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ON THE RELATIONSHIP BETWEEN SELF-REPORTED PHYSICAL HEALTH AND SOCIAL NETWORKS: AMONG KOREAN JUNIOR HIGH SCHOOL STUDENTS*

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This paper tried to examine the relationship between social network patterns and physical health statuses among junior high school students in Korea with three distinctive characteristics with compared to many previous studies. First, based on two-year panel data of Korean Youth Panel Survey, it tried to control for unobserved heterogeneity that might have been exerting effects on students' health but could not have been included in the survey. Furthermore, instead of typical random model of anel data, it employed a modified random model that examined each coefficient to decide if we could treat 'between' effect same as 'within' effect. Thanks to this modified model, we could detect getting along with friends at school had only 'between' effect without statistically significant 'within' effect. Lastly, by including self-perceived psychological problem in the regression, we examined the possibility of direct network effects on physical health. The results revealed that in each of three social dimensions (school, family, and friends) direct effects of network existed on physical health of junior high school students. Especially, cohesive and frequent interacting with friends rather than simple popularity among friends was closely related with physical health.

Key Words: *Social Network, Physical Health Status, Interacting with Friends.*

INTRODUCTION: SOCIAL NETWORKS AND HEALTH AMONG ADOLESCENTS IN KOREA

Health disparities among adolescents haven't got much attention due to its relatively small amount with compared to ones among infants or adults (Y. H. Kang, 2004) with some notable exceptions in Korea. Furthermore most Korean studies have only focused on socio-economic status of families (Y. H. Kang, 2004; H. O. Kim, 2003; M. R. Song et al.,

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2002; J. W. Lee et al., 2001 Y. M. Chang, 2000) or psychological factors such as 'self-respect', 'attachment', or 'alienation' to explain health disparities among adolescents(S. M. Kim and K. O. Lee, 1994; E. Y. Lee and Y. R. Tak, 2001; H. J. Jang and Y. H. Shin, 2002; Y. R. Tak and E. Y. Lee, 2004). For example, one study found that self-perceived financial problem of the family had a strong negative effect on both self-reported physical and psychological health of Korean high school students while actual socio-economic status of the family had no effect (Y. M. Chang, 2000) and another study revealed similar result for Korean junior high school students although health-related behaviors showed some variations across different socio-economic statuses (Y. H. Kang, 2004). Also psychological factors such as self-esteem or attachment to parents showed strong positive effects on perceived health (H. J. Jang and Y. H. Shin, 2002) or health efficacy (Y. R. Tak and E. Y. Lee, 2004) in Korea. There was relatively small number of studies that examined the role of social networks on physical health among adolescents in Korea.

However, studies after studies on the adult health disparities across different racial/ethnic groups in U.S.A. have confirmed that they can't be explained by only socio-economic status (Brawley, 2002; Bledon et al., 1989; Hunter et al., 1993; Katz and Hofer, 1994), but could be more properly explained when social network factors were added (Bloom et al., 2001; Michael et al., 2002). Let's take an example of breast cancer, which became the most prevalent cancer among Korean women. Socio-economic status no matter how it was measured could not explain the racial/ethnic disparities on the prevalence of breast cancer (Hunter et al., 1993; Katz and Hofer, 1994; Mandelblatt et al., 1991; Trock et al., 1993; Vernon et al., 1985; Wells and Horm, 1992). Social networks showed strong effects on regular check-up (Culnan, 1985; Hoffman-Goetz and Mills, 1997; Husaini et al., 2001; Katapodi et al., 2002; McCance et al., 1996; Suarez et al., 1994; Wagle, Komorita, and Lu, 1997; Yeomans-Kinney et al., 1995; Zhuet al., 2000) and specific types of social networks of breast cancer patients' improved positive attitudes and behaviors toward proper treatments in time (Bloom et al., 2001; Fox et al., 1994; Heidrich, 1996; Hoskins et al., 1996; Lugton, 1997; Michael et al., 2002; Sammarco, 2001; Sheinfeld, 1998) and thus, they had direct and systematic results on survival rates (Blanchard et al., 1995; De Boer et al., 1999; Ell, 1992; Maunsell, Brisson, and Deschenes, 1995; Marshall and Funch, 1983; Reynolds and Kaplan, 1990; Turner-Cobb et al., 2000; Vogt et al., 1992; Waxler-Morrison et al., 1991; Welin et al., 1992).

From Berkman and Syme's seminal longitudinal research on the network effects on mortality(Berkman and Syme, 1979) to recent Pressman's study of network size effects on the antibody level after flu shots among college freshmen (Pressman et al., 2005), many studies revealed strong and systematic network effects on health. Most health studies of this kind confirmed the existence of social network effects even after controlling for socio-economic status or psychological factors. Although most U.S. studies of adolescent health focused on deviant or un-healthy behavior such as alcohol use, smoking, or early sexual activities rather than health itself, they confirmed strong positiveeffects of social network effects including parental monitoring (Barnes and Farrell, 1992; Beck, Shattuck and Haynie, 1999; Borawski, Ievers-Landers, Lovegreen et al., 2003; DiClemente, Wingood and Crosby, 2001; Li, Feigelman and Stanton, 2000; Rodgers, 1999; Stanton, Li, and Galbraith, 2000; Stattin and Kerr, 2000), school integration (Bonny, Britto and Brenda, 200; Eccles, Early and Frasier, 1997; Institute of Medicine, 1997; McNeal, 1999; Newmann, 1981; Newmann, Rutter and Smith, 1989; Resnick, Bearman and Blum, 1997; Resnick, Harris and Blum, 1993), or peer-group influence (Alexander et al., 2001; Annette, Mitchell and Fetter, 2001; Beal, Ausiello and Perrin, 2001; Bruce, Denise and Aria, 2001; Eiser, Morgan and Gammage, 1991; Kimberly, 2004; Mechanic, 1983; Mitchell, Boergers and Spirito, 2001). This study tries to fill the gap between adolescent health studies in Korea and network research on health by examining social network effects on adolescent health in Korea, especially on self-reported physical health of junior high school students. Following previous research, we also focused on social networks from family, school, and friends.

SOCIAL NETWORK EFFECTS: BUFFERING EFFECT VS. DIRECT EFFECT

The transition of research focus from socio-economic status or psychological factors to social networks has two important implications. First, it can provide meso-level mechanisms that can link macro-level environmental factors to micro-level factors in health studies (Berkman and Kawachi, 2000). This could be especially critical to open the black box of neighborhood effects on health, which becomes one of the hottest topics in public health in the last decade: in order to avoid 'miasma' theory of neighborhood effect, we need meso-level mechanisms to explain the results (Diez-Roux, 2003; Kawachi and Berkman, 2003).

Second, it also has strong practical implication for intervention strategy. It is widely known that target marketing or target education based on social networks produces better results than education for general audience without specific targets. Network-based target education proved to be more effective and efficient according to many studies for the purpose of health-related behavioral change in general population (Buller et al., 1999; Flax and Earp, 1993; Pearlman et al., 1997; Tessaro, Eng and Smith, 1994) or adolescent groups (Turner and Shepherd, 1999; Van Roseem and Meekers, 2000; Wilst and Snider, 1991). People seek personal networks instead of official institutions or mass-media when they need information about health-related issues, especially about behaviors with social stigma such as drinking, smoking, or sexual activities among adolescents (Youm and Laumann, 2004).

Also this study controls 'unobserved heterogeneity' among students by utilizing longitudinal property of Korea Youth Panel Survey (KYPS). This is an important feature of the paper when we consider the fact that many people have chronic conditions that has consistent effects on physical health but can't be easily observable and thus, won't be normally included in a survey. For example if a student is not so healthy from the birth without specific diseases, maybe due to genetic characteristics, it would be hard to control this unobserved characteristics by traditional cross-sectional statistical tools. Based on longitudinal data, however, we can control this unobserved 'within' effect because we have multiple cases of the same respondents. Thus, we can tell the 'within' effect from the 'between' effect that is measured in traditional cross-sectional analysis: in addition to check if a student with many friends is different from another student with few friends with regard to health status ('between' effect), we can examine if when a student's health status would change if he or she make more friends ('within' effect).

The last characteristic of this paper is to focus on physical health not on psychological health or distress. It is somewhat apparent that social networks are strongly related to psychological well-being but the relationship between social ties and physical health is much less obvious. Especially this study is trying to estimate the effects of social networks on physical health after controlling for psychological distress level. In this sense, the network effect we will get in the regressions is not a 'buffering effect' but a direct effect on physical health.

There exist two camps of network studies on health. Studies focused on buffering effects of networks examined social-psychological

mechanisms that protect people from stressors (Cohen, 1988). Based on social resources from support networks, people can deal with stressors by changing their own perception of stressors or lowering the negative effects of stressors (Wethington and Kessler, 1986; Cohen and Wills, 1985). Many studies confirmed that under the same stressors, people with support networks got less stresses than people without (Bowling and Browne, 1991; Holahan et al., 1995; Matt and Dean, 1993; Kawachi and Berkman, 2001). Another approach focused on direct effects of social networks on health. People with social networks of concern and support are more likely to engage in healthy behaviors and less likely to keep unhealthy habits. And also strong support networks can furnish people with self-identity or self-efficacy that provide consistency and meanings in their lives (Cohen, 2004; Thoist, 1983; Kawachi and Berkman, 2000). This, in turn, would result in healthier behaviors and better immune system (Uchino et al., 1996). We strongly believe social networks have direct sociological effects in addition to psychological buffering effects even on adolescents whose health statuses do not vary much with compared to adults. In this sense, this paper tries to test the direct effects of social networks on physical health among junior high school students after controlling for unobserved heterogeneity based on KYPS.

DATA AND ANALYSIS: KOREA YOUTH PANEL SURVEY WITH MODIFIED RANDOM EFFECT MODEL

This study is based on two years of Korea Youth Panel Survey data in 2003 and 2204 collected and managed by Korea Institute for Youth Development.[1] It included 3,449 junior high school students in 104 schools in Korea. Variables used in regressions are as follows.

DEPENDENT VARIABLE: SELF-REPORTED PHYSICAL HEALTH

The dependent variable is self reported physical health based on the five-scale responses to the statement, 'My health status is not so good': 'Not at all', 'No', 'So, so', 'a little bit', 'very much.'[2] We needed to take

[1] Pease go to http://www.youthnet.re.kr/ for details.

[2] There is no exact word 'physical' in the question but we believe students meant physical health here when they answered because there is a separate question to ask specifically psychological distress. Also as regressions will show, even after controlling for psychological distress, we can detect many statistically significant predictors.

TABLE 1. HEALTH CHANGES BETWEEN 2003 AND 2004 (ROW PERCENTAGES IN PARENTHESES): RESPONSES TO 'MY HEALTH STATUS IS NOT SO GOOD'

		2004					
		Not at all	No	So, so	A little bit	Very much	Total
2003	Not at all	855	260	122	26	10	1,273
		(67.16%)	(20.42%)	(9.58%)	(2.04%)	(0.79%)	(100%)
	No	335	351	147	36	1	870
		(38.51%)	(40.34%)	(16.9%)	(4.14%)	(0.11%)	1(100%)
	So, so	13	199	261	61	2	654
		(20.03 %)	(30.43%)	(39.91%)	(9.33%)	(0.31%)	(100%)
	A little bit	39	63	99	80	6	287
		(13.59%)	(21.95%)	(34.49%)	(27.87%)	(2.09%)	(100%)
	Very much	1	2	3	8	5	19
		(5.26%)	(10.53%)	(15.79%)	(42.11%)	(26.32%)	(100%)
	Total	1,361	875	632	211	24	3,103
		(43.86%)	(28.2%)	(20.37%)	(6.8%)	(0.77%)	(100%)

the logarithm of the original score to adjust the very skewed-to-the-right distribution. Thus, the positive coefficients show negative relationship with health in percentage while negative coefficients mean positive relationship with health in percentage. Although there is only one year gap between two data points, we can observe very wide variation within individuals, which allows us to take serious statistical tests. For example among the students who said 'very much' in year 2003, about 11% said 'no' and 16% said 'so, so' one year later. Table 1 shows the changes in health status between 2003 and 2004.

Also we need to discuss about the limitation of self-reported health with compared to official medical exams or records. We are ready to acknowledge the limitation of this self-reported health status but at the same time, we believe it is sufficiently reliable and valid for this paper. Sometimes self-reported health is known to be better than disease-specific diagnosis to measure health status of people as a whole even longevity (Idler and Kasl, 1991; Kaplan, 1987; Mossey and Shapiro, 1982). Many studies confirmed that self-reported health measure is sufficiently valid and reliable for statistical analysis (Mossey and

Shapiro, 1982; Taubman and Rosen, 1982; Ross and Wu, 1995). Especially considering the prevalence of specific diseases among adolescents is very low, self-reported health is the best measurement for the purpose of this paper.

MAJOR INDEPENDENT VARIABLES: SOCIAL NETWORKS

Following previous studies, social networks in three different social dimensions were examined: school, family, and friends. We have four variables to measure social networks in school setting: (1) aloneness in school (five-point scale), (2) getting along with friends in school (five-point scale),[3] (3) trust in school teacher (five-point scale), and (4) the number of school teacher included in the list of close friends (zero to five)[4]. We decided to include only one measure for family networks after several trials considering statistical significance and correlations between family network-related variables: (1) inclusion of mother in the list of close friends. Lastly we examined two major dimensions of friendship network: (1) size of close friends and (2) strength with close friends measured by average meeting frequency per month. We assume that these variables tap into different dimensions of social networks among Korean junior high school students. Actually, the highest pair-wise absolute value of correlation coefficient among these variables is only 0.34 and most of them were below 0.1 (see table 3).

OTHER CONTROL VARIABLES: INDIVIDUAL-LEVEL VARIABLES

In order to obtain partial effect of social networks after controlling for individual-level attributes, we included the following four types of independent variables: (1) individual attributes, (2) family environment, (3) health-related behavior, and (4) a stressor and psychological problem. First, we consider sex, order in sibling, and number of siblings of the respondent (age is virtually identical to the respondents). Second, in order to measure family milieu, we examined residential area (urban vs. rural), residential type (owner, long-term rent, and monthly rent), mother's working status (housewife, part-time, and full-time), family

[3] This is an average score of responses to two questions: (1) 'I can have a frank talk with a teacher for my personal problems' and (2) 'Teachers show love and concern for me.'

[4] KYPS asked to enlist closest friends up to five and to specify the relationship with each friend. We counted how many teachers were included in the list.

TABLE 2. DESCRIPTION OF VARIABLES USED IN THE REGRESSIONS

	Sample(n)	Mean	S.D.	Max.	Min.
Log(unhealthy status)	65,11	0.55	0.51	0.00	1.61
# of siblings	6,862	2.11	0.66	1	7
Financial hardship of the family	6,622	1.89	1.00	0	5
Study stress	6,619	3.08	1.09	1	5
Smoking frequency a year	6,617	76.21	467.50	0	9125
Drinking frequency a year	6,622	1.47	5.70	0	120
Psychological problem	6,490	1.60	0.85	1	5
Aloneness at school	6,617	2.33	1.05	1	5
Getting along at school	6,621	3.86	0.86	1	5
Trust in teachers	6,622	2.57	0.86	1	5
# of teachers included in close-friend list	6,862	0.01	0.15	0	5
mother included in close-friend list (binary)	6,862	0.22	0.41	0	1
# of close friends	6,611	8.90	12.02	0	150
Meeting frequency with close friends a month	6,588	24.56	9.88	0	30
Study hours at home alone	6,862	9.53	9.45	0	74
Study hours with tutors	6,862	10.77	9.76	0	72
Sex	6,622	Male (50%), Female (50%)			
Order in siblings	6,849	Only-one(13%), first(43%), middle(8%), last(36%)			
Residential area	6,602	Urban(47%) others(53%)			
Residential type	6,452	Owner(71%), long-term rent(20%), others(8%)			
Family type (both parents or not)	6,532	Both parents(91%), others(9%)			
Parental working status	6,030	Both not working(4%), only-one working (49%), both working(47%)			
Mother's education	6,459	Middle-school or lower(18%), high-school (59%), college(24%)			

type ('both parents' or not), parents' working type (both working, only one working, both not working), mother's education level, and self-reported financial hardship of the family (five-point scale). Third, as health-related behaviors, we included the frequency of smoking per

TABLE 3. CORRELATION COEFFICIENTS BETWEEN VARIABLES USED IN THE REGRESSIONS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1.00																						
2	0.06	1.00																					
3	-0.03	-0.07	1.00																				
4	0.03	0.14	0.28	1.00																			
5	-0.02	0.01	0.04	-0.05	1.00																		
6	0.03	0.02	-0.05	-0.03	0.01	1.00																	
7	0.01	0.00	-0.02	0.01	-0.07	-0.02	1.00																
8	0.02	0.01	0.01	-0.03	-0.01	0.17	-0.09	1.00															
9	-0.02	-0.01	-0.11	-0.12	0.11	-0.12	0.01	-0.10	1.00														
10	0.28	-0.01	0.00	0.02	-0.01	0.20	0.02	0.17	-0.16	1.00													
11	0.09	0.01	0.01	-0.01	-0.03	0.03	0.02	0.02	-0.01	0.11	1.00												
12	0.01	-0.01	0.03	-0.01	-0.03	0.03	0.02	0.04	-0.05	0.08	0.06	1.00											
13	0.02	0.14	0.00	0.00	-0.04	0.02	0.04	0.01	-0.02	0.06	0.08	0.44	1.00										
14	0.37	-0.02	0.00	-0.01	0.01	0.03	0.02	0.04	-0.01	0.33	0.15	0.03	0.03	1.00									
15	-0.02	-0.02	-0.02	-0.01	-0.02	-0.02	-0.01	-0.03	0.12	-0.07	0.03	-0.05	-0.06	-0.04	1.00								
16	0.02	-0.05	-0.05	-0.07	0.02	-0.11	0.03	-0.13	0.10	-0.11	0.04	-0.02	0.01	0.00	0.09	1.00							
17	0.16	0.05	-0.03	0.00	-0.03	0.02	-0.01	0.01	-0.01	0.19	0.12	0.01	0.02	0.26	-0.02	-0.01	1.00						
18	-0.17	0.00	0.00	-0.03	0.02	-0.05	0.01	-0.02	0.08	-0.14	-0.01	0.05	0.06	-0.17	0.07	0.06	-0.34	1.00					
19	-0.03	-0.07	-0.04	-0.03	-0.02	-0.02	0.00	0.00	0.05	-0.03	-0.10	-0.05	-0.10	-0.02	0.06	0.01	0.06	0.05	1.00				
20	0.01	0.00	0.00	0.03	-0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.01	-0.01	0.01	0.01	0.00	0.00	0.00	0.05	1.00			
21	-0.01	0.11	-0.01	0.01	0.01	0.00	-0.01	0.00	0.06	0.00	-0.03	-0.05	-0.06	0.00	0.03	0.01	0.04	0.00	0.03	0.02	1.00		
22	-0.05	-0.17	0.01	-0.02	0.01	-0.01	-0.01	0.01	0.01	0.00	0.01	0.07	0.03	-0.02	0.03	0.01	-0.08	0.09	0.02	0.01	-0.05	1.00	
23	-0.03	0.08	0.01	0.04	-0.07	-0.03	0.00	0.00	-0.03	-0.03	-0.02	0.03	0.04	-0.03	-0.02	0.05	-0.07	0.11	0.00	0.00	0.00	-0.01	1.00

1: log(unhealthy status); 2: sex; 3: Order in siblings, 4: # of siblings, 5: Residential area; 6: Residential type; 7: Parental working status; 8: Family type (both parents or not); 9: Mother's education; 10: Financial hardship; 11: Study stress; 12: log(Smoking frequency) a year; 13: log(Drinking frequency a year); 14: Psychological problem15: Study hours at home alone; 16: Study hours with tutors; 17: Aloneness at school; 18: Getting along at school; 19: Trust in teachers; 20: # of teachers included in close-friend list; 21: mother included in close-friend list (binary); 22: # of close friends; 23: Meeting frequency with close friends a month, 0.00 means that it is less than 0.01 (rounded numbers are shown).

year, the frequency of drinking per year, total study hours per week at private institutions (or with tutors), and total hours of study alone at home. Finally, we examined self-perceived psychological problem in general and stressor from study.[5] Table 2 summarizes variables used in the regression. Also table 3 summarizes the pair-wise correlation coefficients between all the variables included in the regressions. None of them showed serious sign of collinearity problem in the regression.

ANALYSIS RESULTS AND DISCUSSION: MODIFIED RANDOM EFFECT MODEL

As we briefly discussed already, there are two kinds of information in this panel data: the cross-sectional information that revealed the differences between students and time-series information that contains the changes within the same students over time. The former is called 'between' effects and the latter 'within' effects. By using statistical tools that are customized to deal with panel data, we can control 'unobserved' heterogeneity among respondents. Unobserved heterogeneity is characteristics of the respondents that are not included in the regression but have effects on the dependent variable: for example in our case, there could be some chronic condition that makes students unhealthy but were not (or could not) be included in the data set.

Three types of models are widely used to analyze panel data by controlling unobserved heterogeneity: fixed, between, and random. Fixed effects regression model is to control unobserved characteristics that differ between cases but not over time. This model enables us to estimate the effects of changes overtime on the dependent variable. This is technically identical to generate dummy variables for each case and include them in a traditional cross-sectional regression to control for fixed and within effects. In the opposite approach, between effect model is to control for unobserved characteristics that change over time but not between respondents. This allows us to estimate the effects of the variation between cases on the dependent variable. In many cases,

[5] Another possibility is to include self-reported financial problem of the family here as a stressor. But there is a separate question to ask about the stresses of the respondent from financial situation (allowance), which turned out to be not statistically significant to predict the respondents' physical health and thus was not included in the regression. We believe financial problem of the family describes family situation rather than direct stressor to the students.

researchers would like to control both fixed and between effects and thus prefer random model. Random model is to combine fixed and between effect models and is a weighted average of fixed and between effects. This is why most studies relied on random effect model to analyze their data.

Random model uses less number of parameters for the estimation than fixed model that loses the degrees of freedom because of controlling for within effects (like creating and using dummy variables for each case) and thus more efficient. However, since it increase the model efficiency for the cost of data fitting, the data fitting of the random model is not guaranteed. Thus in general researchers compare fixed effect model to random model by using Hausman test (Hausman, 1978) under the hypothesis that added parameters in the fixed model are not statistically significant as a whole just like F-test in traditional OLS linear regressions. However, this test is to examine added parameters as a whole and could be misleading. It is possible that only for some specific variables there are sharp differences between the two effects: 'within' and 'between' effects. The coefficients of those variables from the random model could be misleading because they are simply weighted average of two quite different effects. Thus in this research, we checked two coefficients of variables for each model ('within' effect and 'between' effect) and if they are sharply different from each other, we included both effects in the regression instead of including only one parameter from the random model, which is the weighted average of 'within' effect and 'between' effect. This modified version of random model increases p-value in the Hausman test without sacrificing too many degrees of freedom (the p-value of the final model is 0.78). As a result, we could detect that getting along with friends at school has only between effect: there was discrepancy in health between students who got along with other students at school and who haven't while there was no health difference when students became to get along with friends at school more in a year. We will discuss the result of the analysis in detail in the next section.

RESULT OF THE MODIFIED RANDOM MODEL OF LINEAR REGRESSION

We ran four modified random models of linear regression to predict the logarithm of unhealthy status. If there is no superscript 'w' or 'b' at the end of the variable name, within effect and between effect have similar coefficients for the variable. When they were quite different to

the extent that separate estimation improved the data-fitting with statistically significant increase in p-value, we estimated two effects separately and presented both in the table. Results are summarized in table 4.

TABLE 4. COEFFICIENTS OF THE MODIFIED RANDOM MODEL OF LINEAR REGRESSION OF SELF-REPORTED PHYSICAL UNHEALTHY STATUS: P-VALUE IN THE PARENTHESES, B: BETWEEN EFFECT, W: WITHIN EFFECT

	Model 1	Model 2	Model 3	Model 4
	Log(unhealthy)	Log(unhealthy)	Log(unhealthy)	Log(unhealthy)
Female student	0.0656*** (4.43)	0.0642*** (4.36)	0.0668*** (4.52)	0.0633*** (4.23)
First child (vs. only child)	-0.0228 (-0.69)	-0.0247 (-0.75)	-0.0236 (-0.72)	-0.0266 (-0.81)
Middle child (vs. only child)	-0.00397 (-0.081)	-0.00862 (-0.18)	-0.00886 (-0.18)	-0.0108 (-0.22)
Last child (vs. only child)	-0.0484 (-1.46)	-0.0477 (-1.45)	-0.0472 (-1.44)	-0.0494 (-1.50)
# of siblings	0.0235 (1.45)	0.0221 (1.38)	0.0225 (1.40)	0.0232 (1.45)
Big city (vs. others)	-0.0204 (-1.41)	-0.0186 (-1.29)	-0.0190 (-1.32)	-0.0195 (-1.35)
Long-term rent (vs. owner)	0.00601 (0.37)	0.00245 (0.15)	0.00202 (0.12)	0.00126 (0.078)
Monthly rent (vs. owner)	-0.0242 (-1.01)	-0.0271 (-1.14)	-0.0263 (-1.10)	-0.0265 (-1.11)
One-parent working (vs. none working)	-0.0378 (-1.03)	-0.0365 (-1.00)	-0.0389 (-1.06)	-0.0402 (-1.10)
Both-parent working (vs. none working)	-0.0351 (-0.94)	-0.0339 (-0.91)	-0.0370 (-1.00)	-0.0384 (-1.03)
Single parent (vs. both parents)	-0.0404 (-1.57)	-0.0389 (-1.52)	-0.0383 (-1.50)	-0.0374 (-1.47)
Mom's education: high-school (vs. junior high school)	0.0149 (0.73)	0.0230 (1.14)	0.0356* (1.66)	0.0363* (1.69)
Mom's education: college (vs. junior high school)	0.0206 (0.87)	0.0358 (1.52)	0.0583** (2.29)	0.0586** (2.30)

Financial hardship (five-point scale)	0.0964*** (13.8)	0.0923*** (13.2)	0.0922*** (13.2)	0.0920*** (13.2)
Study stress (five-point scale)	0.00660 (1.16)	0.00566 (0.99)	0.00534 (0.94)	0.00526 (0.93)
Log(smoking frequency/ 1year)	-0.00210 (-0.83)	-0.00126 (-0.50)	-0.00125 (-0.50)	-0.000865 (-0.34)
Log(drinking frequency/ 1year)	-0.000590 (-0.22)	0.000422 (0.16)	0.000139 (0.053)	0.000307 (0.12)
Psychological problem^{B}	0.217*** (20.6)	0.201*** (18.6)	0.201*** (18.6)	0.201*** (18.7)
Psychological problem^{W}	0.113*** (10.8)	0.114*** (10.8)	0.114*** (10.8)	0.113*** (10.8)
Study hours at home (/ week)	0.0000802 (0.13)	0.000268 (0.43)	0.000296 (0.47)	0.000317 (0.51)
Study hours with tutor (/ week)	0.00150** (2.36)	0.00167*** (2.64)	0.00167*** (2.65)	0.00172*** (2.72)
Feeling lonely at school (five-point scale)		0.00253 (0.40)	0.00265 (0.42)	0.00185 (0.29)
Getting along with friends^{B} (at school. Five-point scale)		-0.0812*** (-7.43)	-0.0817*** (-7.48)	-0.0784*** (-7.15)
Getting along with friends^{W} (at school. Five-point scale)		-0.00305 (-0.30)	-0.00228 (-0.23)	-0.00112 (-0.11)
Trust in teachers		-0.00832 (-1.18)	-0.00780 (-1.11)	-0.00778 (-1.11)
# of teachers (included in close friends)		0.0125 (0.35)	0.0132 (0.37)	0.0125 (0.35)
Mother is a close friend (binary coding)			0.0462 (1.25)	0.0482 (1.30)
Higsh school educ. Mother X Mother is a close friend			-0.0660 (-1.60)	-0.0677 (-1.64)
College educ. Mother X Mother is a close friend			-0.103** (-2.24)	-0.105** (-2.28)
# of close friends				0.00101 (0.89)

Meeting frequency with close Friends per month				-0.000174 (-0.24)
# of close friends X Meeting frequency				-0.0000930** (-2.09)
Constant	-0.120** (-1.97)	0.245*** (3.09)	0.235*** (2.96)	0.248*** (3.06)
N	5621	5621	5621	5621
P-value for Hausman Test	0.44	0.62	0.75	0.78
R-squared	0.18	0.20	0.20	0.20

Model 1 only included individual-level attributes like many previous studies. Female students were about 6.5% more unhealthy than male students. Also students who perceived financial hardship at home were about 9.6% more unhealthy. Self-perceived psychological problem was single biggest factor on physical health although the causal direction must be both ways. Also its 'between effect' is different from 'within' effect in terms of magnitude. Students who reported psychological problems were 22% more unhealthy than other students whose self-reported psychological problem was one-scale lower: between effect. However, when a student's self-reported psychological problem increased one-scale higher over time, he or she became 11% more unhealthy: within effect. Study hours also had effects on the health of junior high school students. Interesting finding was that hours of study alone at home had no effect while study hours at extra-curriculum institution or tutor had negative effect on health. 10 hours more per week meant 1.5% less healthy status.

Model 2 added network patterns at school to the previous model. Again, two effects of the getting along with friends at school were quite different: its between effect was statistically significant while its within effect was not. Students who got along with friends at school were about 32% (=4*0.0871) healthier than students who didn't by four-scale difference out of five-scale point. However when same student were getting along with friends at school more over time, his or her self-reported physical health status didn't change.

Model 3 added social network patterns at home to the previous model 2. Whether mothers were included in the closest friends list was statistically significant factor. Especially this effect was contingent on mothers' education level. When a mother had education level of junior high school or lower, being cited as one of the close friends had negative effect: student's health would be about 4.6% worse than students whose mom was not cited. However, when the mother was college educated and cited as one of the close friends, the student's health would be about 5.7% (=0.0462-0.103) better than when the mother was not cited. Mother's education revealed a similar pattern. When mother's education level is college or higher, the student's health was about 5.8% worse than when mother was educated junior high school or lower. But if the mother was listed as one of close friends and when mother's education level is college or higher, the student's health was about 4.5% better (=0.0583-0.103) than when mother was educated junior high school or lower. The future research need to investigate these hard-to-interpret effects more closely.

Model 4 contains friendship networks in addition to all variables in the previous model. Both the size of close friendship network and meeting frequency with them had statistically significant effects. The size of close friends had negative effect on physical health until meeting frequency was less than 11 (=0.00101/0.000093) times per month. If average meeting frequency was higher than 11 per month, the more close friends students had, the better their health was. About 12% of the respondents met their close friends less than 11 times a month and about 76% of the respondents met their close friends about 30 times a month. In a nutshell, if students had many friends with weak ties whom they met less than 11 times a month, their health status deteriorated while if they met frequently with strong ties, more close friends meant better health. With contrast to this trend, meeting frequency with close friends always improves health.

CONCLUSION AND DISCUSSION

The result of modified random model we employed implied the existence of direct effects of networks on physical health of adolescents' health in Korea. Even after controlling for self-reported psychological problem and unobserved heterogeneity, we could verify social network effects in every social dimension: school, family, and friends. In general,

richer social networks were related with better health. Getting along with friends at school predicted better physical health. Based on two year data, however, we could confirm only 'between' effects of getting along with friends: 'within' effect was not statistically significant. This differentiation could not have been detected if we employed typical random model. Non-existence of 'within' effect could be due to the lack of short interval of the panel (one year): even if a student was getting along with friends to the greater extent, one year might be too short to produce better results in health. Furthermore, students normally change their classes every year and make new friends and thus, it might be hard to observe noticeable 'within' effect of getting along with friends at school. Also in the dimension of family setting, the best health result could be expected when a mother's education is college or higher and that mother was cited as one of close friends by a student. We needed both features to expect better health: highly educated mother and the inclusion of mother as one of close friends. Lastly, more frequent meeting with close friends always increased self-reported physical health status while the effect of sheer number of close friends was contingent on the meeting frequency. Only when average meeting frequency was more than 11 times a month we could expect the positive effects from many friends. In general, we could expect a positive effect of cohesive support from very close friends whom students meet at least 11 times a month while merely large size of friendship circle could not guarantee better health. This implied that means many weak-tie friends or simple popularity among students could not improve health status while cohesive support from very close friends always develops the health status.

Based on the limitations of the current study, future studies could develop better research scheme. First, although we tried to control for unobserved heterogeneity, based on only two-year panel data, we believe, there would be much room to improve control for unobserved heterogeneity and also causal directions as we collect the data more years in the future. Second, since KYPS was not designed especially for social networks, it was not enough to examine detailed mechanisms of social networks. For example, density among friends, one of the core features of social networks, was missed and could not be used. If KYPS or other data can incorporate more detailed network items in the survey, we could test more hypotheses on network effects. Third, if a research was allowed to focus on especially network effects on health,

we could implement a design to enable us to test more detailed biomedical pathways such as health behaviors and immune system to probe the mechanisms of network effects.

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