Do Social Networks Improve the Effectiveness of Incentive-Based Health Programs?

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Abstract- overview

Although studies have shown that financial incentives are effective in promoting healthy behaviors, existing interventions have focused on adults in the workforce (e.g. Kullgren et al. 2013). Given that the school environment can be an effective instrument for behavior change, there is a need to examine incentive-based health programs in late-adolescent age groups. Large-scale observational studies with about 9,000 freshmen at California Polytechnic State University (Cal Poly) show that every year of college was associated with a 3% BMI increase, especially among minority populations. Reversing or slowing this dynamic has proven difficult because students entering university are newly independent, not experienced in making their own life-decisions, and encounter many distractions (Nazmi et. al. 2012). On the other hand, university students are uniquely social and social networks have been shown to be effective in leading to behavioral change. Indeed, emerging evidence on peer networks suggests that health behaviors and outcomes are shared, transferred, and influenced through social ties (Christakis and Fowler, 2007; Cohen-Cohen-Cole and Fletcher, 2008). However, few interventions have been designed to capitalize on the behavioral pathways of social networks. **The primary purpose of our intervention study is** to determine whether financial incentives, mediated by social network effects, are effective in achieving improved diet quality outcomes as measured by the Healthy Eating Index-2010 (HEI). We will conduct a 3.5-month parallel-design, randomized controlled trial with a racially and ethnically diverse sample of participants who consume food in campus cafeterias. Our findings will provide a unique contribution by testing the efficiency of interventions in structural transmission networks. Given the ubiquitous and increasing existence of social networks, our applications are readily transferrable at relatively low cost to other large-scale student populations in elementary, middle, and high schools.

Background

College freshmen are at particular risk for unhealthy weight-related behaviors and outcome. The transition to college amplifies the rapid growth and development of health-related behaviors during this stage of life. College students typically have very poor diets and low levels of PA, which may result in an increased risk of overweight/obesity and other health-related problems into adulthood. In addition to learning to make decisions about food procurement and food preparation with only limited skill sets, students have to juggle the exposure to extraordinary amounts of food such as all-you-can-eat-dining halls, while reporting little time and energy for PA. Although public health nutrition research has recently emphasized childhood prevention and chronic disease prevention in adults, no major investments have been made to prevent obesity at the critical juncture of young adulthood. Preliminary internal data suggest that the average BMI of Cal Poly upperclassmen are 12% higher than the average BMI of Cal Poly freshmen (Nazmi et al., 2012.). These data demonstrate the importance of developing programs to prevent this unhealthy excess weight gain and establish life-long positive behaviors among college freshmen. Finding a workable public policy solution with feasible and successful interventions that improve the health outcomes of young adults has become an economic imperative.

There is a need for intervention studies at the college level because most health-related studies at the college level are purely observational. The majority of current interventions include some form of educational activity, or "advertising" the benefits of a proper diet (Sharma 2006; Peterson and Fox 2007). Young adults, particularly older ones would rather be active participants in forming ideas about what constitutes a healthy and an unhealthy diet. Health-related

interventions should be aimed at the young adult age group, given a generally higher compliance of freshmen compare to older students (Neumark-Sztainer and Story 1997).

Economic choices play a key role in affecting individual health behaviors. An influential strand of the public health literature explains the general growth in obesity as resulting from choices made by consumers as rational economic decision makers (Finkelstein, Ruhm and Kosa 2005; Lakdawalla and Philipson 2009). In this microeconomic framework, consumers choose from among healthy and unhealthy foods and a level of PA in order to achieve some notion of an ideal weight at minimum time, effort and cost. While these models tend to predict aggregate trends well (Cutler, Glaeser and Shapiro 2003) and provide powerful tools for policy modeling (Schroeter, Lusk and Tyner 2008), they are incomplete. It is now well understood that behavior at an individual level is shaped by how others behave (Manski 1993; Brock and Durlauf 2001), which suggests that social effects need to be incorporated in the classic economic model of rational choice.

New research suggests that peer networks are hallmarks of young adults. As young adults emerge into adulthood, they increasingly share their thoughts, feelings, and support the expansions of personal beliefs and ideas. Referrals from trusted peer network members are seen as far more credible sources than persuasive ads from organizations that have an obvious vested interest in promoting a product or service (Brown and Reingen 1987). Using influential students to promote the financial incentives is analogous to the "word of mouth advertising" that is increasingly popular for older young adults through websites such as Facebook, Instagram, or other social networking sites. Despite the obvious importance of social networks for older young adults and young adults, there are no published intervention studies that utilize social network effects to change health behaviors among these individuals. The dearth of data in this area limits

the ability to create effective health interventions for young adults. Indeed, we are aware of no intervention study has examined the impact of financial incentives on health behavior changes in peer networks.

Objectives

Our study determines whether and to what extent financial incentives may impact improved dietary outcomes in a peer network of Cal Poly students who actively use the school cafeteria during the academic year. This project will comprise a three-phase design, with two objectives per phase.

Phase I: Recruitment and Dietary Intervention

Objective 1: Randomly recruit 50 participants each of two sorority chapters at Cal Poly and establish the participants' demographic, socioeconomic, food consumption profiles, and spatial structure of each of the sorority group's peer networks based on an adjacency matrix, which numerically measures the strength of the social ties between the recruited participants of one sorority (see also Richards, Allender, and Hamilton 2012). [1]

Objective 2: Implement a 2.5-month parallel-design intervention study with the two groups of recruited participants, by weekly educating each group about how to improve their diet quality based on the recommendations for the 12 different components of the HEI-2010[2] when choosing food in the school cafeterias.

[1]It is important to note that the sample will not contain the entire social network (sorority) of each sample member.
[2] HEI-2010 scores are calculated based on a 100 point scale based on 12 major food components. Scores are assigned based on a density approach—that is the standards for maximum scores are given as the amount of the food or nutrient per 1,000 calories. Higher HEI scores indicate closer adherence to current dietary guidelines for individual food and nutrient groups (USDA, 2013).

Phase II: Follow-up and Analysis

Objective 3: Implement a one-month follow-up data collection without any dietary education, to assess the post-study dietary quality of participants' food choices, measure the post-study social networking and dietary information.

Objective 4: Clean and analyze demographic, socioeconomic, dietary, and social network data.

Phase III: Estimation and Dissemination

Objective 5: Estimate the effect of a group financial incentive offered to one sorority group, mediated by the social network effects, on participants' change in dietary quality, as measured by the change in HEI-2010 compared to the baseline assessment.

Objective 6: Describe and disseminate findings in manuscripts and prepare them for publication and presentation at professional research and industry meetings.

Hypotheses

1. Financial incentives provided to participants in one group, relative to the control sorority who does not receive any financial incentives, will demonstrate improved diet quality compared to the average pre-study baseline HEI-2010.
2. Social network effects grow stronger and result in a higher efficiency of the financial incentive over the course of the 2.5 months- data collection.
3. Compared to the control group, the sorority who may obtain the group incentive will show improved dietary behavior and knowledge during the one-month follow-up after the intervention.

Research Design and Methodology

Data collection

We employ a **parallel-design, randomized controlled trial** with 100 sorority members of two Cal Poly chapters, which both include an equal proportion of minority populations, such as Hispanics, Asians, or African Americans. Our recruitment survey is based on demographics, socio-economics, and a brief dietary assessment of students' general eating habits. To account for at-risk groups, we will ask respondents about their body weight and height to calculate the BMI. Only students with at least normal weight (BMI ≥25) who consume food at least three times per week in the school cafeteria will be allowed to apply for participation.

We randomly choose one sorority to receive our group financial incentive after completing the full study of 3.5 months and notify the participants about this final reward at the beginning of the study. By default, the other sorority will be our "control group", which will not receive any financial incentive after completing the study.

Given the parallel-design of our intervention, the same healthy eating topic will be discussed with participants of both groups over 10 weeks. During this 2.5-month time frame, a Foods & Nutrition (FSN) student will personally visit each of the weekly sorority chapter meetings to educate the participants and give them targeted feedback on their progress toward improved dietary outcomes. The FSN student will explain how to improve dietary quality based on the relevant choices at the school cafeteria with concrete practical examples.

To keep participants motivated, we will provide individual incentives. All participants may receive positive attendance points with their respective sororities[3] and will be entered intro weekly drawings for small prizes (e.g. Cal Poly t-shirts, gift cards) which will be randomly

[3] Positive attendance points are rewarded for each chapter meeting as well as participating in philanthropic events outside of chapter events. A sorority member with less than 85% positive attendance points may not attend any social function offered by the chapter until the record has been improved to the required level.

drawn at the weekly chapter dietary intervention meeting. Our financial incentive sorority group may also receive a cash reward of $500 in form of a donation towards their respective charity. However, this sorority is only able to receive this financial group incentive, if the average participants' HEI score improves by 5% over the course of the total 3.5-month study (2.5 with dietary intervention, 1 month of follow-up) compared to the average baseline HEI.

We assess the quality of the participants' food dietary behavior, by electronically collecting dietary recalls based on the validated free web-based self-administered 24-hour recall tool ASA24 (U.S. Department of Health & Human Services- National Cancer Institute, 2014). Each week, participants have to complete the ASA24 for one weekday and for one weekend day. The ASA24 provides the variables needed to calculate the HEI-2010 score. In addition, each participant has to prepare a weekly food log summarizing their food choices on campus, stating the types of foods chosen, which campus cafeteria they visited, and whether they shared the meal with other sorority members.

We will collect social network information by measuring the social ties between the 50 participants in each group. Our study focuses on two groups of participants who each belong to the same social network, which shares routines, norms, and influences. We will measure the social ties between 50 participants from each sorority based on an adjacency matrix as piloted in Richards, Allender and Hamilton (2012) (see Figure 1).

Figure 1. Example Network Matrix for Size N=4

		Network Member			
		A	B	C	D
Network Member	A	-	2	3	2
	B	2	-	1	2
	C	3	1	-	0
	D	4	1	0	-

Each cell of the matrix contains the response to the "how well do you know?" question. Each entry shows how the row student feels about his or her relationship to the column student. For example, student B regards herself as a "friend" to student A, but not a "very good friend." This matrix does not have to be symmetric, as each data point represents each member's own assessment of her relationship with the other member. As in any experiment using social network analysis, there is an inherent "curse of dimensionality" that makes simplification of network interactions a necessity. Our experience (Richards, Allender and Hamilton 2012) suggests that social networks could be adequately characterized even with somewhat higher sample sizes without placing undue burden on participants, which is important for future studies.

Data analysis

At the start of the study, we will establish baseline levels of food consumption, HEI scores, and social ties, which will be compared to the post-study levels to calculate the respective changes. With regard to the social network data, after constructing an adjacency matrix based on responses in the sample, we will calculate proximity metrics for all individuals regarding the degree of connectivity or potential influence of each network member (Freeman 1979). Recent

contributions in empirical social network analysis have used variables derived directly from their data to represent some metric of peer behavior in a traditional regression framework (Christakis and Fowler 2007; Cohen-Cole and Fletcher 2008; Hruschka et al. 2011); however, this approach does not take full advantage of the richness available in a complete social network. In this study we propose a new method of analyzing network data using spatial econometric techniques (LeSage 1998; Richards, Allender and Hamilton 2012). Our methodology employs spatial econometric techniques to measure perceived relationship distances between individuals. An explicitly spatial approach, where the dependent variable depends on a weighted average of the dependent variables from all other points in space based on a distance metric, allows us to characterize the strength of the network relationship between individuals. The use of parametric regression methods provides valuable information that would not be available when data is analyzed using more typical graph theoretic software. For example, if the HEI of a network member rises in her proximity to other network members who have relatively high HEI values, after controlling for all other factors, then we may conclude that peer attributes may be a significant contributing factor to her increased diet quality. By using econometric methods developed in the spatial econometrics literature (LeSage 1998), our methods provide a unique means of accounting for the reflection problem described by Manski (1993) and discussed at length by Cohen-Cole and Fletcher (2008). Namely, we will have at our disposal a number of exogenous variables that will serve as effective instruments for the endogenous peer-health behavior variables. Food choices in the school cafeteria and personal attributes are all determined outside the system, and are likely to be correlated with changes in the health behavior. With these instruments in hand, we will estimate our model using generalized method of moments (GMM) following Kelejian and Prucha (1998) in the spatial econometrics literature. Lastly, we

will estimate a simulation model and examine the clustering properties of likely policy interventions.

Implementation and Impact

Our intervention study is one of the first to **conceptualize economic environment as important factor for health behavior changes** in social networks. In this research, we test for the importance of peer effects as a determinant of dietary quality, and use our findings to simulate how to improve food choices at the school cafeteria in a large social network environment. While we collect data in the university setting, our methods are readily transferrable to an elementary, middle, or High school. Because our dietary intervention will be effective for the entire academic quarter, it has the potential to change treatment students' weekly or habitual behavior in ways that a one-time data collection would not.

Our study is consistent with the call for "the next generation of obesity research" and expands the scope of interventions beyond the individual to a peer network approach. There **are three critical advances that our social network analysis** brings to the study of obesity: (1) the ability to describe and test the efficiency of interventions in structural transmission networks, (2) the ability to more accurately predict how policy interventions will be adopted and take effect, and (3) to more accurately measure the ultimate effectiveness and efficiency of public policy measures that act on individuals in the peer network. Given that informal networks among peers provide a mechanism that has the potential to change a consumer's choice (e.g. Cohen-Cole and Fletcher 2008), we will focus on existing peer groups to identify the impact of students' social network behavior on food choices and assess social network metrics. In pilot studies, we find that influence appears to depend on a **combination of proximity to others in the network and**

personal attributes that cause individuals to be looked to for advice, for instance whether the individual choosing a certain type of food has the same body type as the closest friend. This evidence suggests that a peer network may be a valuable device to influence student health choices beyond standard measurements of individuals; a gap in knowledge we propose to fill with our study.

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