Social epidemiology

Understanding racial-ethnic and societal differentials in STI

S O Aral

Do we need to move beyond behavioural epidemiology?

Prevalence and incidence of sexually transmitted infections (STIs) vary across societies[1] and across subpopulations defined by age, race-ethnicity, and socioeconomic status.[2 3] The efforts to account for such variation and explain it, that can be found in the STD literature, have in general not differentiated between individual and population level health, or between population and individual level determinants of individual STD outcomes.[4] Perhaps this pattern reflects the predominant paradigm in modern epidemiology which has been termed the "risk factor" paradigm and has been linked to "biomedical individualism" as its underlying theoretical foundation.[5 6] This theoretical approach views populations simply as reflective of individual cases while considering social determinants of disease to be at best secondary, if not irrelevant.[7] In the past several years, the risk factor paradigm in epidemiology has been seriously challenged by leading epidemiologists [8 9] and a new paradigm that would emphasise the broader context of individual risk factors has been called for. It has been suggested that whereas traditional epidemiologists ask the question "Why are some individuals healthy and others not?" the social epidemiologist is concerned with the question "Why are some societies healthy while others are not?"[10] Social epidemiology has focused on features of the economy, culture, politics, and the law. Examples of societal characteristics that have received attention include macroeconomic factors such as poverty, unemployment, and income distribution; and features of social relationships such as social cohesion, social exclusion, and sex and race relationships.[11] Also, a renewed interest in effects of neighbourhood environments on morbidity and mortality has emerged.[12–14]

Work in social epidemiology has emphasised neighbourhoods and the community; and considerations of social capital and collective efficacy have usually been applied to chronic diseases, mortality, violence, and mental health as health outcomes. Infectious diseases and, particularly, their modes of transmission are often ignored in this literature. Moreover, the social epidemiological approach is often successful in the description of social correlates of morbidity and mortality; identification of mechanisms of action through which social determinants influence levels and distribution of morbidity in populations tends to be more difficult.

Social epidemiological approaches may have a lot to offer to the explanation of STD differentials within and across societies. Conversely, STD epidemiology, with its distinct transmission dynamics may provide detailed examples of mechanisms of action through which social determinants operate. What follows is a description of one possible way in which relations among social determinants, their mechanisms of action, and their impact on STD morbidity may be conceptualised.

THE SOCIAL NETWORKS APPROACH IN STD EPIDEMIOLOGY

During the past decade an important trend in STD epidemiology research has focused on the role of sexual networks in the spread of STIs in populations. Findings demonstrated that in the United States, the higher rates of sexual contact between the "core" group and the "periphery" among African Americans facilitate the spread of infection overflow into the African American general population; whereas the "sexual segregation" of African Americans from other racial-ethnic groups results in STIs remaining inside this population.[15 16] Other studies have shown that linkages between sexual networks are necessary for the spread of STIs across sexual networks[17]; that so called "core groups" appear to be important in the spread of STIs and in their prevention[18–20]; and that the sexual transmission of sexually transmitted diseases (STDs) and HIV beyond core groups may depend on people who have sexual intercourse with members of core groups and with members of the general population—so called "bridge populations."[17] Studies in Thailand and other populations revealed that large proportions of men in certain occupations, such as truck drivers, the police, and the military tend to function as "bridges" between female sex workers and their wives or girlfriends.[21 22] However, one study conducted in Seattle found the proportion of infection attributable to bridge populations to be remarkably small; with most of the disease burden for gonococcal and chlamydial infections in both high prevalence and low prevalence subpopulations being attributable to mixing within the subpopulation or to direct mixing with members of high prevalence subpopulations.[23] It appears that bridge populations play a very important part in the introduction of infection into subpopulations, once the infection is introduced, most of the disease burden is attributable to mixing within the subpopulation.

Other studies conducted in Canada reveal that sexual network patterns involved in STD epidemics vary across phases of epidemics[24] and that during later phases of STD epidemics, the majority of sexual networks involved in the epidemic are not restricted to one geographic area[25]; frequent contact between network members from a small group of northern reserves and individuals in the major southern population centre of Winnipeg have formed bridges of transmission between these communities. Similarly, a study of elimination and reintroduction of primary and secondary syphilis in Seattle showed that characteristics of persons with primary and secondary syphilis varied across epidemic spread, elimination, and reintroduction periods.[26] There were significant differences between cases during the various epidemic phases with respect to age, sex, ethnicity, drug use, and involvement with commercial and anonymous sex. Moreover, during all phases, imported cases differed from locally acquired cases with respect to age, sex, ethnicity, and drug use behaviours.

One network pattern that has received increasing research attention in recent years is concurrent partnerships, or sexual partnerships that overlap over time.[27] Concurrent partnerships accelerate the spread of an STI through a population by removing the protective factors of time and sequence inherent in serial monogamy.

Sexual networks and patterns of sexual partnership formation and dissolution constitute a major mechanism of action through which the political economy and the sociolegal system influence the rate of spread of STI in a population; availability, accessibility, and utilisation of appropriate health care, and availability and utilisation of condoms being others.

CREATION, MAINTENANCE, AND EVOLUTION OF CORE GROUPS

Sexual networks that are highly critical to the rate of spread of STI include sex

work; exchange of sex for gifts, material needs or drugs; and anonymous sex. The creation, maintenance, and expansion of sex in exchange for money or other goods appears to be highly sensitive to changes in political economy and the sociolegal system. Internal conflicts, war, economic crises, and social collapse are accompanied by the establishment of major sex markets or the expansion of existing ones. For example, in Moscow, Russia, before the August 1998 economic crisis the number of female sex workers was estimated at 15 000–30 000; following the crisis this number increased to 30 000–90 000.[28] Similarly, in Jakarta and Surabaya, Indonesia, between 1997 and 1998—during which time the monetary crisis occurred—the percentage of female sex workers who were less than 20 years of age increased by 38% and 125% respectively; the percentage of female sex workers with less than 12 months' experience increased by 28% and 130% during the same period in these two cities.[29] A decade of conflict in the Balkan region and the poverty of post communist eastern Europe have created a major network of trafficking in women which reaches across eastern Europe, Balkans, the Middle East, and Western Europe.[30] Globalisation, characterising many social, economic, and behavioural patterns, includes sex work and expands the volume of sex workers.[31 32]

The political economy and the sociolegal system and any changes in them systematically impact lower socioeconomic status, minority groups to a greater extent than others. Sociolegal systems tend to reinforce existing hierarchies and protect the privileged. Thus, social parameters often create the context which facilitates the creation, maintenance, and expansion of sexual networks that cause rapid spread of STD among minority racial, ethnic, and socioeconomic groups and in less developed societies. The same context associates longer duration of infection with the less privileged groups and less privileged societies through differential access to, and differential utilisation of, good quality STD care. A detailed description of the sociopolitical context in which African Americans live in the rural southeastern United States powerfully elucidates how contextual features including racism, discrimination, limited employment opportunity, and resultant social and economic inequity may promote sexual network patterns that transmit STIs.[33]

Despite the powerful effects of social context and social determinants embedded in political economy and sociolegal systems on the level and distribution of STDs, most of our research and surveillance attention focuses on the STDs themselves and to a limited extent on the individual behaviours associated with STD acquisition. It is important to develop standard techniques for summarising the extent and nature of sex work within populations and for determining the size and nature of the interactions among core groups, bridge populations, and the general population. Moreover, most research and surveillance activity tends to be conducted within local boundaries, without much attention to sexual links that relate many local sexual networks to each other. Given that prevalence of sex work seems dependent on global forces, and that sex workers seem to be highly mobile across geographic areas, it may be important to consider the establishment of surveillance systems that include monitoring of contextual parameters and social determinants at regional and global levels.[34] STD prevention programmes may be more effective if informed about the local, regional, and global context in which STD rates rise and fall; and which create the inequalities in STD incidence across societies and across groups defined by race-ethnicity and socioeconomic status.

ACKNOWLEDGEMENTS

The author acknowledges Ms Patricia Jackson for her outstanding support in the preparation of this manuscript.

Sex Transm Inf 2002;**78**:2–4

Author's affiliations

S O Aral, Centers for Disease Control and Prevention, National Center for HIV, STD and TB Prevention, Division of STD Prevention, Atlanta, GA, USA

Correspondence to: Division of STD Prevention, CDC, 1600 Clifton Road, NE, M/S-E02, Atlanta, GA 30333, USA; pbj9@cdc.gov

REFERENCES

1 **Aral SO**, Holmes KK. Epidemiology of sexual behavior and sexually transmitted diseases. In: Holmes KK, Mardh P-A, Sparling PF, Wiesner PJ, Cates Jr W, Lemon SM, Stamm WE, eds. *Sexually transmitted diseases*. 2nd ed. New York: McGraw Hill, 1990:19–36.
2 **Fenton K**, Johnson AM, Nicoll A. Race, ethnicity and sexual health. *BMJ* 1997;**314**:1703–4.
3 **Evans BA**, Kell PD, Bond RA, *et al*. Racial origin, sexual lifestyle, and genital infection in London (1992). *Sex Transm Inf* 1998;**74**:45–9.
4 **Aral SO**, Holmes KK, NS Padian, *et al*. Overview: individual and population approaches to the epidemiology and prevention of sexually transmitted diseases and human immunodeficiency virus infection. *J Infect Dis* 1996;**174**(Suppl 2):127–33.
5 **Schwartz S**, Susser E, Susser M. A future for epidemiology? *Annu Rev Public Health* 1999;**20**:15–33.
6 **Diez-Roux**, Ana V. Bringing context back into epidemiology: variables and fallacies in multilevel analysis. *Am J Public Health* 1998;**88**:216–22.
7 **Krieger N**. Epidemiology and the web of causation: has anyone seen the spider? *Soc Sci Med* 1994;**39**:887–903.
8 **Shy CM**. The failure of academic epidemiology: witness for the prosecution. *Am J Epidemiol* 1997;**145**:479–87.
9 **Schwartz S**. The fallacy of the ecological fallacy: the potential misuse of a concept and the consequences. *Am J Public Health* 1994;**84**:819–24.
10 **Kawachi I**, Burris S, Sarat A, eds. The epidemiology of law. In: *Health, law and human rights: exploring the connection*. (In press)
11 **Kawachi I**, Berkman LF. Social cohesion, social capital and health. In: Berkman LF, Kawachi I, eds. *Social epidemiology*. New York: Oxford University Press, 2000.
12 **Stephanie R**. Socioeconomic position and health: the independent contribution of community socioeconomic context. *Annu Rev Sociol* 1999;**25**:489–516.
13 **Yen IH**, Syme SL. The social environment and health: a discussion of the epidemiologic literature. *Annu Rev Public Health* 1999;**20**:287–308.
14 **Kawachi I**, Kennedy BP, Wilkinson RG. *The society and population health reader: income inequality and health*. New York: The New York Press, 2000.
15 **Laumann EO**, Youm Y. Racial/ethnic group differences in the prevalence of sexually transmitted diseases in the United States: a network explanation. *Sex Transm Dis* 1999;**26**:250–61.
16 **Aral SO**. Sexual network patterns as determinants of STD rates: paradigm shift in the behavioral epidemiology of STDs made visible (editorial). *Sex Transm Dis* 1999;**26**:262–4.
17 **Anderson R**, May R, Boily N, *et al*. The spread of HIV-I in Africa: sexual contact patterns and the predicted demographic impact of AIDS. *Nature* 1991;**352**:581–9.
18 **Thomas JC**, Tucker MJ. The development and use of the concept of a sexually transmitted disease core. *J Infect Dis* 1996;**174**(Suppl 2):134–43.
19 **Steen R**, Vuysteke B, DeCoito T, *et al*. Evidence of declining STD prevalence in a South African mining community following core group intervention. *Sex Transm Dis* 2000;**27**:1–8.
20 **VanDam CJ**, Holmes KK. STD prevention: effectively reaching the core and a bridge population with a four-component intervention. *Sex Transm Dis* 2000;**27**:9–11.
21 **Morris M**, Podhisita C, Waver MJ, *et al*. Bridge populations in the spread of HIV/AIDS in Thailand. *AIDS* 1996;**10**:1265–71.
22 **Gorbach PM**, Sopheab H, Phalla T, *et al*. Sexual bridging by Cambodian men: potential importance for general population spread of STD/HIV epidemics. *Sex Transm Dis* 2000;**27**:320–6.
23 **Aral SO**, Hughes JP, Stoner B, *et al*. Sexual mixing patterns in the spread of gonococcal and chlamydial infections. *Am J Public Health* 1999;**89**:825–33.
24 **Wasserheit JN**, Aral SO. The dynamic topology of sexually transmitted disease epidemics: implications for prevention strategies. *J Infect Dis* 1996;**174**(Suppl 2):S201–13.
25 **Jolly AM**, Matusho P, Wylie J. Sexual contact networks and chlamydia transmission in Manitoba, Canada. Paper presented at Sunbelt XIX. International Sunbelt Social Network Conference; 18–21 February 1999; Charleston, SC.
26 **Williams LA**, Klausner JD, Whittington WLH, Handsfield HH, Celum C, Holmes KK. Elimination and reintroduction of primary and secondary syphilis. *Am J Public Health* 1999;**89**:1093–7.
27 **Morris M**, Kretzchmar M. Concurrent partnerships and transmission dynamics in networks. *Social Networks* 1995;**17**:299–318.
28 **R Montgomery**. Presented at the XIII International AIDS Conference, Durban, South Africa, July 2000.
29 **Moran J**. Indonesian monetary crisis and the commercial sex industry; effects on volume, supply and demand. Unpublished report.

Division of STD Prevention, CDC, Atlanta, Georgia. May 2000.
30 **Gall C**. Macedonia village is center of Europe web in sex trade. *New York Times* 2001 July 28.
31 **Koenig ER**. International prostitutes and transmission of HIV. *Lancet* 1989;**1**:782–3.
32 **Report on International workshop on trafficking in women to and from Central and Easter Europe**. Budapest, Hungary, 4–5 October 1996.
33 **Adimora AA**, Schoenbach VJ, Martinson FEA, *et al*. Social context of sexual relationships among rural African Americans. *Sex Transm Dis* 2001;**28**:69–76.
34 **Aral SK**, Berman SM, Aral SO. Anticipating outbreaks: a prevention role for integrated information systems. *Sex Transm Dis* 2002;**29**:6–12.

Vaccination

Preventive human papillomavirus vaccination

M Lehtinen, J Dillner

Considerable gains at the individual and societal level would be obtained if cervical cancer could be prevented

The cancer burden causally associated with human papillomavirus (HPV) infections is high. Cervical cancer is the second most common cancer among females in the world, with 500 000 new cases and 300 000 premature deaths a year.[1] Because of the long preclinical period cervical cancer can be prevented by screening, diagnosis, and treatment of premalignant cervical lesions, but for developing countries preventive vaccination may be the only possibility to significantly reduce cervical cancer incidence. Also in the developed countries considerable gains at the individual and societal level would be obtained, if a significant proportion of cervical cancer and its precursor lesions could be prevented by HPV vaccination (for a systematic review see Lehtinen *et al*[2]). In addition, other anogenital cancers, oropharyngeal and base of tongue cancers, and probably a small proportion of oesophageal cancers are all strongly associated with past HPV infection.[3–5] For these and other possible HPV associated cancers, vaccination may be the only possibility for prevention. Overall prevention of HPV infections may result in a 5–10% reduction of cancer mortality worldwide. This editorial seeks to answer the following two questions: what kind of vaccines will be tested and how should their efficacy be defined?

Preventive HPV vaccines entering clinical efficacy (phase III) trials are plain virus-like particles (VLPs), DNA free capsids comprising the major viral capsid (L1) protein (manufactured by Merck, GlaxoSmithKline, and by NIH), or chimeric VLPs (CVLP), containing various combinations of early viral proteins attached in different ways to the major L1 or the minor (L2) capsid proteins of the virus.

In phase I and II trials HPV VLPs have proved to be safe and highly immunogenic.[6] HPV VLP immunisation induces approximately 100-fold higher neutralising antibody titres than natural infection. The level of mucosal immunoglobulin G (IgG) is 10% but it varies following the menstrual cycle and is lowest at the time of ovulation. The prevailing theory of the mode of action of the vaccine, however, suggests that this variation may not be a major problem. In natural infection the entry of HPV into the basal cells of the epithelium, which support the initial stages of viral replication, is facilitated by a microscopic trauma resulting from, for example, sexual intercourse. Following this micro trauma, circulating antibodies leak to the epithelial surface and neutralise the virus.

The L1 antibodies recognise a conformational, type specific epitope, and have shown close to a 100% protection in animal studies against homologous challenges with both HPV and animal papillomaviruses.[7] While the increasingly large number of oncogenic HPV types (16, 18, 31, 33, 35, 45, 51, 52, 58, 59) that associate with cervical cancer may make it impossible to achieve 100% protection against cervical cancer, it is relatively easy to include the most prevalent oncogenic HPVs (HPV16 and HPV18) into a multivalent VLP vaccine, and even tailor the vaccine composition by the HPV types most prevalent in different geographic areas should this prove necessary.

Analogously to hepatitis B virus (HBV) vaccine HPV VLPs also induce cytotoxic T cell (CTL) responses by entering the MHC class I pathway.[7] If the antibodies fail to neutralise all HPV virions, CTLs recognising viral capsids bound for as long as 10–12 hours to more or less specific cellular receptors (integrin and/or heparan sulphate proteoglycans[8 9]) might block spread of the virus at its most primordial state in the initially infected cells. Production of new virions takes place in the upper layers of the epithelium, and CTLs targeting these cells might effectively reduce spread of the virus. Indication of this has, however, been shown only for the non-oncogenic HPV VLPs, and it is not clear whether such a response is able to eliminate oncogenic HPVs from the basal cells.[10]

CVLPs may offer a significant advantage in this regard. The expression of various early HPV proteins responsible for viral replication (E1), transcription (E2), and oncogenesis (E6, E7) is abundant both in the basal and the differentiating epithelial cells providing good targets for the CTLs. Two vaccines based on different gene constructs—HPV16 L1, L2 truncated E2–E7 CVLP (by an NIH group) and HPV16 L1–E7 CVLP (by Medigene)—have passed or are passing safety and immunogenicity tests. In addition to the induction of high titres of neutralising antibodies, some of which (anti-L2 antibodies) may be cross protective against several HPV types, the CVLP vaccines induce CTL responses against the early proteins in humans.[11] However, for CVLPs data on humans are scarce and need to be expanded. CTL responses against the early HPV proteins are important not only in order to provide theoretically improved protection and possible therapeutic effect, but because they may also offer cross protection against several HPV types. The E1 and E2 proteins are particularly well conserved among the HPVs.

The analogy between the different HPV VLP vaccines and the first human cancer vaccine, HBV vaccine, is very encouraging. The HBV vaccine has an overall efficacy of 95%,[12] and even when given to infants born to mothers with active hepatitis (HBV-e antigen positive women, the offspring of whom are prone to become chronic HBV carriers) its efficacy exceeds 75%. These figures also fit the first available data on long term effects of universal HBV vaccination. The incidence of liver cancer has reduced by 75% among 12–14 year old Taiwanese children 15 years after implementation of the nationwide HBV vaccination programme.[13] This was to be expected on the basis of seroepidemiological data showing that HBs antibody positive