Published in final edited form as:

Soc Sci Med. 2015 January ; 125: 32–39. doi:10.1016/j.socscimed.2014.02.047.

Siblings, Friends, Course-mates, Club-Mates: How Adolescent Health Behavior Homophily Varies by Race, Class, Gender, and Health Status

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Abstract

Many unhealthy behaviors develop during adolescence, and these behaviors can have fundamental consequences for health and mortality in adulthood. Social network structure and the degree of homophily in a network affect how health behaviors and innovations are spread. However, the degree of health behavior homophily across different social ties and within subpopulations is unknown. This paper addresses this gap in the literature by using a novel regression model to document the degree of homophily across various relationship types and subpopulations for behaviors of interest that are related to health outcomes. These patterns in health behavior homophily have implications for which behaviors and ties should be the subjects of future research and for predicting how homophily may shape health programs focused on specific subpopulations (gender, race, class, health status) or a specific social context (families, peer groups, classrooms, or school activities).

Background

Many unhealthy behaviors develop during adolescence, which can have fundamental consequences for health and mortality in adulthood. Health campaigns are increasingly being based on "network interventions" (Valente, 2012). Peers and social networks have long been thought to be important influences on behavior during adolescence (Ennett & Bauman, 1993), an argument that aligns with the assertion that social networks have important effects on health behaviors and health innovations across the life-course (Christakis & Fowler, 2007; M. McPherson et al., 2001; K. P. Smith & Christakis, 2008). Much debate has centered on whether these "network effects" reflect peer influence or

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selection (Cohen-Cole & Fletcher, 2008; Fowler & Christakis, 2008). Recent theoretical research in statistics and elsewhere has noted the difficulty – if not impossibility – of distinguishing between these two mechanisms, even with experimental data (Aral et al., 2009; Aral & Walker, 2011; Shalizi & Thomas, 2011). However, a simpler set of questions remains unanswered: how much homophily do we see on health behaviors in adolescence, and how does this differ by network type?

We define homophily as "the principle that contact between similar people occurs at a higher rate than among dissimilar people" (M. McPherson et al., 2001). This definition thus encompasses both the process of assortative mixing – that individuals seek to associate with those who are similar to themselves – and other social processes that could generate homophilous outcomes such as triadic closure (Feld, 1982; Goodreau et al., 2009). While it is well known that individuals tend to associate with demographically-similar alters (M. McPherson et al., 2001; James Moody, 1999), the question of how much homophily exists for health behaviors among adolescents has received less attention. Although some research has documented homophily among friends (de la Haye et al., 2011; Gaughan, 2006; Kandel, 1978), little is known about how it compares to health behavior homophily in networks forged from other relationships.

In this paper, we make two contributions. First, we document the degree of homophily across various relationship types and behaviors that are strongly linked to health outcomes. We advance research on social networks and health by documenting which behaviors and ties should be the subjects of future research. The degree of homophily for various network types is important because health promotion programs are often targeted towards a specific social context (e.g. family, classroom, after-school) and the degree of homophily in these networks will affect the way a behavior spreads (Valente, 2012). Second, we examine whether there are subgroup differences in health behavior homophily across different networks and health behaviors. This is important for understanding how health inequalities are produced and maintained (K. P. Smith & Christakis, 2008) and for how a behavior may spread through a subpopulation's network.

The Importance of Health Behavior Homophily

Homophily is useful for describing patterns of similarity within social networks (Lazarsfeld & Merton, 1954; M. McPherson et al., 2001; James Moody, 1999), but there are additional reasons it merits attention with respect to health behaviors. Demographic homophily is associated with the spread of information and behaviors (M. McPherson et al., 2001; E. M. Rogers, 1995). This happens because people that are similar are likely to share many interests, talk more often, and more willing to trust information which is shared (Aral & Van Alstyne, 2011).

Health behavior homophily, like demographic homophily, is also an important determinant of the success of health interventions. A recent online experiment (Centola, 2011) compares respondents with identically structured networks with and without homophily on individual obesity, and finds that greater homophily leads to significantly more adoption of a weight loss plan. This effect was quite large, as the rate of adoption was more than three times higher in the homophilous experimental group. The paper concludes "not only that exposure and adoption levels were greatest in homophilous networks, but that the most effective social environment for increasing the 'willingness' of obese individuals to adopt the behavior was the one in which they interacted with others with similar health characteristics" (Centola 2011:1271). Therefore, to better understand how a health promotion campaign or behavior will spread through a network, one needs to know the degree of health behavior homophily within the network. Network interventions to promote healthier behaviors will likely be more successful within the more homophilous network types and subpopulations, while less homophilous networks or groups may require more complex network data or intervention designs (e.g. those suggested by (Valente, 2012)) to achieve the same result.

Health Behavior Homophily Across Network Types

Health promotion programs may be targeted toward a specific context of social interaction, for example the family (Kumpfer & Alvarado, 2003); classroom (Lynagh et al., 1997); or after-school program (Beets et al., 2009). Understanding how behaviors will spread through a context depends in part on the degree of homophily among participants with that relationship type. However, few studies have compared health behavior homophily across network types. Those that have compared homophily across different networks have focused on non-American contexts like the Netherlands (Poelen et al., 2007) or a subpopulation like Latina girls (Kaplan et al., 2001), but not a large representative sample of U.S. adolescents.

In our analysis, we examine how homophily varies among four relationship types (siblings, friends, course-mates and club-mates) for four health behaviors (smoking cigarettes, drinking alcohol, watching television, and exercising), and discern whether some network types are more important for some health behaviors than others. On the one hand, some relationships could be more important for certain behaviors than others, meaning that homophily may be greater within networks *where that behavior occurs*. Behaviors that are more social (drinking and smoking), may be more similar among friends, while behaviors that occur at home (TV watching) may be more similar for siblings, and exercise may be more similar among club-mates, since exercise often occurs in club settings. These tendencies may, however, be moderated by the strength of the tie – both its emotional salience and the frequency of interaction. If we assume that siblings ties have greater strength than friendship ties which in turn have greater strength than course- or club-mate ties, then we would expect this to be the ordering of health behavior similarity, regardless of the health behavior. Additionally, there may be interesting complementarities or multipliers across tie types. For instance, it may be that homophily levels are higher when two individuals are both club-mates and course-mates than one would expect from the linearity of the separate terms. These forms of interaction effects, known as multiplexity in the networks literature, have a long history of study and special theoretical importance (Verbrugge, 1979).

Subgroup Differences in Health Behavior Homophily

Documenting socio-demographic subgroup differences in health behavior homophily patterns is important because the demographic composition of a population can affect how health inequalities are produced and maintained (Blau & Schwartz, 1997; J. M. McPherson

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& Smith-Lovin, 1987). There are numerous examples of health promotion programs having differential effects on different subpopulations, for example by race/ethnicity (Kirby et al., 2004), socioeconomic status (Durkin et al., 2009), or gender (Kling et al., 2007). There are also clear race/ethnic differences in adolescent health behaviors. For example, blacks have lower rates of smoking than whites or Hispanics (Ellickson et al., 2004; Faulkner & Merritt, 1998) and lower levels of drinking than whites (Blum et al., 2000; Seffrin, 2012). Despite blacks' healthier smoking and drinking habits than white adolescents, black girls have significantly lower physical activity than whites and also steeper declines in activity throughout adolescents (Kimm et al., 2002). Similarly, adolescents of low socioeconomic status transition into unhealthy behavior groups for smoking and weight gain at elevated rates, which may be due in part to differences in peer influence (Felton et al., 1999), but social class differences in health behavior homophily or peer influence have not been explicitly examined.

Although sub-group differences in health behaviors are well documented, sub-group variation in health behavior homophily has not been well studied. One expectation for patterns of subgroup differences in health behavior homophily is that race, class and gender groups with lower levels of a behavior in the subgroup will show lower levels of baseline homophily and higher inbreeding homophily for that behavior. Baseline homophily is "homophily created by the demography of the potential tie pool" and inbreeding homophily is that "explicitly over and above the opportunity set" (McPherson et al. 2001, p.419). If a behavior is not widely shared, we expect that those who partake will be a more select group and the behavior will be more heavily niched, resulting in higher levels of inbreeding homophily. If, on the other hand, a behavior is widely shared and expected, then it will be more evenly distributed within the network, resulting in higher baseline homophily and lower inbreeding homophily (Blau, 1977). Finally, adolescents in poor health are typically more socially isolated than their healthy peers (Haas et al., 2010). Accordingly, we expect that these individuals will show higher levels of sibling homophily than their healthy peers (due to their greater level of sibling interaction), and lower levels of homophily in other networks (due to their greater social isolation).

Methods

Data

We use the National Longitudinal Study of Adolescent Health (Add Health) in-school sample (Wave 1) to analyze health behavior homophily among a nationally representative sample of American youth in grades 7 through 12 in 1994–5. These data provide several benefits for our study. First, questions about four important health behaviors (smoking, drinking, exercise, and television watching) were asked of this large (N=90,118) and representative sample of adolescents. Second, because the sample is composed of 144 school-level censuses (minus non-response) and contains some of the richest saturated network data ever collected at this scale, it allows us to examine health behavior homophily across a variety of relational (i.e., sibling and friend) and affiliation (i.e., course-mate and club-mate) networks and to compare these against health behavior homophily amongst those who share a contextual environment but not a network tie (Entwisle et al., 2007). Finally, the large sample size permits theoretically-informed analysis of differences in homophily patterns between key subpopulations.

We use four different samples from the Add Health data set in order to describe several types of network ties: the in-school survey, in-home survey, Adolescent Health and Academic Achievement (AHAA) study, and sibling sub-sample. The in-school survey was the first round of data collection, in which all participating students filled out a survey on their demographic characteristics, health and health behaviors, and friends. We draw our measures of health behaviors, friendship networks, and sets of non-connected dyads from these data. A sub-sample of students attending these schools were selected to be further interviewed in the in-home survey. We can only measure sibling ties amongst pairs selected for participation in the in-home survey. After the original data were collected, students in 78 of the original schools were asked whether they consented to the collection and coding their high school transcripts, which we use to construct course-taking affiliation networks. Finally, in the in-school survey, twins were identified and recruited for participation in the in-home survey; other sibling pair types were recruited into the sibling sub-sample only by chance.

Network Measures

Our unit of analysis is same-school dyads. We define four types of networks: relational networks between (1) siblings and (2) friends, and co-affiliation networks between (3) those taking the same courses or (4) participating in the same clubs. For each network, we compare connected dyads with unconnected dyads who attend the same school. We also contrast homophily patterns across networks, capturing different contexts where health behaviors occur: family, friendship, classroom, and after-school activities.

Sibling ties are identified through the sibling sub-sample described above, which is a subset of all potential sibling ties in the schools because ties can only be defined between pairs of individuals selected for the in-home survey. Friendship ties are defined from the in-school survey, in which every respondent had the opportunity to nominate up to five male and five female friends. We examine all pairs between which a friendship nomination was sent, and separately differentiate reciprocated and non-reciprocated ties, which differ on the degree of tie equity and joint recognition in the friendship (James Moody, 1999). Two additional networks are defined by co-affiliation, shared membership in classes and school clubs (Breiger, 1974; Field et al., 2006; Frank et al., 2008). We identify course-mate ties pairs who took any courses together in the 1994/5 school year in the AHAA dataset (Field et al 206; Frank et al. 2008). We define club-mates as pairs within a school who reported participating in one or more of the same clubs in the in-school survey. Last, we define same-school ties among pairs attending the same school in the in-school sample without any of the above measured ties. Smith (J. A. Smith, 2012) uses a likeminded approach with case-control logistic regression on dyads where the cases are tied and the controls are untied pairs.

We employ all available sets of these ties. This decision has a number of consequences. First, twins, half siblings, adopted children, and step-siblings were oversampled, but full siblings were not (Harris et al., 2006) which biases our sibling sample toward less common sibling types. We address the issue of not observing all possible sibling ties by comparing sibling pairs only to reference pairs where sibling ties could have been observed, but were not – i.e., pairs where both members attended the same school and were in the in-home sample, but no sibling tie was measured. Moreover, we document health behavior associations by sibling pair type in Appendix Table A1. A second consequence of the study design is that we do not observe all possible course-mate ties because only 91% of students in the 78 schools selected for the AHAA study opted to participate. Because we define course-mate reference ties only amongst those who participated in the AHAA, we do not expect this to result in any biases. Finally, although nearly all participants in the in-home sample filled out friendship data, the completeness of these data is limited by the maximum of five male and five female friends that can be nominated (see Moody [1999: 288–300] for a description of how this may have affected the networks). As discussed above, in one set of analyses we treat *all* nominations of friendship, regardless of who nominated whom, as indicating friendship ties. This helps expand the coverage of our friendship networks beyond the maximum of ten out-going nominations, because individuals can be nominated by others in the network, but it does not guarantee full coverage. We expect this data limitation of the friendship network data to result in conservative homophily estimates because false-negatives, ties that exist in reality but which we did not observe, would be in the untied reference category.

In our main analysis, we code these networks to be mutually exclusive, such that sibling ties take priority, followed by friendship ties, course-mate ties, club ties, and same-school ties (reflecting expected tie strength ordering). Friendship ties are measured only among pairs that are not siblings, course-taking ties are only measured between pairs that are not siblings and not friends, and club ties are only measured among pairs that are not siblings, friends or course-mates. We also conducted analyses that allowed for multiplexity and found that this decision does not largely alter the conclusions. We focus our exploration of multiplex ties on combinations of friend, course-mate, and club-mate ties. We ignore sibling ties here because of the comparatively very small number of observed ties.

Using these methods and data, we found the following within-school tie counts: 2,054 sibling ties, 521,256 friendship ties, 593,178 course-taking ties, and 13,964,858 club ties. (Although this may seem implausibly large, consider that a 50-person football team creates N(N−1)=50*49=2450 ties, and that many students join multiple clubs.) The reference pairs we use to separate baseline from inbreeding homophily were all same-school dyads that met the inclusion criteria discussed above. However, in the interest of computational feasibility, we employ only a random subset of these reference pairs: 25% were selected as reference pairs for the sibling and course-taking network analyses, and 5% were selected for the club and friendship analyses because the pools of eligible dyads were much larger. Based on these definitions, we see the following counts of within-school reference pairs: 697,746 reference sibling dyads, 108,979 reference course-mate dyads, 3,210,435 reference friendship dyads, and 3,310,670 reference club-mate dyads.

Measures of Health Behaviors

We examine four health behaviors that are important for chronic disease development and adult health and mortality (Lantz et al., 1998; R. G. Rogers et al., 2000; Stringhini et al., 2010). Our measures of health behaviors come from the in-school survey and are coded ordinally. Although these health behaviors were measured on different scales, rescaling the variables in a supplementary analyses found substantively similar results. Questions about smoking and drinking were asked in a similar manner and coded on the same scale. Respondents were asked, "During the past 12 months, how often did you smoke cigarettes?" and "During the past 12 months, how often did you drink beer wine or liquor?" Responses range from never, once or twice, once a month or less, 2 or 3 days a month, once or twice a week, 3 to 5 days a week, or nearly everyday. Respondents were also asked about exercise habits: "How many times in a normal week do you work, play, or exercise hard enough to make you sweat and breathe heavily? Responses were never, 1 or 2 times, 3 to 5 times, 6 or 7 times, or more than 7 times. The fourth health behavior is TV watching, which was examined as follows: "Outside of school hours, about how much time do you spend watching television or video cassettes on an average school day?" Responses are none, less than 1 hour, 1–2 hours, 3–4 hours, and more than 4 hours. Multiple responses are coded as missing.

Other measures

An important contribution of our study is that we examine variations in health behavior homophily across sociodemographic groups. We focus on the following axes of stratification: gender (male vs. female), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other race), social class (operationalized as the highest level of parental education: college vs. no college), and respondents' health status (coded from self-rated health as fair or poor health, good health, very good health, or excellent health).

Analytical Strategy

We examine the similarity of health behaviors across different relationship types using a dyad-based strategy. Our first question is simply how similar are health behaviors amongst those with each observed network tie. Table 1 presents these correlation coefficients. Our second question is how much of the homophily owes to shared contextual environments and population composition (baseline homophily) and how much is above what would be expected by chance (inbreeding homophily). We conduct regression-based assessments that compare baseline and inbreeding homophily and account for the complex network dependencies in our data. We estimate a linear regression model with two-way clustered standard errors, which accounts for network dependencies in dyadic analyses, with performance comparable to the more frequently employed MRQAP methods (Cameron et al., 2011; Lindgren, 2010).

Our regression model is based on an extension of the DeFries-Fulker model (DeFries & Fulker 1985) in behavioral genetics. Their method (p. 469, eq. 2) can be re-expressed as $Y_i = \alpha + \beta_1 Y_j + \beta_2 R_{ij} + \beta_3 Y_j R_{ij} + \varepsilon_{ij}$, where R_{ij}=1 for monozygotic twins, R_{ij}=0.5 for dizygotic twins, and β_3 is an estimate of heritability. Substituting a dichotomous indicator for the presence of a tie (T_{ij}) for R_{ij}, we estimate the degree of inbreeding homophily between pairs of individuals i,j is then estimated as:

$$Y_i = \alpha + \beta_1 Y_j + \beta_2 T_{ij} + \beta_3 Y_j T_{ij} + \mu_i + \mu_j + \varepsilon_{ij} \quad (1)$$

where Y_i is ego's health behavior and Y_j is alter's health behavior. In this model, β_1 can be interpreted as a measure of 'baseline' homophily for this health behavior, while the interactive effect, β_3, can be interpreted as the 'inbreeding' homophily in that network type (T) (M. McPherson et al., 2001). In short, the inbreeding homophily component measures the degree of health behavior similarity observed above what would be expected between random pairs without any measured ties who attend the same school. Finally, the μ terms represent the robust error terms for persons i and j, respectively, that account for shared variance amongst those socially connected (Cameron et al., 2011). This approach permits us to statistically compare homophily in pairs with each tie against same-school pairs with no other ties. These results are presented in Table 2.

After evaluating the magnitude of health behavior homophily and apportioning it into baseline and inbreeding components, we next examine how much variation in inbreeding homophily is seen across demographic subgroups. To do this, we extend the model to permit hypothesis tests for variation in homophily coefficients by race, gender, SES and health status. We specify this as:

$$Y_i = \alpha + \beta_1 Y_j + \beta_2 T_{ij} + \beta_3 Y_j T_{ij} + \beta_4 D_i + \beta_5 Y_j D_i + \beta_6 T_{ij} D_i + \beta_7 Y_j T_{ij} D_i + \mu_i + \mu_j + \varepsilon_{ij}, \quad (2)$$

where D_i is an indicator of the sociodemographic subgroup across which homophily variation is being investigated for person i. The crucial coefficient in this model is β_7, which indicates how much the homophily coefficient for those in group D_i=1 differs from those in group D_i=0 (whose homophily coefficient is represented by β_3). These results are presented in Table 3.

Results

First we present correlations for each type of health behavior by relationship types (Table 1). Sibling homophily is greatest for the four network types for all health behaviors, with correlations of .35 to .36 for smoking, drinking and television and .21 for exercise. In the Electronic Supplementary Material, we also examined how results differ within siblings of different genetic similarity (Table A1). In general, identical twins show higher levels of homophily than members of other sibling pairs.

After siblings, friends are the next most homophilous, with correlations of .30 for smoking, .26 for drinking, .16 for television and .13 for exercise. Reciprocated friend pairs had much higher levels of health behavior homophily than unreciprocated pairs, as expected (cf. Christakis and Fowler 2007). 76% of friendship nominations were non-reciprocated. Respondents with course or club ties have less similar health behaviors than siblings or friends, but more similar than schoolmates with no other ties. Course-mates, club-mates and schoolmates are similar for smoking, but for the other health behaviors, club-mates are more similar than course-mates, followed by schoolmates. Additionally, we tested whether the correlations for health behaviors differed in sport club vs non-sport pairs and found no large differences.

Table 2 presents results from our multivariate models. These results are easily interpretable in terms of the *degree* of homophily: a one-unit increase in the alter's health behavior (on the scale of 0–6 for smoking and drinking or 0–4 for exercise and TV watching) is associated with a β increase in ego's when they have T type of tie (compared to no tie). These numbers answer the question, how much more associated are connected dyads' health behaviors than that for two un-associated persons' who attend the same school?

We model these data in two different ways in Table 2. First, we model each of the network ties separately and find a similar pattern for all four health behaviors: siblings are the most similar to each other, friends are the second most similar, followed by course-mates and club-mates. Although the level of homophily varies for each health behavior and relationship tie, the patterns of homophily for these four relationship types are stable and the level of homophily for siblings, friends, course-mates and club-mates for all health behaviors is significantly higher than schoolmates. This table also shows that reciprocated friendships have much higher levels of homophily compared with non-reciprocated ties. Course-mates have on average lower levels of homophily than siblings and friends, but higher than schoolmates for TV watching and exercise, but not smoking and drinking. Club-mates are more similar than schoolmates for drinking, TV watching and exercise, but not smoking.

We also model the network ties jointly, and present these results in the bottom of Table 2. We permitted multiplexity across the social networks by modeling their effects simultaneously. The reference ties in this analysis are all same-school pairs where both nodes were included in the in-home sample as well as the AHAA supplement. The patterns of the results of this model are similar to those that modeled the ties separately. Estimates were more stable for the smoking and drinking models of friendship homophily than for the same models for television watching and exercise, where friendship effects are appreciably weaker (though statistically significant). We also estimated the interactive effects of friendship, club, and course ties to assess whether their effects are non-additive, and found little evidence for this above what could be expected due to multiple testing (see ESM Table A3). Therefore we analyze subgroup variation in homophily patterns with separate ties models.

Next, we examine whether health behavior homophily varies by race, class, gender, and health status of adolescents (Table 3). First we address differences by race. We find that across most ties and health behaviors whites have higher levels of homophily than blacks, Hispanics, or other race groups. Black and Hispanic inbreeding homophily is always lower for friend and club network ties. For siblings, there are only a few differences. For example, Hispanic siblings have more similar exercise patterns than white siblings, but less similar smoking behavior. Among course-mates, Blacks, Hispanics, and other race group have higher levels of homophily than whites for smoking, but there are few differences for the other health behaviors.

Overall, we find a potentially surprising lack of large gender differences in homophily across all four health behaviors. There are no gender differences for siblings or course-mates across any of the behaviors and the differences are very small for club-mates. There are some differences for friends, where for smoking and TV, girls are more similar for friend homophily than boys, but for drinking girls are less similar than pairs of boys.

We see some variation in homophily patterns by levels of parental education, but the amount depends on the type of tie being examined. Friend homophily is higher for high SES adolescents than those whose parents have not gone to college across all four behaviors. Among the other relationship types, high SES adolescents are much more similar to their siblings, course-mates and club-mates only for TV watching, but not the other behaviors.

Last, we turn to whether homophily patterns differ for adolescents in poor health compared to those in good health. We find no differences on health status for siblings on any health behaviors. However, we do find some differences for friend, course-taking and club homophily. Those in poor health are more like their friends in terms of smoking behavior and less like friends for TV and exercise. There are no differences in friend homophily for drinking. Adolescents in poor health are less like their course-mates for TV-watching, but no different for for smoking, drinking, and exercise. Finally, adolescents in poor health are less like their club-mates for TV and exercise, more similar for drinking, but no different for smoking.

Sensitivity Analysis

We conducted two sensitivity analyses. First, we examine to what extent demographic similarity of the pair explains homophily patterns. In Table A2, we present results from equation (2) adding an additional term $\beta_8(|D_i - D_j|)$ which measures whether the two individuals share a demographic subgroup. Much reduced coefficients relative to those in Table 3 would lend support for the hypothesis that demographic similarity was an important factor in the observed health behavior homophily patterns. However, the coefficients are very stable from Table 3 to A2, indicating that we find no evidence that pair-level demographic homophily explains the observed health behavior homophily patterns.

Additionally, because two-way standard errors (Cameron et al., 2011; Lindgren, 2010) is a new method for handling network dependencies in social networks, we also estimated these same methods using more traditional MRQAP methods (Dekker et al., 2007) using 1000 iterations per model. However, because our current model combines several networks into one analysis, and performing the appropriate permutations on such a large set of dyads would not be computationally feasible, we estimated models separately by school. These results are presented in Appendix B, and showed that the effects that we document are consistently statistically significant while accounting for network dependencies for friendship networks and for exercise behavior in club-mate networks, but that this is less consistently true for course-taking networks and for health behaviors other than exercise for club-mate networks.

Discussion

Social networks can shape the way health behaviors and health programs spread (Entwisle et al., 1996; M. McPherson et al., 2001; K. P. Smith & Christakis, 2008). Network structure, the demographic composition of the network, and the level of homophily among individuals in the network will affect processes of contagion and diffusion (Centola, 2010; J. M. McPherson & Smith-Lovin, 1987). Although a substantial amount of prior work has focused on demographic homophily, recent research suggests that health behavior/health status homophily can have independent and important effects on health outcomes (Centola, 2011). In this paper, we focus on adolescent health behavior homophily because unhealthy behaviors developed in adolescence are important for health and mortality later in life (Crimmins et al., 2011; Maralani, 2013). Our research explores homophily across four important health behaviors: smoking, drinking, TV watching, and exercising. We examine how homophily on each of these varies across four types of ties defined through relational (sibling and friendship) and co-affiliation (shared course, and shared club) networks. Finally, we consider whether sociodemographic subgroups differ in their homophily levels.

There are several constraints on our analysis. For one, there are strengths and limitations in our measurement of health behaviors. We focus on four, but there are many other potentially important health behaviors. Also, while our methods yield easily interpretable coefficients to measure homophily, we do not distinguish between those who do and do not partake in a health behavior. Instead, we differentiate *degrees* of health behaviors. The former is also an interesting question, one that future work should address. Another limitation stems from the pair-level research design we employ. Pair-level analyses of health behavior homophily are not capable of analyzing the interaction between higher-order network structures (e.g., cycles, or extra-local peer groups) and behaviors. These network-based approaches have much to offer (Bearman et al., 2004; J. Moody & White, 2003), but this is beyond the scope of this paper.

The first contribution of this paper was to show that homophily levels are high across several health behaviors, and that these associations are generally robust to the independent modeling of baseline and inbreeding homophily – there is more homophily amongst network ties than would be expected by chance due to shared context. Our findings also point to variability in health behavior homophily by network type. Of all the potential ways to conceptualize social networks, sociologists have tended to focus on socio-metric friendship ties (de la Haye et al., 2011; Gaughan, 2006; Kandel, 1978), whereas economists have focused more on peers defined through co-affiliation networks of course- or school-mates (Gaviria & Raphael, 2001; Manski, 1993). We find that friends' health behaviors are much more similar than club-mates, course-mates and school-mates, but less similar than siblings. Somewhat surprisingly, we did not find much evidence that homophily in multiplex ties is greater than we would expect from the sum of the effects of each constituent tie.

Considering variability in these results across types of network ties is a second contribution of this study. We posited two alternative orderings to the relationship between network types and health behaviors. On the one hand, some network types might be more important for some health behaviors than others, depending on where the behavior occurs. For instance, more social behaviors such as drinking and smoking may be more similar among friends. On the other hand, it could be that the more likely a tie is to be close, the more similar the pair, no matter the behavior. We found the same pattern for homophily across relationship ties for all four health behaviors. This seems to support the notion that the presumed closeness of the tie in question matters more than the social context in which it occurs. Siblings are more similar than friends who are more similar than club-mates, who are more similar than course-mates who are more similar than schoolmates. It may be that siblings are the most similar in these regards because they share genetic predispositions as well as home environment. In additional analysis in the Appendix, we find that the smoking, drinking and exercise behavior of identical twins is more similar than for dizygotic twins, full and half siblings (Table A1). However monozygotic twins, dizygotic twins, and full siblings have very similar TV watching behavior similarity, while half sibling are less similar for this behavior. Thus, health behavior homophily is both socially and genetically patterned across the four examined health behaviors.

Our third contribution is to examine subgroup differences in health behavior homophily. Differences in homophily patterns by race, class, gender and health status could affect how behaviors and programs will spread through these networks and can shape and maintain health inequalities across groups. We theorized that race, class and gender groups with lower levels of a behavior in the subgroup would show lower levels of baseline homophily and higher inbreeding homophily for that behavior. This was motivated by the idea that if a behavior is not widely shared, then those who partake are a more select group and will be more connected to others also doing that behavior. Christakis and Fowler (Christakis & Fowler, 2008) posited similar collective behavior dynamics with respect to smoking cessation. If, on the other hand, a behavior is widely shared, then it will be better distributed within the network. We find this is true for smoking and drinking, two behaviors for which whites have higher levels (Blum et al., 2000; Ellickson et al., 2004; Faulkner & Merritt, 1998; Seffrin, 2012). The support for this hypothesis for TV watching and exercise is less clear as race differences are more varied for these behaviors. Non-white groups exhibit lower levels of inbreeding homophily, with the exception of smoking homophily in coursetaking networks. We conjecture that these patterns vary by the racial/ethnic composition of the school, which should be investigated in future research. Support for this hypothesis is also less clear for gender. The gender differences in homophily across behaviors may be due to the fact that the timing and setting of these risk behaviors are highly gendered and vary by behavior. Future research should assess when and where adolescents engage in these behaviors by gender and how this influences homophily.

We also examine whether adolescents in poor health have different health behavior homophily patterns than those in good health, either because they are more socially isolated or have different patterns of interaction (Haas et al. 2010). We find no differences on health status for siblings on any behaviors. However, we do find some differences for friend, course-taking and club homophily. Those in poor health are more like their friends in terms of smoking behavior but are less like friends for drinking, and less like course-mates and club-mates for TV. It may be that smoking is an activity that those in poor health can do, but drinking with friends may be precluded by medication use.

In summary, this paper draws on recent theoretical and empirical work about social networks to consider a set of questions that has been neglected in prior research: how similar are health behaviors across different network types, and to what extent do subgroups differ in their health behavior homophily. These results are important for helping researchers to contextualize how health behavior homophily may shape the ways in which health interventions spread through adolescent networks.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research uses data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 23 other federal agencies and foundations. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth). No direct support was received from grant P01-HD31921 for this analysis. This research also uses data from the AHAA study, which was funded by a grant (R01 HD040428-02, Chandra Muller, PI) from the National Institute of Child Health and Human Development, and a grant (REC-0126167, Chandra Muller, PI, and Pedro Reyes, Co-PI) from the National Science Foundation. This research was also supported by grant, 5 R24 HD042849, Population Research Center, awarded to the Population Research Center at The University of Texas at Austin by the Eunice Kennedy Shriver National Institute of Health and Child Development. Opinions reflect those of the authors and do not necessarily reflect those of the granting agencies. The authors also wish to acknowledge funding from National Institute of Health grants R24 HD066613 and T32 HD007289, which supported this research. We also acknowledge jimi adams and Jason Boardman for their comments on an earlier draft of this paper. Any errors are the authors' alone.

References

Aral S, Muchnik L, Sundararajan A. Distinguishing influence-based contagion from homophily-driven diffusion in dynamic networks. Proceedings of the National Academy of Sciences of the United States of America. 2009; 106:21544–21549. [PubMed: 20007780]

Aral S, Van Alstyne M. The diversity-bandwidth trade-off. American Journal of Sociology. 2011; 117:90–171.

Aral S, Walker D. Identifying social influence in networks using randomized experiments. Ieee Intelligent Systems. 2011; 26:91–96.

Bearman PS, Moody J, Stovel K. Chains of affection: The structure of adolescent romantic and sexual networks. American Journal of Sociology. 2004; 110:44–91.

Beets MW, Beighle A, Erwin HE, Huberty JL. After-school program impact on physical activity and fitness: A meta-analysis. American Journal of Preventive Medicine. 2009; 36:527–537. [PubMed: 19362799]

Blau PM. A macrosociological theory of social structure. American Journal of Sociology. 1977; 81:26–54.

Blau, PM.; Schwartz, JE. Crosscutting social circles: Testing a macrostructural theory of intergroup relations. New Brunswick, NJ: Transaction Publishers; 1997.

Blum RW, Beuhring T, Shew ML, Bearinger LH, Sieving RE, Resnick MD. The effects of race/ethnicity, income, and family structure on adolescent risk behaviors. American Journal of Public Health. 2000; 90:1879–1884. [PubMed: 11111260]

Breiger RL. The duality of persons and groups. Social Forces. 1974; 53:181–190.

Cameron AC, Gelbach JB, Miller DL. Robust inference with multiway clustering. Journal of Business & Economic Statistics. 2011; 29:238–249.

Centola D. The spread of behavior in an online social network experiment. Science. 2010; 329:1194–1197. [PubMed: 20813952]

Centola D. An experimental study of homophily in the adoption of health behavior. Science. 2011; 334:1269–1272. [PubMed: 22144624]

Christakis NA, Fowler JH. The spread of obesity in a large social network over 32 years. New England Journal of Medicine. 2007; 357:370–379. [PubMed: 17652652]

Christakis NA, Fowler JH. The collective dynamics of smoking in a large social network. New England Journal of Medicine. 2008; 358:2249–2258. [PubMed: 18499567]

Cohen-Cole E, Fletcher JM. Is obesity contagious? Social networks vs. Environmental factors in the obesity epidemic. Journal of Health Economics. 2008; 27:1382–1387. [PubMed: 18571258]

Crimmins, EM.; Preston, SH.; Cohen, B., editors. Explaining divergent levels of longevity in high-income countries. Washington, DC: National Academies Press; 2011.

de la Haye K, Robins G, Mohr P, Wilson C. Homophily and contagion as explanations for weight similarities among adolescent friends. Journal of Adolescent Health. 2011; 49:421–427. [PubMed: 21939874]

Dekker D, Krackhardt D, Snijders TAB. Sensitivity of mrqap tests to collinearity and autocorrelation conditions. Psychometrika. 2007; 72:563–581. [PubMed: 20084106]

Durkin SJ, Biener L, Wakefield MA. Effects of different types of antismoking ads on reducing disparities in smoking cessation among socioeconomic subgroups. American Journal of Public Health. 2009; 99:2217–2223. [PubMed: 19833980]

Ellickson PL, Orlando M, Tucker JS, Klein DJ. From adolescence to young adulthood: Racial/ethnic disparities in smoking. American Journal of Public Health. 2004; 94:293–299. [PubMed: 14759945]

Ennett ST, Bauman KE. Peer group-structure and adolescent cigarettte-smoking - a social network analysis. Journal of Health and Social Behavior. 1993; 34:226–236. [PubMed: 7989667]

Entwisle B, Faust K, Rindfuss RR, Kaneda T. Networks and contexts: Variation in the structure of social ties. American Journal of Sociology. 2007; 112:1495–1533.

Entwisle B, Rindfuss RR, Guilkey DK, Chamratrithirong A, Curran SR, Sawangdee Y. Community and contraceptive choice in rural thailand: A case study of nang rong. Demography. 1996; 33:1–11. [PubMed: 8690134]

Faulkner DL, Merritt RK. Race and cigarette smoking among united states adolescents: The role of lifestyle behaviors and demographic factors. Pediatrics. 1998; 101:art. no.-e4.

Feld SL. Social structural determinants of similarity among associates. American Sociological Review. 1982; 47:797–801.

Felton G, Parsons M, Ward DS, Pate RR, Saunders RP, Dowda M, et al. Tracking of avoidance of alcohol use and smoking behavior in a fifth grade cohort over three years. Public Health Nursing. 1999; 16:32–40. [PubMed: 10074820]

Field SH, Frank KA, Schiller K, Riegle-Crumb C, Muller C. Identifying social positions from affiliation networks: Preserving the duality of people and events. Social Networks. 2006; 28:97–186. [PubMed: 20354579]

Fowler JH, Christakis NA. Estimating peer effects on health in social networks: A response to cohen-cole and fletcher; and trogdon, nonnemaker, and pais. Journal of Health Economics. 2008; 27:1400–1405. [PubMed: 18692263]

Frank KA, Muller C, Schiller KS, Riegle-Crumb C, Mueller AS, Crosnoe R, et al. The social dynamics of mathematics coursetaking in high school. American Journal of Sociology. 2008; 113:1645–1696.

Gaughan M. The gender structure of adolescent peer influence on drinking. Journal of Health and Social Behavior. 2006; 47:47–61. [PubMed: 16583775]

Gaviria A, Raphael S. School-based peer effects and juvenile behavior. The Review of Economics and Statistics. 2001; 83:257–268.

Goodreau SM, Kitts JA, Morris M. Birds of a feather, or friend of a friend? Using exponential random graph models to investigate adolescent social networks. Demography. 2009; 46:103–125. [PubMed: 19348111]

Haas SA, Schaefer DR, Kornienko O. Health and the structure of adolescent social networks. Journal of Health and Social Behavior. 2010; 51:424–439. [PubMed: 21131619]

Harris KM, Halpern CT, Smolen A, Haberstick BC. The national longitudinal study of adolescent health (add health) twin data. Twin Research and Human Genetics. 2006; 9:988–997. [PubMed: 17254442]

Kandel DB. Homophily, selection, and socialization in adolescent friendships. American Journal of Sociology. 1978; 84:427–436.

Kaplan CP, Napoles-Springer A, Stewart SL, Perez-Stable EJ. Smoking acquisition among adolescents and young latinas: The role of socioenvironmental and personal factors. Addictive Behaviors. 2001; 26:531–550. [PubMed: 11456076]

Kimm SYS, Glynn NW, Kriska AM, Barton BA, Kronsberg SS, Daniels SR, et al. Decline in physical activity in black girls and white girls during adolescence. New England Journal of Medicine. 2002; 347:709–715. [PubMed: 12213941]

Kirby DB, Baumler E, Coyle KK, Basen-Engquist K, Parcel GS, Harrist R, et al. The "'safer choices" intervention: Its impact on the sexual behaviors of different subgroups of high school students. Journal of Adolescent Health. 2004; 35:442–452. [PubMed: 15581523]

Kling JR, Liebman JB, Katz LF. Experimental analysis of neighborhood effects. Econometrica. 2007; 75:83–119.

Kumpfer KL, Alvarado R. Family-strengthening approaches for the prevention of youth problem behaviors. American Psychologist. 2003; 58:457–465. [PubMed: 12971192]

Lantz PM, House JS, Lepkowski JM, Williams DR, Mero RP, Chen JM. Socioeconomic factors, health behaviors, and mortality - results from a nationally representative prospective study of us adults. Journal of the American Medical Association. 1998; 279:1703–1708. [PubMed: 9624022]

Lazarsfeld, P.; Merton, R. Friendship as a social process: A substantive and methodological analysis. In: Berger, M., editor. Freedom and control in modern society. New York: Van Nostrand; 1954. p. 18-66.

Lindgren KO. Dyadic regression in the presence of heteroscedasticity-an assessment of alternative approaches. Social Networks. 2010; 32:279–289.

Lynagh M, Schofield MJ, SansonFisher RW. School health promotion programs over the past decade: A review of the smoking, alcohol and solar protection literature. Health Promotion International. 1997; 12:43–60.

Manski CF. Identification of endogenous social effects: The reflection problem. Review of Economic Studies. 1993; 60:531–542.

Maralani V. Educational inequalities in smoking: The role of initiation versus quitting. Social Science & Medicine. 2013; 84:129–137. [PubMed: 23466258]

McPherson JM, Smith-Lovin L. Homophily in voluntary organizations - status distance and the composition of face-to-face groups. American Sociological Review. 1987; 52:370–379.

McPherson M, Smith-Lovin L, Cook JM. Birds of a feather: Homophily in social networks. Annual Review of Sociology. 2001; 27:415–444.

Moody, J. Sociology. Chapel Hill: University of North Carolina; 1999. The structure of adolescent social relations: Modeling friendship in dynamic social settings.

Moody J, White DR. Structural cohesion and embeddedness: A hierarchical concept of social groups. American Sociological Review. 2003; 68:103–127.

Poelen EA, Scholte RH, Willemsen G, Boomsma DI, Engels RC. Drinking by parents, siblings, and friends as predictors of regular alcohol use in adolescents and young adults: A longitudinal twin-family study. Alcohol and Alcoholism. 2007; 42:362–369. [PubMed: 17537828]

Rogers, EM. Diffusion of innovations. New York: Free Press; 1995.

Rogers, RG.; Hummer, RA.; Nam, CB. Living and dying in the USA: Behavioral, health, and social differentials in adult mortality. San Diego: Academic Press; 2000.

Seffrin P. Alcohol use among black and white adolescents exploring the influence of interracial friendship, the racial composition of peer groups, and communities. Sociological Quarterly. 2012; 53:610–635.

Shalizi CR, Thomas AC. Homophily and contagion are generically confounded in observational social network studies. Sociological Methods & Research. 2011; 40:211–239. [PubMed: 22523436]

Smith JA. Macrostructure from microstructure: Generating whole systems from ego networks. Sociological Methodology. 2012; 42:155–205. [PubMed: 25339783]

Smith KP, Christakis NA. Social networks and health. Annual Review of Sociology. 2008; 34:405–429.

Stringhini S, Sabia S, Shipley M, Brunner E, Nabi H, Kivimaki M, et al. Association of socioeconomic position with health behaviors and mortality. Journal of the American Medical Association. 2010; 303:1159–1166. [PubMed: 20332401]

Valente TW. Network interventions. Science. 2012; 337:49–53. [PubMed: 22767921]

Verbrugge L. Multiplexity in adult friendships. Social Forces. 1979; 57:1286–1309.

- Compares homophily in four health behaviors in four networks
- Sibling and friend homophily is stronger than course and club networks
- Patterns vary by demographic characteristics

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Table 1

Correlations of health behaviors across relationship types

	N	Health Behavior			
		Smoking	**Drinking**	**TV**	**Exercise**
Separate Ties					
Sibling	2,054	0.355	0.350	0.366	0.209
Friend (All friendship ties)	521,256	0.303	0.262	0.164	0.131
Non-reciprocated friendship ties	398,968	0.272	0.235	0.151	0.113
Reciprocated-friendship ties	122,288	0.405	0.354	0.200	0.185
Course-mate	593,178	0.083	0.044	0.069	0.047
Club-mates	13,964,858	0.043	0.063	0.128	0.089
Schoolmate and no other ties	7,327,830	0.076	0.024	0.032	−0.011
Multiplex Ties					
Friend and course-mate	8,548	0.351	0.287	0.144	0.133
Friend and club-mate	4,340	0.303	0.282	0.163	0.210
Club and course-mate	114,550	0.079	0.069	0.117	0.107
Friend, course-mate and club-mate	3,928	0.298	0.295	0.151	0.206

Table 2

Homophily coefficients from linear regression models with two-way clustered errors

	Health Behavior			
	Smoking	**Drinking**	**TV**	**Exercise**
Separate Ties Models				
Sibling Homophily				
Baseline Homophily	0.068**	0.024**	0.035**	−0.001
Inbreeding Homophily	0.287**	0.326**	0.331**	0.210**
Friend Homophily				
Any Nominations				
Baseline Homophily	0.036**	0.037**	0.049**	0.008**
Inbreeding Homophily (All friendship ties)	0.267**	0.224**	0.114**	0.123**
Reciprocated Nominations				
Baseline Homophily	0.036**	0.037**	0.049**	0.008**
Inbreeding Homophily (Non-reciprocated ties)	0.236**	0.197**	0.102**	0.105**
Inbreeding Homophily (Reciprocated ties)	0.369**	0.317**	0.151**	0.178**
Course-taking Homophily				
Baseline Homophily	0.095**	0.043**	0.046**	0.012*
Inbreeding Homophily	−0.012	0.000	0.023**	0.035**
Club Homophily				
Baseline Homophily	0.040**	0.041**	0.050**	0.008**
Inbreeding Homophily	0.002	0.022**	0.078**	0.081**
Joint Ties Models				
Baseline Homophily	0.077**	0.023**	0.034**	−0.011
Inbreeding Homophily (All friendship ties)	0.270**	0.227**	0.066**	0.069**
Inbreeding Homophily (Course-mates)	0.008	0.018**	0.020**	0.030**
Inbreeding Homophily (Club-mates)	−0.010	0.016*	0.066**	0.091**

** p<.01

Note: Separately-estimated models are separated by dividing lines.

Table 3

Homophily coefficients by relationship type and demographic characteristics from linear regression models with two-way clustered errors.

	Health Behavior			
	Smoking	**Drinking**	**TV**	**Exercise**
Siblings				
Race				
Baseline Homophily	0.032**	0.030**	0.036**	−0.014**
Inbreeding Homophily (White)	0.318**	0.313**	0.279**	0.163**
Black	0.031	−0.087	−0.046	0.062
Hispanic	−0.160	0.108	−0.056	0.180**
Other	0.011	−0.013	0.154*	−0.003
Gender				
Baseline Homophily	0.060**	0.026**	0.027**	0.003
Inbreeding (Male)	0.286**	0.347**	0.327**	0.164**
Female	0.005	−0.043	0.011	0.041
Parental Education				
Baseline Homophily	0.078**	0.024**	0.019**	0.000
Inbreeding Homophily (No College)	0.258**	0.302**	0.263**	0.174**
College	0.086	0.063	0.170**	0.079
Health				
Baseline Homophily	0.067**	0.025**	0.036**	−0.001
Inbreeding Homophily (Good Health)	0.263**	0.325**	0.339**	0.204**
Poor Health	0.113	−0.033	−0.11	0.026
Friends				
Race				
Baseline Homophily	0.008**	0.033**	0.040**	−0.001
Inbreeding Homophily (White)	0.306**	0.265**	0.086**	0.129**
Black	−0.179**	−0.142**	−0.046**	−0.041**
Hispanic	−0.110**	−0.093**	−0.015*	−0.009
Other	−0.040**	−0.048**	0.030**	−0.006
Gender				
Baseline Homophily	0.031**	0.040**	0.046**	0.006**
Inbreeding Homophily (Male)	0.247**	0.235**	0.099**	0.101**
Female	0.038**	−0.022**	0.029**	0.005

	Health Behavior			
	Smoking	**Drinking**	**TV**	**Exercise**
Parental Education				
Baseline Homophily	0.043**	0.037**	0.034**	0.008**
Inbreeding Homophily (No College)	0.260**	0.206**	0.090**	0.116**
College	0.015*	0.047**	0.038**	0.013**
Health				
Baseline Homophily	0.033**	0.037**	0.050**	0.008**
Inbreeding Homophily (Good Health)	0.251**	0.221**	0.114**	0.121**
Poor Health	0.081**	−0.011	−0.015	−0.025**
Course-mates				
Race				
Baseline Homophily	0.027**	0.033**	0.038**	−0.010
Inbreeding Homophily (White)	0.006	−0.005	0.033**	0.036**
Black	0.158**	0.022	−0.019	−0.008
Hispanic	0.189*	0.009	−0.016	−0.008
Other	0.164*	0.004	−0.014	−0.005
Gender				
Baseline Homophily	0.085**	0.045**	0.033**	0.011
Inbreeding Homophily (Male)	−0.018	0.006	0.029**	0.035**
Female	0.013	−0.012	−0.011	−0.011
Parental Education				
Baseline Homophily	0.108**	0.041**	0.036**	0.003
Inbreeding Homophily (No College)	−0.014	0.001	0.012	0.041**
College	0.004	−0.004	0.027**	−0.018
Health				
Baseline Homophily	0.092**	0.047**	0.046**	0.011
Inbreeding Homophily (Good Health)	−0.012	−0.002	0.026**	0.038**
Poor Health	−0.001	0.027	−0.041*	−0.024
Club-mates				
Race				
Baseline Homophily	0.012**	0.037**	0.039**	−0.001
Inbreeding Homophily (White)	0.021**	0.030**	0.071**	0.087**
Black	−0.018**	−0.020**	−0.044**	−0.015**
Hispanic	−0.018**	−0.009	−0.034**	−0.018**

	Health Behavior			
	Smoking	**Drinking**	**TV**	**Exercise**
Other	−0.017**	−0.003	0.036**	−0.010*
Gender				
Baseline Homophily	0.035**	0.043**	0.047**	0.006**
Inbreeding Homophily (Male)	0.003	0.022**	0.075**	0.056**
Female	−0.002	−0.006*	0.005	−0.005
Parental Education				
Baseline Homophily	0.048**	0.041**	0.035**	0.010**
Inbreeding Homophily (No College)	0.000	0.022**	0.037**	0.080**
College	0.008**	0.001	0.059**	0.004
Health				
Baseline Homophily	0.036**	0.040**	0.051**	0.008**
Inbreeding Homophily (Good Health)	0.003	0.021**	0.079**	0.082**
Poor Health	0.006	0.030**	−0.036**	−0.037**

** p<.01

* p<.05

Note: Separately-estimated models are separated by dividing lines.