Sexual Behavior and Exposure to HIV Infection: Estimates from a General-Population Risk Index

Stefano Campostrini, PhD, and David V. McQueen, ScD

ABSTRACT

Objectives. The spread of the human immunodeficiency virus (HIV) in the general population has been a much debated topic in the mass media. The aim of this study was to create an approach to estimating the risk of exposure to HIV resulting from sexual behaviors.

Methods. A theoretical estimate was applied to data obtained from a large-scale risk factor survey carried out in Britain. An HIV infection-exposure risk index was constructed by ranking different sex-related categorizations derived from variables in the survey.

Results. The risk index involved a Delphi-based assessment of self-reported behavioral factors associated with HIV exposure and subsequent transmission. Roughly 85% of the adult population aged 18 to 50 were estimated to be at some risk for behavioral exposure to HIV virus with regard to reported sexual behavior. Over time, those who could be considered at no risk have declined as a proportion of the population.

Conclusions. The estimates appear to refute commonplace assertions that exposure to HIV through sexual behavior is not a problem for general populations. (*Am J Public Health.* 1993;83:1139–1143)

Introduction

Epidemiological models of the spread of the acquired immunodeficiency syndrome (AIDS) often concentrate on tracing the dynamic growth of seropositivity in special groups. Conversely, a behavioral perspective may view the spread of the human immunodeficiency virus (HIV) in the general population as akin to a study of the diffusion of an innovation (the HIV virus and/or AIDS) as it is "adopted" in the population. Both approaches are concerned with the rate of change over time, mathematical descriptions, and, ultimately, predictions of spread. The problem of risk is related to this dynamic diffusion process in that it represents the possibility of an individual being "caught up" in the process. While it is theoretically arguable that each person in a population can be assigned a true risk of exposure to the HIV virus, it is very difficult in practice, both from a clinical and a behavioral point of view. This point was brought out in a recent official British document:

> Projections of the numbers of HIV infections are an automatic by-product of the transmission models, but these simply reflect the assumptions on sexual behavior which have been built in, and are not therefore true predictions. They are primarily useful for exploring the development of the epidemic beyond the short term under different assumptions.[1]

This kind of thinking underpins many of the mathematical models that abound in HIV research.[2–5]

Few would doubt that most of the biomedical research efforts devoted to AIDS have concentrated on the biology of the virus and the medical complications associated with people with AIDS. Biomedically based behavioral research has concentrated on special risk groups, namely homosexuals, intravenous drug users, hemophiliacs, and workers in the so-called sex industry. From a behavioral public health perspective, those least researched and understood are the residual categories of people potentially "at risk" (i.e., the rest of the population).

In a population-based life-style and health survey begun in July 1987,[6] more than 35 000 people from the Glasgow, Edinburgh, and London metropolitan areas have been interviewed by telephone (as of late 1992).[7] One of the major components of the survey questionnaire has been a section on AIDS-related attitudes, opinions, knowledge, and behavior. Questions on sexual behavior were posed to respondents between the ages of 18 and 50. On the basis of the possible responses to these questions, we decided to construct a risk index for HIV transmission that could help in understanding how sexual behavior might contribute to the spread of AIDS.

Methods

In addition to questions on AIDS-related knowledge, attitudes, and sexual practices, individuals were questioned

At the time of the study, the authors were with the Research Unit in Health and Behavioural Change, University of Edinburgh, Edinburgh, Scotland.

Requests for reprints should be sent to David V. McQueen, ScD, Behavioral Sciences Branch, Office of Surveillance and Analysis, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Mailstop K30, Atlanta, GA 30333.

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about cigarette smoking, alcohol use, drinking and driving, safety, physical activity for exercise, diet, blood pressure, and life-style. Standard sociodemographic details were obtained, and interviewers were questioned with regard to the conduct of the interview. In order to provide comparability, core questions were used from other life-style and risk factor surveys (e.g., studies conducted in the United States[8] and Canada[9]) carried out by telephone. Also, comparability was kept in mind with regard to sexual telephone surveys (e.g., a study on sexual behavior conducted in France[10]).

The survey used a random-digit dialing, computer-assisted telephone interviewing technique.[11] With the exception of holiday periods, interviews were carried out during the day, in the evenings, and on weekends continuously throughout the survey period. Participants were selected randomly from adults 18 to 60 years of age residing in households with telephones.

The monthly sample frame was selected by a multistage cluster procedure. This procedure, based on a random digit dialing technique, used a modified Waksberg method[12] (as routinely seen in other computer-assisted telephone surveys on behavior and AIDS[13]). Following a household contact and determination of the number of eligible respondents within the household, an adult was randomly selected by the computer and interviewed at the time or, if the selected participant was not available, in a return call. The response rates, calculated by the established Council of American Survey Research Organizations (unpublished data, 1982) method, varied slightly from month to month and averaged around 76% in Scotland and 70% in the London area. For this paper, the 1990 data (n = 9080), aggregated by month of observation were examined. The sample included 7269 individuals 18 to 50 years old.

Prior to the initiation of the survey, a pilot study was conducted to examine the effect of coverage differences between participants in households with and without phones on the key study variables.[14] These differences were minor, and the results were similar to those found elsewhere in such comparisons.[15–17]

The Delphi method used in this study is designed to ascertain expert opinions on a particular subject.[18] It was developed by the RAND Corporation in the early 1950s as a way of minimizing interpersonal feelings and cross-opinions, especially those that might arise in face-to-face meetings.[19] Over the years, the Delphi technique has been widely used in several fields of application.[20] It is particularly useful in instances in which the subject matter (e.g., the estimate of AIDS risk in a population) is controversial, little or no consensus exists, and a judgment is needed in a timely and inexpensive manner; it also provides a way to reach a consensus on a multidimensional subject in which several different disciplines might have relevant input. Thus, it minimizes the dominance of any single individual in the expert group. Given the disparity in views about what constitutes risk for heterosexual AIDS transmission, we believed that this method was the most appropriate one for obtaining a rational and informed view of risk.

The Delphi technique is used to gather and synthesize the judgments of several experts who constitute an anonymous research panel. The method uses a series of questionnaires completed by a panel of experts to seek consensus on a problem of interest. The main characteristic of the Delphi technique is that, at every stage, the panel is informed of the results of the preceding round, and these results are used to construct the modified questionnaire for the next round. The main purpose is to produce agreement among the panelists while identifying divergent opinions. Initially, for the construction of the index presented here, eight researchers connected with the survey were selected as members of a panel. Then the same technique was applied to a national expert group to verify the results obtained in the first run of the technique and to better refine the index.

The HIV infection-exposure risk index described here was constructed by using the Delphi technique to rank different sex-related categorizations derived from variables contained in our survey. Thus, the index is based on an expert assessment of self-reported behavioral factors associated with HIV exposure and subsequent transmission. Possible scores range from 1 to 31; higher scores indicate lesser risk. Our Delphi studies involved three rounds. In round 1, the first, rather complex "tree" of sexual behaviors was ranked. In round 2, the second tree was ranked. Finally, in round 3, the second tree was reranked after consideration of feedback from the second round. The second panel, consisting of 12 judges, was representative of the main disciplines involved with the public health aspects of AIDS: virology, psychology, epidemiology, sociology, and statistics.

In the first round, the combination of eight sex-related variables was given to the panelists to rank. The variables considered, based on the interview instrument, were (1) whether respondents had engaged in any sexual activities with a person of their own sex in the past 5 years (asked of men only); (2) whether they currently engaged in such activities; (3) whether they had a steady sexual partner; (4) how long this relationship has lasted; (5) whether, during the past year, they or their partner have had other partners; (6) their marital status; (7) whether they use condoms; and (8) the number of sexual partners over the past 5 years. The combinations and permutations of the eight variables yield 48 possible discrete outcomes. It was a difficult task for the panelists to rank these different outcomes and to cope with such a complicated tree. The difficulty is illustrated by the results: initial agreement among the panelists was quite low, and most panelists suggested simplifying the tree. In accord with the Delphi technique, their suggestions resulted in the elimination of two variables in the second round: (1) the respondent's marital status and (2) the respondent's report of "other partner" (because it added little to the other information). Thus, the new categorical tree was much simpler and clearer than the earlier version. Nevertheless, the level of agreement among the panelists remained too low. A further round was added in which the panel was asked to rank the tree of the previous round, taking into consideration the judgments provided by the other panelists. These rankings were returned to the panelists anonymously, with the names of those making rankings substituted by asterisks in order to avoid personal influences. Part of the Delphi principle involves seeking consensus through an interaction among the experts composing a panel, but this interaction must not be affected by the presence of someone who could have a particular influence on the other panelists.

After three rounds of ranking, good agreement among the panelists was achieved (i.e., the variability of each ranking was minimalized). Only 3 of the 31 categories remained slightly problematic: (1) homosexuals who reported that they had only one partner and that they currently used condoms, (2) homosexuals who reported that they had only one partner and that they did not currently use condoms, and (3) heterosexuals who reported that they had had a steady partner for less than 5 years, that they had had

more than three partners in the past 5 years, and that they did not currently use condoms.

Figure 1 shows how the 31 categories of sexual behavior have been reduced to 5 categories based on our judgment and on the advice of our Delphi panelists. As with any Delphi approach, most of the main issues in classification reached consensus; nonetheless, one cannot expect unanimity, particularly with regard to gender difference and risk. The final classification of 5 categories, a heuristic procedure based on our judgment, is better understood both conceptually and in terms of graphical presentation. The first category termed high risk, takes into account 8 classifications within the risk tree; the second category, medium risk, includes 9 classifications; the third category, low risk, includes 6 classifications; the fourth category, very low risk, includes 6 classifications; and the last category, no risk, includes 2 classifications.

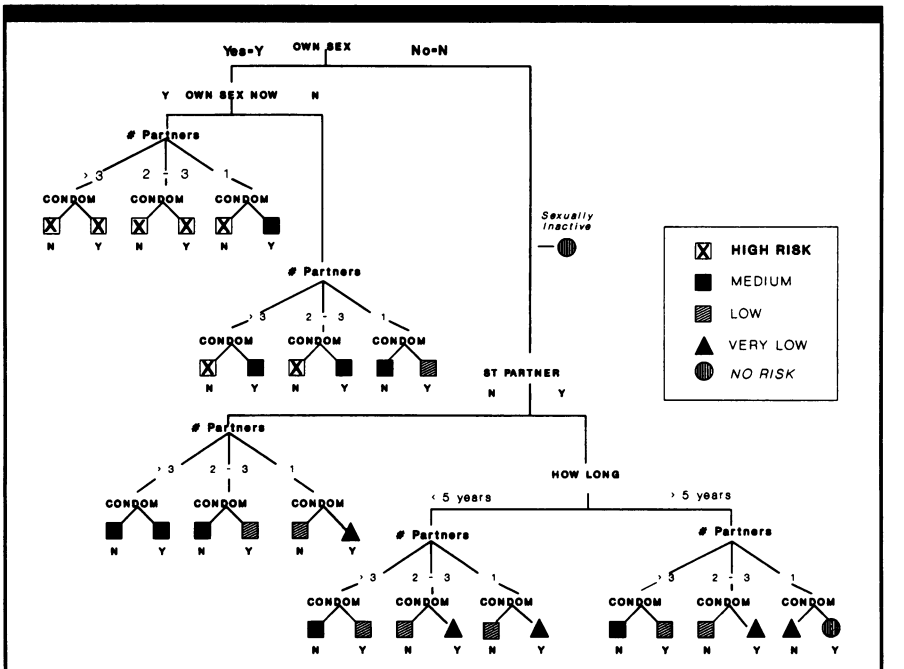

FIGURE 1—Final result of the Delphi exercise: the infection-exposure risk index.

Results

Use of the Delphi technique to classify possible risk exposure through behavior is largely a theoretical exercise designed to assist in developing a synthetic indicator that includes several dimensions of sexual behavior. The practical value of our approach is to incorporate data on sexual behavior, collected over time, into this Delphi-derived index. The results show that a small proportion (1.2%) of the population of London, Edinburgh, and Glasgow is at high risk. This represents an estimate of the proportion of people with a consistently high risk of becoming exposed to the HIV virus because of their sexual behavior; it does not take into account the subsequent biological risks of infection or other behavioral modes of potential infection.

TABLE 1—The Infection-Exposure Risk Index Applied to Sample Data, by Selected Demographic Characteristics

	Level of Risk, %									
	High		Medium		Low		Very Low		None	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
City										
London	3.5	...	28.2	19.5	13.0	16.1	39.3	46.7	16.0	17.8
Edinburgh	2.8	...	20.4	16.5	15.4	11.4	45.2	58.4	16.1	15.7
Glasgow	1.5	...	22.7	12.4	14.2	15.3	46.9	55.3	14.7	17.0
Age										
18–24	3.7	...	45.3	29.7	21.1	20.6	19.9	35.9	10.1	13.8
25–34	2.9	...	27.7	19.2	14.1	15.9	40.3	49.4	15.0	15.5
35–49	2.2	...	14.6	8.5	10.0	12.3	54.7	59.2	18.5	20.0
Education										
Less	1.7	...	22.0	12.8	11.6	13.4	50.9	58.1	13.8	15.8
More	3.3	...	27.4	19.3	15.3	16.6	37.3	45.8	16.7	18.3

Table 1 shows the new index applied to the behavioral data with regard to several demographic factors. The three major cities considered in the analysis have distinct patterns, with London showing the highest risk profile, followed by Edinburgh and finally Glasgow. The relationship of the index to age is complex. For the high risk category, the age group 25 to 34 is at highest risk, followed by the 35 to 49 category. For the medium and low categories, the risk is apparently inversely proportional to age: the younger the individual, the greater the risk. This difference between the first and the other risk categories relates to the different age composition of the homosexual group (i.e., there were fewer reported homosexuals in the youngest category).

Other social factors reveal a complex pattern of assessed risk. For example, educational level (based on the age at which subjects left school) yields a diverse picture. In the high, medium, and low risk categories, the more educated run a higher risk than the less educated. However, the more educated are underrepresented in the very low category and predominant in the no risk category.

A major strength of our analysis is that changes are considered over time. The data have been examined for the period from January 1989 to May 1990 (n = 11 130) and aggregated by month of observation. Figures 2 and 3 show these trends in the data; the regression lines associated with the data points illustrate the direction of the trends. Although there has not been any relevant change in the high, low, and very low categories, a significant decrease has characterized the no risk category as well as the medium category, which shows a very consistent increase. These change and no-change situations were assessed by a logistic regression analysis (results are shown in Table 2). Further analyses indicated that the time trend was different for each city. The de-

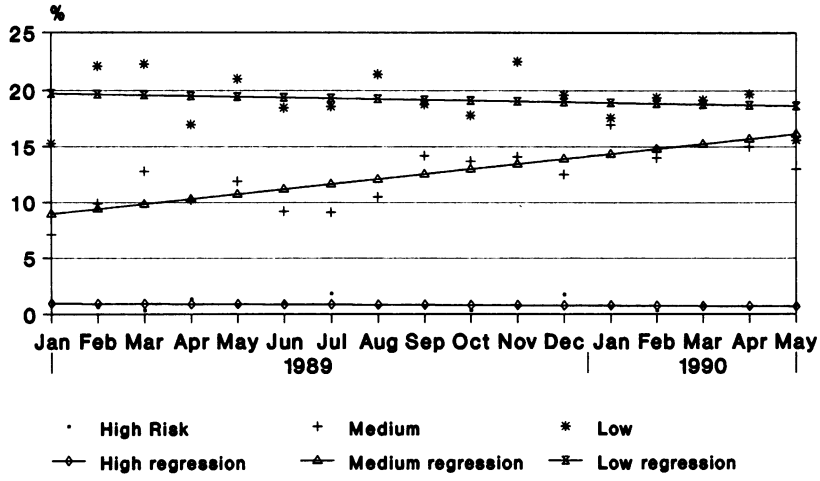

FIGURE 2—Trends in the infection-exposure risk index: high to low risk by month, 1989 through 1990.

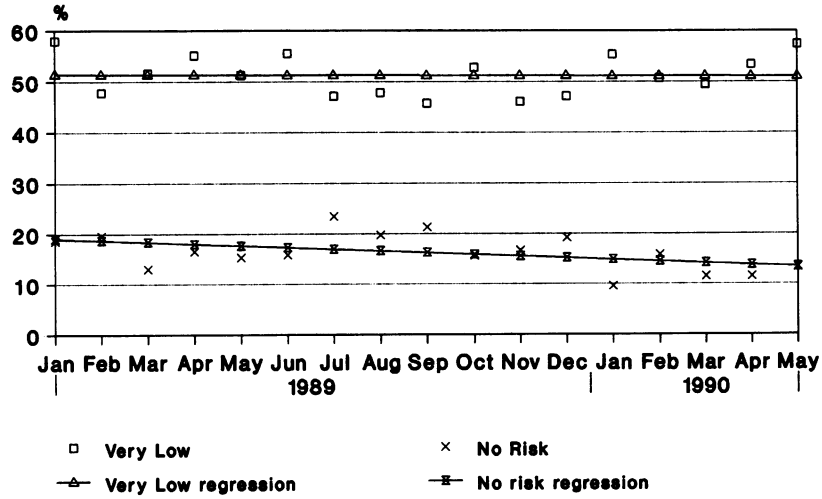

FIGURE 3—Trends in the infection-exposure risk index: very low to no risk by month, 1989 through 1990.

TABLE 2—Logistic Regression: Single Categories of the Infection-Exposure Risk Index against Time (in months)

Risk Level	β	SE	Wald χ^2	*df*	P
High					
Time	0.0184	0.0119	2.3980	1	.1215
Constant	−4.8646	0.2843	292.7163	1	.0000
Medium					
Time	0.0171	0.0030	32.8859	1	.0000
Constant	−1.5436	0.0702	483.3811	1	.0000
Low					
Time	−0.0046	0.0035	1.6709	1	.1961
Constant	−1.6307	0.0818	397.0899	1	.0000
Very low					
Time	0.0010	0.0025	0.1571	1	.6918
Constant	−0.1682	0.0590	8.1394	1	.0043
No risk					
Time	−0.0255	0.0037	46.7556	1	.0000
Constant	−1.2923	0.0837	238.6187	1	.0000

crease in the no risk category was significant only in Glasgow, while in London and Edinburgh there has not been a decrease in the low risk category. The increase in the medium category was much more significant in Edinburgh than in London or Glasgow. In future work, we will analyze these trends over a longer period of time.

Discussion

The spread of AIDS in the general population has become a much debated issue in the media, occasionally producing considerable controversy (e.g., the screening in 1990 on British television of the view of Duesberg[21] that "AIDS is not or cannot even be an infectious disease" and the best-selling American book[22] proposing that heterosexual AIDS is a myth). Unfortunately, this debate seldom involves data on population sexual practices. It is our contention that the index described here provides insight into general population risk, even though it is based only on the risks connected with sexual behavior. The index adds new information to help understand the spread of AIDS and provides an instrument that can explore changes in population risk over time.

All survey methods have limitations. Risk factor surveys may be biased from several sources, including errors attributable to the respondents (self-reporting error) and those attributable to the method of collecting data. Error is a common problem in all survey approaches to sexual behavior, and certainly more research is needed to better understand optimal modes and procedures to reduce and control errors[23]; however, critics of the survey approach to understanding sexual behavior should consider two points. First, no criteria exist on which to standardize self-reported data concerning sexual behavior; thus, the question of validity, while interesting, is nonproductive because the alternatives to obtaining absolute and correct data on sexual practices are not feasible at best and probably illegal at worst. Therefore, the researcher must rely on the memory and veracity of the respondent. Second, there is evidence that the validity of self-reported data on many health-related behaviors is quite good.[24–26] Thus, the problem is not whether, but how, to conduct a survey in an optimal way to collect behavioral information. Furthermore, in considering time trends and changes, an underestimate or overestimate of behavior is less

important as long as the so-called bias effect is stable during the entire data collection process.

In our opinion, those who argue that the general population is at little risk of AIDS are misguided. The percentage of the population that practices sexual behaviors resulting in high risk, as judged by our index, is probably less than 2%; however, more than 15% still report sexual behavior involving some risk of infection. Taking the "kind" assumption that this is an overestimate provides only limited comfort. Taking the "unkind" assumption that this is an underestimate, because respondents are underestimating and/or a group at even higher risk is not well represented in our sample, provides a much more pessimistic scenario for the inevitable spread and increase of HIV and AIDS in the general population. The pessimistic scenario makes very persuasive arguments for the support of strategies to reduce the risk related to sexual behavior in the general population. □

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