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How do peers influence BMI? Evidence from randomly assigned classrooms in South Korea

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ABSTRACT

Obesity among children is an important public health concern, and social networks may play a role in students' habits that increase the likelihood of being overweight. We examine data from South Korean middle schools, where students are randomly assigned to classrooms, and exploit the variation in peer body mass index. We use the number of peers' siblings as an instrument to account for endogeneity concerns and measurement error. Heavier peers increase the likelihood that a student is heavier; there is no spurious correlation for height, which is unlikely to have peer contagion. Public policy that targets obesity can have spillovers through social networks.

1. Introduction

The proportion of overweight children in OECD countries has risen steadily over the past several decades (OECD, 2015), and estimates of the medical costs of youth obesity are substantial (Biener et al., 2017). Social factors rather than individual characteristics may play a large role, especially for adolescents. However, empirical research on the impacts of peer effects and social contagion on obesity is difficult because of well-known issues such as self-selection, common environmental factors (frequently called contextual effects), and the "reflection problem," in which the direction of influence is unclear (Manski, 1993; Epple and Romano, 2011). Christakis and Fowler (2007) use measured height and weight data in Framingham Heart Study, spanning 32 years, to show that an individual's own chance of becoming obese increases by 57 percent if his or her friend is obese. By examining the correlation of obesity within clusters of social ties, they argue their effect is not due to common factors. However, there is some controversy about the validity of their identification strategy, with others claiming that these correlations are spurious (Cohen-Cole and Fletcher, 2008b). Replicating Christakis and Fowler (2007) with a large sample of adolescents, Cohen-Cole and Fletcher (2008b) show that peer effects on obesity are reduced substantially once controls for contextual effects are included. In further work, they show that similar peer effects can be found in acne, headaches, and height using the same empirical approach, but that these effects also disappear when using a more comprehensive estimation approach (Cohen-Cole and Fletcher, 2008a); Fowler and Christakis (2008) dispute a number of these claims.

Since this work, there have been two general strategies to address these empirical challenges. The instrumental variables approach uses pre-determined peer characteristics or the characteristics of peers' relatives or other friends to provide identification (Trogdon et al., 2008; Mora and Gil, 2013; Cawley et al., 2017). However, these instruments may still be correlated with unobserved peer attributes that cause social network formation. Another approach is to use institutional settings in which peers are randomly assigned. For example, more-fit peers improve fitness outcomes among cadets who are randomly assigned to squadrons at the United States Air Force Academy (Carrell et al., 2011). Similarly, there is peer influence in weight gain among female college students randomly assigned to dormitory rooms (Yakusheva et al., 2014).

In this paper, we avoid the nonrandom sorting problem by using a unique practice of Korean middle schools: the random assignment of students into a physical homeroom classroom in which they stay with the same classmates throughout the day for an entire school year. Because of the amount of time spent with these peers, they form a useful social network to examine. Our data, drawn from a sample of seventh graders, come with two shortcomings, however. First, they are cross-sectional, meaning that we cannot use lagged observations to better ascertain the direction of influence – that is, the reflection problem. Second, student height and weight are self-reported. While self-reports have generally been found to be reliable, it is possible that students with particularly tall or heavy peers systematically misreport their own height and weight, leading to spurious correlation (Strauss, 1999; Kuczmarski et al., 2001; Lee et al., 2011).

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We address these issues by using peers' number of siblings as an instrumental variable for peers' average body mass index (BMI). Numerous studies have found that the number of siblings is correlated with a child's BMI and the likelihood of being obese (Hesketh et al., 2007; Chen and Escarce, 2010; Haugaard et al., 2013; de Oliveira Meller et al., 2015). Mechanisms posited for this correlation include that children with more siblings tend to have higher level of physical activity and lower food intake. Importantly, the number of siblings of the randomly-assigned peers in Korean classrooms cannot directly affect a student's own health. In the sec:methods Section, we describe this instrument in greater detail and provide evidence for its validity.

Our estimates show that a one unit increase in average peers' BMI increases a student's BMI by 0.83 units. Follow-on data, which unfortunately does not include a sufficient number of peers for a lagged approach as in Christakis and Fowler, does indicate that seventh grade peers still have a substantial impact on the student's BMI in eighth grade. Our results are robust to the inclusion of a number of student, peer, and teacher characteristics. We further show that our results are driven by peer effects in weight, rather than height; effects on the latter would suggest that our results are tainted by non-classical measurement error or unresolved non-random sorting.

While South Korea has rates of overweight that are among the lowest in the OECD, the proportion of men who are overweight has increased rapidly in recent years (OECD, 2010). Among male children, the proportion of boys who are overweight is actually greater than the OECD average (OECD, 2015). Our results are therefore relevant for other developed countries, and the strength of our identification approach provides important evidence on the impact of social networks on health outcomes.

2. Methods

2.1. Data set

We use the Gyeonggi Education Panel Study (GEPS2012), which surveyed 4051 seventh grade students in middle schools in Gyeonggi province (surrounding Seoul, South Korea). Students were sampled with a two-stage cluster sampling design; first, 63 schools were chosen from the population of 624 middle schools in Gyeonggi province. Then, two classrooms were drawn within each school, and all students in the classrooms were surveyed. GEPS also surveyed parents, homeroom teachers, principals, and schools. Each student is linked to their homeroom teacher, who manages the classroom to which the students belong; subject teachers rotate through to present lectures to the same set of students (Lim and Meer, 2017).

Students were asked to report their height and weight, with which we construct BMI. BMI has been criticized as sometimes misclassifying an individual as obese or overweight when he or she is muscular, because it cannot distinguish adipose tissue from muscle, bone, and other lean body mass (Burkhauser and Cawley, 2008). Nevertheless, BMI is a convenient measure, particularly because it rescales to a fairly consistent metric across ages (Bellizzi and Dietz, 1999).

GEPS surveys students in 8th and 9th grade as well, and students once again provide their height and weight. However, since not every classroom in a school is surveyed, data on peers is incomplete in 8th and 9th grades. While we examine the impact of 7*th* grade peers on later BMI outcomes, we do not examine contemporaneous peer effects in those later grades.

Starting with 4051 students, we drop 128 observations that have missing height or weight information. We have a final sample of 3909 students after dropping 14 additional students who do not have classroom information or whose parents report that the sum of male and female children at home is zero. There is no correlation between attrition from the sample and other student or teacher characteristics. Table 1 reports summary statistics for our sample.

Table 1
Summary statistics.

Variable	Mean	(Std. Dev.)	Min	Max	N
A. Student Characteristics					
BMI in 7th Grade	19.4	(3.0)	11.8	34.1	3909
8th Grade	19.9	(3.1)	10.5	39.5	3556
9th Grade	20.2	(3.1)	12.6	35.9	3467
Weight in 7th Grade (kg)	49.7	(9.6)	26	99	3909
8th Grade	53.8	(10.4)	30	120	3561
9th Grade	55.8	(10.7)	32	110	3476
Height in 7th Grade (cm)	159.9	(6.9)	128	184	3909
8th Grade	164.1	(7.3)	136	198	3701
9th Grade	165.7	(7.7)	142	192	3608
Number of Siblings	1.15	(0.73)	0	17	3909
Female Student	0.48	(0.50)	0	1	3909
Dad with BA or more	0.43	(0.50)	0	1	3801
Mom with BA or more	0.30	(0.46)	0	1	3775
Both Parents	0.84	(0.36)	0	1	3908
Own Home	0.63	(0.48)	0	1	3845
Family Income (million KRW)	4.78	(5.01)	0	99.99	3837
B. Peer Characteristics					
Peers' BMI in 7th Grade	19.4	(0.7)	17.1	21.8	3909
8th Grade	19.9	(0.7)	18.2	22.8	3556
9th Grade	20.2	(0.7)	18.6	22.5	3467
Peers' Weight in 7th Grade (kg)	49.7	(2.2)	43.1	57.1	3909
8th Grade	53.8	(2.5)	46.7	64.9	3561
9th Grade	55.8	(2.6)	48.9	63.9	3476
Peers' Height in 7th Grade (cm)	159.9	(1.5)	154.4	165.8	3909
8th Grade	164.0	(1.8)	156.5	170.4	3701
9th Grade	165.6	(2.0)	157.6	173.0	3608
Peers' Number of Siblings	1.14	(0.15)	0.74	1.81	3909
C. Homeroom Teacher Characteristics					
Female Teacher	0.82	(0.39)	0	1	3768
Teacher over 40	0.29	(0.45)	0	1	3768
Teacher Experience below 5 Yrs	0.21	(0.41)	0	1	3768
Teacher's College	0.69	(0.46)	0	1	3732
Post Graduate Teacher	0.39	(0.49)	0	1	3768
Administrative Teacher	0.06	(0.24)	0	1	3632

2.2. Tests of random assignment

2.2.1. Peer assignment

The random assignment of peers is crucial to our identification strategy. Middle school classrooms in Korea use some form of random assignment to classrooms due to both social norms and government policies (Lim and Meer, 2017; Kang, 2007). Students are re-randomized in each year through 9th grade. This is an important feature for examining the impact of peers on later outcomes; if students were somehow sorted into classrooms based on their BMI, the measured impacts of 7th grade peers on 8th and 9th grade BMI might actually reflect this sorting rather than a causal effect.

We also provide empirical evidence to support this point. First, we conduct a series of Pearson's χ^2 tests for the independence of students' assigned classroom and students' characteristics, including gender, number of siblings, father's and mother's education, parents' marital status, as well as whether parents own their own home. Eleven of 378 tests are not available in seventh grade because five schools are single-sex (5 tests) and one school has only one classroom sampled (1×6 tests). Five tests are unavailable for eighth and ninth grades.

Table 2 shows the number of rejections for the null hypothesis of independence in a series of Pearson's χ^2 tests at 1, 5, and 10 percent significance level. For each significance level, the rejection rates are below or near the significance level. Hence, we conclude there is little evidence of nonrandom assignment of students into classroom with respect to student's observable characteristics.

We also test whether the characteristics of classroom peers are correlated with the student's own characteristics. In general, regressing own characteristics on peers' characteristics is not appropriate because of the negative bias that is inherent with random assignment (Guryan et al., 2009). Intuitively, when peers are randomly assigned, the