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Impact of social networks, mental health, and sobriety on exercise within a collegiate recovery community

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Keywords

physical activity, campus recovery community, social networks, sobriety

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Impact of Social Networks, Mental Health, and Sobriety on Exercise within a Collegiate Recovery Community

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Abstract

Exercise is especially beneficial for individuals recovering from addiction. In addition to improved physical, emotional, and mental health, exercise is linked to long-term recovery for those overcoming addiction. With nearly 10% of college students in recovery, and many utilizing campus resources such as collegiate recovery communities (CRCs) to support their recovery, it is important to understand the relationship between exercise and the recovery process among college students. The purpose of this study was to use social network analysis and theory to understand exercise behaviors among a group of college students in recovery. The relationship between exercise and sobriety, mental health variables, and social connections was examined among a network of students involved in a CRC. Of the 50 students involved in this network, 40 participated in the study (80% response rate). Logistic regression analysis revealed a significant model ($R^2 = .598$, $p < .0001$) predicting whether CRC members exercised enough to yield health benefits. Length of sobriety, higher stress, lower depression, having fewer network ties, and being connected directly to others exercising regularly were significant predictor variables in the model. This study supports the relationship between sobriety and exercise, as well as an association between network connections and exercise behaviors. Incorporating exercise opportunities as part of CRC programming to help students stay sober, as well as identifying key target points for intervention within similar groups of students, could be useful in future practice.

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Substance use disorders (SUDs) and addictions (e.g., alcohol use disorder, drug dependency, sex addiction) affect approximately 20 million adults in the United States annually (Substance Abuse and Mental Health Services Administration (SAMHSA), 2017a). SUDs are characterized as maladaptive patterns of substance use despite persistent negative consequences (e.g., strains on social relationships, financial instability, physical injuries or ailments) of partaking in such behaviors (SAMHSA, 2018). Due to the well-established benefits of exercise, including improved physical functioning and mental health (Bernstien & McNally, 2018), a rising number of SUD treatment interventions are being supplemented with exercise-oriented components (Brown et al., 2014; Weinstock, Farney, et al., 2017). Preliminary investigations indicate incorporating exercise as an adjunctive treatment for addiction is associated with reduced symptoms of mental health disorders (More et al., 2017), decreases in substance use (Brown et al., 2014), and increases in long-term abstinence from substances (Linke et al., 2019; Linke & Ussher, 2015; Weinstock et al., 2008).

Comorbid mental health disorders (e.g., depression, anxiety; National Institute on Drug Abuse (NIDA), 2018) are common in individuals struggling with addiction. This propensity for comorbidity is particularly troubling given SUDs and mental health issues have a propensity to exacerbate one another (Smith & Book, 2008). Moreover, persons with addiction also diagnosed with mental health conditions (e.g., depression) are less likely to fully engage with treatment and are more likely to relapse (Weinstock et al., 2007). Because exercise can improve mental health (Chekroud et al., 2018) and is related to reduced rates of relapse in those overcoming addictions (Linke et al., 2019; Linke & Ussher, 2015; Park et al., 2016; Sanchez et al., 2017), understanding factors related to increases in exercise behaviors among people seeking recovery could be helpful in assisting their long-term recovery.

Approximately 39% of college students struggle with at least one mental illness (Eisenberg & Lipson, 2019), and 16-20% of college students meet criteria for SUDs based on the DSM-IV (Diagnostic and Statistical Manual of Mental Disorders; American College Health Association, 2017). As a result, many college students are seeking treatment (i.e., seeing a medical professional, inpatient and/or outpatient) for SUDs and/or mental health issues (American College Health Association, 2017). After completing treatment, many individuals pursue (or return to) a college education while in *recovery* (National Institute on Alcohol Abuse and Alcoholism, 2015; SAMHSA, 2017b), accounting for about 9-10% of the college population (Association of Recovery in Higher Education, 2017)**.** According to the Recovery Science Research Collaborative (RSRC), *recovery* is defined as, "an individualized, intentional, dynamic, and relational process involving sustained efforts to improve wellness" (Ashford et al., 2019, p. 183). The process of *recovery* entails holistic and continued growth and enhancement of personal health, well-being, and quality of life (Ashford et al., 2019). Sustaining recovery and positive mental health after treatment requires social and community supports (Iarussi, 2018), which can be difficult to come by on some college campuses (Wiebe, Cleveland, & Dean, 2010). Thus, to combat campus-related risks for recovering students (e.g., high rates of drinking among the general college student population; ACHA, 2017) and sponsor a supportive social/community network, many universities are establishing collegiate recovery communities (CRCs). According to the Association of Recovery in Higher Education (ARHE), a CRC is a college or university-provided, supportive environment within campus that reinforces the decision to engage in a lifestyle of recovery. CRCs are therefore designed to support a student's educational pursuit while in recovery to ensure that students do not have to sacrifice one for the other (education or recovery; ARHE, 2017). CRCs accomplish this task by facilitating peer-to-peer social support between and among students in recovery, establishing 12-step groups/meetings on campus, and arranging sober leisure activities (Cleveland et al., 2007), among other services. Evaluations on CRCs have yielded promising results in that CRC members have consistently demonstrated low relapse rates (i.e., longer sobriety), in addition to GPAs and graduation rates well above the averages for the rest of the student body (Brown et al, 2018; Harris et al., 2008; Smock et al., 2011). While social influence and support has been evaluated as an important component of CRCs (Grahovac et al., 2011; Laitman et al., 2014), exercise – a behavior proven to facilitate recovery – has yet to be a studied within CRCs.

Social Network Analysis and Theory

According to social network theory, a person's exercise behavior can and will be influenced by their social relationships (Valente, 2010). Several studies have employed social

network analysis (SNA), a theoretical framework and methodology measuring social connections and structures (Borgatti et al., 2013), when studying exercise behavior relative to social connections (Aral & Nicolaides, 2017; Barclay et al., 2013; Patterson et al., 2019; Patterson & Goodson, 2017). These studies suggest the way someone is connected within their networks, and characteristics of their social connections, are related to exercise behaviors among individuals. Thus, using SNA to measure network properties relative to exercise in a CRC could reveal important social connections that impact exercise behaviors in this group.

There are two primary approaches to SNA: egocentric network analysis and sociometric network analysis (Valente, 2010). Egocentric network analysis focuses on the perspective of each individual ego (person) in a sample. Therefore, egocentric analysis does not limit the ego to identifying social connections from a single group or network, but considers any relationship that might be important to the ego in some way (Perry et al., 2018). In sociometric network analyses (also known as whole network analysis), the sets of ties among all members of a given, defined networks are studied, and therefore the perspective shifts from the ego to the network itself (Patterson & Goodson, 2019; Valente, 2010). Instead of focusing on each respondent's unique personal networks (egocentric networks), the focus shifts to the social structures and connections present within a defined group. Although sociometric studies only focus on the connections within a specified group, they give researchers the opportunity to investigate individual, group, and network-level factors in relation to an outcome of interest (Valente, 2010).

By focusing on the connections between and among groups of people, SNA helps to explain how behavior is influenced by the social environment (Valente, 2010). Network theory posits: a) people are interdependent, and connections are meaningful to understanding health behaviors and outcomes; b) relational data are often more important than attribute data in understanding health behavior (i.e., the way people are connected has a greater impact on health than individual-level constructs); and c) the creation or removal of a single connection can potentially impact an entire network due to interdependence and nonlinearity of networks (Meadows, 2008). In sum, using SNA satisfies a need — both theoretically and methodologically — to investigate more than the individual person in order to understand their (or a group's) health behaviors (Patterson & Goodson, 2019; Valente, 2010).

Network composition (proportions of various characteristics present in someone's network) is a common characteristic related to exercise behaviors. In their study, Patterson and Goodson (2018) found that the presence of siblings in college students' social network was related to less compulsive exercise (a form of unhealthy exercise often associated with prioritizing exercise and feeling guilty when exercise is missed; Patterson & Goodson, 2017). Additionally, the overall number of connections a person has to others in their network (i.e., degree), has also been related to exercise (de la Haye et al., 2010; Prochnow et al., 2020). Degree can be calculated non-directionally, accounting for all cumulative incoming and outgoing ties within a network, or directionally, focusing on whether ties are incoming or outgoing (Valente, 2010). In-degree is a measure that represents the number of nominations a person receives from other members of their network, and out-degree represents the number of outgoing nominations a node indicates across their network (Borgatti et al., 2013).

The Current Study

The purpose of this study was to determine whether mental health, length of sobriety, and network variables were related to whether a student in recovery exercised enough to experience

health benefits. Based on exercise literature, we hypothesized those who were sober longer and those who had healthier mental health scores would report more exercise (Chekroud et al., 2018; Weinstock et al., 2017). Based on network theory, we expected that having more connections in the network (measured via in-degree), and having more connections to regular exercisers, would be related to more exercise in this sample (Centola, 2011; Valente, 1996).

Methods

Campus Recovery Community Description

This study focuses on a single CRC from a large, private institution in the southern United States, which was created in 2016, two years prior to data collection. Components of the CRC included multiple meetings offered each day (e.g., Alcoholics Anonymous meetings), academic advising and support, community service opportunities, "sober" socials, a dedicated space for students in recovery, and housing services to help students find living arrangements supportive of their recovery. This CRC prioritized complete abstinence/sobriety from addiction as part of the recovery process. Therefore, in this study, recovery is a process of maintaining wellbeing while also abstaining from substance abuse. Student members of this CRC are expected to participate in recovery programming at least twice per week throughout the academic semesters.

Network Boundary Specification

Researchers met with recovery staff members to specify/define the boundaries of the CRC network by identifying all students in recovery from alcohol and substance use disorders who were a part of the CRC. For a student to be considered a member of the network, they had to be active and participating in recovery programming/meetings at least twice per week. Students who were not in recovery (i.e., did not have an addiction), but were involved in secondary programs through the CRC (e.g., peer alliance coalition, event planning) were not included. Similarly, students in recovery who did not attend meetings regularly (e.g., students studying abroad or away for an internship) were not included. Together with CRC staff members, we determined the network consisted of 50 students in recovery.

Procedure

An email describing the study purpose and providing a link to complete an online survey was sent to all 50 CRC network members. Students were told their participation was voluntary and that all answers would remain confidential. Qualtrics online survey software was used to collect demographic information, mental health data, exercise data, and network data. Forty of the 50 students completed the survey (80% response rate). The Institutional Review Board approved the study prior to data collection.

Measures

For demographic data, participants were asked to indicate how long they had been sober (i.e., how many months they had gone since using), their age on the day they completed the

survey, classification (i.e., freshman, sophomore), sex, race (defined using a dummy variable, where white students were given a 1 and students of color were given a 0), ethnicity, and GPA.

Mental health. The 21-item version of the Depression Anxiety Stress Scale (DASS) was used to measure individual anxiety, depression, and stress (Lovibond & Lovibond, 1995). The DASS produces three separate scores: an anxiety score, a depression score, and a stress score, each created from a combination of seven self-report items within the overall 21-item instrument. Each DASS item uses a 4-point Likert scale (0 = did not apply to me at all, 3 = applied to me very much, or most of the time). Total depression, anxiety, and stress scores were created by summing appropriate items for each and multiplying by two (Lovibond & Lovibond, 1995). Higher sum scores indicate more severe depression, anxiety, and/or stress. Congruent with past studies using the DASS (Moussa et al., 2017; Parkitny & McAuley, 2010), our sample registered a good internal consistency score ($\alpha = .94$).

Exercise. The Godin-Shepard Leisure Time Exercise Questionnaire (Godin LTEQ) was used to collect exercise data (Godin & Shephard, 1985). The Godin LTEQ measures intensity and duration of exercise during a typical 7-day period by asking participants to report the number of times they engage in strenuous, moderate, and mild levels of exercise for more than 15 minutes in a given week. Per the scoring instructions of the Godin LTEQ, sum scores for strenuous, moderate, and mild activity were created by multiplying strenuous activity by 9, moderate activity by 5, and mild activity by 3. According to Godin (2011), a combined moderate and strenuous activity score of 24 and above is associated with substantial health benefits for the individual. Therefore, Godin LTEQ scores were dichotomized, with those who registered scores of 24 or higher receiving a "1" and those who had scores less than 24 receiving a "0." This will be referred to as *beneficial exercise* throughout the remainder of the paper. Studies using the Godin LTEQ resulted in data with test-retest reliability coefficients ranging between .74 and .80 (Jacobs et al., 1993; Joseph et al., 2014).

Network data. Sociometric data were collected by asking participants to identify fellow CRC members they "felt they could go to with a personal matter." This question was chosen because it is popular in network research (Borgatti et al., 2013; Valente, 2010), and it was determined most appropriate by CRC staff prior to data collection. Participants were given a list of the names of all CRC members, giving each the opportunity to select as many network members as they felt they could go to with a personal matter. Sociometric data were used to calculate two network variables: in-degree (number of incoming nominations each person received from others in the network), and one-step reach to someone who exercised enough to achieve substantial health benefits (number of direct links to persons within the network who have combined strenuous and moderate activity scores of 24 or higher). In-degree was chosen because it represents popularity and prestige of a node within a network (Valente, 2010), and is more robust to missing data (Costenbader & Valente, 2003). One-step reach was calculated to assess social influence regarding exercise in this network.

Analysis

Network variables were calculated in UCINET version 6.662 (Borgatti et al., 2002). Descriptive statistics, bivariate correlations, and a binary logistic regression analysis were

conducted using SPSS version 25 (IBM, 2018). Listwise deletion was used for missing data. We used bivariate correlations (see Table 2) to determine which variables to include in the regression model (Thompson, 2006). Each person's length of sobriety, in-degree, race, age, depression scores, and one-step reach to beneficial exercisers (Godin scores of 24 or higher) were regressed onto their combined strenuous and moderate activity scores derived from the Godin LTEQ (See Table 3). Network graphs visualizing relationships and attributes were created using NETDRAW version 2.166 (Borgatti, 2002). These graphs help illustrate patterns present within the network.

Results

Most of the participants were female (57.5%; *n* = 23), white (72.5%; *n* = 29), and undergraduate students (80%; *n* = 32). The average age was 22.5 years (*SD* = 4.2), and average length of sobriety was 16.9 months (*SD* = 18.4). The average score for stress was 15.7 (*SD* = 14.0), 10.3 (*SD* = 12.3) for anxiety, and 14.0 (*SD* = 14.8) for depression.

The average total Godin LTEQ score was 26.7 (*SD* = 22.4), and the average combined strenuous and moderate score was 18.3 (*SD* = 20.7), with 30% (*n* = 12) of participants registering a combined strenuous and moderate activity score high enough to experience health benefits. In Figure 1, the red squares represent those who exercise enough to experience health benefits, and squares vary by size based on length of sobriety (the bigger the square, the longer the person had been sober). The average in-degree for network members was 7.3 (*SD* = 6.6). Sixty-five percent (*n* = 26) of participants had a one-step reach to beneficial exercisers. See Table 1 for all descriptive statistics.

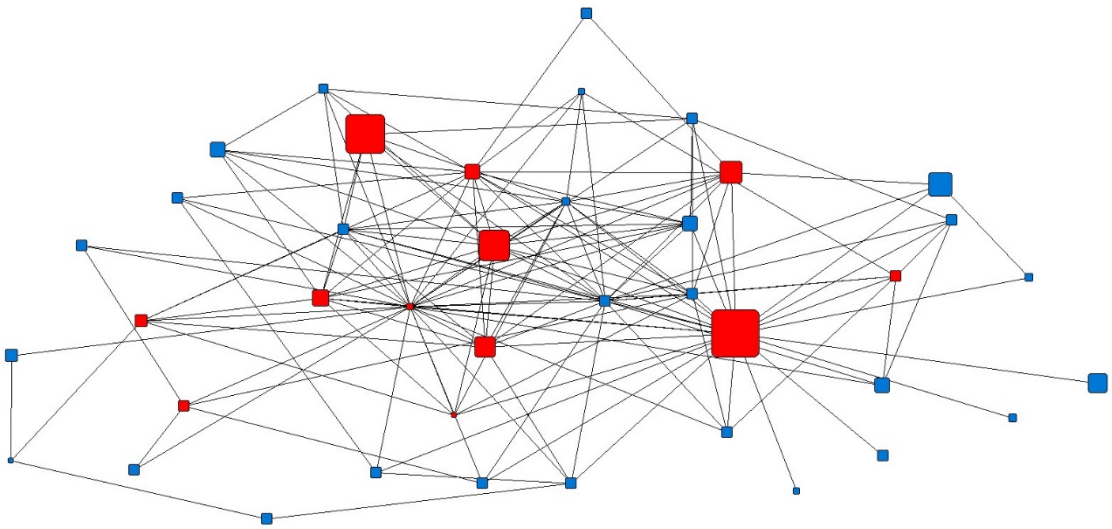

Figure 1. Network graph of 40 students in recovery. Nodes vary by size based on length of sobriety (the larger the node, the longer a person has been sober). Red nodes represent those who engage in beneficial exercise (Godin LTEQ score ≥ 24).

Table 1

Descriptive Statistics for Students (n = 40) Involved in a Campus Recovery Community

Variable	*n*	*%*	*M*	*Median*	*SD*
Age (years)			22.5	22	4.2
Gender					
Female	23	57.5			
Male	17	42.5			
Classification					
Freshman	2	5.0			
Sophomore	7	17.5			
Junior	8	20.0			
Senior	15	37.5			
Graduate/Professional	8	20.0			
Race/Ethnicity					
White	29	72.5			
Black	1	2.5			
Hispanic	6	15.0			
Asian	3	7.5			
Native American	1	2.5			
Depression			14.0	11	14.8
Anxiety			10.3	9	12.3
Stress			15.7	14	14.0
Length of Sobriety (months)			16.9	12	18.4
Godin LTEQ Scores			26.3	21	22.4
People with Mod + Stren Scores ≥ 24	12	30.0			
Network Variables			4.65	3	4.59
In-degree	28	70.0			
One-step Reach to People with Mod + Stren Scores ≥ 24					

Note. LTEQ = Leisure Time Exercise Questionnaire; Mod + Stren = Combined moderate and strenuous scores from the Godin LTEQ; *M* = mean; *SD* = standard deviation

Bivariate correlations were conducted between beneficial exercise and demographic variables (age, race, sex), length of sobriety, mental health variables (stress, anxiety, and depression scores), and network variables (in-degree and one-step reach). Age ($r = .362$, $p = .022$), race ($r = .389$, $p = .013$), sobriety ($r = .489$, $p = .001$), depression ($r = -.367$, $p = .020$), in-degree (-.349, $p = .027$), and one-step reach to beneficial exercisers ($r = .463$, $p < .001$) were all significantly related to the individual exercising enough to experience health benefits. Stress, anxiety, and gender were not related at the bivariate level. See Table 2 for all correlations.

Table 2

Bivariate Correlations between Demographic Variables, Length of Sobriety, Mental Health Scores, Network Variables, and Beneficial Exercise among a Sample of College Students in Recovery

	Age	*Race*	*Sex*	*Sobr*	*Stress*	*Anx*	*Dep*	*In-degree*	*One-step*	*Ex for Hlth*
Age	-									
Race	.203	-								
Sex	-.176	.227	-							
Sobr	.621**	.309	-.121	-						
Stress	-.018	.265	-.109	-.051	-					
Anx	-.028	.031	-.038	-.084	.509**	-				
Dep	-.221	.047	.025	-.339*	.560**	. 213	-			
In-degree	-.340*	-.192	.066	-.340*	-.083	.029	-.035	-		
One-step	.525**	.345*	.063	.711**	.201	-.030	-.140	-.522**	-	
Ex for Hlth	.362*	.389*	-.152	.489**	.014	-.130	-.367**	-.349**	.463**	-

Note. Sex reference = female; Sobr = sobriety; Anx = anxiety; Dep = depression, One-step = one-step reach to beneficial exercisers; Ex for Hlth = beneficial exercise; *$p < .05$, **$p <. 001$

A binary logistic regression analysis was conducted to assess whether demographic variables, length of sobriety, depression, and network variables (in-degree and one-step reach) were relative to someone engaging in beneficial exercise. According the regression model, demographic variables, length of sobriety, depression, and network variables accounted for 69.2% of the variance in beneficial exercise (Nagelkerke $R^2 = .69$, $p = .001$). As shown in Table 3, length of sobriety ($OR = 1.18$, $p = .048$), depression scores ($OR = .379$, $p = .037$), in-degree ($OR = .537$, $p = .028$), and one-step reach to a beneficial exerciser ($OR = 7.16$, $p = .045$) were all related to beneficial exercise.

Discussion

This study found network characteristics are related to beneficial exercise in this group of college students in recovery from substance use. It also suggests a relationship between sobriety and beneficial exercise, as well as between depression and beneficial exercise in this group. Figure 1 illustrates the pattern that those who engaged in beneficial exercise (the red nodes) tended to have longer lengths of sobriety (the larger nodes). Only 30% of this network achieved beneficial exercise scores. Almost 60% of the variance in beneficial exercise was associated with longer sobriety, higher stress, lower depression, lower in-degree, and higher one-step reach scores to beneficial exercisers. In particular, each additional connection to a beneficial exerciser (one-step reach) increased the odds of the individual being a beneficial exerciser by 710%. These findings are congruent with our original hypothesis; longer sobriety, lower depression, and being connected to regular exercisers were related to scoring above a 24 on the Godin LTEQ. However, contrary to our hypothesis, higher in-degree was negatively related.

Table 3

Binary Logistic Regression Model Predicting Beneficial Exercise within a Campus Recovery Community (Nagelkerke R^2 = .692, p =.001)

Variables	*Beta*	*SE*	*Wald*	*Sig*	*OR*	*95% CI*
Age	.279	.291	.920	.338	1.322	.747-2.337
Race (ref: white)	2.628	1.659	2.510	.113	3.848	.536-7.911
Sobriety	.164	.083	3.905	.048	1.179	1.001-1.387
Depression	-.237	.103	3.927	.047	.379	.125-.951
In-degree	-.623	.283	4.852	.019	.448	.228-.668
One-step Reach to Beneficial Exercisers	1.960	.342	4.008	.045	7.160	1.055-9.552

Note. SE = standard error; Sig = significance at α = .05; OR = odds ratio; 95% CI = 95% confidence interval

In accordance with network theory, results suggest network variables were associated with whether someone engaged in beneficial exercise in this network. First, having a higher in-degree (i.e., having more incoming social ties within the network) was negatively related to achieving sufficient amounts of exercise. This relationship between receiving more network nominations (in-degree) and less exercise could be due to the time demands of friendships (Verbrugge, 1979). With each additional social connection, a person will give more time and energy towards those connections, perhaps diminishing opportunities to engage in regular exercise (Cohen, 2004). Further, persons in recovery often rely heavily on their social support system (i.e., require more from their direct ties than people not in recovery; Chappell, 1994; Cleveland et al., 2007), and as a result, connecting with a person in recovery might be more taxing or time consuming than other relationships. Similarly, individuals might initially need more support in the recovery process, but as they progress in their recovery and become empowered, they could develop more independent coping strategies, such as exercise.

Another explanation for in-degree being related to less exercise could be the overall social norm of the network. Only 30% of the network registered beneficial exercise scores, suggesting a "network norm" of less exercise. However, as a person had greater connectivity across the network with higher in-degree scores, they were likely connecting to people who exercised less, exposing them to a norm of less exercise. However, while in-degree was negatively associated with exercise, one-step reach to beneficial exercisers was associated with the individual also doing so. These findings are supported by previous network studies stressing the importance of *who* someone is connected to more than *how many* connections a person has in their network (Fiorillo & Sabatini, 2011; Litwin & Phan, 2013; Shirado et al., 2013).

Further, these results suggest the *possibility* of a "contagion effect" which can occur within networks, suggesting that people often develop similar behaviors to those with whom they are connected (Aral & Nicolaides, 2017; Christakis & Fowler, 2007). However, because this study is cross-sectional, we cannot be certain whether being connected to another person who exercises translates to diffusion of exercise across social ties, or if those who exercise regularly are simply more likely to connect with others who exercise similarly (Centola, 2011). Network theory supports the likelihood of both; behaviors spread through ties, but people also gravitate to

those who behave similarly based on the concept of homophily (Valente, 1995). Thus, future intervention efforts could capitalize on the "spread" of behaviors through networks by connecting those who exercise less with those who exercise more, particularly if they can find common ground or shared values in other ways.

Being sober longer was associated with beneficial exercise. Recovery from SUDs often entails a process of change characterized by sobriety and improvements in overall health and well-being (Ashford et al., 2019; Betty Ford Institute Consensus Panel, 2007; National Institute on Drug Abuse, 2017), such as exercise and nutritional choices (White, 2009). Thus, it is possible that individuals who had been sober for longer periods of time also pursue healthy exercise habits – although due to the study design we are unsure whether these behaviors were adopted prior to or after pursuing recovery. Treatment interventions geared to address SUDs may benefit from implementing adjunctive exercise components, particularly social forms of exercise (e.g., CrossFit, yoga) which serve to promote the recovery goal for enhanced overall health and well-being (Brown et al., 2018; Weinstock et al., 2017).

Depression scores were associated with reduced odds of beneficial exercise in this sample. This finding is supported by literature suggesting exercise can alleviate feelings of depression and improve mood among college students (Annesi et al., 2017), and exercise can have similar effects as some pharmacological methods on the prevention and treatment of depression (Dinas et al., 2011).With people in recovery being at increased risk for mental illness (NIDA, 2018), this relationship between less depression and higher activity levels is especially noteworthy.

While depression scores were associated with engaging in higher levels of exercise, surprisingly, stress and anxiety scores were not related to beneficial exercise in this sample at the bivariate level. Exercise is generally associated with stress reduction (Wunsch et al., 2017), however those relying on exercise as a means to cope with stress may not experience such benefits. Successful adjustment is achieved most often when exercise as a coping strategy is coupled with other effective strategies, such as problem- or task-focused coping (Russell et al., 2018). Therefore, while some may experience reduced stress in relation to exercise, our data did not show such a relationship.

Similarly, there was not a significant relationship between anxiety and beneficial exercise in this study. This was surprising, given extant literature supporting a relationship between exercise and reduced anxiety (e.g., de Moor et al., 2006; Hamidah et al., 2015; McAuley et al., 1996). According to the American College Health Association (2017), anxiety is one the fastest growing public health concerns on college campuses. Further research is needed to understand the relationship between anxiety and exercise, especially among those recovering from addiction.

Limitations

This study observed only one network, and therefore results cannot be generalized outside of this network. Repeated studies on similar groups (e.g., residential treatment centers, Alcoholics Anonymous/support groups) could examine how length of sobriety, mental health, and network characteristics are associated with exercise behaviors. Further, based on feedback from CRC staff members, we specified the network as those attending programming twice per week within the CRC. Those who attended less often or less regularly might still be important people within the network, despite them not meeting boundary specifications. In the same vein, we did not collect data on how long students had been involved in the CRC, which could have a

direct relationship with social position within the network. These are data that could be included in future studies.

Another limitation was the cross-sectional nature of the study; hence the temporality of observed effects is unknown. A longitudinal study design could establish whether sobriety, mental health, and social network variables precede exercise, or if those who exercise tend to have the characteristics and relationships noted in this study. Additionally, only 80% of the network was represented in our data. While network analysis is robust to some missing data (Borgatti et al., 2013; Costenbader & Valente, 2003), each missing person (and subsequently, each missing social connection) changes the overall structure of the network. Thus, it is possible if one of the persons who did not respond had provided data, network patterns could change. Finally, while each individual received a unique in-degree score, the logistic regression model did not take into account the dependent nature of respondents' observations, and therefore could bias estimates.

Implications for Health Behavior Research

A major contribution of this study is demonstrating the utility of SNA in CRCs. This analysis adds a unique perspective to framing, understanding, and intervening upon CRCs. By using SNA and a social network theory lens, we found that connections among college students in a specific CRC are associated with beneficial exercise.

By identifying attributes and network characteristics related to exercise in a network of recovering college students, this study supports continued promotion of exercise behaviors as a part of the addiction recovery process. Specifically, our findings suggest that helping college students in recovery maintain longer lengths of sobriety (e.g., via CRCs, sober social events, stigma reduction campaigns on campus), and connecting them to others who exercise regularly on campus, *could* improve exercise outcomes, and ultimately contribute to long-term recovery and well-being. Researchers studying exercise behaviors among college students in recovery should consider incorporating SNA to identify whether certain network characteristics help or hinder someone's exercise behaviors. In doing so, researchers and practitioners are provided target points for behavior change within groups of students in recovery (Valente, 2017).

This study affirms the relationship between exercise and longer sobriety. Future research could investigate whether certain exercise modalities (e.g., CrossFit, yoga) are more complementary to maintaining recovery than others. Further, because this study supports connecting students in recovery to beneficial exercisers, investigating whether group-based exercise improves mental health and long-term recovery is worthwhile. Because group-based fitness can offer the social connections and support that could facilitate recovery, in addition to improved health (Heinrich et al., 2017), CRCs may benefit from including them in their programming.

Conclusion

As the number of students using CRCs continues to increase across the United States ARHE, 2017), universities could consider developing partnerships between campus fitness programs and CRCs to help foster long-term recovery for college students. CRCs could also consider incorporating exercise as a regular programmatic element within their communities, similar to offering 12-step meetings or sober socials. Finally, future research should test the

impacts of linking "sedentary" students with "active" students in an effort to promote exercise and create a contagion effect across an entire network.

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