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A population's higher-risk sexual behaviour is associated with its average sexual behaviour—An ecological analysis of subpopulations in Ethiopia, Kenya, South Africa, Uganda and the United States

Chris R. Kenyon [a,*], Achilleas Tsoumanis [a], Ilan Steven Schwartz [b,c]

[a] HIV/STI Unit, Institute of Tropical Medicine, Antwerp, Belgium
[b] Department of Medical Microbiology, Faculty of Health Sciences, College of Medicine, University of Manitoba, Winnipeg, MB, Canada
[c] Department of Epidemiology and Social Medicine, Faculty of Health Sciences, University of Antwerp, Antwerp, Belgium

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ABSTRACT

Background: Given the large variation in the prevalence of sexually transmitted infections between populations it is important to characterize how sexual vary between populations. In this paper we assess how the distribution of lifetime sexual partners varies between populations. We ask: do populations with higher mean lifetime sexual partners merely differ by virtue of the presence of a core-group with increased number of partners or do the population distributions move as more coherent wholes?
Methods: We defined those in the top decile of lifetime sex partners in each country as constituting the higher-risk behaviour group (HRB). Spearman's correlation was used to evaluate the relationship between mean lifetime partners and prevalence of those in the HRB by ethnic group within Ethiopia, Kenya, South Africa, Uganda and the United States. In each case, data from nationally representative surveys were used. Two-sample Wilcoxon rank-sum were applied to test if there was a difference in the number of lifetime partners between the highest and lowest-risk subpopulations, separately for men and women. To account for autocorrelation, all analyses were conducted using means/medians excluding those in the HRB. A P-value of <0.05 was considered statistically significant.
Results: In each country, a positive correlation existed between subpopulations' mean lifetime partners and the prevalence of the HRB. Spearman's correlation varied from 0.20 to 0.99 for men and 0.74 to 1.0 for women. This association was statistically significant in 6 out of 10 comparisons. There was a statistically significant difference in the number of lifetime partners between the highest and lowest-risk ethnic groups in all countries except South Africa, where the difference was only significant for women.
Conclusions: Our results suggest that sexual behaviours vary coherently between different populations. As such, sexually transmitted infection control efforts would benefit from including both targeted campaigns focusing on the HRB and population-strategies that seek to address factors responsible for high mean risk behaviour.

1. Background

Given the dramatic variations in the prevalence of human immunodeficiency virus (HIV) and other sexually transmitted infections (STIs) in populations both between and within countries, it is important to understand how sexual behaviours vary between these populations (Kenyon et al., 2013a; Morris et al., 2009). This involves not just investigating variations in the average behaviour of populations and the prevalence of higher-risk behaviour, but also how these relate to one another.

Do trends in sexual behaviour of a population move as a coherent whole, or do sub-groups with higher-risk behaviour vary independent of the mean/rest of the population? A close association has been found between mean population blood pressure and the prevalence of hypertension (Rose and Day, 1990). Strong associations have also been found between populations' mean weight, cholesterol level, sodium and alcohol intake and the prevalence of those respectively classified as being overweight, hypercholesterolaemic, and consuming excessive sodium and alcohol (Rose, 1993a; Ouyang et al., 2015; Laaser et al., 2001; Chaiton et al., 2008; Razak et al., 2013). This association has been suggested to result from

* Corresponding author. Tel.: +0032 03 2476666; fax: +0032 032161431.
E-mail addresses: ckenyon@itg.be (C.R. Kenyon), atsoumanis@itg.be (A. Tsoumanis), ilan.steven.schwartz@gmail.com (I.S. Schwartz).

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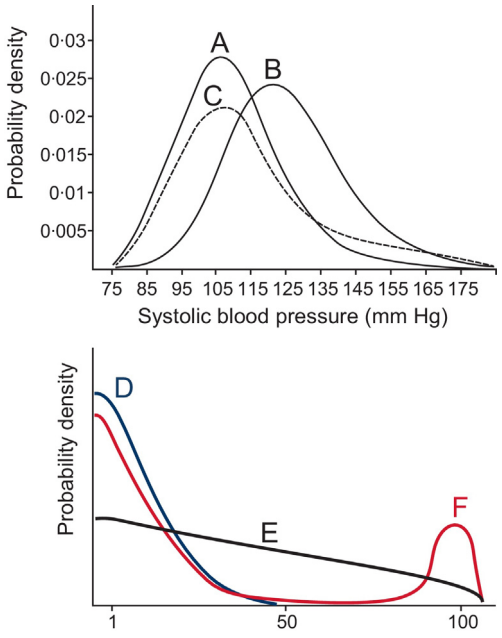

Fig. 1. Distributions of systolic blood pressure for the averages of the five populations with the lowest mean values (A) and the five with the highest values (B) from the Intersalt Study. A positive association between mean and prevalence of hypertension could be due to either a right shift in the entire population distribution curve (B) or due to a right skewing of the population distribution (C) where the left hand part of the population distribution remains unchanged [Based on figure from reference (Rose and Day, 1990)]. (ii) In the case of lifetime sex partners, where the left side of the distribution curve is relatively fixed, a positive association between mean and prevalence of those with 100 or more sex partners could either be due to a shift of the whole population distribution curve from (D) to (E), or a shift mainly in the proportion who have 100 or more partners (F). The change in the distribution from (D) to (E) can be visualized as a flattening of the distribution.

a conformity bias (peer pressure) which acts to promote conformity in norms and behaviours within populations (Rose and Day, 1990; Rose, 1993a; Cialdini and Goldstein, 2004; Christakis and Fowler, 2008). In turn, this constrains the amount of variation tolerated within populations (Rose, 1993b). Consequently, behaviour in populations tends to vary in a synchronized fashion and different populations may differ in both average and high-risk behaviour.

In this paper we assess if the same relationship between average behaviour and prevalence of high-risk behaviour applies to sexual behaviour. We investigate the relationship between the average number of lifetime sex partners and the prevalence of those with higher-risk behaviour by ethnic groups within five countries: Ethiopia, Kenya, South Africa, Uganda and the United States of America (USA). Higher-risk behaviour (HRB) is defined as being the top decile for reported lifetime sexual partners in that country. HIV prevalence varies by up to 50 fold by ethnic group within these countries (Table 1) and the reasons for this remain incompletely elucidated (Shisana et al., 2014). Number of lifetime partners has been established as an important risk factor for a large number of STIs including HIV at an individual level (Mishra et al., 2009; Central Statistical Agency [Ethiopia] and ICF International, 2012). At a population level some (Kenyon et al., 2013a, 2015) but not all (Auvert et al., 2001) studies have found a positive association between mean number of lifetime partners by ethnic group and HIV prevalence.

The distribution of the number of partners is an important variable in STI epidemiology in two ways. First, the shape of the distribution may inform what is determining the variation in mean values. Do ethnic groups with higher average lifetime partners simply have an increase in the size of the HRB (slope F in Fig. 1) or do they have a more generalized increase in the lifetime partners throughout the population (slope E)? If the higher average lifetime partners is determined by this latter right shift of the population distribution, then this suggests the size of the HRB is associated with and may be influenced by average behaviour (average number of life partners). This is also of considerable public health relevance: if the mean is driven up purely by an enlarged HRB, then strategies targeting the HRB are most appropriate. Alternatively, if there is evidence of a more general shift, then strategies targeting the general population should be prioritized.

Second, an important principle of STI epidemiology is that the magnitude of the variance of number of sex partners, in addition to the mean number of partners, plays a crucial role in determining the value of the basic reproductive number (May and Anderson, 1987; Cooke and Yorke, 1973; Hethcote and Yorke, 1984). Consequently, a small sexually active 'core-group' can be responsible for STI persistence in a larger population. Previous studies have argued that a power law exists between the variance and mean of the reported numbers of sex partners (Anderson, 1991; Anderson and May, 1988). Thus, a logarithmic plot of the relationship between the variance in the number of different sexual partners per unit of time versus the mean number of partners produces a straight line. Anderson and May (1988) first reported this association using data from a wide range of published and unpublished studies. These studies used different sampling methods, sampled a range of heterosexual and homosexual populations in the developed and developing world, and recorded number of partners from a period that ranged from the past month to the respondent's lifetime. The same result was found using data from a behavioural survey of men and women in England and Wales (Anderson, 1991). Once again, means and variances were calculated for samples stratified by age, sex and period of recall (1 month to lifetime). There is, however, considerable debate on this topic in the literature. For example, a subsequent study using more rigorous statistical techniques found that the best fitting models for the relationship between the variance and mean of the reported numbers of sex partners does not have a power-law tail (Jones and Handcock, 2003; Morris et al., 2008). In this paper we examine if an association exists between mean and variance of number of sex partners by ethnic group stratified by gender in five countries.

2. Methods

The five countries included in our analysis were selected based on the presence of each of the following criteria: (1) availability of nationally representative surveys that included a question on lifetime number of sex partners; (2) high heterogeneity in human immunodeficiency virus (HIV) prevalence between ethnic groups within these countries; and (3) evidence of homophily in choice of sexual partners within the ethnic groups being compared. The subpopulations compared were ethnic/racial group in all countries. In the USA, we also compared men who had sex with men and those who reported no sex with men. For Ethiopia, Kenya, and Uganda, we used region of residence as a proxy for ethnic/racial group, for the following reasons: many ethnic groups exist in each of these countries (over 80 in Ethiopia); ethnic group is highly correlated with region of residence; HIV prevalence varies considerably by region in each of these countries (Table 1); and the surveys used were designed to provide representative samples at the regional level but not for each ethnic group (Central Statistical Agency [Ethiopia] and ORC Macro, 2005; Kenya National Bureau of Statistics (KNBS) and ICF Macro, 2010; Uganda Ministry of Health, 2012).

We defined the HRB group as the decile of men or women in each country reporting the most lifetime sex partners. The threshold numbers of partners for entry into the HRB for women and men