Frequency of Sexual Partner Change in a Norwegian Population

Data Distribution and Covariates

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The number of new sexual partners per year (partner frequency) is a key factor in the spread of sexually transmitted diseases. Data from two Norwegian population-based surveys conducted in 1987 and 1992 were used to estimate recent (in the previous 3 years) and earlier partner frequency and to examine covariates affecting the distribution of partner frequency. Seventy-two percent of respondents reported having no new partners per year, and 2% reported having more than three new partners per year. Results from a Poisson regression model indicated that a low partner frequency was associated with being married or cohabiting, being female, greater age, and late sexual debut. Partner frequency was lower in 1992 than in 1987 (rate ratio = 0.8, 95% confidence interval 0.7-0.9). In comparison with earlier life, there was a large reduction in partner frequency for married/cohabiting individuals. In contrast, there was either no change or some increase in partner frequency for single persons. Am J Epidemiol 1997;145:636-43.

sex behavior; sexual partners; sexually transmitted diseases

Editor's note: A companion article by Stigum et al. appears on page 644 of this issue.

The introduction of acquired immunodeficiency syndrome into our societies has led to heightened interest in epidemiologic research on sexual behavior (1-3). Results from mathematical models reveal that partner frequency, defined as the number of new partners per unit of time, is a key factor in the spread of sexually transmitted diseases in a population (4). Whereas many reports on sexual behavior have focused on the number of partners over a lifetime, during the previous 3 or 5 years, or during the previous year, few reports have analyzed partner frequency directly. In 1987, the National Institute of Public Health in Norway conducted a nationwide sexual survey. The aim was to collect information on aspects of sexual behavior relevant to the spread of human immunodeficiency virus (HIV) and other sexually transmitted diseases. Five years later, the survey was repeated, with the primary aim of studying changes in sexual behavior that had occurred since the first survey. Despite the importance of partner frequency in the spread of sexually transmitted diseases, there have been few systematic studies of the factors influencing partner frequency in the general population. The purpose of this study was to investigate how demographic factors and previous partner frequency influence recent partner frequency. We used data from both of the above surveys to examine the distribution of recent partner frequencies, to estimate the yearly prevalence of sexual partner change, and to explore the factors associated with recent partner frequency and change in partner frequency. The effect of changes in partnership formation rates on the spread of sexually transmitted diseases is explored in a companion article (16).

MATERIALS AND METHODS

Subjects

The target population of the 1987 survey included all individuals living in Norway who were 18-60 years of age at the time of the survey. A random sample of 10,000 individuals was drawn from this population by the Central Bureau of Statistics. A questionnaire containing questions on sociodemographic background variables and sexual behavior was sent by mail, and return responses were anonymous. Previous results of this study can be found elsewhere (5-8).
In 1992, the survey was repeated, using a slightly modified questionnaire which was sent to a new sample of 10,000 individuals with the same age range as the first sample (9). To study response bias, we sent a short questionnaire 2 months after the main questionnaire to a random subsample of 2,000 subjects drawn from the 1992 sample. In total, 10,915 questionnaires were returned from the 1987 and 1992 surveys. Response rates were higher among women and younger participants. Because of lower response rates in the older age groups, we selected data from the 9,829 responders aged 18–52 for the analyses presented here. The response rate for this group was 64.6 percent in 1987 and 50.2 percent in 1992. Within this selected sample, 94.2 percent (9,141/9,700) reported having sexual experience. Those who reported ever having same-sex experience (3.9 percent; 361/9,141) were excluded. (This group generally has different behavior patterns and different covariates for high partner frequency.) For 293 individuals, partner frequency could not be calculated because of missing data. Data from individuals who reported having more than 15 new partners per year (0.1 percent; 10,847) were considered outliers and were excluded. The resultant sample size for the analysis was 8,477. A total of 675 subjects answered the subsample survey; 85 of these were nonresponders in the 1992 survey.

Variables

The questionnaires contained items on sociodemographic background variables, including sex, age, cohabitation status, education (<9, 10–12, or ≥13 years), and population density (sparse/rural or community/city), and more than 40 questions on sexual behavior. Some of these questions referred to lifetime sexual experience. One set of questions was addressed to single subjects and to married/cohabiting subjects who reported having extra partners in their current partnership. The following items from the questionnaire were chosen for testing as covariates of partner frequency: biologic sex (gender), age, cohabitation status, education, population density, previous HIV testing, and age at first sexual intercourse.

Two measures indexing the number of new partners per year were calculated. First was recent partner frequency (ωr), which was based on the 3 years prior to the survey and was a function of the number of partners in the previous 3 years (P3), age at the time of the survey (a), and age at first sexual intercourse.

Recent partner frequency was calculated as follows:

\[ \omega_r = \begin{cases} 
0, & \text{if } P_3 = 0; \\
(P_3 - 1)/3, & \text{if } P_3 > 0, \text{ and } a - a_f \geq 3; \\
(P_3 - 3)/3, & \text{if } P_3 > 0, \text{ and } a - a_f < 3. 
\end{cases} \]  

(1)

The logic behind equation 1 is such that all partners during the past 3 years are new if first intercourse took place within the past 3 years; however, if first intercourse took place sometime prior to the past 3 years, then we assume that all but one of the partners are new. Note that subjects who have had a steady partner for more than 3 years and no extra partners will be assigned a recent partner frequency of zero.

The second measure, earlier partner frequency (ωe), was based on the time period from age 16 to the age 3 years prior to the survey, and was calculated as follows:

\[ \omega_e = \begin{cases} 
0, & \text{if } a - a_f < 3, \text{ and } a \geq 21; \\
(P_e - (P_3 - 1))/(a - 16 - 3), & \text{if } P_3 > 0 \text{ and } a - a_f \geq 3, \text{ and } a \geq 21; \\
P_e/(a - 16 - 3) & \text{if } P_3 = 0, \text{ a} - a_f \geq 3, \text{ and } a \geq 21, 
\end{cases} \]  

(2)

where \( P_e \) is the total number of partners. The formula counts all partners minus those who were new within the past 3 years. Time is counted from age 16 up to the person’s age 3 years prior to the survey, regardless of age at first intercourse. This time period can be considered the period in which one is at risk of becoming sexually active. To obtain a minimum of 2 years during which frequency could be measured, we calculated early partner frequency only for those participants who were at least 21 years old.

The 1992 subsample questionnaire contained, among other items, a question on response/nonresponse to the 1992 survey, reasons for not responding, and a question on the total number of partners up to that time in life.
Statistical methods

The two-way associations between recent partner frequency and the independent variables were analyzed by the nonparametric Mann-Whitney or Kruskal-Wallis test using SPSS for Windows (10). Multivariate regression analyses were based on the following model:

\[
\begin{align*}
E(\omega_r) &= \lambda_i = e^{a+\beta x_i} \\
\text{Var } \omega_r &= \Phi\lambda_i,
\end{align*}
\]

(3)

where \(\Phi\) represents some dispersion parameter. \(\omega_r\) is the recent partner frequency, and \(x_i\) is the vector of values of the covariates for the \(i\)th subject. If the \(\omega_r\)'s are distributed according to a Poisson distribution with mean \(\lambda_i\), then \(\Phi = 1\) and \(RR = e^\beta\) can be interpreted as a rate ratio. In our situation, \(\Phi\) is not equal to 1, but we nevertheless will refer to \(RR\) as a rate ratio. This model and alternative formulations are discussed by McCullagh and Nelder (11). The model was fitted using Poisson regressions in EGRET (12). Two multivariate regression analyses were conducted. The first model tested the association between recent partner frequency and all of the covariates, with the exception of earlier partner frequency. In this application, the rate ratios can be directly interpreted relative to the expected value for recent partner frequency. Next, we analyzed how earlier partner frequency predicted recent partner frequency using an augmented model that included earlier partner frequency along with the other covariates. This two-step model procedure was conducted because interpretation of the rate ratios is not straightforward once earlier partner frequency is included in the model. This occurs because earlier and recent partner frequency are the same measure for two different time points, and, as explained below, the rate ratios are not easy to interpret.

After inspection of a plot of the estimated coefficients (\(\beta\)'s) for categories of earlier partner frequency (\(\omega_e\)) data on this variable were transformed by taking the natural logarithm and were then added to the model as a continuous measure. In this application, the predicted recent partner frequency therefore equals

\[
E(\omega_r) = \exp(\beta_0 + \beta_1 \Omega_1 + \cdots + \beta_n \Omega_n + \beta \ln(\omega_e)) = RR_0 \times RR_1^n \times RR_{\omega_e}^\beta, \tag{4}
\]

where \(\Omega_1\) to \(\Omega_n\) are the values for the other covariates. In order to look more closely at what these rate ratios measure, we divide both sides of equation 4 by \(\omega_e^\beta\). Now it can be seen that the rate ratios pertain to values of the ratio \(\omega_r/\omega_e^\beta\). If the \(\beta\) coefficient for earlier partner frequency equals 1, then the rate ratios measure relative change in partner frequency. However, it can be seen that when \(\beta\) is not equal to 1, the rate ratios do not have that interpretation. Thus, instead of reporting rate ratios, we use the formulation in equation 4 to estimate the relation between recent and earlier partner frequency for each pattern of covariates.

Overdispersion was estimated as follows:

\[
\Phi = \frac{1}{n-p} \sum_{i=1}^{n} \frac{(\omega_n - \lambda_i)^2}{\lambda_i},
\]

(5)

where \(n\) and \(p\) are the numbers of observations and parameters, respectively. The estimated deviances (dev) and standard errors (SE) were adjusted for overdispersion using

\[
\text{dev}' = \sqrt{\hat{\Phi}} \text{SE}' = \hat{\text{SE}} \times \sqrt{\hat{\Phi}}, \tag{6}
\]

with the corresponding adjustment in the confidence intervals. Prior to the analysis, we examined all variables with more than two coding categories to decide whether the variable coding should be recategorized, unchanged, or entered as continuous. This was done by plotting the estimated regression coefficients (\(\beta\)'s) of the categorized variable against category midpoints. Interaction terms between biologic sex and the other covariates and between age and the other covariates were tested in both models.

To assess whether the assumptions underlying the model in equation 3 were met, we plotted the squared residuals against the values for expected partner frequency. The residuals were smoothed by third-order polynomials, and 95 percent confidence intervals were plotted for both models. Further regression diagnostics were conducted by plotting delta-\(\beta\) values (for each \(\beta\)-estimate) against the values for observed partner frequency to identify data points with strong influence (13).

RESULTS

Bivariate associations with recent partner frequency

The distribution of recent partner frequencies for each level of the independent variables is shown in table 1. To facilitate comparisons, we categorized recent partner frequency into five groups ranging from zero to more than three new partners. Overall, 72 percent of subjects had zero new partners per year, meaning that they either had no partner or had the same partner during the 3 years prior to the survey. Approximately 2 percent of subjects had more than three new partners per year. The data distribution for the 1992 survey was shifted slightly toward lower frequencies than the 1987 distribution. The distribu-
TABLE 1. Recent sexual partner frequency for 8,477 Norwegian subjects aged 18–52 years with sexual experience and no same-sex partners, 1987 and 1992

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of cases</th>
<th>No of new partners per year</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>8,477</td>
<td>0.34</td>
<td>72.0</td>
</tr>
<tr>
<td>Survey</td>
<td></td>
<td></td>
<td>0.002</td>
</tr>
<tr>
<td>1987</td>
<td>4,804</td>
<td>0.37</td>
<td>70.9</td>
</tr>
<tr>
<td>1992</td>
<td>3,673</td>
<td>0.30</td>
<td>73.5</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Male</td>
<td>3,830</td>
<td>0.47</td>
<td>66.8</td>
</tr>
<tr>
<td>Female</td>
<td>4,645</td>
<td>0.24</td>
<td>76.3</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>18–25</td>
<td>1,734</td>
<td>0.77</td>
<td>39.8</td>
</tr>
<tr>
<td>26–35</td>
<td>3,013</td>
<td>0.31</td>
<td>76.0</td>
</tr>
<tr>
<td>36–52</td>
<td>3,549</td>
<td>0.16</td>
<td>83.9</td>
</tr>
<tr>
<td>Cohabitation status</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Single</td>
<td>2,113</td>
<td>1.05</td>
<td>24.8</td>
</tr>
<tr>
<td>Married/cohabiting</td>
<td>6,352</td>
<td>0.10</td>
<td>87.7</td>
</tr>
<tr>
<td>Education (years)</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≤9</td>
<td>4,161</td>
<td>0.28</td>
<td>78.0</td>
</tr>
<tr>
<td>10–12</td>
<td>1,724</td>
<td>0.46</td>
<td>65.5</td>
</tr>
<tr>
<td>&gt;13</td>
<td>2,573</td>
<td>0.37</td>
<td>66.6</td>
</tr>
<tr>
<td>Population density</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sparse/rural</td>
<td>1,161</td>
<td>0.19</td>
<td>81.7</td>
</tr>
<tr>
<td>Community/city</td>
<td>7,258</td>
<td>0.37</td>
<td>70.4</td>
</tr>
<tr>
<td>HIV† testing</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No</td>
<td>7,553</td>
<td>0.32</td>
<td>72.6</td>
</tr>
<tr>
<td>Yes</td>
<td>772</td>
<td>0.56</td>
<td>63.5</td>
</tr>
<tr>
<td>Age (years) at first sexual intercourse</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≤15</td>
<td>1,311</td>
<td>1.01</td>
<td>63.3</td>
</tr>
<tr>
<td>16</td>
<td>1,459</td>
<td>0.43</td>
<td>67.9</td>
</tr>
<tr>
<td>17</td>
<td>1,423</td>
<td>0.36</td>
<td>69.9</td>
</tr>
<tr>
<td>18</td>
<td>1,469</td>
<td>0.27</td>
<td>73.5</td>
</tr>
<tr>
<td>≥19</td>
<td>2,539</td>
<td>0.08</td>
<td>77.6</td>
</tr>
<tr>
<td>Earlier partner frequency</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>0</td>
<td>178</td>
<td>0.10</td>
<td>5.6</td>
</tr>
<tr>
<td>0.1–1</td>
<td>5,616</td>
<td>0.13</td>
<td>81.7</td>
</tr>
<tr>
<td>1.1–2</td>
<td>759</td>
<td>0.18</td>
<td>61.7</td>
</tr>
<tr>
<td>2.1–3</td>
<td>200</td>
<td>0.12</td>
<td>53.0</td>
</tr>
<tr>
<td>≥3</td>
<td>295</td>
<td>0.29</td>
<td>51.9</td>
</tr>
</tbody>
</table>

* p for difference between categories.
† HIV, human immunodeficiency virus.
‡ From age 16 years to age 3 years prior to survey.

tion for males was shifted toward higher frequencies than that for females. Recent partner frequency declined with increasing age, and it was much lower among married/cohabiting subjects than among singles. For education, the middle category had the highest partner frequencies, followed closely by the high category. Frequencies were lower among persons from sparsely populated areas than among those from densely populated areas. Previous testing for HIV was associated with higher partner frequencies. The association with age at first intercourse was strong and consistent: The distributions shifted toward higher partner frequencies with earlier sexual debut. Aside from respondents whose earlier partner frequency equaled zero, the distribution showed a strong and constant shift toward higher partner frequencies with increasing earlier partner frequency.

Multivariate associations with partner frequency

The first Poisson regression tested the importance of the covariates after the exclusion of earlier partner frequency.
The results were based on the 7,928 individuals who had complete data (6.1 percent had missing data on one or more of the independent variables). Table 2 shows the rate ratios from the Poisson regression for the variables that were independently associated with recent partner frequency. After adjustment for the other variables, partner frequency was lower in 1992 than in 1987. Two interaction terms were significant: biologic sex with age and biologic sex with cohabitation status. These findings indicate that the expected partner frequencies for females relative to males depend on age and cohabitation status. Table 2 includes rate ratios for the extreme age groups. Young, single females reported somewhat lower partner frequencies than young, single males, whereas cohabiting or older females reported less than half the frequency of the corresponding male groups. Recent partner frequency decreased by a factor of 0.9 for every 10-year increase in age among males, and by a factor of 0.8 for every 10-year increase in age among females. The ratio was 0.2 among married/cohabiting males compared with single males and 0.1 among married/cohabiting females compared with single females. Subjects from densely populated areas and subjects who had been tested for HIV reported higher than average frequencies. The association between recent partner frequency and age at first intercourse was again very strong; the frequency declined by a factor of 0.8 for every 1-year increase in age at sexual debut. Education was not included in the model. With the exception of a few data points representing the highest recent partner frequencies, the squared residuals were proportional to the expected partner frequency, indicating that the model formulation expressed in equation 3 was valid. The estimated value for the measure of overdispersion was 1.60.

Subsample survey

Of the 675 subjects who answered the subsample survey, there were 85 nonresponders to the 1992 survey. For 55.4 percent of the nonresponders, reasons for nonresponse included having no time, forgetting to respond, and thinking the questionnaire was too long or unclear. For 15.4 percent the survey was of no concern, 14.4 percent thought it was "meaningless," 10.6 percent reported that the questions were too intimate, and 4.1 percent feared a breach of confidentiality. Among the responders, 96.1 percent had sexual experience; the mean lifetime number of partners was 8.5 (12.8 for males and 5.6 for females). Among the nonresponders, 93.9 percent had sexual experience; the mean lifetime number of partners was 8.2 (11.2 for males and 5.3 for females).

Predicted recent partner frequency as a function of earlier partner frequency

To determine the importance of earlier partner frequency in predicting recent partner frequency, we expanded model 1 by including earlier partner frequency as a covariate. Biologic sex, cohabitation status, and population status remained significant and important predictors. Survey, age, HIV testing, and age at first intercourse were also statistically significant, but with rate ratios close to 1. After the other covariates were controlled, the \( \beta \) coefficient of the logarithm of earlier partner frequency was estimated as 0.50 (95 percent confidence interval 0.4-0.6); that is, the predicted recent partner frequency was proportional to the square root of earlier partner frequency (equation 4). Figure 1 shows the relation between earlier partner frequency and recent partner frequency.
frequency and predicted recent partner frequency for the four strata composed of the two most important covariates: cohabitation status and biologic sex. At the point "0.8 new partners per year," which equals the mean earlier partner frequency, single males are predicted to have increased their partner frequency, single females are predicted to have remained at about the same level, and cohabiting individuals are predicted to have decreased their frequency considerably, compared with earlier in their lives. The predicted frequency was higher among subjects from densely populated areas than among those from sparsely populated areas, was about the same in both surveys, and did not depend importantly on age, education, HIV testing, or age at first intercourse.

Again, with the exception of only a few data points representing the highest frequencies, the squared residuals were proportional to the expected partner frequency, meaning that the model formulation used in equation 3 was valid. The estimation of overdispersion was 1.41.

Regression diagnostics

We inspected delta-\( \beta \) plots for all of the \( \beta \)-estimates (\( \beta = \ln(\text{rate ratio}) \)) to check for data points with unduly high influence on the estimated rate ratios. These plots show the change in the \( \beta \)-estimate when one data point is removed, by data point. Plotting against the observed partner frequency yielded the most revealing results. Initially, subjects with a recent partner frequency greater than 15 were included in the analysis. The plots indicated that several \( \beta \)-estimates were strongly influenced by these subjects. Subjects with partner frequencies above 15 new partners per year were therefore excluded. No other data points/subjects stood out in the plots.

DISCUSSION

Our analysis showed that the distribution of partner frequencies was highly skewed: 72 percent of subjects had no new partners per year, while 2 percent had more than three new partners per year. Correlates of
high partner frequency were being single, young, and male and having an early sexual debut. There was a decrease in partner frequency from 1987 to 1992. Married/cohabiting respondents decreased their partner frequency substantially compared with earlier in their lives, whereas partner frequency among single individuals remained at the same level or increased.

Selection bias

The sampling frame was the Central Person Registry, and the study populations were, therefore, representative at the time of each survey. Based on the sample representing the restricted age span, ranging from 18 to 52 years, the response rate was 65 percent in the 1987 survey and 50 percent in the 1992 survey. Selective nonresponse may therefore have influenced our estimates of mean partner frequency, the decrease in partner frequency between surveys, and the associations between partner frequency and the covariates. The 1992 subsample survey did not allow the estimation of partner frequency, but it did provide information such that we could test for differences between persons who responded to the 1992 survey and those who did not. This comparison revealed that number of lifetime partners did not differ significantly between responders and nonresponders (p = 0.8 (Mann-Whitney test)). In the 1992 survey, we kept track of the dates on which we received the questionnaires. The distribution fell into two easily distinguishable periods: before and after reminder notices were sent out. Partner frequency was the same in the two groups, with a mean value of 0.30 (n = 2,290) for the group answering prior to the reminder and a mean value of 0.32 (n = 1,383) for the group answering after the reminder (p = 0.09 (Mann-Whitney test)). This may suggest that partner frequency among the nonresponders was not substantially different from that among the responders. Even so, the small observed decrease in partner frequency between 1987 and 1992 could have been influenced by selection bias. Presumably, the estimated associations between partner frequency and the covariates were less influenced by selection bias.

Partner frequency definitions

Whereas many reports on sexual behavior have focused on the number of partners a person has had during a specified time, such as his or her lifetime, the past 5 years, or the past 3 years (1, 3, 14), we have chosen to study partner frequency, measured as the number of new partners per year. Partner frequency is more closely related to the risk of acquiring sexually transmitted diseases (4, 15) than is number of partners over time, and recent partner frequency measures the risk behavior close to the present time. However, it is difficult to measure the number of new partners per year. In designing the questionnaire, we decided against asking people directly about their number of new partners and instead defined recent partner frequency on the basis of number of partners in the previous 3 years and age at first intercourse (equation 1). Earlier partner frequency could have been defined as the number of partners since sexual debut divided by time since debut, but this measure would have been biased such that for two persons with the same age and the same number of partners, the one with the later debut would have received a higher value for partner frequency. Instead, we counted risk time—that is, the time during which someone was expected to have sexual partners—from age 16 up to the previous 3 years, but we also included partners encountered before age 16 in the calculation (equation 2). To obtain a period of at least 2 years during which to count partners, we measured earlier partner frequency only for persons aged 21 years or older. Thirty-three percent of the sample reported having had a sexual experience by age 16. The choice of age 16 as a starting point was based on the need to counterbalance two factors: Using a lower age than the median age leads to lower estimates of earlier partner frequency, particularly for young subjects; but because of the definition used, a higher cutoff age will lead to greater exclusion among those who are younger. However, changing to the use of age 17 as a starting point did not alter the conclusions.

Sex differences

In many studies of sexual behavior, women report having fewer partners than men (3, 14). In a closed population, males and females must have the same average partner frequency. In our data, the ratio of female-to-male mean partner frequency was 0.24/0.47 = 0.50. However, some subjects had partners that were not represented in the survey. If we exclude people with partners younger than 18 years (141 males and 9 females), the ratio increases to 0.54. If, in addition, we exclude individuals whose last partner was a sex worker (45 males and 1 female), the ratio increases to 0.55; but this is still far from unity. The difference may be caused by selective response, or by differences between the sexes in how numbers of partners are counted. The subsample survey data, although limited because of the low response rate, do not support the first explanation. Males reported roughly twice as many partners as females in both the response group and the nonresponse group. With regard to the second possibility, we note that our ques-

tionnaire did not include definitions of the terms “intercourse” and “partner.” Particularly at the start of sexual life, there may be experiences that may or may not count as sexual episodes or persons who may or may not be counted as “partners.” There could be a difference between the sexes in terms of the types of sexual encounters that are counted as occurring with partners. This could account for the differences in the reported number of partners between the sexes.

REFERENCES