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Adolescent Affiliations and Adiposity: A Social Network Analysis of Friendships and Obesity

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Abstract

Friendship choices and BMI were measured for 617 adolescents (12-14 years). Overweight youth were twice as likely to have overweight friends. There was a weak association between social position and weight status, overweight youth nominated more friends but were nominated as friends less frequently than their normal weight peers.

A recent large-scale study of adults indicated that obesity seemed to spread among family and friends like an infectious disease [1]. There are several reasons to believe obesity may spread through adolescent friendship networks similar to the processes described for adults [2]. First, during adolescence young people attempt to disassociate from their parents and identify with their peers. Second, studies in several public health areas have demonstrated an association between individual and friendship behavior. Third, adolescent peer groups are formed around shared behaviors (sports, computer games, video games, eating, etc.) that directly or indirectly affect weight status. Conversely, adolescent peer influences may be less salient to weight status because parents control some of their children's diet and can also restrict or support physical activity opportunities. This study was designed to determine if overweight adolescents are more likely to have overweight peers.

Methods

In-school surveys were conducted with 11-13 year old adolescents in four schools (17 classes) in the greater Los Angeles area. Participation was solicited from 685 adolescents with interviews conducted with 617 (90.1% response rate) boys (36%) and girls (64%) most of whom were in the 7^{th} grade with 562 having complete data needed for analysis (Table 1). Height and weight were measured by trained research staff. Body weight was measured with a Tanita TBF 300/A analyzer. Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared and the percentiles [3] converted to a dummy variable indicating whether each participant was overweight (above the 95^{th} percentile).

Results

Table 2 reports two random-effects logistic regression models with individuals nested within classes. The model tests the respondent's likelihood of being overweight as a function of demographic characteristics, behavior and attitude self-reports, network properties, and friends' weight status. Results show that being overweight was associated with being male, younger, poor academic performance, less positive meanings for physical activity, positive family social support, and friends' average BMI. For girls, being overweight was associated with poor academic performance, negative meanings for physical activity, naming more friends in the class, and friends' average BMI. Overweight girls were less likely to be named as a friend though the result did not reach statistical significance (in the bivariate analysis overweight girls received 0.67 fewer friendship nominations, $p<0.05$ than normal weight ones).

These two regression models are imperfect estimators of peer influence because they cannot completely account for interdependencies that arise from being connected to the same others directly or indirectly. The Exponential Random Graph Model (ERGM) using a Markov Chain Monte Carlo (MCMC) approach was used to test whether friendship links are associated with similarity on weight status. In the ERGM, the conditional log odds of the probability that a friendship tie is present relative to its absence is modeled as a function of the network change statistics of certain structural properties. The network change statistics are changes in the count of network configuration types when the tie from node i to node j changes from being present to absent. This study employed the latest specification for ERGM which generalize Markov random graph models [4]. A common model was applied to all 15 classes and parameter estimates and their standard errors aggregated as in a meta-analysis to determine if the effects generalize across classes [5].

After controlling for structural effects, weight status similarity had a strong and statistically significant effect ($T^2 = 53.73$, df = 15, $p < .001$) with a mean effect size of 0.22 ($p < .001$) indicating friendships were more likely to exist between students of the same rather than different weight statuses. The estimated between-classroom standard deviation of this effect size was 0.06 (p=NS). For naming friends, there was a significant main effect of weight status ($T^2 = 27.93$, df = 15, $p < .05$) with a mean effect size of .13 ($p < .05$), indicating that overweight adolescents named more friends than non-overweight ones. The estimated between-class standard deviation of this effect size was 0.13 ($p < .05$) indicating the estimated effect size was different between classes. In sum, the ERGM analyses also indicate that overweight students were more likely to be friends with each other, and overweight students named more friends than their normal weight peers.

Discussion

This study showed that overweight adolescents were more likely to have overweight friends than their normal weight peers. The logistic regression model estimated an approximate twofold increase in friends' average BMI percentile for overweight girls versus non-overweight girls. The magnitude of this network effect is similar to that found for adolescent smoking [7] and perhaps other risk behaviors. These results have two important implications: the social contagion of obesity may start at a young age and social affiliations by obesity status may have far-ranging consequences for adolescent development.

The data also suggest that overweight girls named more friends and were slightly less likely to be named as a friend than normal weight girls. The social marginalization this suggests is worrisome [6]. Overweight girls may feel marginal which may lead to poor mental health states which may lead to other deleterious behaviors.

The study raises several questions, however, including whether these network affiliations persist over time and at what age they begin to manifest themselves. The limited nature of these data cannot address these issues. It should be stressed that the data are observational and cross-sectional and so no inferences regarding causal direction of hypotheses can be advanced. It is possible that overweight adolescents are connected to the same normal weight third party in their neighborhood or that overweight adolescents may select overweight friends.

These findings suggest important social processes that underlie the obesity epidemic affecting the US. Obesity status may determine adolescent social networks and its consequences for social marginalization and long-term adverse health outcomes compel us to address this issue through more systematic observation and intervention.

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Table 1

Sample Characteristics.

	N=562
BMI Scores	
CDC BMI Percentile Average	60.98 (32.0)
CDC BMI Categories	
Under Weight	6.23%
Normal Weight	60.32 %
At Risk for Overweight	17.44 %
Overweight	16.01 %
Socio-Demographic Characteristics	
Female	64.3 %
Age	12.7 (SD=1.0)
Grade	7.05
Academic Grades (1=Mostly F's; 5=Mostly A's)	4.18 (SD=0.82)
Ethnicity	
Asian	36.14 %
Hispanic/Latino	29.66 %
White	12.16 %
Mixed	12.16 %
Other	6.0 %
African American	3.19 %
Behaviors& Attitudes	
Positive Meanings	2.54 (SD=0.56)
Negative Meanings	1.86 (SD=0.48)
Friend Social Support	2.41 (SD=0.80)
Family Social Support	2.33 (SD=0.86)
Network Characteristics	
Number Sent	4.35 (SD=0.99)
Number Received	4.05 (SD=2.00)

Table 2

Multi-Level Logistic Regression on the Likelihood of being Overweight by Socio-demographic Characteristics, Network Variables, and Friends' Weight Status.(Coefficients are -odds ratios with 95% confidence intervals below).

Model	Logistic	Girls Only
N	562 17 Clusters	372
Female	0.53** (0.31, 0.93)	
Age	0.70* (0.50, 0.99)	0.77 (0.52, 1.14)
Grade	1.00 (0.60, 1.71)	0.97 (0.49, 1.92)
Good Academic Performance	0.51** (0.36, 0.70)	0.44** (0.28, 0.71)
Ethnicity (Asian & Other Ref.)		
Hispanic/Latino	1.24 (0.63, 2.42)	1.36 (0.51, 3.65)
White	1.38 (0.59, 3.26)	1.28 0.38, 4.32)
African American	1.08 (0.30, 3.98)	1.90 (0.35, 10.24)
Mixed	1.03 (0.44, 2.39)	1.31 (0.39, 4.44)
Positive Meanings	0.53* (0.31, 0.89)	0.59 (0.28, 1.28)
Negative Meanings	1.54 (0.93, 2.54)	2.22* (1.11, 4.43)
Friend Social Support	0.76 (0.51, 1.14)	0.79 (0.45, 1.39)
Family Social Support	1.80** (1.23, 2.64)	1.50 (0.85, 2.66)
Number Friends Named	1.16 (0.89, 1.52)	1.57* (1.01, 2.46)
Frequency Named as Friend	0.97 (0.85, 1.10)	0.89 (0.75, 1.07)
Friends' Average BMI	1.83* (1.04, 3.20)	2.51* (1.07, 5.90)

* p<.05

** p<.01