Peer Effects on Childhood Obesity from a Physical Activity and Dietary Intervention Program

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Abstract

Objectives: The purpose of this research is to estimate peer effects on third grade students' BMI and to investigate the social and physiological explanations for such effects.

Methods: The BMI of students participating in a childhood obesity intervention program is used to assess peer effects on students' BMI within the framework of identification of endogenous social effects. Two-stage instrumental variable models are applied using the data *before* and *after* the intervention program, and further peer effects are compared by gender and two BMI categorization groups: *improvement* versus *non-improvement.*

Results: Strong peer effects are found for the overall sample, and for females and males in general. However, when classifying students into improvement versus non-improvement groups, the peer effect is only found among females who are categorized in the improvement group and males in the non-improvement group. Males are more likely to be influenced by their interactions with peer friends towards the direction of unhealthy behavior; females, on the contrary, are more likely to be influenced by interaction with peer friends towards the direction of healthy behavior.

Conclusions: Peer effects are found for students aged 8-11, with gender differences in the psychological and social behavioral motivations.

Keywords

Peer Effect, Childhood Obesity, Intervention.

INTRODUCTION

Currently, childhood obesity is one of the most challenging health issues in the United States (US). Ogden and Carroll (2014) show that approximately 12.7 million children and adolescents from the age of 2 to 19 years across the US are considered obese. Childhood obesity rates have more than tripled during the last four decades, ranging from approximately 5% in 1971 to 17% in 2010.[1] Nationwide, Texas ranks 10th among all US states regarding obesity rates for children aged 10 to 17.[2]

Although some variations in the definition exist, for this article, peer effects refer to the influence exerted on individual students from peers (e.g. friends) who are also exposed to the same environment, or to individuals of the same age.[3] Recent literature emphasizes peer effects on health-related behavior among different age groups with particular attention to adolescents' unhealthy behavior such as smoking and physical fitness problems.[3-6] Adolescents are of special interest due to their vulnerability at a period where lifestyles and self-consciousness are becoming established.[7]

Peer effects on BMI or prevalence of childhood obesity have been identified in previous studies using national health surveys (e.g. The Framingham Heart Study) or local health datasets (e.g. Arkansas public schools).[5,8,9] These studies indicate that peer effects analyses are dependent on factors such as the definition of the peers, the estimation method, and the correction for potential endogeneity, which are more than just a statistical correlation between individuals and peer groups.[5]

A major research gap exists given the fact that there are few studies investigating peer effects under the context of BMI categorization change over time, which is a result of children's behavioral changes. A primary unanswered research question is how to analyze the peer effect together with children' healthy behavior meanwhile accounting for their natural growth; little is known about the underlying framework of peer effects in terms of social preference and social identity within this context.

A specific challenge in obesity research is to ascertain the peer effect given that all students are exposed to the same school environment, or similar family backgrounds. The effects of experiential learning on healthy food choices, dietary habits and encouragement for physical activities at school might motivate similar behavior among students which in turn influence BMI towards the same direction. In this case, an individual student's BMI change may be the result of behavioral changes of the individual students themselves, influence from behavioral changes of the peer group or a combination of both. Further, similar trends for BMI changes among students likely result from similar family backgrounds, such as low family income levels or a predisposition for low physical activity. Children from low-income families often face difficulties related to limited access to healthy and affordable food,[10,11] high frequent visits to near-to-school fast-food restaurants,[12] and less access to physical exercise facilities in their neighborhoods.[13] These research findings suggest the possibility that similar behavior or physical fitness measures of an individual student may arise from similar family income levels or family backgrounds, or similar unhealthy lifestyles resulting from the neighborhood environment. Additionally, there is also a mutual peer effect of those within the same social

network, which may lead to potential simultaneous bias.[14] Such endogeneity effects have not been appropriately considered in prior obesity research.

This research aims at examining the relationships between peer effects, gender groups and BMI trend categorization groups when students' improved behavior creates a new less or more *obesogenic* environment, utilizing data gathered from *Texas Eat Grow and Go (TGEG),* a school-based childhood intervention that focuses on gardening and physical activity education.

The purpose of this study is not to examine the effect of the intervention program, but to explore the underlying psychological and behavioral interpretation of peer effects based on social group identity theory and social network affiliation for two gender groups.

This article adds to the literature in two important ways. First, a large body of literature investigates peer effects on adolescent obesity using different instrumental variable (IV) to account for endogeneity. For example, peer's birth weight, or their parents' self-reported health related measures are used as a proxy for peer's BMI or weight considering biological and environmental relations.[15] In this analysis, a new IV, number of days that parents walk for at least 10 minutes per week, is employed to account for the endogeneity of peer effects on students' BMI. The validity of this IV is based on research findings in health economics that examine relations between parental physical activities, parental-children health related behavior and children's BMI.[16-18] These findings show that students with physically-active parents have lower BMI percentile values than those with physically-inactive parents.[18] The association between parents' physical exercises and students' BMI serves as the theoretic support for the validity of the IV.

Second, previous studies typically conduct rudimentary analyses across gender and ethnic groups. We analyze the gender impact on peer effects for two BMI trend categorization groups (*improvement vs non-improvement*), and also explore the underlying psychological and behavioral interpretations. The theory of social identity suggests that building up the social identity for any individual involves categorization, identification, and comparison.[19-21] According to it, males and females demonstrate different ways of interaction regarding identification and comparison.[19-21] Evidence shows that male students care about athletic participation more than female students and the close relationship between boys would be reinforced by participation in sports activities;[22-24] meanwhile female students care more about popularity and attractiveness compared to male students.[22,23]

As students' BMI categorization groups change over time, peer effects (i.e. interactions) on BMI might or might not vary. A systematic review evaluates physical attractiveness and its influence on peer interactions among children, and shows that physically attractive children demonstrate more positive general behavior compared to unattractive children based on fitness-related evolutionary theory and socialization theory.[25] Another study on children's peer culture shows that children would spend lots of efforts including time and energy to obtain and maintain access to certain groups with desired characteristics.[26] It is also identified that physically attractive children get preferential treatment.[25] It is natural to assume that children within a desirable BMI category (or body image) would interact more with children with similar characteristics and influence each other in a positive way. The findings of our analysis support that physical activities contribute to maintaining or switching students to normal weight BMI category among third grade school children, and show that the underlying gender differences in

terms of behavior and psychology cause distinct peer effect (i.e. interactions) on BMI values within each BMI categorization group respectively.

METHODS

Target Population

TGEG is an intervention program designed to help reduce childhood obesity for third grade students in Texas public elementary schools. Texas A&M AgriLife Extension Service in collaboration with TAMU School of Public Health, University of Texas School of Public Health, Austin Regional Campus began implementing TGEG in 2012. A total of 16 Title I schools (i.e. approximately over 40% of students are from low income families) in four counties within Texas participated in this program[a], which is the focus of this article. The intervention measures include promoting physical activities among students both at school and at home, dietary and gardening education by means of class curriculum and extracurricular activities such as working in a small garden on campus.

Surveys and Data Collection

Surveys for students and parents were distributed to each school at the beginning of the 2012 fall semester (denoted as $t1$), and at the end of 2013 spring semester (denoted as $t2$)[b]. BMI of students' was measured at the same time when the surveys were collected. Survey questions reflect behavioral changes in physical activities, dietary habits, and gardening activities at school and at home, and student-parent interactions at home from $t1$ to $t2$. Sociodemographic questions are included in the parent's surveys.

[a] The participation of schools is voluntarily and contingent upon the contact between TGEG organizers and schools.
[b] Parent surveys were sent home, completed by parents and returned to schools; student surveys were always administered at the school by the researchers.

Variables of Interest

The dependent variable is students' BMI. Independent variables include students and parents' demographics (i.e. age, gender, education, and marital status), behavioral variables from both the student survey and the parent survey. More specifically, they include students' behavior (i.e. moderate physical activities at school, vegetable consumption, and physical activities at home); parents' behavior (i.e. vegetable provision, and demonstrating how to prepare vegetables snacks); student-parent's interactions (i.e. parents walking with their child at home). Please refer to Table 1 for more details. Other independent variables include teachers' encouragement for eating healthy food at school, food availability at home at the end of month[c], percentage of minorities in the class and percentage of students registered for the free lunch program in the class.

Control Variables: Gender and BMI Trend Categorization Groups. The peer effect analysis is conducted controlling for gender and BMI trend categorization groups. The classification of two BMI trend categorization groups are based on the latest FitnessGram data and third to fifth grade elementary school students' BMI trend. According to the 2011-2012 FitnessGram data released by the Texas Education Agency (TEA), we have grade-level BMI information for both third grade and fourth grade of 11 of the TGEG participating schools (missing information for 5 schools). Among these schools, the *percentage of students whose BMI values are classified as 'at Some Risk'* is higher at fourth grade than third grade for at least one sex or both for all 11 schools. There are 10 schools with higher *percentage of students whose BMI values are*

[c] Original Categories of variables have been modified or combined for sensible economic explanations.

classified as 'at High Risk' at fourth grade compare to third grade for at least one sex or both. Based on this trend, there is a high risk for students' BMI increases or BMI categorization group changes when students move from third grade to fourth grade. Given this fact, we define the *BMI improvement group* as students who remained in the normal weight group for both periods, switched from any other groups to the normal weight group, or switched from the obese group to the overweight group. The *BMI non-improvement group* consists of all other cases.

Econometric Model

Correctly identifying potential endogenous social effects requires specifying the composition of the reference group, and framing relations between the individual and the reference group and other independent variables that may affect the individual and the reference group simultaneously. Following Manski's work in ***Identification of Endogenous Social Effects,***[14] the foundation for interpreting simultaneous/similar trends between the individual and the reference group is generalized as: 1) endogenous/causal effect, referring to the influence from the reference group because of the same intrinsic unobserved characteristics; 2) exogenous /contextual effect, referring to the influence from the reference group because of extrinsic characters of the reference group; and 3) correlated effects, referring to the influence from the reference group because of the same institutional environment.[14,15]

The econometric model employed to analyze peer effects follows Manski's identification theory:[14,27]

$$y_{ist} = \bar{y}_{jst} * \beta + x_{ist} * \eta + Z_{jst} * \gamma + \lambda_t + \mu_{ist} \qquad j \neq i \;\; t=1 \text{ or } 2; \tag{1}$$

y_{ist} is the BMI score of individual i in school s, at time t; $\bar{y}_{jst}$ (endogenous/causal effect) is the BMI of the individual i's peer group, calculated as the average BMI of students in the peer group; "peer group" is defined as other students in the same grade assuming that they are exposed to the same school environment where they can interact through dietary education, classroom activities and physical activities. x_{ist} is a vector of independent variables, which are discussed in the methods section, Z_{jst} (exogenous /contextual effect) includes the peer groups' characteristics, i.e. percentage of minorities and percentage of students registered for the free lunch program. λ_t is a time trend effect, and μ_{ist} is an individual specific error term. Similarly, the IV "number of days that parents walk at least 10 minutes per week" is calculated as the average total number of days that parents walked for at least 10 minutes per week within the peer group.

RESULTS

BMI Changes over Time

The final sample included 734 student surveys at $t1$, 712 student surveys at $t2$; 560 pre-intervention parent surveys at $t1$ and 405 parent surveys at $t2$. Students in the sample had an average age of 8 years and 53.68% of participants (n=734) were female. Nearly half (49.82%) of participating students were Hispanic. White, Black and Asian students accounted for 25.18%, 26.61% and 3.39% respectively. The final sample (n=573) used for analysis excluded observations with missing BMI data either in the timeframe $t1$ or $t2$.

Approximately 87.06% (n=680) of parents who responded to the survey were females with an average age of 36 years. For the education level, 55.13% of the parents (n=673) had a high

school degree or lower and the rest 44.87% had a college degree or higher. Approximately 55.67% of parents (n=679) had a full time job.

The number of students in the overweight, obese and underweight groups decreased from $t1$ to $t2$, while the number of students in the normal weight group increased modestly from 283 to 294. Figure 1 shows the details. Two sample *t*-tests with equal variance in Table 2 panel A show average BMI for all participating students' increased by 0.488 points from $t1$ or $t2$, and average BMI for female students' increased by 0.567 points from $t1$ or $t2$. The BMI for male students remained the same. Behavioral variables changes are shown in Table 2 panel B. Among these self-reported measures, students significantly improved regarding daily moderate physical activities, outdoor physical exercises at home per week; parents improved in terms of demonstrating to their child how to prepare vegetables snacks.

General Peer Effects on the Overall Sample

The validity of the IV was tested by a standard identification test. Both the F-test of excluded instruments ($p<0.001$) after the first stage estimation and Cragg-Donald Wald F-test (F=77.396) for weak identification justified that the IV employed in this analysis was valid through the strong correlation with the endogenous variables and explaining the variation in individual BMI by its correlation with peer's BMI.

Results based on the full sample, male students, female students, non-improvement and improvement group students are shown in Table 3. In general, evidence indicated significant peer effects among all participating students, shown in column 1 of Table 3. A one-point BMI increase in the peer group was associated with 1.015 points increase in the individual's BMI.

Parents' education was significant in the model, which indicated individual's BMI would be 0.871 points lower if the parent had a college degree or higher compared to other students whose parent did not have a college degree.

In terms of the behavioral variables, doing physical activities at home (β=-1.292), eating vegetables (β=0.716), and parents' demonstrating how to prepare vegetable snacks (β=1.039) showed significant association with students' BMI. Among these significant factors, doing physical activities was found to be associated with students' BMI decrease. In contrast, behavior related with vegetables was associated with students' BMI increase.

Peer Effects by Gender and BMI Categorization Groups

Peer effects were found both among males (β=1.017) and females (β=0.995) and the results are shown in the second and third columns of Table 3[d]. For male students, parents' education (i.e. whether they have a college degree or not) was associated with a student's BMI decrease (β=-1.374). Regarding the behavioral variables, those that had a significant effect on students' BMI among male students had no effect among female students and vice versa. For example, compared to doing none or little physical activities at home, doing two or three times physical activities at home was associated with 1.666 points decrease in female students' BMI, but it had no effect on male students' BMI; doing more than three times physical activities at home was associated with 1.532 points decrease in male students' BMI, but it had no effect on female students' BMI.

d A pooling test using likelihood ratio of models for the final sample by gender separately shows that LR statistic equals 38.07 and hence the model can be separated by gender at the significance level of 0.01.

We separated the sample into two groups: BMI improvement group and BMI non-improvement group. The final sample included 258 students in the non-improvement group and 315 students in the improvement group. Results are shown in the fourth and fifth columns of Table 3 for each group. Peer effects were identified both in the improvement group (β=1.109) and in the non-improvement group (β=0.976). The results show that for students who remained or switched to the improvement group, the individual's BMI increased 1.109 points when their peers' BMI increased one point, meanwhile for students who were in the non-improvement group, the individual's BMI increased 0.976 points. The higher peer effect in the improvement group indicated stronger favorable interactions between individuals and their peers within this group.

We further investigated peer effects across the two BMI trend categorization groups by gender, which are shown in Table 4. The results revealed heterogeneous peer effects across gender and BMI trend categorization groups. Interestingly, significant peer effects were found among males in the non-improvement group (β=1.176) and females in the improvement group (β=1.472). These results indicate that for male students, the BMI values of those who were not making any improvements in BMI categorization from $t1$ to $t2$ were strongly affected by interactions with their peers, i.e. the BMI value of an individual male in the non-improvement group increased 1.176 points when his peers' BMI increased one point. On the other hand, for female students, the BMI values of those who were making improvements in BMI categorization from $t1$ to $t2$ were strongly affected by interactions with their peers, i.e. the BMI of an individual female in the improvement group increased 1.472 points when her peers' BMI

increased one point. No significant peer effects were found either in the improvement group for male students or the non-improvement group for female students.

DISCUSSION

Our analysis focuses on the general peer effects and their differences by gender and BMI trend categorization groups. Evidence shows that intervention program results are different depending on the length of time duration: intervention results over shorter periods are typically more significant than longer periods.[28] However, students' BMI collection for TGEG program is at an interval of about six months and the rate of change in BMI from the previous six months prior to enrolling in TGEG is unknown. In addition, children at the age of 9 to 11 years would be influenced by the maturation effects and the natural growth accompanied by increasing BMI values for this age range as shown by the CDC 2000 Children's Growth Chart.[29] It is possible that the rate of change in BMI was steeper prior to the study and participation in TGEG slowed this increase.

Peer Effects in Terms of Behavioral Explanations

Our results reemphasize the effectiveness of doing physical activities on students' BMI values and examine the distinctions between the effectiveness of different physical activities intensities among male and female students. More specifically, higher physical activity intensities (over three times compared to none or little activity per week) are associated with a decrease in male students' BMI. Median physical activity intensities (two to three times compared to none or little activity per week) are associated with a decrease in female students' BMI. Previous studies find that during the age of 9-13, male students spend more time on

moderate and vigorous physical activities on a daily basis compared to females students.[30] Furthermore, the calories consumed by male students doing moderate and vigorous activities are higher than female students.[31] In this regard, physical activities prove to lower students' BMI and keep or move students into a normal BMI categorization, which serves as group identification in this analysis.

Children's eating behavior is more controlled or influenced by parents in terms of generic and environmental factors.[32] Regarding generic factors, food preference of children is generally influenced from tastes and preference of their parents; regarding environmental factors, family's income level, parents' life styles, and attitudes towards body image all might influence children's eating behavior.[32] Hence, compared to physical exercises, eating behavior is not likely to arouse the peer influence to the extent of physical exercises since parents have more control or influence on the food preference and eating behavior. Moreover, considering the high percentage of the free lunch participation in the sample, there is not much power among students to determine what to eat although they do learn about healthy eating and nutrition knowledge in the class through the intervention program.

Justification of Gender Difference in Peer Effects in Terms of Psychological Explanations for Social Group Categorization

The results of the peer effects across BMI trend categorization groups show that gender differences on peer effects are closely related to the BMI trend categorization status. Relatively speaking, males are more likely to be influenced by their interactions with peer friends towards the direction of unhealthy BMI categorization; females, on the contrary, are more likely to be

influenced by interaction with peer friends towards the direction of healthy BMI categorization. Female students in the improvement group benefit by access to the group and maintaining membership within the group by their own efforts.

Body weight, as an indicator of body image, and activities participation, reflects how students evaluate themselves and determines who they would like to interact with. The above analysis suggests that the social network with the underlying categorization and separation (i.e. maintaining a presence in the improvement group or not) proves to be associated with the different level of peer effects. The BMI categorization determines the scope of the social network, and also influences the intensity of interactions among members in the network.

Gender differences are normally reviewed under a different relationship process, which includes behavioral and social-cognitive styles, stress and coping, and relationship provisions.[33] For example, "The Male Warrior Hypothesis" examining inter-group and out-of-group relations among males proposes strong preference for inter-group social hierarchy.[34] This inter-group identification shows close dependency on factors such as social attitudes across different cultural backgrounds. In contrast, males are more likely to exhibit competition and violence towards out-of-group members to ease the potential psychological discomfort in case of intergroup conflict.[34] To explain the peer effect among males in the non-improvement group, it is very likely that they build their own network probably holding the same or similar beliefs about exercising habits and body image. What is more, improvements in terms of doing more exercise gradually on a daily basis from members of outside of the group may be seen as a threat with a risk of being ignored by male students.

Generally, females are found to be more prone to arouse jealousy by their peer's physical attractiveness.[35] Moreover, females associate body dissatisfaction with self-esteem but males do not.[36] In contrast to males, females in the improvement group perceive body weight, which is closely related to body image, as a barrier for a higher level social network. Psychological experiments show that when females see identification for belonging to a specific group which could improve their self-esteem, they would adopt behavior to identify, obtain and keep group membership.[20,37] This explains why females in the improvement group might develop their social network and how they are influenced by other members in this group.

The analysis of gender differences in peer effects is grounded in the difference among two BMI trend categorization groups. The improvement and non-improvement status regarding BMI serves as a threshold for the group identity, which helps explain the underlying social group categorization and according behavior in specific groups by gender. However, group identity could be based on other categorization methods and not limited to this specific way.

Future research question could focus on longer time periods to investigate how peer effects on health related outcomes change as children grow into adolescents and adolescents grow into adults. Full understanding of peer effects in a dynamic context and associated gender differences help researchers to better design certain health related interventions and more targeted school health education.

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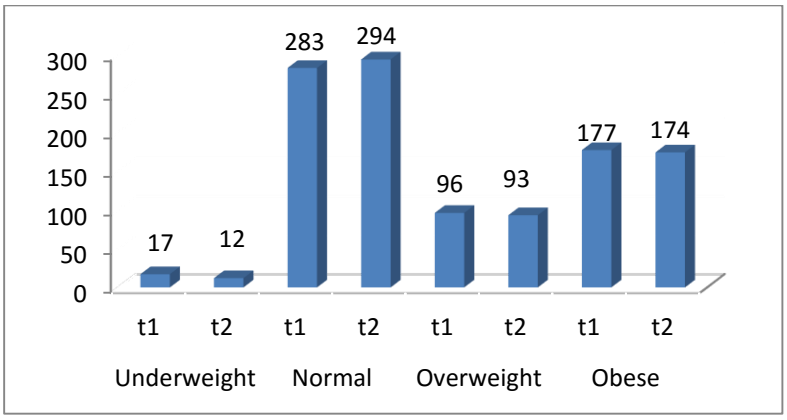
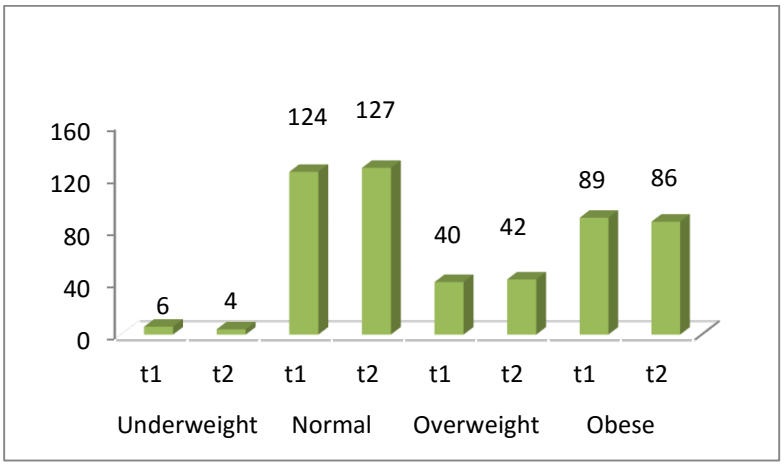
Figure 1 BMI Categorization Change over Time

Panel A BMI Categorization Change for Overall



Panel B BMI Categorization Change for Males



Panel C BMI Categorization Change for Females

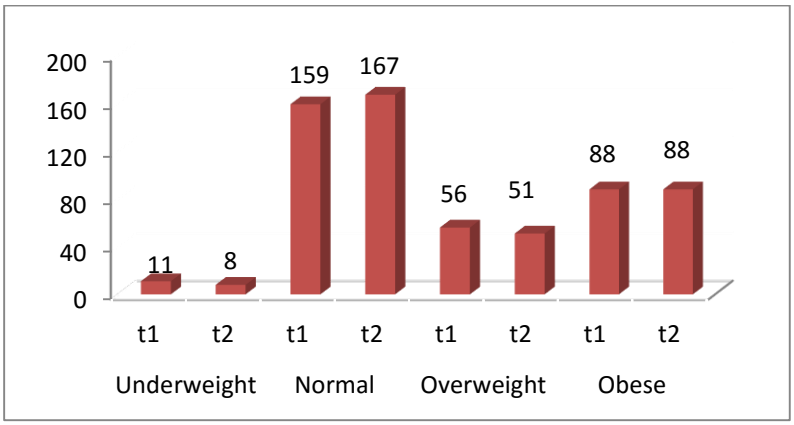


Table 1 Explanatory Variables

Variable	Label	Level	Interpretation
Students Behavior			
Moderate physical activities (30 min) yesterday	Almost every day, I do moderate physical activities.	0	No
		1	Yes
Vegetables consumption yesterday	Yesterday, did you eat vegetables like potato?	0	No, I did not eat yesterday
		1	Yes, I ate yesterday
Physical activities at home per week	In the last week, how many times after school did the child was active? For example, do sports, dance, or play outdoor games.	0	None or just once
		1	2-3 time
		2	4-5 times
		3	6 times or more
Parents Behavior			
Vegetables Snacks making demonstration	Did you show your child how to make vegetables snacks last week?	0	No
Vegetables Provision at home	How confident are you that you could regularly serve vegetables at each dinner?	0	Not at all or just a little
		1	Pretty confident or very confident
Student-Parent Interactions			
Days of Parents Child walking exercise last week	During the last week, how many days did you take a walk with your child?		
Other			
Food availability at the end of month	How often do you run out of food before the end of month?	0	Almost always
		1	Sometimes or never
Encouragement from teachers	Does your teacher like for me to be healthy?	0	Not at all
		1	Yes

Table 2

Panel A Mean BMI Changes over Time

Proportion	BMI at $t1$	BMI at $t2$	Difference ($t2-t1$)	Std. Err.	95% Confidence Interval	
Overall (n=573)	19.017	19.505	0.488**	0.257	-0.993	0.017
Male (n=259)	19.252	19.645	0.392	0.394	-1.167	0.382
Female (n=314)	18.823	19.390	0.567**	0.338	-1.231	0.098

* p<0.1, ** p<0.05, *** p<0.01

Panel B Behavioral Variables Changes over Time

Variable	Mean at $t1$	Mean at $t2$	Difference ($t2-t1$)		Std. Err
Students Behavior					
Moderate physical activities (30 min) yesterday	0.846	0.902	0.056	**	0.020
Vegetables consumption yesterday	0.546	0.489	-0.056		0.030
Physical activities at home per week	1.327	1.579	0.252	***	0.072
Parents Behavior					
Vegetables Snacks making demonstration	0.319	0.442	0.123	***	0.037
Vegetables Provision at home	1.707	1.669	-0.038		0.035
Student-Parent Interactions					
Days of Parents Child walking exercise last week	1.957	2.085	0.128		0.144
Other					
Food availability at the end of month	0.150	0.129	-0.021		0.027
Encouragement from teachers	0.954	0.947	-0.007		0.013

* p<0.1, ** p<0.05, *** p<0.01

Table 3 General Peer Effects on the Full Sample, by Gender and BMI Categorization Groups

	Full	Male	Female	Non-Improvement Group	Improvement Group
Peer Effect	1.015***	1.017*	0.995*	0.976*	1.109***
	(0.384)	(0.537)	(0.571)	(0.505)	(0.288)
AGE	0.170	0.207	0.306	0.413	-0.256
	(0.703)	(0.991)	(1.017)	(0.928)	(0.506)
Gender	0.195			0.409	-0.011
	(0.380)			(0.524)	(0.284)
Marital	-0.056	-0.914	0.423	0.362	-0.417
	(0.402)	(0.625)	(0.600)	(0.550)	(0.303)
Education	-0.871**	-1.374***	-0.696	-0.818	-0.005
	(0.384)	(0.529)	(0.533)	(0.576)	(0.267)
Food availability at the end of month	0.846	2.232**	0.028	-0.015	-0.096
	(0.591)	(0.886)	(0.745)	(0.737)	(0.472)
Moderate physical activities (30 min) yesterday	0.551	0.553	0.692	1.686**	0.488
	(0.503)	(0.781)	(0.703)	(0.662)	(0.381)
Vegetables consumption yesterday	0.716*	0.551	0.885*	1.564***	-0.019
	(0.368)	(0.515)	(0.508)	(0.550)	(0.239)
Physical activities at home per week 2 or 3 times	-1.292**	-0.625	-1.666**	0.013	-1.379**
	(0.607)	(0.932)	(0.806)	(0.715)	(0.569)
4 or 5 times	-1.203*	-1.532*	-0.822	-0.539	-1.303**
	(0.653)	(0.924)	(0.891)	(0.804)	(0.611)
6 or more times	-1.584**	-2.031**	-1.037	-0.838	-2.195***
	(0.718)	(1.002)	(1.038)	(0.870)	(0.617)
Vegetables Provision at home	-0.197	-0.420	0.005	-0.298	0.360
	(0.410)	(0.561)	(0.567)	(0.596)	(0.306)
Vegetables Snacks making demonstration	1.039**	0.696	1.344**	1.484**	-0.239
	(0.410)	(0.674)	(0.539)	(0.612)	(0.299)
Days of Parents Child walking exercise last week	0.007	0.188	-0.124	0.129	0.110
	(0.106)	(0.163)	(0.138)	(0.155)	(0.084)
Encouragement from teachers	-1.912	-2.099	-2.140	-2.178	0.079
	(1.363)	(1.636)	(2.450)	(1.426)	(0.896)
% of Minority	-1.239	-2.026	-1.299	-3.186	-1.047
	(1.519)	(2.614)	(1.921)	(2.208)	(1.048)
% of Free lunch	1.726	3.352	0.152	2.366	-2.571*
	(2.021)	(2.862)	(2.971)	(3.145)	(1.432)
Time effect	0.175	-0.266	0.263	0.150	-0.417
	(0.454)	(0.643)	(0.648)	(0.563)	(0.351)
Observations	529	222	307	233	296
Adj.R-squared	0.952	0.958	0.948	0.970	0.981
F-statistics	641.079	369.802	354.078	449.974	1193.736
Under Identification Test (Kleibergen-Paap LM Statistic)	41.599	17.887	21.634	18.214	22.379
Weak identification Test (Cragg-Donald Wald F statistic)	77.396	33.310	35.587	36.011	36.917

* p<0.1, ** p<0.05, *** p<0.01

Table 4 Gender Differences of Peer Effects across BMI Categorization Groups

	Non-Improvement Group & Male	Improvement Group & Male	Non-Improvement Group & Female	Improvement Group & Female
Peer Effect	1.176**	0.213	0.420	1.472***
	(0.484)	(0.659)	(1.895)	(0.343)
AGE	0.259	1.299	1.441	-0.918
	(0.980)	(1.172)	(3.085)	(0.631)
Marital	-0.674	-0.673	1.280	-0.592
	(0.787)	(0.620)	(1.611)	(0.363)
Education	-1.244*	-0.377	-0.666	0.258
	(0.718)	(0.458)	(0.813)	(0.349)
Food availability at the end of month	1.116	0.297	-0.548	0.199
	(1.060)	(0.931)	(1.114)	(0.568)
Moderate physical activities (30 min) yesterday	1.237	0.637	1.784*	0.941**
	(0.856)	(0.836)	(1.004)	(0.469)
Vegetables consumption yesterday	1.173	0.568	1.581*	-0.336
	(0.754)	(0.392)	(0.876)	(0.316)
Physical activities at home per week	-0.550	-1.568	-0.189	-1.617**
2 or 3 times				
	(0.967)	(1.216)	(1.221)	(0.675)
4 or 5 times	-1.322	-1.787	-0.343	-1.421*
	(0.995)	(1.176)	(1.097)	(0.812)
6 or more times	-1.823*	-2.458**	0.144	-2.360***
	(1.043)	(1.052)	(1.297)	(0.805)
Vegetables Provision at home	-0.121	0.516	0.122	0.247
	(0.668)	(0.475)	(1.058)	(0.364)
Vegetables Snacks making demonstration	0.910	-0.789	1.669*	0.070
	(0.847)	(0.652)	(0.945)	(0.341)
Days of Parents Child walking exercise last week	0.120	0.241	0.078	0.019
	(0.198)	(0.176)	(0.213)	(0.083)
Encouragement from teachers	-1.319	2.836	-2.205	-0.458
	(1.373)	(2.520)	(6.953)	(1.125)
% of Minority	-5.178*	-0.264	-1.861	-0.777
	(3.033)	(2.933)	(3.028)	(1.144)
% of Free Lunch	2.550	-0.454	3.509	-4.755**
	(3.610)	(2.216)	(7.879)	(1.878)
Time effect	-1.155	-1.011	0.351	-0.124
	(0.771)	(0.784)	(0.999)	(0.457)
Observations	97	125	136	171
Adj.R-squared	0.975	0.976	0.965	0.983
F-statistics	305.993	641.769	275.129	672.449
Under Identification Test (Kleibergen-Paap LM Statistic)	15.802	5.072	4.342	17.429
Weak identification Test (Cragg-Donald Wald F statistic)	30.488	8.623	3.478	26.964

* p<0.1, ** p<0.05, *** p<0.01