Comparison of Direct Estimate and Partner Elicitation Methods for Measuring the Number of Sexual and Injection Partners

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The number of sexual partners and number of injection partners an individual has are key variables in epidemiologic research on infectious diseases such as HIV, STDs, and the hepatitides. The number of partners is a prominent risk factor for such infections. Researchers and clinicians routinely measure the number of partners in observational studies, evaluations of behaviorally-oriented preventive interventions, and individual clinical risk assessments. The number of partners is also a central parameter in models of transmission dynamics for particular infections.

The most common method for measuring the number of partners is the direct estimate (1), in which subjects simply estimate the number of partners for a given recall period (e.g., “how many people have you had sex with in the last year?”). Despite the widespread use of the direct estimate for measuring the number of partners, relatively little is known about the quality of data it produces. In this paper, we assess the intermethod and test-retest reliability of the direct estimate, describe subjects’ direct estimate response strategies and processes, and indirectly evaluate the validity of the direct estimate. Intermethod reliability here refers to the correspondence between the direct estimate and the partner elicitation approach, in which individual partners are elicited and then counted. Test-retest reliability refers to the consistency of measurements produced by the same method on two different occasions. For each type of reliability, we examine the mean difference, covariation, and agreement between methods or sets of measurements.

Method

This paper is based on two studies of persons at presumed high risk for HIV in Colorado Springs, Colorado (2-3), and Seattle, Washington (4).

Subjects

Colorado Springs. Subjects in this study included prostitutes, drug injectors, and their close personal contacts recruited from an STD clinic, a drug treatment program, an HIV testing program, and outreach activities. They were predominantly white, relatively mobile, young adults with low educational levels. For the present analyses, we included data from 449 persons who were active needle-sharers and/or were sexually active non-prostitutes in the six months prior to the first interview.

Seattle. Subjects in this study were recruited from a large epidemiologic study of drug injectors, an HIV testing clinic, and an outreach services program for gay/bisexual methamphetamine injectors. These subjects were demographically and behaviorally representative of the populations served at the recruitment sites. They were largely white, young to middle-aged adults who were quite diverse in terms of socioeconomic status and sexual orientation. For the present analyses, we included data from 150 subjects who had injected drugs and/or had sex (but were not prostitutes) in the two years prior to enrollment.

Procedure

Colorado Springs. The first half of the interview included questions on subjects' demographic characteristics, HIV knowledge, drug use, and sexual behavior. At the very end of this section, interviewers asked subjects, in two separate direct estimate questions, to report the number of persons with whom they had sex and shared needles in the prior six months. The next half of the interview focused on the elicitation of "close personal contacts." Interviewers asked subjects to list persons with whom they had sex, used drugs, shared meals, shared lodging, and/or shared clothing/personal possessions in the previous six months. Subjects were not limited in the number of contacts they could name. After eliciting contacts, interviewers asked subjects to indicate the type of contact (e.g., sexual, needle-sharing, etc.) they had with each contact and provide demographic and locating information about their contacts. We refer to contacts with whom subjects reported having sexual contact as sexual partners and those with whom subjects reported sharing needles as needle-sharing partners.

Seattle. Overall, the procedures in the Seattle study followed a similar sequence as in the Colorado Springs study. Prior to the direct estimate questions, interviewers gave explicit and detailed definitions of sexual and injection partners (persons with whom subjects had injected drugs) (see (4)). Half of the subjects were randomly assigned to be asked direct estimate questions on the number of sexual and injection partners. After subjects gave a direct estimate response, interviewers asked them how they answered the direct estimate question. Their responses to this question constitute their self-reported response strategies. Earlier analyses showed that providing direct estimates did not influence the number of partners recalled (4).

Subjects were also assigned (based on partial random assignment) to different follow-up conditions that involved different recall periods for behavioral questions. In the short follow-up condition, subjects were interviewed on two occasions separated by a mean of 11 days. In both interviews, the recall period was the prior two years. In the long follow-up condition, subjects were interviewed on two occasions separated by a mean 103 days. The recall period was the prior year for the first interview and the prior two years for the second interview. (For other details on the experimental design not relevant to the current analyses, see (4)).

One set of direct estimate and partner elicitation questions focused exclusively on sexual partners and another set focused exclusively on injection partners. Interviewers asked the sexual partner and injection partner questions in a balanced order across subjects who were sexually active drug injectors. The partner elicitation questions emphasized that subjects were to list all partners in the recall period, take as much time to recall as necessary, and refer to partners by first names, nicknames, initials, made-up names, or brief descriptions. When a subject indicated that he or she was finished recalling, the interviewer prompted (repeatedly, as necessary) with a nonspecific question about additional partners (e.g., “is there anyone else you have had sex/injected drugs with in the last year?”) until the subject insisted that he or she could not recall any additional partners. Next, the interviewer read the list of partners back to the subject and prompted again. Then, the interviewer asked the subject how many, if any, additional partners she or he had in the recall period but either just could not

remember or did not want to mention at that time. If a subject recalled other partners at later points in the interview, the interviewer recorded them.

Procedures for the second interview were essentially identical to those in the first. In the second interview, after eliciting partners of a particular type, the interviewer and subject compared the lists of partners from both interviews and determined which partners, if any, were first encountered after the first interview. The final section of the interview included questions about specific partners, up to the first twelve mentioned by a subject. Subjects were randomly assigned to one of four separate subsets of questions about partners to reduce the length of the interview. One subset included questions about the dates of first and last sexual/injection contact with a partner.

Data analysis

Unless otherwise noted, we used data from subjects' first interviews for each study. Also, we excluded prostitutes (persons who exchanged sex for money or drugs) from all analyses related to sexual partners. The nature, context, and number of most of prostitutes' sexual partnerships are quite different from those of other sexually active persons. As a result, comparisons between measurement methods for prostitutes may not be very informative.

We computed the intermethod reliability (between the direct estimate and number of partners recalled in an interview) for both studies and the test-retest reliability for the Seattle study only. The Pearson correlation corresponding to the matched pair t-test indicates the magnitude of mean difference between two methods or sets of

measurements (5). A mean difference r of .00 reflects perfect reliability in terms of mean difference. To gauge covariation, we calculated the Pearson correlation between the two methods or sets of measurements, with an r of 1.00 representing perfect reliability. To assess the level of absolute agreement between the two methods or sets of measurements, we computed the intraclass correlation coefficient (6-8). A coefficient of 1.00 indicates perfect reliability.

For each method's distribution of the number of partners, we calculated the degree of heaping on multiples of five with a new measure that we developed (9). The measure, called H, indicates the extent to which each of a hypothesized set of values in a distribution (multiples of five, in this case) has a higher frequency than its immediately neighboring values (e.g., for the value 5, the immediately neighboring values are 4 and 6). H is 1.00 when the observed heaping on the hypothesized set of values is greater than that for any other possible set of the same number of values, positive when the observed heaping is greater than that expected by chance, 0 when the observed heaping is equal to that expected by chance, and negative when the observed heaping is less than that expected by chance. We included subjects in the test-retest and heaping analyses for a particular method even if they did not have data on the other method.

We classified each Seattle subject's self-reported direct estimate response strategy into one or more categories described in the literature on response processes for similar questions. Multiple categories could apply to a subject's response strategy, although "no explanation/don't know" is exclusive from the other categories.

We assessed the validity of the direct estimate indirectly with the Seattle data. For the Seattle subjects with a two year recall period in both interviews, we compared the mean direct estimate and mean number recalled in the second interview with an estimate of the mean number of new partners for a comparable period. We derived the estimate by scaling up data on the number of new partners subjects had first sexual/injection contact between interviews (see (4) for details on this measure).

Results

Reliability

Intermethod. Tables 1a and 1b show the univariate descriptive statistics for the number of partners produced by each method. The results in these tables are based only on those subjects who estimated they had fewer than 21 partners of a particular type and who had data on each of the two measures. Within recall periods and partner types, the two methods have generally similar distributions.

The arbitrary cutoff of 20 or fewer self-estimated partners eliminates the influence of a very small number of outliers in the direct estimate distributions (maximum direct estimates ranged from 50 to 1000 across partner types and recall periods). Furthermore, it is reasonable to expect that some subjects could mentally enumerate up to 20 partners in responding to the direct estimate question, thus making this a suitable range for comparison. We also calculated descriptive statistics for all subjects (including those with more than 20 self-estimated partners) in each of the three recall periods. Based on all subjects, the sample sizes, mean direct estimate (*DE*), and mean

number of partners recalled (*NR*) for sex partners are: 6 months -- n = 395, mean *DE* = 5.15, mean *NR* = 3.07; and 2 years -- n = 32: mean *DE* = 11.75, mean *NR* = 7.88. The corresponding figures for needle-sharing/injection partners are: 6 months -- n = 198: mean *DE* = 3.94, mean *NR* = 3.73; 1 year -- n = 23: mean *DE* = 12.74, mean *NR* = 10.30; 2 years -- n = 26: mean *DE* = 50.15, mean *NR* = 11.77.

Tables 2a and 2b display the mean difference, covariation, and agreement between the two methods. When all subjects are included, the direct estimate produces slightly to mildly higher means than the number recalled across partner types and recall periods. For subjects with fewer than 21 self-estimated partners, the direct estimate produces very slightly higher means than the number recalled for the Colorado Springs subjects with a 6 month recall period. However, the mean number recalled is modestly higher than the mean direct estimate for the Seattle subjects (1 and 2 year recall periods) with fewer than 21 self-estimated partners. In both studies, the proportion of subjects who recalled more partners than they estimated tends to be greater than the proportion who estimated more partners than they recalled (% DE < / > NR in the Tables 2a and 2b).

Across recall periods and partner types, the direct estimate and number recalled tend to covary moderately. The Pearson correlations tend to be substantially stronger when only those subjects with fewer than 21 self-estimated partners are included. Among this latter set of subjects, the two methods covary more strongly for sexual partners than injection partners. The intraclass correlation coefficients display a similar pattern as the Pearson correlations indicating a moderate to high degree of absolute agreement between the two methods.

In the Seattle study across partner types and recall periods, the number of partners recalled before the interviewer began prompting corresponds (in terms of mean difference, covariation, and agreement) to the direct estimate slightly to moderately more strongly than the total number of partners recalled (data not shown).

Test-retest. We compared the test-retest reliability of each method for the Seattle short follow-up subjects with the two year recall period who completed both interviews (the long follow-up subjects had different recall periods in the two interviews) (see Table 3). For sex partners, both methods yield somewhat more partners in the second interview than the first. For injection partners, both methods yield very slightly to mildly more partners in the first interview than the second. The partner elicitation method produces more stable means across time than the direct estimate for both types of partners.

Each method displays high degrees of test-retest covariation and agreement for sex partners, although the levels of test-retest covariation and agreement for injection partners are more moderate. In terms of test-retest covariation and agreement, the direct estimate is slightly less reliable than the number recalled for sex partners but slightly more reliable for injection partners. In addition, the discrepancy between the direct estimate and number recalled tends to grow as the direct estimate increases. For subjects with fewer than 21 self-estimated partners, the Pearson correlations between the absolute value of the discrepancy between methods and the direct estimate range, across the three recall periods, between .62-.71 for sex partners and .39-.49 for injection/needle-sharing partners.

Response strategies and processes

Subjects overwhelmingly reported using enumeration (of partners) as a response strategy for making direct estimates (see Table 4). Relatively few subjects used estimation from a typical rate of accruing partners or simple guessing in producing direct estimate responses. Subjects who reported using enumeration tended to estimate having had fewer partners than those who did not report using this strategy (mean difference r's range between -.29 and -.48 across recall periods and partner types).

Subjects' direct estimates show moderate heaping on multiples of 5 not present in the number recalled (see Table 5 and Figures 1a and 1b). For every partner type and recall period, the direct estimate displays greater heaping than the number recalled.

Validity

Both the direct estimate and the number recalled appear to underestimate the true number of partners considerably. For sex partners (n = 26 subjects), the mean direct estimate (13.92) closely approximates the estimated mean number of new partners (13.88), and both of these means are almost twice as high as the mean number recalled (7.58). For injection partners (n = 19 subjects), the mean direct estimate (12.84) and mean number recalled (11.16) are each only a small fraction of the estimated mean number of new partners (107.24).

Even though the mean direct estimate and estimated mean number of new partners are very similar for sex partners, the direct estimate likely is an underestimate of the total number of partners in the recall period. The proportions of recalled partners (aggregated across subjects) in the first interview with whom subjects reported having first sexual/injection contact prior to the recall period range across recall periods between .31-.32 for sex partners and .44-.49 for injection partners. These results suggest that new partners do not represent all partners in a given recall period.

Furthermore, after recalling partners, many Seattle subjects estimated having had additional partners during the recall period whom they could not recall or did not want to mention. These estimates of the number of unrecalled partners also suggest that the direct estimates are underestimates. The direct estimate tends to be slightly lower than the sum of the number recalled and the estimated number of unrecalled partners (mean difference r's range between -.41 and .06 across partner types and recall periods for all subjects).

Discussion

Both the direct estimate and number of partners recalled show reasonably similar, moderate to high levels of test-retest reliability. The correspondence between the two methods, though, tends to be somewhat lower, even for subjects with fewer than 21 self-estimated partners. Across measurement methods, the number of sex partners is more reliably measured than the number of injection/needle-sharing partners with respect to most, but not all, reliability criteria. A large majority of Seattle subjects reported using enumeration as a response strategy for the direct estimate. However,

their direct estimates also show a noteworthy degree of heaping on multiples of five that is not present in the number recalled. Based on comparisons with the estimated mean number of new partners for a comparable period, the direct estimate seems to provide a better estimate of the true mean number of partners (for all subjects) than the number recalled. Nevertheless, both the direct estimate and the number recalled still appear to underestimate the true number of partners substantially.

Seattle subjects recalled more partners relative to their direct estimates than Colorado Springs subjects did. Two differences in data collection procedures for the Colorado Springs and Seattle studies might account for this finding. First, the Colorado Springs elicitation question included multiple relations (as opposed to the separate elicitation of sexual and injection partners in Seattle) and, as a result, Colorado Springs subjects may have been more likely to overlook partners of a particular type during recall. Second, interviewers in the Seattle study elicited an appreciable proportion of partners who might not have otherwise been recalled through repeated, non-specific prompting (4).

Regardless of these different results between studies, interviewers should not use the direct estimate as a benchmark for evaluating the completeness of partner elicitation, as in contact interviews for partner notification or social network research. For individual subjects, the number recalled exceeds the direct estimate more often than the direct estimate exceeds the number recalled.

It may be that many subjects based their direct estimates on some sort of a quick assessment of the number of partners available in immediate memory (cf. (10)), loosely indexed in the Seattle study by the number of partners recalled before interviewer prompting. For Seattle subjects, the number recalled prior to prompting corresponds to the direct estimate somewhat better than the total number recalled. Prompting seems to elicit partners who do not come to mind automatically or easily.

In large part, the stronger correspondence between the direct estimate and the number recalled before interviewer prompting is likely due to many subjects' use of enumeration as a direct estimate response strategy. The predominance of enumeration as a response strategy and its greater use by subjects making low estimates mirror results from other studies that used direct estimates to measure the number of sexual partners (11) and frequency of other behaviors that occur on an irregular basis (12-15)).

The notable degree heaping in the direct estimates reflects a kind of error in response probably due to some subjects giving a "round" number of partners for their answers. In line with our results, Golubjatnikov et al.'s (16) direct estimate data on the number of sexual partners also show prominent heaping on multiples of five.

In addition to the results described earlier, other evidence indicates the direct estimate tends to produce an underestimate of the true number of partners. The number recalled almost certainly underestimates (probably by a large margin) the true number of partners, given Seattle subjects' substantial forgetting in the recall of partners (4). Thus, the direct estimate must be an underestimate, at least for subjects with fewer than

21 self-estimated partners, because this group of subjects, across studies, had direct estimates that are essentially equal to or less than the number recalled. Brewer et al. (4) demonstrated that the proportional level of forgetting is not related to the number of partners recalled, indicating that subjects with fewer than 21 self-estimated partners forgot partners at the same rate as other subjects.

Moreover, other research on the number of acquaintances people have in particular social contexts suggests that accurate direct estimates should be much larger than the number recalled. Sudman (1) studied members of eight different work and church groups and demonstrated that subjects on average recalled only a fraction (16-90%) of the number of acquaintances they recognized in a later task. However, the mean direct estimate of the number of acquaintances approximated the mean number of acquaintances recognized. In our studies, the mean direct estimate does tend to be much larger on average than the mean number recalled when all subjects are included, due to a very small percentage of subjects with extremely high direct estimates. Nonetheless, the comparisons with the estimated mean number of new partners in the Seattle study suggest that the mean direct estimate still falls short of the true mean number of partners. In any event, our other results indicate that for most subjects (i.e., those with 20 or fewer self-estimated partners), the direct estimate is an underestimate of the true number of partners.

Furthermore, if forward telescoping were present in our data (i.e., subjects remembering partners as falling inside the recall period even though they actually last encountered partners prior to the recall period), it would likely not alter our interpretations. Forward

telescoping is more typically involved with questions requiring limited memory retrieval for response (e.g., direct estimates) than questions requiring extensive retrieval (e.g., partner recall) (17).

In conclusion, both methods appear equally well-suited, from a measurement perspective, for describing individual differences in the number of partners. The direct estimate obviously requires much less interview time and seems to provide a better, but still flawed, estimate of the mean number of partners. Partner elicitation, though, can provide far more data on constructs of potentially greater epidemiological significance than simply the number of partners in a given period, such as concurrency of partnerships (18) and the number of <u>new</u> partners in a specific period (19).

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Table 1. Descriptive Statistics on Direct Estimates and Numbers of Partners Recalled (for Subjects with Direct Estimates < 21)

	n	Mean	Median	SD	Range
Sexual partners					
Colorado Springs					
6 month recall period					
Direct estimate	386	2.96	2.00	3.16	0-19
Number recalled	386	2.87	2.00	2.81	0-17
Seattle					
1 year recall period					
Direct estimate	25	3.92	2.00	4.69	1-20
Number recalled	25	4.20	2.00	4.82	1-17
2 year recall period					
Direct estimate	28	5.75	4.50	5.58	1-20
Number recalled	28	6.29	5.00	6.06	1-23
Injection/needle-sharing partners					
Colorado Springs					
6 month recall period					
Direct estimate	197	3.74	2.00	3.91	0-20
Number recalled	197	3.65	2.00	4.34	0-42
Seattle					
1 year recall period					
Direct estimate	20	5.90	4.00	4.48	1-15
Number recalled	20	7.95	5.00	7.39	1-25
2 year recall period					
Direct estimate	20	6.95	6.00	4.55	1-19
Number recalled	20	8.65	8.00	4.98	2-19

Table 2. Mean Difference and Correlation between Direct Estimate (*DE*) and Number of Partners Recalled (*NR*)

	Mean Diff. (*DE - NR)*	Mean Diff. r	% *DE* < / > *NR*	Covariation r	Intraclass Corr.
Sexual partners					
Colorado Springs					
6 month recall period					
All subjects	2.08	.08	18/15	.43	.10
Subjects with *DE* < 21	0.06	.05	18/13	.80	.79
Seattle					
1 year recall period					
All subjects (all *DE* < 21)	-0.28	-.21	16/4	.96	.96
2 year recall period					
All subjects	3.88	.26	22/25	.56	.38
Subjects with *DE* < 21	-0.54	-.20	25/14	.90	.90
Injection/needle-sharing partners					
Colorado Springs					
6 month recall period					
All subjects	0.21	.05	32/30	.53	.53
Subjects with *DE* < 21	0.06	.06	31/29	.51	.54
Seattle					
1 year recall period					
All subjects	2.43	.15	35/7	.73	.54
Subjects with *DE* < 21	-2.05	-.51	35/0	.94	.78
2 year recall period					
All subjects	38.38	.20	46/35	.24	.04
Subjects with *DE* < 21	-1.70	-.10	50/25	.42	.37

Table 3. Test-retest Reliability Correlations, Seattle (2 Year Recall Period)

	n	Mean Diff. r (1st int. > 2nd int. = pos. r)	Covariation r	Intraclass Correlation
Sexual partners				
Direct estimate	28	-.28	.95	.92
Number recalled	61	-.17	.98	.93
Injection partners				
Direct estimate	21	.18	.84	.84
Number recalled	43	.01	.77	.77

Table 4. Subjects' Self-reported Response Strategies for Direct Estimates, Seattle

Strategy	% Who Reported Using Strategy for Recalling:	
	Sex Partners (n = 37)	Injection Partners (n = 42)
Enumeration	68	69
Estimation from a typical rate	16	7
No explanation/don't know	14	14
Simple guess/estimate	8	14
Other	0	2

Table 5. Degree of Heaping on Multiples of Five

Partner Type	Direct Estimate	Number of Partners Recalled
Sexual partners		
Colorado Springs		
6 month recall period	.18	.12
Seattle		
1 year recall period	.17	-.11
2 year recall period	.50	-.42
Injection/needle-sharing partners		
Colorado Springs		
6 month recall period	.48	.00
Seattle		
1 year recall period	.06	.06
2 year recall period	.44	-.31