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Classification of incidence and prevalence of certain sexually transmitted infections by world regions

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SUMMARY

Objectives: This study sought to assess if there is a meaningful way in which variations in sexually transmitted infection (STI) prevalence can be classified at the level of world regions.
Methods: Linear regression was performed to assess if the incidence and prevalence of six STIs (HIV, herpes simplex virus type 2, chlamydia, gonorrhea, syphilis, and trichomoniasis) by world region was positively correlated. Partitioning around medoids (PAM) was then used to assess if the regions of the world can be classified according to the incidence and prevalence of these STIs.
Results: We found evidence that STI incidence/prevalence varies considerably in different regions around the world. Linear regression revealed that the incidence and prevalence of certain STIs by world region was positively correlated (Pearson's correlation coefficient varied from 0.664 to 0.985). PAM provided support for dividing the world regions into two, three, or four STI incidence/prevalence categories, but it provided most support for the two-category system. In each of these systems the East Asia/Pacific and North Africa/Middle East regions were in the lowest STI category and Sub-Saharan Africa was the only region in the high STI category.
Conclusions: The incidence and prevalence of certain STIs by world region are positively correlated. The world regions can be meaningfully classified according to STI incidence/prevalence.

1. Introduction

There are large differences in the prevalence and incidence of particular sexually transmitted infections (STIs) between different populations. These differences have been noted in sub-populations within countries and in comparisons between countries and between regions.[1–3] This study aimed to assess if there is a meaningful way in which these variations can be classified at the level of world regions. A common classificatory strategy is to divide the world into developed countries and developing countries – with low and high STI prevalences, respectively.[4–11] STI prevalences are, however, far from uniformly high in developing countries and in some cases are lower than in developed countries. A reasonable first step in establishing a taxonomy of global STI variation would be to map the distribution of the major STIs. This was the main aim of this study. We sought to map the distribution of seven STIs (HIV, herpes simplex virus type 2 (HSV-2), human papillomavirus (HPV), chlamydia, gonorrhea, syphilis, and trichomoniasis) and the sexually associated disease, bacterial vaginosis (BV), by world region. Whilst previous publications have mapped the global distribution of each of these STIs individually, none has done this for all of these STIs simultaneously. Furthermore, no study that we are aware of has assessed if the variations in prevalence of these STIs support a classification system of world regions based on STI prevalence. A part of this mapping exercise is an assessment of the extent to which six of these STI rates (HIV, HSV-2, chlamydia, gonorrhea, syphilis, and trichomoniasis) co-vary between regions. This is an important question, because if STI rates do co-vary to a significant extent, then this may be indicative of a common risk factor driving the higher rates.

2. Methods

2.1. Incidence of syphilis, gonorrhea, chlamydia, and trichomoniasis

The World Health Organization (WHO) has published estimates for the incidence and prevalence of four curable STIs by world

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region for the years 1990, 1995, 1999, and 2005.[12–15] The methodology used was broadly similar. Prevalences were estimated for the four STIs by sex and by world region. These estimates were based on a literature review of STI prevalence in different populations, WHO archival information from country-specific reports, and other sources, such as official STI prevalence estimates from developed countries. As far as the world-region classificatory system utilized is concerned, the 1995 and 1999 publications followed the United Nations (UN) standard regions, whereas the 2005 report used the WHO world regions. We used the estimates from 1999, as we regard the nine world regions typology used in this report to better reflect the heterogeneity of STI incidence and prevalence than the six world regions typology of the 2005 report. In addition the nine-region typology was more compatible with the other data sources we utilized. (See **Supplementary Material** Table 1 for a list of countries by UN standard regions.) An example of the difference this makes is provided by the Americas. In the 1995 and 1999 reports, Latin America and the Caribbean are one region and North America another. Their significantly different rates of STIs are lost in the 2005 report, where both these regions are combined into one. Regional adult prevalence for each infection was calculated using mid-year population estimates for 15–49-year-olds. The duration of infection was then estimated by sex and by region. These estimates were based on the probability a symptomatic or asymptomatic person would get treatment for their STI. To calculate regional STI incidence for adults, the estimated prevalence was divided by the estimated duration of each disease. The 1999 report only reported regional incidence and prevalence figures for each STI in total numbers of cases. We calculated the incidence and prevalence per million 15–49-year-olds using mid-year population estimates of 15–49-year-olds. The population estimates we used were 2003 (mid-year) figures obtained from the United States Census Bureau.[16]

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ijid.2013.09.014.

2.2. HIV

Regional HIV prevalence data for 15–49-year-olds for 2003 and 2009 were obtained directly from the 2003 and 2010 UNAIDS Global AIDS reports.[17,18]

2.3. HSV-2

Age- and gender-specific HSV-2 prevalences were obtained from the review of Looker et al.;[19] this is a systematic review of studies investigating HSV-2 incidence and prevalence from 1966 to 2005. For each of the world's 12 regions, pooled prevalence values by age and gender were generated for the year 2003, in a random-effect model. Prevalence was reported as the total number HSV-2-seropositive. Only surveys from general populations were included. Since this study reported only the total number of persons estimated to be HSV-2-seropositive in each region, we calculated the prevalence as the percentage of the population HSV-2-seropositive in 2003. The population estimates we used were 2003 (mid-year) figures obtained from the United States Census Bureau.[16] The indicator we chose to represent HSV-2 prevalence was female HSV-2 prevalence in 40–44-year-olds. HSV-2 prevalence increases monotonically with age in all populations around the world until at least age 44 years.[20] HSV-2 prevalence in men and women co-vary fairly closely by country and region, but HSV-2 prevalence in women is generally higher than in men. We chose the percentage of 40–44-year-old women who were seropositive for HSV-2 as our indicator of HSV-2 prevalence, as a narrow age band was least likely to be affected by differences in age composition between regions, and older female prevalence was most likely to demonstrate differences in HSV-2 prevalence by region. To make the Looker et al. regions coterminous with the UN standard regions, we combined their data for Japan and the Pacific with those of East Asia, and the data from South Asia with those from Southeast Asia (see **Supplementary Material** Table 1).

2.4. HPV

HPV prevalences were taken from a meta-analysis and a systematic literature review of global HPV prevalence. Studies published between January 1995 and January 2005 were used.[21] Inclusion criteria included the following: studies required detailed descriptions of study populations, methods used to collect cervical samples, and assays used for HPV DNA detection and typing. Only women with normal cervical cytology were included in the survey. Final analyses included 78 studies that could be separated into women with normal cytology, and 44 of these had data on age-specific HPV prevalence. For our study we excluded regional data that depended on a single study of less than 500 women. This excluded Eastern Europe, which had only a single study of 309 women, and North Africa and the Middle East, which had a single study of 172 women. The other regions were represented by studies that included between 6226 and 69 820 women. HPV regional prevalence estimates were adjusted for a broad range of factors, including geographical region, study sample type, study design, and age. To make the regions from the HPV prevalence data coterminous with the UN standard regions, we combined their data for Japan and Taiwan with those of East Asia, the data from South Asia with those from Southeast Asia, and the data from Central America with those of South America (see **Supplementary Material** Table 1).

2.5. Bacterial vaginosis

BV prevalences were obtained from a recent systematic review of the global patterning of BV.[22] This review included only 46 studies that were representative population-based or antenatal-based samples, and the diagnosis of BV was based on Nugent's scoring system, a scoring system based on Gram stains of vaginal secretions. For the purposes of comparing BV by region, a BV summary indicator was developed, which is defined as the percentage of studies done in a particular world region that revealed a BV prevalence of $\geq$30%.

2.6. STI mortality data

The combined mortality from gonorrhea, syphilis, and chlamydia by country in 2002 are estimates taken from the World Health Report, 2004.[23] The WHO derived these data from 112 national vital registration systems that capture about one third of deaths occurring in the world. Population laboratories and epidemiological analyses of specific conditions were then used to improve the estimates. The deaths are coded according to International Statistical Classification of Diseases and Related Health Problems (ICD) classification rules. We reclassified the countries according to the UN standard regions and then recalculated the total numbers of persons who live in these regions and the numbers who died from the three STIs per region. We used these two figures to calculate the estimates for the death rate associated with these STIs per million population per region in 2002.

2.7. Statistical analysis

We used partitioning around medoids (PAM) clustering based on Euclidean distance, to classify world regions according to STI incidence/prevalence. PAM clustering is a statistical technique of grouping entities from a dataset that have a high degree of