

**Social and Sexual Networks:  
The National Longitudinal Study of Adolescent Health\***

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The predominant threats to adolescents' health and well-being stem from the choices that adolescents make and the behaviors they engage in. For example, becoming pregnant, acquiring a sexually transmitted disease, suffering a violent accident, considering suicide, beginning to smoke, and developing a weight problem are all at least in part attributable to behaviors and choices that adolescents make in conjunction with others around them (Adcock, Nagy, and Simpson 1991; Bauman and Fisher 1986; Bearman 1991; Hayes 1987; Jeanneret 1992; Resnick et al. 1997; Smith and Crawford S. 1986; Thompson 1995). Therefore, to systematically study the determinants of the health of adolescents, research must focus on a complex constellation of factors that influence adolescent behavior. The most fundamental of these are the social contexts and relationships in which adolescents are embedded. With this in mind, the National Longitudinal Study of Adolescent Health (hereafter, *Add Health*) was explicitly designed to provide detailed measurement from a large nationally representative sample on the most central social contexts and relationships that influence the health status of adolescents. The specific contexts focused on in *Add Health* are: families, dyadic friendships, peer groups, romantic and sexual partners, schools, neighborhoods and communities (Resnick et al. 1997).

As is described in greater detail below, the highly clustered community-based design of *Add Health* is unusual, but one of its primary benefits is that it provides information from multiple sources from which we can generate images of the social and relational world of adolescents. In addition to collecting extensive self-report and network data from over 90,000 adolescents in 80 communities, *Add Health* collected data on family relations from parents and siblings; on the composition of peer groups from

adolescents' friends; on romantic relationships from romantic partners; on geographic proximity from GPS data; and on schools from other students and school administrators. As a result, *Add Health* provides measurement of multiple levels of context from multiple perspectives, making it possible to interweave spatial and social networks and to construct models of health risk based on real patterns of association within the adolescent world.

We begin this chapter by outlining the major design features of the *Add Health* study, the sample structure, and the fieldwork experience. We then describe how social and sexual networks are measured in *Add Health*, and discuss some studies that illustrate the type of analyses that are possible with these data. We conclude with a brief overview of the network design elements proposed for the next wave of *Add Health* data collection.

## **1. Design Overview of *Add Health*<sup>1</sup>**

Concern with the collection of linked social and sexual network data is reflected in the unusual design of the *Add Health* study. Rather than sample adolescents randomly from the population at large, *Add Health* rests on a multi-stage, clustered sampling design. At the first stage, we drew a nationally representative sample of high schools ( $n = 80$ ), and enrolled all students attending each sampled school; from these students we selected a representative sample of adolescents for further in-depth study. Between 1994 and 1996, *Add Health* collected three waves of data: the initial school-based survey, the in-depth in-home interview of a subset of students identified in the school-based study (*Wave I*;  $n = 20,745$ ) and a follow-up in-home interview approximately one year later

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<sup>1</sup> Additional details about the study design can be found in Bearman et al. 1996 ([www.cpc.unc.edu/projects/addhealth/design.html](http://www.cpc.unc.edu/projects/addhealth/design.html)).

(*Wave II*;  $n = 14,738^2$ ). Parents of adolescents who participated in the in-home phases of the study were also asked to complete a questionnaire, and school administrators completed a brief questionnaire in the first and third years of the study. Ultimately producing a nationally representative study of American adolescents in grades 7-12, this design allowed us to collect – for the first time ever – complete social network data describing the structure of adolescent relationships in many different American communities.

### *1.1 Sample Details and Design Features*

The primary sampling frame for *Add Health* was derived from the Quality Education Database, which lists all high schools in the United States. Schools were stratified by region, urbanicity, school type (public, private, parochial), ethnic mix, and size; the *Add Health* sample of schools consists of 80 high schools (defined as schools with an 11<sup>th</sup> grade and more than 30 students) selected from this list with probability proportional to size. For each sampled high school, *Add Health* identified and recruited one of its feeder schools (typically a middle school) with probability proportional to its student contribution to the high school. Though almost 70% of contacted schools agreed to participate in the study, when schools refused *Add Health* replaced them with another school (or school-pair) selected from the same strata. The final sample of school consists of school pairs from 80 different communities, and includes private, religious, and public schools from communities located in urban, suburban and rural areas of the country.<sup>3</sup> All students attending one of the sampled schools were asked to complete the in-school

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<sup>2</sup> We did not follow respondents who were high school seniors at *Wave I*, so our loss to follow-up was not actually as severe as it appears from the difference in *ns* between *Wave I* and *Wave II*.

questionnaire, which contained basic social and demographic information, as well as an extensive social network module (described below).

Between September 1994 and April 1995, the paper and pencil, op-scan in-school questionnaire was administered to all students in each sampled school. Each school administration occurred on a single day within one 45-60 minute class period, and we made no effort to include students not in school on the day of the administration. Nevertheless, over 80% of the enrolled students completed the questionnaire. Though seven of our recruited schools ultimately did not allow us to survey students in the school (but did provide us with a roster for subsequent sampling purposes) we have in-school questionnaire data from 90,118 students attending 141 schools.

Sampling for the second stage of data collection (the *Wave I* in-home survey) proceeded from the population of students identified in the in-school phase. From the union of students on school rosters and students not on a roster who completed an in-school questionnaire, *Add Health* randomly selected 200 students from each community and administered a 90-minute computer assisted (CASI) in-home interview. Since students who did not complete the in-school survey but were on a sampled school's roster were eligible to be selected for participation in the in-home main sample, the *Wave I* sample includes students who had dropped out of school. Numerous supplementary special samples were drawn and adolescents in these groups were interviewed as well. *Add Health* completed 20,745 *Wave I* in-home interviews, with an 80% response rate. Parental interviews are available for slightly more than 85% of all adolescents in the in-home sample.

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<sup>3</sup> Because some sampled high schools included a middle school, the actual number of schools included in the study is 141.

In two large and 12 small schools, we attempted in-home and parent interviews for *all* students enrolled in a high school or middle school. The two large high schools were selected purposefully: one is a predominantly white school located in a small town ( $n \approx 1,000$  students); the other is characterized by substantial ethnic heterogeneity and is located in a major metropolitan area ( $n \approx 1,700$  students). The twelve smaller schools are located in rural and urban areas; both public and private schools are represented ( $n \approx 150$  students per school). Because we surveyed all students in these schools, they generate a large number of romantic and friendship pairs in which both members of the pair completed the in-depth in-home interviews. Therefore, for these schools we have much more complete images of the social networks and romantic partnerships in which adolescents are embedded.

Approximately one year after the *Wave I* interview, we conducted follow-up interviews with most of the adolescents who participated in the first wave of the in-home survey. Follow-up interviews were not attempted with *Wave I* seniors at *Wave II*. Over 88% of all eligible *Wave I* respondents participated in *Wave II*, resulting in 14,738 interviews.

## 1.2 *Design Issues and the Collection of Network Data*

In addition to serving as the sampling frame for the in-home survey, the in-school questionnaire is the primary source for complete friendship network data. From a roster of all students at their school, every student was asked to nominate his or her five best male and female friends, and to report on whether they had specific types of contact with each nominated friend. Figure 1 reproduces a page of the in-school questionnaire that

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was used to collect social network data. Because all students in the school are surveyed, we have data on the complete school-based friendship network of adolescents. In addition to the network data, all students were asked to provide basic social and demographic information, including reporting on their parents' educational and occupational background, their family's household structure, the sports and extra-curricular activities that they participated in during the school year, risk-behaviors they engaged in, their visions for the future, their self-esteem, and their general health status.

Data collected during the in-home phase of *Add Health* provide more detailed measurement on a much broader range of health-related behaviors and experiences, including drug and alcohol use, sexual behavior, and criminal activities. Other items assess overall health status, health utilization, decision making, family dynamics, aspirations and attitudes. Portions of the in-school social network module were repeated at *Wave I*, though since not *all* students complete this phase it is not possible to generate complete models of network position (except in the saturated settings).<sup>4</sup> Nevertheless, this data provides rich ego-based network information. Most importantly for those interested in the spread of infections, in addition to collecting friendship nominations, the *Wave I* instrument collects detailed data on romantic and sexual partnerships during the past 18 months: each adolescent in the in-home sample was asked to nominate up to three recent romantic and three non-romantic sexual partners from the school-based rosters. Even if the nominated partner was not in the in-home sample, we are able to link the nomination to the partners' in-school data, thereby augmenting the data provided by the in-home subject with partners' self-report data.

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<sup>4</sup> The laptops used to collect data at *Wave I* were each loaded with the Student Directory information for each school so that adolescents to nominate their friends and partners.

### 1.3 *Data Security*

Because of the clustered design, it is a potentially trivial problem to deductively identify individual data collected for *Add Health*. To reduce the likelihood of any sort of breach of confidentiality, we developed an elaborate and rigorous security system to protect the identities of participating schools and students. The basic principle of the security system is the separation of identities and responses, which we accomplished through a complex identification scheme whereby each respondent was assigned up to five separate identifiers. We subcontracted with York University in Canada to act as the Security Manager and the depository for all identifying information.<sup>5</sup>

## 2. **Fieldwork experience**

Fieldwork for the in-school survey and *Waves I* and *II* was conducted by the National Opinion Research Center (NORC). Due both to the massive scale and the clustered design, the fieldwork required to complete *Add Health* was truly unprecedented: the initial goal was to survey almost 100,000 adolescents in 160 schools in 80 communities nation-wide in a year's time. The reality was an aggressive timeline for recruitment of schools and survey administration, constant efforts to prevent negative publicity and community backlash, struggles to conform to the requirements of the security system, and nagging worries that the survey would be canceled mid-stream.

### 2.1 *In-School Component*

Once the sample of schools was drawn, NORC began to recruit schools. This meant sending advance packets of information (advance letters and brochures describing

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<sup>5</sup> Throughout the fieldwork, York retained the links between the identifying information and the questionnaire data; NORC retained only the questionnaire data.



the study) to each sampled school, and then contacting school principals and districts by telephone. However, each school came with its own unique personality and set of procedures. In many instances we encountered reluctance or resistance: for some districts we were required to submit a detailed research proposal, while in others our efforts got caught in bureaucratic swamps. Negotiations were painstakingly lengthy (in some cases as long as three months) and at several points senior project staff at NORC or study investigators from the Carolina Population Center got involved in the recruitment efforts.

To counter schools' reluctance to participate, NORC sent specialized letters, followed up with telephone calls and occasionally arranged for in-person visits by field staff and senior project staff from NORC and, in some instances, visits by senior study investigators. As a time savings strategy, we began parallel recruitment efforts in certain strata, though in several cases school visits by the study investigators effectively converted initial refusals into agreements to participate. Our most effective negotiations focused on the benefits the school would enjoy as a result of their participation, as well as on ways to reduce perceived burden to the school. For example, we promised to provide data to the school that would allow them to comparatively assess their students' health, we offered to collect the data over several days, and we offered administrative help with pre-data collection tasks. In addition to negotiating the reduction of burden, we also had to concede to some other special requests, including designing and administering a separate questionnaire for one school and presenting the findings to the entire student body. In other cases, we agreed to limit the number of times we would contact households for the in-home survey. As a last resort, we settled for only a school

enrollment roster from which we could draw our in-home sample. We found that the commitment to provide data to schools was a strong incentive to schools, significantly more important than the token financial incentive we were able to provide.

Despite our best efforts, approximately 20% of our initially sampled schools refused to participate. Refusals occurred at every step along the way: they occurred prior to agreeing to participate, at the beginning of the school year, immediately before the survey session, and on a couple of occasions, the day of the administration itself. Often the refusals were a result of idiosyncratic factors that could not be anticipated, including an affair between a principal and teacher, an angry parent heavily connected to an active PTA organization, and an upcoming school board election. The top three reasons for school refusals were (1) potential backlash from communities and fear of parent organizations' negative mobilization given the linkage between the in-school and the more sensitive in-home survey; (2) time away from class instruction; and (3) burden on school personnel.

While recruitment efforts continued, we began administering the in-school survey in the fall of 1994. When they agreed to participate in the study, each school had agreed to provide us with a roster of the names of all enrolled students. Though we explicitly requested electronic rosters, and even provided each school with a template, we received roster data in over one hundred different formats (and mainly in hardcopy!). As a result, pre-administration roster processing was a major undertaking. We keyed and processed the roster data (containing over 100,000 names in total), assigned a special identifier to each student as part of the security system, sorted by girls and boys and by grade, and produced a Student Directory for each school. We printed tens of thousands of

directories, which were used by the students to nominate household member and friends during the survey.

Once a school had agreed to participate in the study, we began the consent process. To comply with federal legislation, we sent special requests for permission to parents of public school children to have their child's name appear in the Student Directory. This special consent to release directory information came on top of our parental permission requirement for the in-school survey.<sup>6</sup> All told, we sent 160,000 times two permission forms out into the universe: we sent one set to schools for the adolescents to hand carry home, and mailed another set directly to the parents. To placate parents' fears, we established a toll free number and encouraged parents to call with questions or concerns. Parents used this number so much that NORC had to hire a full-time person to answer the toll free line five days a week, routing the problem parents to senior staff attention.

Because the schools were asked to host and proctor the survey sessions, it was important that we implemented standardized procedures across all of the sampled schools. We developed In-School Administration Manuals for field staff to train the teachers and proctors on the distribution and secured return of materials. In some instances, despite our requests, schools declined our offer to train their staff. For those schools all we could do was stress the importance of each teacher reading the manual and contacting either the school coordinator or NORC with questions.

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<sup>6</sup> Careful negotiations between NICHD (the federal funding agency) and the Office of Protection from Research Risks, allowed us to use passive parental consent except in those schools or districts that mandated active consent. We feared that requiring active consent forms for participation in the in-school survey would have effectively killed the study. In the end, seven schools required active consent. To bolster the return rate in these schools we helped organize pizza parties to the homerooms that returned the most forms. These tricks did not work. In these schools we also sent home a third set of permission forms. As expected, the final participation rates for these schools was low, ranging from 20 – 60%.

The logistical coordination for the preparation and shipment of survey materials to schools was another massive undertaking. We ordered tens of thousands of pencils, pre-printed envelopes, questionnaires, boxes and labels. We prepared specialized “teacher boxes” with all of the survey materials required for each classroom. We mailed the boxes three days prior to the Survey Day session using overnight shippers so that boxes could be easily tracked. Even so, schools signed for boxes and subsequently lost them within their own schools. A few school janitors misplaced boxes, others inadvertently threw them out, and yet others were lost by the shippers.

On the days of the administration, we requested that schools issue PA announcements to remind teachers and students of the survey. Field staff and their clerical assistants arrived an hour before the sessions to facilitate the administration and help with any last minute details. At the end of the administration, and in keeping with the security system, students were asked to tear off the first page of the questionnaire (which contained their identifying information) and place it into a special envelope called “names.” Next they placed the questionnaire in another envelope called “answers,” and finally, they placed the Student Directory into a third envelope. Teachers placed the permission forms in a fourth envelope.

All materials were returned to a central location where field staff and their clerical assistants carefully checked each and every envelope to ensure the proper contents of each. They then shipped the materials to three separate locations with the first page identifying information shipped to York University, questionnaires to the optical scanning subcontractor, and Student Directories to NORC for shredding.

While most survey sessions were executed without a hitch, we did have our share of excitement. Parents in several communities organized picketing and rallies against the study, and a few principals got cold feet and attempted to cancel the session. But aside from these isolated setbacks, it was a heroic effort on the part of schools and teachers to pull it all off. The excitement in the schools on Survey Days was truly incredible. The students knew something important was happening to them, and to their schools.

## 2.2 *In-Home Component, Wave I*

In spite of the large number of respondents in the in-school phase of Add Health, *Wave I* of the in-home component was the largest field effort NORC had ever undertaken (As originally drawn, the in-home sample consisted of approximately 27,000 adolescents). To mount this portion of the study, NORC hired a huge field force, including 5 field task leaders, 35 field managers, and 511 field interviewers. Because of *Add Health's* community-based design, we sought to recruit and hire the field interviewers locally.<sup>7</sup> Since approximately 70% of our field force had no experience as professional interviewers, we developed a one-day general training on basic interviewing skills and then a separate five-day project specific training session which we held at five separate locations around the country.

We also spent a significant amount of time planning and brainstorming on how to counter and be prepared for (1) community backlash; (2) diffusion among students; (3) organized diffusion among parents to block the survey in their communities; and (4) refusals by parents or students to participate in the in-home survey.

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<sup>7</sup> Though we did not allow any interviewers to work in the neighborhood or community in which they resided, in order to maintain confidentiality.

The in-home interview had its own set of major logistical coordination issues. We prepared bulk supply boxes for each of the 511 interviewers that included the permission forms, assignment logs, showcards, GPS devices, batteries, and other materials required for the interview. We carefully loaded the questionnaire program and enrollment rosters on 550 laptops and conducted extensive testing before shipment to the interviewers.

As had been the case in the in-school phase, the security system again affected all of the technical and operational procedures, including (1) what we could and could not print on field materials; (2) our laptop systems and programs (where we incorporated three levels of password protection and double encrypted all software and data); and (3) the complicated data transmission protocols that decoupled the identifying information from the actual questionnaire data and transmitted the separate types of files to York University and NORC, respectively.

Data collection began in May 1995 and continued through December 1995, with the majority of the cases completed by September of 1995. Advance letters were mailed to each parent alerting them that an interviewer would visit their home and seeking the parent's consent. Interviewers then knocked on doors to secure consent in person. Both the advance letter and the consent forms again contained a toll free number that parents could call if they had questions or concerns.<sup>8</sup> This time around most parents who called simply wanted to confirm the legitimacy of the survey, though some parents called to refuse.

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<sup>8</sup> We retained our full-time person who continued to answer calls five days per week for the duration of the field period.

Across all communities, refusals to the in-home survey were not as much of a problem as we had anticipated; after all of our conversion attempts we had an 80% participation rate. Parents and adolescents refused for many of the same reasons that they refuse many health-related surveys: they said they were too busy, they were not interested, they had concerns over privacy, and they felt the subject matter was too sensitive. As far as we could determine, the network components of the study did not factor into the refusal rate.

The adolescent in-home interview was conducted using a computer assisted interview (CAPI ) and, for all sensitive health status and health risk behavior questions, (including nomination of romantic and sexual partners) audio-CASI (ACASI) technology.<sup>9</sup> For the CAPI portions of the interview (about two-thirds of the interview), an interviewer asked the adolescent questions and entered the response into a computer; in the ACASI portion, adolescents listened to recordings of questions through earphones and directly keyed their responses into a laptop computer. Before the ACASI portion began, the interviewer turned the laptop around so that the adolescent could view the screen, and trained the adolescent on how to record answers for the self-administered portion.<sup>10</sup>

Most interviews were conducted in the adolescents' homes, but interviews were also administered in backyards, on porches, and even in a McDonalds. The average interview lasted about 90 minutes. For parents who wanted to see the questionnaire, we included an option in the laptop for them to walk through a blank questionnaire. For

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<sup>9</sup> ACASI technology has been shown to reduce response bias associated with sensitive questions and non-normative behavioral items (Turner et al, 1998). We adopted it here in order to reduce the impact of interviewer or parental effects on adolescents' responses to questions about their sexual behavior.

parents who wanted to listen to the interview, we gently explained the importance of privacy and standardization. In some instances, parents insisted; when this occurred we did not conduct an interview in that household.

All in all, we found that adolescents really enjoyed completing the interview. In communities where we sampled only 200 adolescents, interviewers were frequently approached by adolescents not selected for the survey and asked if they could participate and why they were not chosen. One feature the adolescents were particularly enthusiastic about was the computer administration. In fact, some adolescents were so adept at using the computer that they continued past the ACASI section and self-administered the last sections which should have been interviewer-administered.<sup>11</sup>

We also encountered our share of resistance, though most of this was directed toward the schools. In one community we decided to suspend all further recruitment and interview efforts when a group of parents aggressively mobilized against the study, and in a few other communities we had to temporarily suspend interviewing.

### 2.3 *In-Home Component, Wave II*

In the spring of 1996, we recontacted approximately 17,000 households.<sup>12</sup> Like *Wave I*, the *Wave II* questionnaire was a 90-minute CAPI/ACASI interview that included the school enrollment rosters. Because of the smaller sample, we reduced our field staff for *Wave II*: the field force this time around consisted of 4 task leaders, 24 field

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<sup>10</sup> Immediately before the ACASI section the adolescent was given a few practice items so they could develop a sense of the look and feel of the technology.

<sup>11</sup> Once we discovered this was occurring with some regularity, we inserted another password at the end of the ACASI section so that the adolescents could no longer continue on their own.

<sup>12</sup> As noted above, *Wave I* seniors were not recontacted at *Wave II*.



managers, and 335 field interviewers. The training program was retooled to take into account what we learned from *Wave I* as well as the new features included for *Wave II*.

The reception we received for *Wave II* was remarkably different from what we encountered at *Wave I*. Now adolescents knew what to expect, and often wanted to participate; this was reflected in our follow-up response rates, which were approximately 90%. Parents also seemed more relaxed, and we encountered less negative diffusion and fewer attempts to block the survey from the communities. Wherever possible, we sent the same interviewer who completed the interview in *Wave I* to the *Wave II* household. When this wasn't possible, some adolescents would say, "Hey, you're not the same lady who was here last year!" At the end, we discovered that we were able to weather the political landmines and logistical challenges posed by the survey design to successfully complete *Add Health*.

### **3. Measurement of Network Data in *Add Health***

Recall that a primary aim of the *Add Health* study was to carefully measure the major social contexts affecting the health and well-being of adolescents. Like many other recent health-related studies (Laumann et al. 1994), *Add Health* collected extensive ego-centered network data. However, because of its unique clustered design (coupled with the fact that adolescents' social worlds tend to be focused on their schools), *Add Health* also was able to collect complete social network data for 80 American communities. Because the *Add Health* study collected friendship nominations from all students who attended each participating school, both individual (ego-) and school-level networks could be constructed. This unique design enables us to comprehensively measure the

structure of the extended friendship network each respondent is embedded in, as well as to describe the overall social structure of the respondent's particular school.

In addition to the extensive friendship data collected in the in-school survey, *Add Health* collected two additional waves of friendship nominations, again soliciting opposite sex and same sex friendship nominations from the School Directory. Further, all in-home respondents identified (from the School Directory) up to three others with whom they had had romantic relationships in the past 18 months, and up to three others with whom they had had non-romantic sexual relationships. Because some of these romantic and sexual partners are also in the study (often by chance, and in the saturated settings by design), these data make it possible to construct romantic relationship and sexual partnership networks. Consequently, the risk and spread of STDs can be studied from an actual network transmission model based on empirical data; and researchers can compare sexual networks with friendship networks.

In order to protect the confidentiality of *Add Health* respondents, raw social network nomination data are not publicly available. To provide researchers with social network data arising from *Add Health*, much of our early effort on *Add Health* was directed towards developing the network data for the public use and contract data sets. The vast majority (85%) of all friendship nominations and roughly 50% of the romantic partnership and non-romantic sexual relationships were other students in the sampled schools. Consequently, we have extensive sociometric data on friendships for the adolescents in 144 schools, and two additional waves of friendship data for the two large saturated field settings. Further, in our saturated field settings we obtained relatively complete images of romantic partnership and sexual network structures as they unfolded

over time. Focusing on the in-school friendship nominations alone, we processed over 540,000 friendship nominations between 82,629 respondents in 121 schools, which provide the central focal point for social relations throughout the junior and senior high years. Despite the general sense that the adolescent friendship environment is critical for shaping adolescent health and health risk behaviors, few people have had the opportunity to see what these large-scale networks look like at multiple levels of observation or to estimate their effects across different social contexts. *Add Health* provides such opportunities; progress along these fronts is described more fully below.

In the course of our preliminary work with the nomination data, we constructed hundreds of variables at multiple levels of observation, from characteristics of each individual's ego-network, the structural composition of these networks and the behaviors of all friends in the sent, received, and sent and received networks, to group level (peer group), and school level networks. For each individual we have constructed numerous variables that define individual position in the school social network, including centrality, reach, maximum reach, prestige, and influence domain among others (Wasserman and Faust 1994).

For each school we have constructed detailed measures of the global network structure from density at maximum reach to centralization. In addition, for each school we have calculated in-group preference for friendships based on gender, race, and ethnicity. For the first time, multiple levels of social network data are available on the same population, thus making possible the analysis of multi-level network models across a diverse set of outcome variables (for related treatments, see Frank 1996; van Duijn et al. 1999). These publicly available constructed network variables are more fully described

in *The Add Health Network Variables Codebook* (Bearman et al. 1997). The composition of each individual's peer context (at multiple levels of observation) is a key component of the network data set developed for *Add Health*.

#### **4. Summary of Selected Network Findings**

The wealth of network data in *Add Health* makes numerous distinct studies possible. Here we briefly summarize some of the analyses our group has completed. We focus on analyses using a range of social network data, from sexual networks to friendship networks, and highlight the diversity of dependent variables one can consider, from sexual behavior to suicidality and friendship choice.

##### *4.1 The Structure of Adolescent Sexual and Romantic Networks*

Systematic differences in the sexual network structures that govern patterns of direct and indirect contact can have striking implications for disease transmission (Anderson et al. 1990; Gupta and Anderson 1989; Jacquez et al. 1988; Klov Dahl 1995; Kretzschmar and Morris 1996; Morris 1993; Morris 1997). Yet aside from a few studies (many of which are reported on in this volume) arising from ego-centered or snowball samples, the actual structure of sexual networks remains largely unknown. Our research identifies the structure of a complete sexual and romantic network amongst interacting adolescent residing in a mid-sized mid-western town (Bearman, Moody and Stovel 2003). Drawing from one of the saturated settings, we are able to describe the complete structure of all romantic and sexual relationships within an 18 month period in a single school, involving roughly 800 students. This structure is reproduced as Figure 2.

Though the sexual network in this school is highly connected, the connectivity depends on long chains of ties, and is therefore extremely fragile. Critical to our observed network is the pronounced absence of cycles. In contrast to theoretical expectation, the observed structure of the sexual network does not appear to have a core. The absence of cycles guarantees that we are unable to observe a densely interconnected core functioning as a disease reservoir. Rather, we observe a spanning tree, characterized by the specific absence of cycles of length four (Harary 1969). A cycle of length four would be produced if, from a girl's perspective, she were to have sex with her former partner's current partner's former partner. We show that we can almost exactly replicate the structural features of the observed network, with respect to size reach, centralization, density, and number of cycles, through simulation given a prohibition against the formation of cycles of length four.

#### *4.2 Peer Influence on Sexual Debut and Pregnancy Risk*

Most analyses of peer influence on sexual behavior concentrate solely on best friends (Billy and Udry 1985; Billy et al. 1984; Brown and Theobald; Dishion et al. 1995). Results from these studies generally show little influence. In contrast to studies of best friends, Bearman and Brückner's (Bearman and Bruckner 1999) work considers network influences on sexual behavior by focusing on the structure of social relationships in which adolescents are embedded. Specifically, Bearman and Brückner consider influences that arise from social networks observed at a level more distal than best friend: the ego-network, the peer group, the leading crowd, and the school as a whole. They show that social relations have a significant influence on both sexual debut and pregnancy risk when distal network structures are considered. These influences tend to be positive, in that having a

more developed social network tends to delay intercourse or reduce pregnancy risk, controlling for the risk status of individuals (Bearman and Brückner 1999). Most critical are influences that arise from the larger ego-networks in which individuals are embedded. The influence of more distal social relationships is stronger for girls than it is for boys; likewise, girls are more likely to be positively influenced than are boys. This finding suggests that relationality operates differentially by gender for adolescents.

#### 4.3 *Social Networks and Adolescent Suicidality*

Bearman and Moody (Forthcoming) consider the effect of social networks on suicidality. The main outcome measures are (1) has the adolescent seriously considered suicide in the last 12 months and (2) if yes, has he or she attempted suicide. They show that among adolescent males, 10.2% thought about suicide and 2.2% attempted suicide. Among females, 16% thought about suicide and 5% attempted suicide in the last year. For all adolescents, they find a strong relationship between suicidal thoughts and depression (+), experience with suicide among friends or family (+), heavy drinking (+), parental distance (+) and having a gun in the household (+). Additionally, for females we find a strong relationship between suicidality and having no friends (+), having friends who are not friends with each other (+), self-esteem (-) non-consensual sexual relations (+), same-sex romantic attraction (+), age (-), attachment to school (-), getting into fights (+) and body-mass index (+). For males, we find playing a team sport reduces the odds of suicidal thoughts.

Females are more likely than males to attempt suicide (odds ratio 1.59). Conditional on having suicidal thoughts, there are few sex differences in the pattern of risk factors associated with attempting suicide. These analyses suggest that above and

beyond the effects of depression, the social environment affects suicidality for both males and females through knowledge and exposure to suicide among friends and family. For females, suicidal thoughts are substantially increased by social isolation and dissonant local friendship patterns, non-consensual sexual relations, and romantic attraction to other females. These social and relational factors have little impact on boys' risk of suicidal thoughts or attempts, echoing the findings we observe for sexual debut that suggest that relationality plays a more critical role for girls than it does for boys.

#### 4.4 *The structure of adolescent friendship networks*

Moody (2002) used *Add Health* social network data to describe friendship patterns among adolescents and to test balance theory models of friendship formation and change. He finds that within school friendship networks tend to form clustered hierarchies embedded within a loosely connected web of students who are involved in multiple friendship groups. The friendship groups identified in these networks tend to be homogeneous with respect to many attributes and behaviors. In addition to actor similarity (Cohen 1977; Kandel 1978) and organizational opportunity factors (Feld 1981), social balance<sup>13</sup> is one of the strongest predictors of friendship choice. Extending traditional balance models to account for differences in transitivity from each student's point-of-view, Moody shows that a student's friendship relations are more likely to form if they increase transitivity and decrease intransitivity. Since the same pattern of relations can be transitive from one person's point of view and intransitive from another's, such actions need not lead to the static crystallized structures often hypothesized within the

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<sup>13</sup> Social balance theory (Davis 1970; Davis and Leinhardt 1972) is a theory of action stating that actors seek to avoid dissonance in their social relations. For instance, if Ann and Betty are friends, and Ann dislikes Carole, balance theory predicts that Betty will also dislike Carole. Balanced triads are transitive; unbalanced triads are intransitive.

balance literature (Davis 1970; Davis and Leinhardt 1972). Instead, each actor's attempt to create local balance leads to new imbalances for others, which spurs further relational change.

Indeed, the school networks are not static and the observed friendship groups change as people with bridging friendships bring disconnected groups together or dissolve previous groups. In the Add Health data, the level of change between time points was quite high. Overall, about half of all time 2 (in-home *Wave I*) friendships are new friendship relations, with reciprocated relations at time 1 (in-school) having a much higher retention rate (between 75% and 80%). However, while change in particular friendships is common, large-scale status change is uncommon. Thus, popular students at time 1 tend to be popular at time 2 (mean correlation of about .6), with few students moving far in the popularity rankings. The greatest movement occurs among middle-ranked students, with less than 20% of those in the 3<sup>rd</sup> quintile, for example, remaining in the 3<sup>rd</sup> quintile a year later compared to over 50% at either tail of the distribution. Friendship relations that crossed race lines, were asymmetric, or contributed to intransitivity were all less likely to be maintained than those that fell within race, grade or increased ego's local balance.

## **5. Conclusion**

From the outset, the *Add Health* study was designed as a network study. Social networks provide a direct link between individuals and the social structure they are embedded in; for adolescents, networks of peers and friends are one of the most important social contexts, particularly with respect to health outcomes. Since most American adolescents' social worlds revolve around their school, the study draws its



respondents from a carefully selected sample of schools. Since many students (and in some cases, *all* students) from sampled schools participated, *Add Health* was able to collect directed sociometric data from relatively large populations of students. Further, the use of a school-specific roster allows us to assess the characteristics of other members of a respondent's local social and sexual network, without relying on respondents' reports of their partners' characteristics. Perhaps most importantly, the roster-based nomination strategy, in conjunction with the complete population coverage, allows researchers to identify the existence of structural bridges, holes, and cliques in the social and sexual networks of American adolescents. The implications of these structural characteristics of networks for both individual behavior and disease transmission have been theoretically foreshadowed for the past several decades; for the first time, we are able to evaluate them empirically.

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Figure 1: Sample Page from In-school Questionnaire

The next questions are about your female friends. First list their names on the line marked "Name". Then, just as you did for other household members and for male friends, look them up in the Student Directory and write their student numbers in the boxes below their names. Then, darken the ovals that correspond to the student numbers.

Look back at the EXAMPLE on page 6 if you need help with this. If a friend goes to a school for which you don't have a directory, give her the number 7777. (If your friend isn't in school at all, give her the number 7777 also.) If your friend goes to your school and isn't listed in the Student Directory, give her the number 9999; if your friend goes to the other school and isn't listed, give her the number 8888.

Remember: If a female friend goes to your school but is not listed in the directory, write 9999.  
If a female friend goes to the other school but is not listed in the directory, write 8888.  
If a female friend does not go to your school or the other school, write 7777.

After you have listed your female friends and their numbers, answer the five questions about each of them.

### YOUR FEMALE FRIENDS

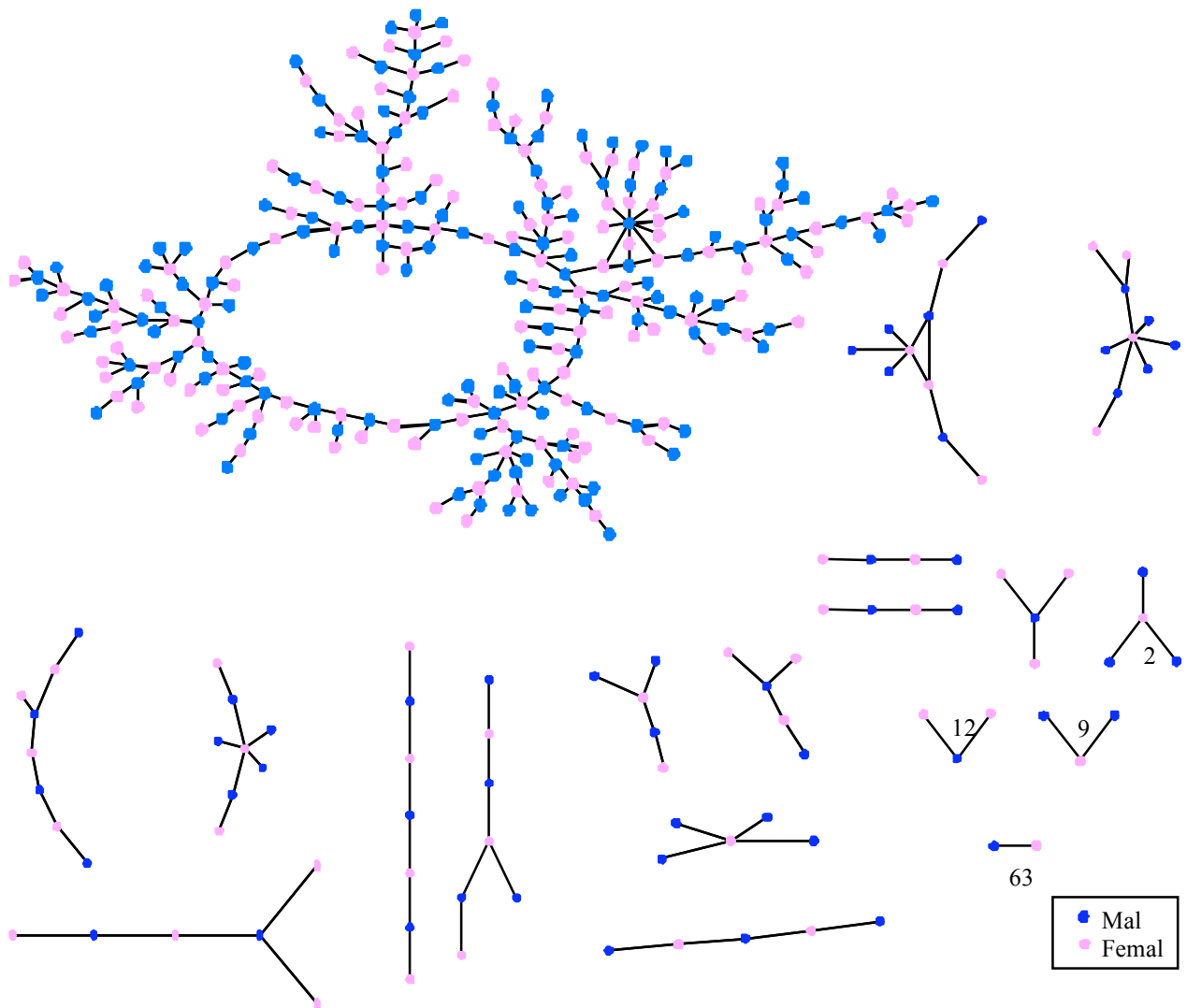
List your closest female friends. List your best female friend first, then your next best friend, and so on. Boys may include girls who are friends and girlfriends.

	Best Female Friend 1	Female Friend 2	Female Friend 3	Female Friend 4	Female Friend 5
Name:					
Number:	<div> <div>0</div><div>0</div><div>0</div><div>0</div> <div>1</div><div>1</div><div>1</div><div>1</div> <div>2</div><div>2</div><div>2</div><div>2</div> <div>3</div><div>3</div><div>3</div><div>3</div> <div>4</div><div>4</div><div>4</div><div>4</div> <div>5</div><div>5</div><div>5</div><div>5</div> <div>6</div><div>6</div><div>6</div><div>6</div> <div>7</div><div>7</div><div>7</div><div>7</div> <div>8</div><div>8</div><div>8</div><div>8</div> <div>9</div><div>9</div><div>9</div><div>9</div> </div>	<div> <div>0</div><div>0</div><div>0</div><div>0</div> <div>1</div><div>1</div><div>1</div><div>1</div> <div>2</div><div>2</div><div>2</div><div>2</div> <div>3</div><div>3</div><div>3</div><div>3</div> <div>4</div><div>4</div><div>4</div><div>4</div> <div>5</div><div>5</div><div>5</div><div>5</div> <div>6</div><div>6</div><div>6</div><div>6</div> <div>7</div><div>7</div><div>7</div><div>7</div> <div>8</div><div>8</div><div>8</div><div>8</div> <div>9</div><div>9</div><div>9</div><div>9</div> </div>	<div> <div>0</div><div>0</div><div>0</div><div>0</div> <div>1</div><div>1</div><div>1</div><div>1</div> <div>2</div><div>2</div><div>2</div><div>2</div> <div>3</div><div>3</div><div>3</div><div>3</div> <div>4</div><div>4</div><div>4</div><div>4</div> <div>5</div><div>5</div><div>5</div><div>5</div> <div>6</div><div>6</div><div>6</div><div>6</div> <div>7</div><div>7</div><div>7</div><div>7</div> <div>8</div><div>8</div><div>8</div><div>8</div> <div>9</div><div>9</div><div>9</div><div>9</div> </div>	<div> <div>0</div><div>0</div><div>0</div><div>0</div> <div>1</div><div>1</div><div>1</div><div>1</div> <div>2</div><div>2</div><div>2</div><div>2</div> <div>3</div><div>3</div><div>3</div><div>3</div> <div>4</div><div>4</div><div>4</div><div>4</div> <div>5</div><div>5</div><div>5</div><div>5</div> <div>6</div><div>6</div><div>6</div><div>6</div> <div>7</div><div>7</div><div>7</div><div>7</div> <div>8</div><div>8</div><div>8</div><div>8</div> <div>9</div><div>9</div><div>9</div><div>9</div> </div>	<div> <div>0</div><div>0</div><div>0</div><div>0</div> <div>1</div><div>1</div><div>1</div><div>1</div> <div>2</div><div>2</div><div>2</div><div>2</div> <div>3</div><div>3</div><div>3</div><div>3</div> <div>4</div><div>4</div><div>4</div><div>4</div> <div>5</div><div>5</div><div>5</div><div>5</div> <div>6</div><div>6</div><div>6</div><div>6</div> <div>7</div><div>7</div><div>7</div><div>7</div> <div>8</div><div>8</div><div>8</div><div>8</div> <div>9</div><div>9</div><div>9</div><div>9</div> </div>

Darken the oval under the name if:

39. you went to her house in the last seven days ..... ① ..... ② ..... ③ ..... ④ ..... ⑤
40. you met her after school to hang out or go somewhere in the last seven days ..... ① ..... ② ..... ③ ..... ④ ..... ⑤
41. you spent time with her last weekend ..... ① ..... ② ..... ③ ..... ④ ..... ⑤
42. you talked with her about a problem in the last seven days ..... ① ..... ② ..... ③ ..... ④ ..... ⑤
43. you talked with her on the telephone in the last seven days ..... ① ..... ② ..... ③ ..... ④ ..... ⑤

Figure 2: The Structure of romantic relations at “Jefferson High”



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