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Original article

Relationship quality, coital frequency, and condom use as predictors of incident genital *Chlamydia trachomatis* infection among adolescent women

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Abstract

Purpose: To explore associations of relationship quality, coital frequency, unprotected coitus, and chlamydia infection over time.

Methods: Data came from 142 adolescent females with sexually transmitted infections attending three primary care adolescent clinics and one county STD clinic. Interview data were collected at 3 time points: enrollment, 1 month, and 3 months after enrollment. Predictor variables included relationship quality, coital frequency, unprotected coitus, and partner change. The outcome variable was infection with *C. trachomatis* at 3 months. Analyses were conducted using structural equation modeling.

Results: Chlamydia infection at 3 months was directly influenced by unprotected coitus during the previous 2 months (B = .25; $p \leq .05$) and partner change during the enrollment/1-month interval. Unprotected coitus was directly associated with coital frequency, both cross-sectionally and longitudinally. Increased relationship quality was associated with increased coital frequency but did not have direct effects on unprotected coitus.

Conclusions: The data showed a protective effect of condom use for chlamydia infections. Prevention efforts should attend to the interpersonal factors behind decisions to use or not use condoms.

Keywords: Relationship quality; Adolescents; Chlamydia infection

Prevention by condoms of sexually transmitted *Chlamydia trachomatis* has not been consistently documented. Among adult women, some studies show evidence of effectiveness of condoms in reduction in risk of chlamydia infection [1] whereas others do not [2,3]. A National Institute of Health Workshop on Condom Effectiveness concluded ". . .the available epidemiologic literature does not allow an accurate assessment of the degree of potential protection against chlamydia offered by correct and consistent condom usage" [4]. Evidence for condom effectiveness is particularly meager for adolescent women, who have the highest rates of chlamydia of any age group [5]. Nonetheless, consistent condom use remains a centerpiece of public health efforts to prevent sexually transmitted infections and demonstration of condom effectiveness in prevention of chlamydia infections remains important. Moreover, understanding of factors associated with consistent condom use is critical to efforts to prevent genital chlamydia infections among adolescents.

Sexual intercourse serves a complex set of functions in human relationships; reproduction, intimacy, trust, power, love, libido, and aggression are only a few of the terms that apply. Condom use may be affected by characteristics of the

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sexual partnerships and the sexual situation. Condom use is most consistent in relationships described as "new" and less consistent in "established" relationships [6,7]. Adolescent women report significantly less consistent condom use in new relationships characterized by emotional commitment and affiliation [8,9]. However, the time required to discontinue condom use is relatively brief among adolescents, perhaps less than 1 month [10]. These data suggest that consistent condom use is a relatively short-lived characteristic of many adolescent sexual relationships. A recent cross-sectional study of adolescent women reported increased risk of chlamydia infection among those in relatively new relationships, and among those who did not use condoms in established relationships [11].

Continuing questions about the effectiveness of condoms for infections due to *C. trachomatis* suggests the importance of examining condom use within the context of romantic/sexual relationships and associated sexual behaviors. The purpose of this research was to examine potential linkages among relationship characteristics, coital frequency, condom use, and incident chlamydia infection during a 3-month longitudinal study.

Methods

This study was part of a larger project evaluating factors associated with repeated bacterial and protozoan sexually transmitted infections among adolescent women. Participants ages 14–21, attending a metropolitan sexually transmitted infection (STI) clinic or 1 of 3 community adolescent health clinics, were eligible for entry if they were treated for *N. gonorrhoeae, C. trachomatis, T. vaginalis,* or were sexual contacts of patients with these infections. A total of 142 participants had complete data and were used in this analysis. The participating clinics serve primarily lower- and middle income residents of areas with high rates of teen pregnancy and sexually transmitted infections. The average maternal education was 12th grade.

Potentially eligible patients were identified from clinic and laboratory records. Each eligible patient was invited to participate at the time of receipt of treatment. Participant recruitment began in 1995 and was completed in 1999. Appropriate single-dose treatment was provided for each subject. All subjects received counseling to advise sex partners of the need for testing and treatment along with provision of condoms. Each subject provided written informed consent but the requirement for parental consent was waived. The study was approved by the institutional review board of Indiana University/Purdue University at Indianapolis.

Data were collected at 3 time points using a structured interview administered by trained research assistants. At enrollment, an interview was conducted. Each of the 4 most recent partners during the previous 2 months was identified by initials or first name. Participants responded to subsequent items about relationship characteristics, sexual behaviors and condom use with each partner. The enrollment interview required 20–25 minutes for completion.

The follow-up interviews were conducted approximately one month and 3-months after the enrollment interview. Approximately 85% of women in the study completed at least 1 return visit. Approximately 65% of the participants completed at least 3 return visits (i.e., had 3 visits). At the 1-month interview, the initials or first name of each of the 4 partners identified during the enrollment interview were confirmed. Any new partners were also identified. Subsequent interview items addressed partner-specific relationship characteristics, sexual behaviors, and condom use. The 3-month interview identified up to four sex partners from the previous two months (i.e., since the 1-month interview). New partners were defined as those not identified at either the enrollment or 1-month interview. The interview then assessed partner-specific relationship characteristics, sexual behaviors, and condom use for each partner. Data from subsequent or additional partners were not used for this analysis, as few subjects had more than 1 partner at any given time period. Change in the most recent sex partner from one time point to another was accounted for with the introduction of the partner change variable.

Measures

At each visit, participants were asked to identify sex partners by first name or initial. Partner-specific relationship quality was composed of 5 items ($\alpha = .90$ enrollment, $\alpha = .92$ at 1-month, $\alpha = .90$ at 3 months) assessing emotional, affiliative, and supportive characteristics of the interpersonal relationship of each sex-partner dyad. This scale was used in previous research [12,13]. An example of items included in this scale is: "I enjoy spending time with X" (where X indicates the partner's name or initials). Individual item responses were coded as "strongly disagree," "disagree," "agree," or "strongly agree." Scale scores ranged from 5 to 20 with higher scores indicating more positive aspects of the interpersonal relationship. Group mean relationship quality scores were 17 at enrollment and 16 at 1 month and 3 months.

Coital frequency was assessed by asking "How many times in the past 2 months ("1 month" was used at the 1-month visit) did you have sex? This item was asked for each partner and responses were recorded verbatim. Participants with responses such as "don't know," "lots," or "too many" were asked for an approximate number, and "missing" was entered when a precise estimate was not provided. A small number of responses (less than 1%) exceeded 60 (e.g., coital frequencies of more than daily). These coital frequency scores were truncated at 60. Coital frequency thus ranged from 0–60, with median coital frequencies of 5 coital events at enrollment and 3months, and an estimated 4 coital events at 1 month. Coital frequency was subsequently recoded into 7 ordinal categories: 0, 1–10, 11–20, 21–30,

31–40, 41–50, and 51–60. We chose this recoding to represent a range in coital frequencies, rather than analyze potential differences in chlamydia infection based on single event differences. Information on the most recent sex partner in the past 2 months was used for these analyses in order to test the effects of partner-specific relationship quality on other measures.

Condom use was assessed by a subsequent item, asked for each partner: "Of the times you had sex with X, how many times was a condom used?" Unprotected coitus was subsequently defined as the number of unprotected events with a specific partner (the number of times a condom was not used during coitus). This measure allows a direct estimate of potential exposure to sexually transmissible *C. trachomatis,* if present in the partner. The number of unprotected coital events ranged from 0–60. Unprotected coitus was subsequently recoded into 7 ordinal categories, as with coital frequency. For measures of coital frequency and unprotected coitus, the number of events was doubled for the 1-month visit as the 1-month behavioral measures only record 1 month's worth of behavior while enrollment and the 3-month measures account for 2 months of behavior. We doubled the results to make the results interpretable as an artificial decline over time would have appeared.

A comparison of the frequencies of the scores for the enrollment and the 3-month measures showed that the distribution was similar to the scores for the 1-month measure after doubling: for coital frequency at 1 month X = 13, σ = (15.2); for unprotected coitus at 1 month X = 3.8, σ = (7.0). A comparison of the frequencies of the scores at enrollment and at 3 months reduced by half showed that the distribution was similar to the scores for the 1-month measure before doubling: coital frequency at enrollment X = 6.6, σ = (8.6); at 3 months X = 5.6, σ = (6.35); unprotected coitus at enrollment X = 4.3, σ = (6.85); at 3 months X = 3.7, σ = (6.0). We, therefore, felt that the error introduced by doubling was small in comparison to the benefits.

Partner change was coded as "no" or "yes" to indicate whether the most recent sex partner at 1 month differed from the most recent partner at enrollment; and, whether the most recent partner at 3 months differed from the most recent partner at 1 month.

Chlamydia infection was evaluated at enrollment by standard culture methods and at each return visit by polymerase chain reaction (PCR) tests of urine provided by the participant. Observed, single dose antibiotic therapy was provided for each participant with a positive chlamydia test at the 1-month visit.

Statistical methods and models

The primary analytic approach used weighted least squares (WLS) estimates of the model coefficients obtained using asymptotic covariance matrices [14]. The structural equation models (SEM) were performed using LISREL 8.5 [16]. SEM allows for the simultaneous estimation of equations, the estimation of both direct and indirect relationships among variables, and the provision of global fit indices [14].

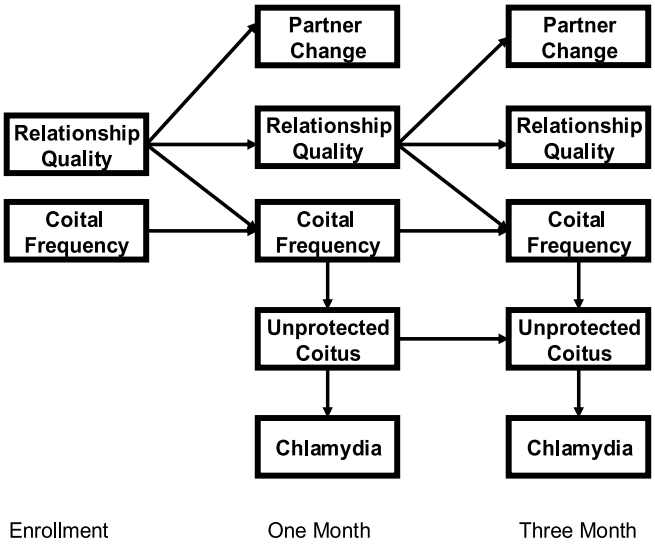

Fig. 1. Arrows represent hypothesized relationships between relationship quality, coital frequency, and chlamydia infection.

In the models, specific sexual and health behaviors as well as relationship quality and partner change variables were treated as single indicator constructs. The overall structural model was evaluated by examination of the magnitude and direction of individual path coefficients as well as several indicators of goodness of fit. Individual paths were consider significant based on the critical t of 1.96 (α = .05). Overall model goodness of fit was assessed using the chi-square (Ξ^2), the root mean square error of approximation (RMSEA), the adjusted goodness of fit index (AGFI), and the expected cross validation index (ECVI). The Ξ^2 is used as a rough measure of goodness of fit with a rule of thumb of a 4 to 1 ratio of degrees of chi-square to degrees of freedom [14,17–19]. The RMSEA adjusts for multiple errors in model specification; values of .05 and below indicate good fit. The AGFI adjusts the goodness of fit estimation for degrees of freedom. A value in the mid .90s and above is considered a reasonably good fit to the data [14].

The hypothesized relationships among relationship quality, coital frequency, unprotected coitus, and chlamydia infection are represented in Figure 1 by the arrows between each pair of variables. At enrollment we included measures of relationship quality and coital frequency. Chlamydia infection status at enrollment was not included in the models because of lack of comparability to diagnostic measures used at follow-up visits: cervical cultures at enrollment and urine based PCR at the 1- and 3- month visits. A comparison of the frequency distribution for enrollment chlamydia infection was similar (in the same direction) as the 1- and 3-month chlamydia infection frequency distributions. Un-

Table 1
Partner change, relationship quality, coital frequency and condom nonuse—by chlamydia infection status

	Chlamydia Infection			
	1-Month		3-Months	
	No	Yes	No	Yes
Partner change N (%)				
No	77 (85)	14 (15)	71 (88)*	10 (12)
Yes	45 (88)	6 (12)	43 (70)	18 (30)
Relationship quality	16.3 (3.0)	16.0 (2.8)	16.5 (3.0)*	15.3 (2.8)
Coital frequency	6.5 (7.9)	7.0 (5.7)	12.4 (13.5)*	6.0 (6.7)
Unprotected coitus	3.9 (7.3)	3.3 (4.8)	8.5 (12.9)*	3.1 (5.4)

Values are means (standard deviation) in absolute numbers unless otherwise noted.

* $p < 0.05$ by chi square within time period.

** $p < 0.05$ by t-test within time period.

treated and undiagnosed cases from enrollment are assumed small given the sensitivity of cervical cultures [15]; however those undiagnosed cases would have been diagnosed by the 1-month visit and treated and would not be relevant to the understanding of the results. No path was hypothesized from infection at 1 month to infection at 3 months given that chlamydia infections are diagnosed and treated at each visit so that subsequent infections were treated as incident infections. At 1 month and at 3 months, we included measures of partner change, relationship quality, coital frequency, condom non-use, and infection with chlamydia. The outcome variables were chlamydia infection at 1 and 3 months. Cross-sectional associations included covariances between relationship quality and coital frequency at enrollment, at 1 month and 3 months are included in the analysis but are omitted from Figure 1 to simplify its interpretation.

Results

Results are presented in 3 parts. First, univariate distributions and bivariate correlations allow more detailed understanding of the study sample in inter-relationships among the key measures. Second, the structural model for longitudinal relationships of relationship quality, coital frequency, exposure, and chlamydia infection is presented. Third, two alternative models are presented.

Univariate and bivariate statistics

Table 1 shows the apparently paradoxical association of unprotected coitus and chlamydia infection. Table 1 also shows that infection was much more likely in association with partner change and that average relationship quality was higher among uninfected than in the infected participants. Thus the association between exposure and chlamydia infection may be due to the low levels of coital activity (and hence exposure) among the infected (Table 1). This data support the importance of complex multivariate models to disentangle the complex behavioral and interpersonal influences on condom use that may influence studies of condom effectiveness.

Partner change, relationship quality, coital frequency, condom non-use, and chlamydia infection—a structural equation model

The final structural model is shown in Figure 2. The overall fit of the model with data was excellent: $\chi^2(41) = 34.5$, $p = .75$; RMSEA = .00; ECVI .82 (95% confidence intervals: .82; .89); AGFI = .99. The final model shows all significant paths. All cross-sectional covariances and insignificant longitudinal paths were not included in Figure 2 to focus attention on significant longitudinal relations.

In general, unprotected coitus was associated with increased risk of chlamydia infection, with indirect effects of relationship quality on unprotected coitus mediated by coital frequency. The numbers associated with the arrows can be thought of as standardized B coefficients, so that larger numbers (numbers approaching ±1.00) represent a stronger association and smaller numbers (numbers approaching 0) represent weaker associations between the predictor variable and the other ("dependent") variable. The valence associated with number refers to either a positive or negative relationship between the predictor variable and the other ("dependent") variable. Significant longitudinal effects included the effect of relationship quality at enrollment on coital frequency at 1 month ($\beta = .38$) and relationship quality at one month on coital frequency at 3 months ($\beta =$

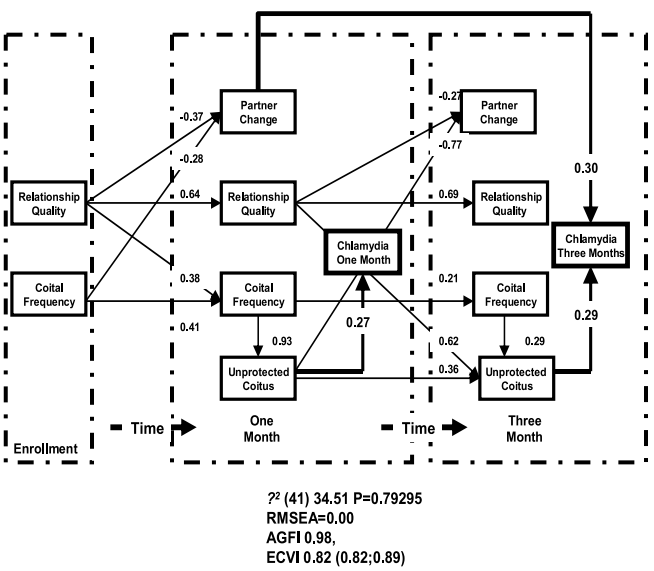

Fig. 2. Solid arrows represent significant paths. Larger font arrows represent direct paths into chlamydia at 1 month and at 3 months. Thin font arrows represent indirect paths into chlamydia at 1 month and at 3 months. Variables in the same dashed boxes were measured at the same time period. All values significant at ($\alpha = .05$, $p < .001$) Standardized coefficients are shown.

.21). These suggest short-term stability (i.e., over a 3-month span) in the association of relationship characteristics and coital frequency. In other words, a 1 standard deviation increase in relationship quality at enrollment was associated with a .38 standard deviation increase in coital frequency at 1 month. A 1 standard deviation increase in relationship quality at 1 month was associated with a .21 standard deviation increase in coital frequency at 3 months. The arrows between relationship quality at enrollment to partner change at 1 month, and between relationship quality at one month to partner change at 3 months represent longitudinal associations between these variables. Over time, relationship quality was negatively associated with partner change ($\beta = -.37$ at 1 month; $\beta = -.27$ at 3 months): a 1 standard deviation increase in relationship quality at enrollment was associated with a .37 standard deviation decrease in partner change at 1 month. A one standard deviation increase in relationship quality at 1 month was associated with a .27 standard deviation decrease in partner change at 3 months (i.e., adolescents who reported high quality of relationship were less likely to change partners in the interval 2-month period). The arrow from unprotected coitus at 1 month to chlamydia infection at 1 month means that the a 1 standard deviation change in unprotected coitus was associated with a .27 standard deviation increase in chlamydia infection at 1 month. In other words the likelihood of chlamydia infection at 1 month increases by .27 ($\beta = .27$). The arrow from unprotected coitus at 3 months to chlamydia infection at 3 months means that the a 1 standard deviation change in unprotected coitus was associated with a .29 standard deviation increase in chlamydia infection at 3 months: the likelihood of chlamydia infection at 3 months increases by .29 ($\beta = .29$). As an additional point in support of model hypotheses, the arrow from partner change at 1 month to chlamydia infection at 3 months means that a one standard deviation change in partner change at 1 month was associated with a .30 ($\beta = .30$) standard deviation increase in chlamydia infection at 3 months. While the only direct paths leading to chlamydia infection at 3 months are from partner change at 1 month and unprotected coitus at 3 months, the likelihood of chlamydia infection at 3 months is the sum of the paths that predict partner change at 1 month and unprotected coitus at 3 months: it is the sum of both direct and indirect paths.

An alternative model (not shown) omitted relationship quality to test the hypothesis that coital frequency was primarily associated with unprotected coitus and subsequent chlamydia infection. Goodness of fit indices showed significantly less adequate fit of this alternative model to the data: $\chi^2 = 43.0$ ($p = .02$); RMSEA = .07; ECVI = .58 (95% confidence interval .48; .73) and AGFI = 96.0. This suggests that understanding of the potential effect of unprotected coitus on risk of chlamydia infection requires understanding of both coital frequency and relationship characteristics.

Discussion

Increased condom non-use increased risk of genital chlamydia infection. Infections were treated by directly observed single dose therapy so that subsequent infections are unlikely to represent untreated prior infections. The high sensitivity of diagnostic methods (PCR) makes it unlikely that subsequent infections were undetected (and therefore untreated) at earlier examinations (1 month). Cervical culture (less sensitive) was used at enrollment, thus, the chlamydia infections detected at 1 and 3 months represented incident infections acquired during the preceding time interval. These data offer direct evidence of the effectiveness of condoms for prevention of sexually transmitted infections due to chlamydia. Unprotected coitus, however, varied according to specific aspects of the interpersonal sexual relationship. The most direct influence was coital frequency. However, coital frequency was directly influenced by relationship quality. Coital frequency increased in relationships characterized by higher levels of emotional comfort and affiliation.The most important finding of this research was the demonstration of the embedding of a clinical outcome—genital chlamydia infection—and a health-related behavior—sexual intercourse without a condom—within the dynamic context of interpersonal sexual relationships of adolescents.

These findings confirm and extend other research. A number of studies note that condom use varied as a function of partner characteristics: condom use decreased when the partner was described as “main” or “established”, and increased when the partner was described as “new”, “casual,” or “secondary.” [9,12,20–22]. These studies typically suggest that condom use declines because of low perceived risk due to assumed monogamy and the trust implied by condom non-use. If this were true, however, direct longitudinal paths (across variable longitudinal associations) should have been observed between relationship quality and unprotected coitus. Instead, coital frequency increased as interpersonal familiarity and closeness increased.

We suggest that sex for many adolescents represents an ongoing confirmation of relationship affiliation and trust. This does not mean, of course, that these relationships are long-lived and stable from a perspective of life-long monogamy. However, more frequent sex affirms the still relevant romantic ideals of attraction, passion, and both physical and emotional exclusivity [23,24]. Thus, it appears, that condom use declines and is abandoned as unnecessary or is replaced by more effective pregnancy prevention methods. Ellen et al. showed that condom use with a “main” partner (defined as “someone you have sex with and you consider to be the person you are serious about”) was a function of partner-specific perceived risk for gonorrhea and chlamydia [25]. The adult-like attachment processes (i.e., reciprocal use of sex as a motivation for “proximity maintenance” as well as a way to establish a “safe haven” [26] of many

adolescent sexual relationships) means that adolescents must reconcile the sexual partner as a potential health risk as well as "safe haven." Of course, relationship quality and coital frequency do not eliminate the possibility that at least one dyad member has additional sexual partnerships. These "concurrent" partnerships are especially important risks for sexually transmitted infection if condom use has declined or ceased [10,27,28]. In addition, the direct association of partner change on incident chlamydia infection at 3 months demonstrates that the introduction of a new partner into the individual's sexual network increases risk of sexually transmitted infections.

Several limitations of these data should be considered. First, relationship quality was considered only from the perspective of one dyad member. Second, the doubling of the number of events at the 1-month visit may have introduced some error into the model, however, interpretation would not have been possible without doing so. Third, sample sizes were insufficient to explore more complex models that integrate other socio-psychological factors such as perceived risk, perceived control in sexual situations, condom use self-efficacy, and attitudes about condom use. Some researchers maintain that prevention and intervention efforts are more effective when targeting specific groups [29]. In this light, the data lend themselves to meaningful results regarding adolescent populations attending STI clinics and who are at high risk for chlamydia initially [5]. Fourth, given the limitation in our sample size and the fact that data were gathered from clinics in specific geographical locals, any generalizations to other populations should be made with care. Finally, our analyses focused on the most recent sex partner rather than all sex partners. A substantial proportion of participants reported partner change during the observation period, and this behavior alone was associated with increased risk of infection. It is important to note, however, that the observed association between relationship quality, coital frequency, unprotected coitus, and chlamydia infection was observed while controlling for partner change.

The direct association of relationship quality with coital frequency and its indirect association with unprotected coitus suggests that efforts to reduce adolescent sexually transmitted infections by abstinence-only approaches will be insufficient as isolated public health approaches. Our results support the usefulness of condoms in the prevention of chlamydia. More importantly however, relationship quality factors were shown to influence the transmission of chlamydia through coital frequency, partner change, and condom use. In this light, prevention programs should target both members of the relationship. For example, routine testing has been shown to be the best intervention in decreasing the associated health risks of chlamydia [30]. Given the association of condom use and coital frequency and relationship quality, the implications for chlamydia prevention efforts would emphasize communication about sexual expectations and monogamy for established couples while addressing setting of personal sexual limits and consistent condom use as well as communication skills for new or less established relationships.

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