Myanmar are subjected to the extreme South-Asia Monsoon phenomenon, and then they are the most affected by humidity in summer when the highest temperatures run by the countries.

The product of death cases times GDP divided by population (or population density too), may give a useful variable for studying developing countries, as shown in Figure 3. For example the fact that in Mexico die between 5,000 and 20,000 children per year (WHO 2013), when Mexican GDP per capita is high among developing countries, tells that wealth, or medium technological product (GDP), is not an important factor, in Mexico, to controlling children deaths due to diarrhea.

Correlations found here support that excessive rainfall and crowded settlements contribute to the transmission of infections; hinting that population density imposes a practical boundary in controlling enteric infections in developing countries.

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