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Quality of life as a predictor of social relationships in Oxford House

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Abstract

Improved access to housing and recovery support is a low-cost, high-potential opportunity to help people recovering from alcohol and substance use sustain their recoveries. Oxford House (OH) recovery homes represent a recovery-favorable social environment for at least some people, but it is still unclear which resident characteristics and relational dynamics affect the social integration of residents. In the current study, OH residents in three geographic locations completed a social network instrument and self-rated their quality of life (QOL). The instruments were administered to the current (per wave) residents of 42 OHs at three time points over a period of a year. Findings indicated that those with a higher QOL were more likely to form friendships with those with a lower QOL than with their similar QOL peers, and vice versa. This finding would not have been predicted based on relationship mechanisms typical of broader social contexts, where homophily (similarity-based assortativity) is common. The self-governance model that characterizes OH residences, in which success among residents is necessarily viewed as mutually dependent and therefore mutually beneficial, seems a likely explanation for our result. Specifically, and aligned with current knowledge about what works in peer oriented recovery, our results suggest the governance mechanisms of OH favor relationships between those more stable in their recovery and those who are at a higher risk of dropout or relapse. This study reveals a potential research avenue examining an important ingredient for the effectiveness of OH.

Keywords

Substance use disorders; Recovery homes; Oxford Houses; Social embeddedness; Quality of life

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²In-text quantitative summaries are means across waves weighted by the wave sample size.

³Houses contained few residents to start. Therefore, even if just one opted out, the house-level response rate was strongly impacted.

1. Introduction

Substance dependence recovery is a process often requiring multiple courses of treatment, with relapses a common occurrence (Koob & Simon, 2009; Miller, Westerberg, Harris, & Tonigan, 1996; Volkow & Fowler, 2000). For some individuals with substance use disorder (SUD), a stable living environment is known to be effective in maintaining abstinence (Jason, Davis, Ferrari, & Anderson, 2007; Jason, Olson, Ferrari, & Lo Sasso, 2006). An example is Oxford Houses (OH), which are democratically run, community based recovery residences, in which house members self-organize under basic principles of sobriety and peer support. OHs are known to decrease the likelihood of relapse when residents stay for a sufficiently long period, currently thought to be about six months (Jason, Olson, et al., 2007). Jason, Stevens, Ferrari, Thompson, and Legler (2012) found that OH residents who are friends with at least one other resident are less likely to leave their residence early. Additionally, Brereton et al. (2014) found that the presence of recovery home members in personal social networks predicted retention in the recovery home. These findings point to resident social relationships in the house system as a major factor in preventing early dropout and facilitating a sustained recovery (Jason et al., 2012). The purpose of this study was to further explore the relationships occurring in OH among residents.

These relationships, developed in a process of *social integration* involving such mechanisms as becoming acquainted with other residents, learning and following house rules and norms, and supporting one's own and others' sobriety, constitute a novel and abstinence-supportive social environment for the recovering individual. The social environment monitors residents for potential recovery-threatening behavior, recognizes positive behavior being modeled, and rewards residents for positive changes (Jason, Davis, et al., 2007; Jason, Olson, et al., 2007; Polcin, Mericle, Howell, Sheridan, & Christensen, 2014; Stevens, Jason, Ram, & Light, 2015). Heilig, Epstein, Nader and Shaham (2016) discuss the role of social integration in addiction in a broader context.

To date, however, few studies have attempted to model the social integration process itself. In a recovery home context, this means addressing how characteristics of residents and the existing residential network structure affect ongoing relationship maintenance, formation, and change. One example is a small study of 5 OHs with 31 total residents. The results indicated that involvement in recovery-related activities (e.g. attending AA meetings) were positively associated with trust in other house members and the likelihood of having a "confidant" within the house (Jason, Light, Stevens, & Beers, 2014). Further development of this research may help to confirm or adjust theory underlying the recovery-supportive role of Oxford House—which clearly depends on social relationships (Brereton et al., 2014; Jason et al., 2012)—in the recovery process.

This article focuses on the role that residents' perceived quality of life (QOL) plays in relationship dynamics. Previous studies suggest that recovery house stays are helpful in part by providing social support for recovery (Kaskutas, Bond, & Humphreys, 2002). In general, if a new resident is able to develop and maintain strong relationships with other residents, these relationships can become "social capital" (Coleman, 1988) that help him or her through the inevitable rough patches of recovery: negative emotional states, behavioral

lapses, and the fear associated with change and uncertainty, for instance (Koob & Simon, 2009). More specifically, relationships with other residents who score higher on a dimension associated with recovery, such as QOL (Jason & Stevens, 2017), may be particularly beneficial. A review by Reif and colleagues (2014) finds that interventions in which people who are relatively confident and stable in their recovery—those one might expect to report a relatively high QOL—are paired with people less stable in their recovery—those one might expect to report a relatively low QOL—tend to be effective at improving the recovery process and outcomes. Recovery homes are likely to include residents with varying perceptions of their own QOL, for recovery-related and probably other reasons. So the question naturally arises as to whether the patterning of relationships in OH with respect to QOL appears to mimic recovery-supporting mentorship relationships found in previous research. Our study explores how relationship formation and change are dynamically affected by self-reported QOL.

1.1. QOL as a predictor of relationships

Recently, Stevens, Guerrero, Green, and Jason (2018) found that both hope and sense of community were predictors of QOL for individuals living in OHs. These findings suggest one of the important functions of a recovery residence is in the creation of a sense of community, but more granular investigations of mechanisms and relations need to be pursued.

Studies of relationship formation typically find that *homophily*—a preference for others who are similar to one's self in many respects—is an important basis for friendships (Lazarsfeld & Merton, 1954). Theoretical arguments explaining this phenomenon have centered on the tendency of shared activities and perspectives to facilitate interpersonal understanding, acceptance, and feelings of support (Feld, 1981; McPherson, Smith-Lovin, & Cook, 2001). Homophily-based friendship choice can be further reinforced by network closure effects such as transitivity—the tendency for friends of friends to also become friends—in that friendship brings similar individuals who are not yet friends into closer and more regular contact by virtue of mutually shared activities and interests (Kossinets & Watts, 2012). Homophily is also known to predict friendship for demographics such as social class, gender, and ethnicity (Marsden, 1988) even among young children (Martin, Fabes, Hanish, & Hollenstein, 2005), as well as characteristics such as tastes in music (Steglich, Snijders, & West, 2010) and social popularity (Dijkstra, Berger, & Lindenberg, 2011).

QOL, as conceptualized and measured in health related research, represents an individual's perceived well-being (e.g. Saxena, Carlson, Billington, & Orley, 2001). Higher QOL should normally be a preferred state for relationship partners as well as for one's self, as higher-QOL alters will tend to be happier, more satisfied, calmer, less stressed, and a better resource. Relationships can sort according to similarity on a desirable characteristic such as QOL when the relationship is exclusive (e.g. marriage), or has costs associated with it that limit the optimal number of such relationships. Friendships are normally of this nature; empirical studies invariably find that people limit the number of others whom they consider a friend (Snijders, 2005), consistent with friendship as a selective relationship. Selective relationships promote clustering on desirable traits through *assortativity*: highly desirable

individuals represent a mutually best dyadic choice. Less desirable individuals end up together not because of preference, but because the desirable relationships are already taken or otherwise inaccessible. Assortative processes are commonly observed in, for instance, adolescent peer group dynamics (Dishion, Patterson, & Griesler, 1994) and marital relationships (Schwartz, 2013).

In light of these considerations, we might normally expect relationships to tend to cluster based on similar QOL, all else equal. However, in the context of OHs, where social support is a major and fundamental component of residency and where, moreover, residents depend on one another to keep the house afloat financially and otherwise, the dependency of friendship dynamics on QOL could differ from traditional expectations of relationship homophily. Instead, residents with relatively high QOL could be inclined to befriend residents with lower QOL, motivated by the mutual beneficence of whole-house survival associated with the success of everyone living in the OH residence and the particular vulnerability of individuals who are less secure in their recovery. Thus, examination of the effect of QOL on friendship should allow for these differing dynamics to be detected.

1.2. Recovery and social networks

Light, Jason, Stevens, Callahan, and Stone (2016) proposed a general framework for studying recovery as a socially-embedded, dynamic process (see also Wölfer, Faber, & Hewstone, 2015). That approach was influenced by recent advances in dynamic social network modeling, particularly the Stochastic Actor Oriented Modeling (SAOM) framework developed by Snijders and colleagues (e.g., Snijders, van de Bunt, & Steglich, 2010). The recovery residence social system is a process of relationship formation and change, which may in addition be causally linked to recovery-related characteristics of individuals. This modeling framework has several characteristics including being dynamic (a model of change), endogenous (it can include feedback), stochastic (it assumes that outcomes are inherently probabilistic) and data-based (parameters can be estimated from data, using well-established statistical principles). These features align well with current conceptions of the recovery process and the objectives of the present study.

We could summarize the framework as a type of complex system model (e.g., Hu, Boker, Neale, & Klump, 2014; Strogatz, 1994). SAOMs were developed specifically to model changes in social networks. Thus, if we identify a recovery home resident's social environment with the social network of relationships in that home, SAOM provides a natural, dynamic system framework for answering questions about how resident characteristics bear on the evolving structure of the house friendship network (Light et al., 2016).

In this study, given our primary interest in the role of QOL in recovery home social integration, we employed a simplified version of the SAOM framework that included only predictors of friendship relationships. We tested whether dyads with similar QOL were more likely to create or maintain friendships with each other. Because of the special nature of OH governance and the resulting social processes, we also ensured our examination could reveal whether friendship patterns with respect to QOL *differ* from those expected in other populations. Specifically, we modeled friendship networks as a function of QOL with two

different SAOM specifications that, together, allow for a variety of relational patterns to be revealed. We then discuss the results in the context of the OH and substance use recovery literatures.

2. Method

2.1. The OH model

OHs are a network of over 2000 self-governed, rented, gender-specific single-family recovery homes for 6 to 12 individuals. OHs are the largest network of recovery homes in the United States (Jason, Olson, & Foli, 2008). Residents can remain in these OHs for as long as they want, provided they pay about \$100 a week in rent, abstain from using drugs or alcohol, and comply with democratically agreed-upon house rules. The OH model includes procedures and practices designed to encourage a supportive environment across houses. This OH network is the only substance abuse recovery home model that had been endorsed by SAMSHA (SAMSHA's National Registry of Evidence-Based Programs and Practices, 2011), and has been found an effective resource for substance abuse recovery in many empirical studies (Jason et al., 2006; Jason, Olson, & Harvey, 2015).

2.2. Participants

Data were collected from a total of 396 residents (88% of all eligible) of 42 Oxford Houses ($n=6.14$ per house, 5.45 of whom participated, on average) at three time points, about four months apart during a one-year period (see Table 1 for details). Response rates by wave were 87%, 79%, and 88% for waves 1–3, respectively. Additionally, of the total 122 house level observations across three waves, 80% had 20% missingness within a house, and only two (1.5%) had >50% missingness. Some individuals included at baseline ($n=123$) left the houses before the second or third wave of data collection, and some residents ($n=83$ at wave 2, $n=132$ at wave 3) entered the houses after the first wave of data collection (further detail of missingness, new enrollment, and attrition are presented in the results). The final analysis sample included the 396 residents who completed at least one assessment and who were not the only survey participant in their house for any wave.

2.3. Procedures

Data were collected from Oxford Houses located in North Carolina, Texas, and Oregon; these states were selected because OH had well-established, stable statewide organizations that could assist in locating and approaching specific houses as potential participants, and because taken together, they provided some level of geographical diversity. Field research staff assembled lists of houses in each state with the help of the statewide OH organization. Inclusion criteria for houses included only that the house must have been operating for at least one year, and that it was within one of the specified states. All house residents were recruited and could opt out at will. Staff approached these houses in approximately the order that their contact location information became available, and requested that the member-elected house presidents introduce the study to other members by reading a description from a project-provided script. If the president and all (or all but at most one) other members agreed, the house was accepted into the study. We accepted the first 13 consenting houses from each state, with an additional three houses because of temporal overlap in the consent

process, for a total of 42. Although the absence of complete, centralized data on all roughly 2000 US OH's made full probability sampling impractical, project leaders, who have decades of experience conducting research among these houses, judged the final sample as reasonably representative of the national population. However, the same lack of comprehensive national data prevented any formal test of representativeness.

Once houses were recruited, staff recruited participants via face-to-face meetings. Individuals were informed about the purpose, objectives, and methodology of the study and were advised of the voluntary nature of the study before signing and returning a consent form. Interviews were scheduled and conducted that included self-report measures of QOL, social network, and other demographic information. Participants were compensated \$20 for completing each assessment. Permission to do this study was granted by the DePaul University Institutional Review Board.

2.4. Measures

2.4.1. QOL—An item from the World Health Organization Quality of Life Assessment Brief Version (WHOQOL Group, 1998) was used to assess QOL. The WHOQOL index measures domains involving physical, psychosocial, social relationships, and environment. We used one item in this index that measures an overall impression of one's QOL: "How would you rate your quality of life?" Response options ranged from 1=very poor to 5=very good. We chose to use a single item rather than an aggregation of all items because the WHOQOL constitutes an index, not a scale, implying the items are not necessarily intended to represent a single underlying construct. Moreover, while the index's use has been fairly well established in large scale population level studies, this is not the case for clinical studies. As such, the single overall item represents the most practical measure for our research purposes.

2.4.2. Social network instrument—The Social Network instrument measures relationships known to be important to how OH residents relate to each other within the house. This instrument measures several different types of relationships: friendship, mentoring, and trust (Jason & Stevens, 2017). Because this study is concerned with social acceptance, we focused on friendship, which was assessed by asking, "How friendly are you with this person?" Response options included: close friend; friend; acquaintance; stranger; adversary. The friendship rating was coded present (1) if the respondent identified a peer as a close friend or friend, and not present (0) otherwise (i.e., acquaintance, stranger, or adversary). Such measures have been found to be reasonably reliable in network studies (e.g. Hlebec & Ferligoj, 2002), and this particular measure has been successfully applied in other related studies (e.g. Light et al., 2016).

2.5. Analysis

After examining descriptive aspects of measures (Table 1), we examined three SAOMs (Table 4). The models included one *null model*, exclusive of any QOL related terms, that acts as a baseline for comparison with two more complex models that include QOL in multiple ways. The latter two models have similar complexity, and represent two different specifications allowing for different patterns of ego-alter friendship mixing with respect to

QOL. Effects (predictors) included in at least one of our models are defined and explained in Table 2; the RSiena manual (Ripley, Snijders, Boda, Voros, & Preciado, 2018) expands on these explanations.

The *null model* contains only network structural effects unrelated to QOL, namely outdegree, reciprocity, transitivity, indegree-popularity, and outdegree-activity effects (effects 1–6 in Table 3). These effects are like predictors in a regression model, but based on calculations from the time-evolving modeled network.

Model 1 adds to the effects in the null model QOL-ego, QOL-alter and QOL-similarity effects, which address, respectively, the effect of QOL on the number of out-choices made by ego, the number of in-choices received by ego, and the effect of ego-alter similarity on ego's preference for that alter. The similarity effect is symmetric with regard to QOL, in the sense that its contribution to the probability of a tie to alter is the same regardless of whether ego's QOL is higher or lower than alter's, so long as the absolute value of the difference is the same. If the associated coefficient is positive, then ego's preference to be tied to an alter is proportional to the degree of QOL similarity between ego and alter. A negative coefficient simply reverses this relationship such that more distance in QOL between ego and alter increases the probability of a tie. This specification represents a standard approach to modeling relational mixing with respect to a covariate (QOL in our case). Because of this specification's assumption of symmetry in QOL similarity, it cannot capture patterns in which a resident always prefers a peer with a higher QOL, but not a peer with a lower QOL, or vice versa.

Because of the limitations to the *Model 1* specification, and given structural components of OH that might bear on relationship patterns, we specified a second model to capture potential patterns that the first specification cannot. For example, residents depend on one another to keep the house operating smoothly. OH residents rotate through leadership positions (e.g., treasurer, comptroller) that entail certain responsibilities upon which the stability of the household rests. If one resident starts to slip, the well-being of others could be affected. This dependency could incentivize residents who are more secure and stable in their recovery (high QOL) to support those less so (low QOL) to ultimately support the stability of the house. Such a pattern would be counter to the concept of homophily. Model 1 can capture anti-homophily (heterophily), which would include such a pattern, but would also impose the reverse relationship—low QOL residents are more likely to nominate high QOL alters than their similar QOL peers and would assume both occur with the same strength. We wanted to consider a model that does not enforce this in the case that the effect of relative QOL varies depending on the direction of the difference. Like *Model 1*, the specification of *Model 2* includes QOL-ego, but replaces QOL-alter with a higher-QOL effect, i.e., higher QOL egos preferring lower QOL alters (notice, too, that the amount of difference does not matter, so this measure is essentially dichotomous). Additionally, QOL similarity is replaced by an interaction between ego's QOL and the higher-QOL effect. The interaction term can diminish, enhance, or even completely reverse the effect of higher QOL depending on the QOL of ego. We investigate this model because, as noted previously, the nature of OH could counteract typical social preferences in a way that breaks the symmetry assumption of the similarity effect in *Model 1*. A limitation of the *Model 2* specification is

that it is not expected to be able to capture a pattern of homophily very well. Thus, the two models are complementary, and facilitate a more comprehensive examination of the effect of QOL on friendship patterns in OH. The results of a goodness-of-fit assessment of both models can further guide our interpretation of the data by revealing which has a better capacity to explain the data.

We assessed model fit in multiple ways to compare the relative credibility of the models. We followed the goodness-of-fit testing approach proposed by Schweinberger (2012) and discussed in the RSiena software manual (Ripley et al., 2018). Our approach measures statistical agreement of 3000 model-simulated networks with the observed network according to user-defined multivariate network statistics; the difference was measured using Mahalanobis distance (MHD).¹ The statistics included the network indegree and outdegree distributions, the triad census (counts of each of 16 types of possible directed triads), and a 3×3 mixing matrix for the number of ties observed between every possible pairing of ego-alter QOL values. We reported the MHD for each statistic for each model, along with probabilities of a test statistic (MHD) equal to or larger than that observed under the assumption of no difference. A larger MHD and smaller *p*-value implied worse fit. We additionally calculated an entropy-based measure for explained-variation designed specifically for SAOMs (Snijders, 2004), and reported it as a pseudo-*R*² for each of the three models. A larger value of the pseudo-*R*² implies a better fit. Models were compared based on MHDs and the pseudo-*R*² values.

We conducted the analyses using the RSiena software package (Ripley et al., 2018) for the R statistical computing environment (R Core Team, 2017). We report “statistical significance” where 95% confidence intervals did not include zero. RSiena utilizes all available data, but only during the approximate time an individual is part of the network for a particular house. In general, parameter estimates are pooled across houses and waves, and missing data are in effect treated as MAR (Little & Rubin, 1987). Further details are available in the RSiena manual (Ripley et al., 2018).

3. Results

3.1. Description of the data

Statistics describing the analytic sample are presented in Table 1. In summary,² across waves, the average resident was about 38.4 years old and had a QOL of 1.3 (min=0, max=2). The majority (81.6%) of the sample participants were White (non-Hispanic), 8.7% were Black (non-Hispanic), 7.6% were Hispanic, and 2.2% reported some other race/ethnicity classification. Just over half (54.3%) of the sample participants were male. The mean across houses of the house-level mean outdegree was 3.1 friendship ties. The mean density indicates that, in the average house, 59% of ties that could be present were present, and the average number of directed friendship ties within a house was 17.1. The minimum within-house response rate at waves one, two, and three were 43%, 40%, and 57%, respectively.³ The proportion of houses with a response rate of at least 80% at each wave was 81%, 75%,

¹Mahalanobis distance is a generalization of Euclidean distance that additionally accounts for correlation among the dimensions of a multivariate statistic.

and 85%. Like any statistical model, missingness can create inferential issues for SAOMs. We therefore assessed the sensitivity of our findings to these lower-retention houses by fitting a model that excluded any houses that had a response rate lower than 80% at any wave (an exclusion of 140 participants in total). The results of the sensitivity analysis substantively mirrored those of the analysis reported in the Results section, which included all houses regardless of response rate. Specifically, the statistical significance and sign of coefficients was the same in both analyses, and the magnitude of the coefficients was approximately the same.

Some characteristics of the friendship network among the entire sample is described in Table 2. The numbers of possible ties (and tie density), excluding cross-house ties at waves one, two, and three were 1369 (0.60), 884 (0.62), and 1208 (0.60), respectively. Table 2 also describes a moderate number of tie transitions from wave one to two and from two to three resulting in Jaccard coefficients of 0.69 (wave one to two) and 0.77 (wave two to three) indicative of a fairly stable friendship network. Participant stability is also described in Table 2. During the transition from wave one to two, 63 new participants joined the study and 116 left. During the transition from wave two to three, 115 new participants joined the study and 87 left. While not reported in Table 2, resident QOL also changed over time. Specifically, of residents present at both waves one and two, 37 residents increased their QOL and 45 decreased it. Among those present at both waves two and three, 20 increased their QOL while 44 decreased it. Notably, wave three QOL data are not used in our analysis because the observation at wave three is precisely the time point at which the model of the network transitions stops (Ripley et al., 2018).

3.2. Stochastic actor-oriented model results

3.2.1. Null model—The coefficients and fit statistics for the null model are reported in Table 4. Parameter estimates are parenthetically reported in-text along with their 95% CIs (b=estimate, [95%CI lower, upper]). Outdegree (b=2.70, [−0.48, 5.87]), reciprocity (b=0.72, [0.02, 1.41]), and transitive triplets (b=0.32, [−0.03, 0.67]) effects were all positive; only reciprocity was statistically significant. The outdegree effect is usually negative in other SAOM studies (e.g. Light, Greenan, Rusby, Nies, & Snijders, 2013; Steglich et al., 2010), but for this data set, a positive coefficient suggested that, controlling for other effects in the model, residents typically nominated more than half of other house residents as friends. Recall that in this study, a “friend” is defined as something more than a mere “acquaintance” (specifically, a friend or close friend). Probably the typical house size (on the order of 5–8 individuals) played a role in this implied familiarity as well. The positive reciprocity effect shows that residents tended to reciprocate friendship nominations. Indegree popularity (b=−0.33, [−0.84, 0.17]) and outdegree activity (b=−0.21, [−0.53, 0.10]) effects were both negative and not statistically significant.

The model fit metrics for the null model provided a baseline for quantifying improvements in fit for the other two models. The indegree MHD was 7.16 ($p=0.56$), the outdegree MHD was 8.65 ($p=0.67$), the triad census MHD was 46.14 ($p=0.05$), and the QOL mixing matrix MHD was 29.20 ($p=0.27$). All MHDs suggested the fit of the baseline model was reasonably consistent with the data from the standpoint of null hypothesis significance testing (all

$p = 0.05$). However, the statistical power of a test of the null hypothesis is not clear. As such, we rely on the quantitative values of MHD and p to compare fit across models rather than statistical significance. Finally, the pseudo- R^2 value for the null model, and the baseline against which model 1 and model 2 were compared, is 0.12, and we were interested in how much the QOL-related model terms added to *Model 1* and *Model 2* improved this value and the MHDs.

3.2.2. Model 1—As shown in Table 4, the signs, approximate magnitudes, and statistical significance of all but one of their common effects were similar to the null model. The transitive triplets coefficient, while similar in magnitude, became statistically significant in this model ($b=0.38$, $[0.11, 0.66]$). The indegree popularity and outdegree activity effects remained non-significant, though the parameter signs were the same, and the magnitudes were similar.

The QOL-related effects added to *Model 1* included QOL ego, QOL alter, and QOL similarity. Of these, only the QOL ego effect was statistically significant ($b=0.73$ $[0.01, 1.46]$), with the positive coefficient implying that higher-QOL individuals chose more friends than lower-QOL individuals. In this model, alter's QOL had no significant effect on the likelihood of receiving a friendship nomination ($b=-0.10$, $[-0.63, 0.44]$), and QOL similarity was found to be negative, but not statistically significant ($b=-0.82$, $[-1.77, 0.12]$). The negative sign is suggestive of heterophily—a tendency for high QOL egos to choose lower QOL alters, and vice versa—albeit not statistically significant.

Model 1 fit metrics suggested a moderate improvement over the null model. The indegree distribution MHD was 7.90 ($p=0.45$), the outdegree distribution MHD was 10.55 ($p=0.40$), the triad census MHD was 42.66 ($p=0.08$), and the QOL mixing matrix MHD was 21.97 ($p=0.20$). Thus, the triad census and QOL mixing statistics suggested a somewhat better fit. The pseudo- R^2 value was 0.14, a 15% improvement compared with the null model.

3.2.3. Model 2—For this model, again consulting Table 4, the sign, approximate magnitude, and statistical significance of common model effects were similar to the null model, but again the transitive triplets coefficient is statistically significant in this model ($b=0.43$, $[0.02, 0.83]$).

Turning to the QOL effects in *Model 2*, QOL ego became non-significant, and directionally negative ($b=-1.24$, $[-3.25, 0.78]$). The higher QOL effect was also not statistically significant ($b=0.53$, $[-1.02, 2.08]$). However, the ego QOL x higher QOL interaction was found to be positive and statistically significant ($b=3.29$, $[0.29, 6.30]$) suggesting ego's preference for having a higher QOL than a selected alter depends on ego's QOL. We further discuss this finding in a later section of the results.

The model fit metrics for model 2 suggested an overall improvement over both the *null model* and *Model 1*. The indegree (9.17, $p=0.37$) and outdegree (10.89, $p=0.28$) MHDs indicated a subtly worse but still adequate fit vs. the null model or model 1, but the triad census MHD suggested a substantial improvement over the preceding models (33.31, $p=0.24$), as did the MHD of the QOL mixing matrix (10.31, $p=0.77$). The latter fit statistic is

particularly important, as it suggests that *Model 2* represents the role of QOL in friendship choice better than either of the other two models. Finally, the pseudo- R^2 value for *Model 2* was 0.17, about a 41.6% improvement compared with the *null model*, and a 21.4% improvement over *Model 1*.

3.2.4. Model implications—Because the effects of QOL on tie formation appeared in several different terms in *Model 1* and *Model 2*, interpretation of the results benefitted substantially from calculating model predictions for a representative set of these QOL values. The middle and right-most panes in Fig. 1 visually present the relative expected probabilities of friendship nomination for each ego-alter combination of low, middle, or high QOL given all three QOL related coefficients in *Models 1* and *Model 2*. The brightest squares are those in which friendship nomination is most likely. The left-most visual for the *null model* in Fig. 1 is uniform in shade as a result of the model containing no QOL related effects. Thus, the null model implied no variation in friendship probabilities across the various ego-alter combinations of QOL.

The middle visual for *Model 1* in Fig. 1 shows a pattern consistent with the negative QOL similarity coefficient, or heterophily. It is clear from this figure that the high QOL-ego to low (or medium) QOL-alter squares have the highest probabilities of friendship. However, the *Model 1* figure also suggests a relatively low probability for friendships to high-QOL alters that are initiated by low-QOL egos (the upper-left square).

Comparing the visual for *Model 2* to that of *Model 1*, it is evident that *Model 2* is more fully consistent with heterophily. The lower-right (high ego, low or medium alter) squares again show the highest friendship probability, but now the upper left (low ego, hi or medium alter) show the next-highest probabilities. Given the somewhat better fit of *Model 2* to the data—according to the QOL mixing fit statistics and the pseudo- R^2 values—we are led to put more confidence in the results represented in the coefficients and model predictions from *Model 2*.

4. Discussion

The structure and behavioral norms associated with OH residences are designed and theorized to encourage mutual help and support of peers. However, no previous work has examined whether this occurs in practice, or whether such support tends to be extended from those more stable in their recovery to those less stable. Alternatively, does social interaction in OH mirror what might be expected in a more typical social environment in which those with higher status prefer one another, leaving the lower status individuals to themselves? The evidence presented in this study suggests OH defies the conventional expectation, somehow encouraging those with a higher quality-of-life (QOL) to engage with lower QOL peers in friendship, and vice-versa (heterophily with respect to QOL). There are several reasons why such an unusual pattern of friendship relationships might be found in the OH social context.

One possible path to understanding comes from the research literature on AA sponsorship (Stevens & Jason, 2015a). Sponsors within the AA paradigm provide information, act as an

empathetic friend, and introduce the sponsee to others in recovery. Sponsees see the role of the sponsor as more than just an advice giver (Stevens & Jason, 2015a). Sponsorship represents an important aspect of AA affiliation and involvement (Majer, Jason, Ferrari, & Miller, 2011) and it reduces the likelihood of an individual dropping out (Kelly & Moos, 2003). Effective sponsors engage in 12-step activities themselves, are trustworthy, and make themselves available (Stevens & Jason, 2015b). Given that sponsorship is a good predictor of reductions in substance use behavior for the sponsee (Stevens & Jason, 2015a,b) and, moreover, given the central role of AA-related practices in OH residences, expectations for sponsorship relationships are likely to carry over to OH friendships generally. Sponsorship usually involves a “more recovered” individual helping a “less recovered” one, and Witkiewitz et al. (2018) provide evidence that this perspective is comparable to a higher-QOL resident helping one with lower QOL. It is entirely plausible that when individuals have achieved a certain degree of recovery success in their personal lives, they appreciate and value the opportunity to help others who are less sturdy or secure in their recovery. This is similar to Riessman’s (1965) helper therapy principle which suggests the person providing help or assistance to another also obtains benefits, and helping others can increase a person’s sense of well-being, as well as provide a sense of purpose and satisfaction (Dreher, 1995; Harris & Thoresen, 2005). Future studies should examine these hypotheses in more detail.

In addition, all OH residences—even those where average member QOL is quite high—benefit from the growth and success of all residents, particularly those at high risk for dropout. A useful example derives from the requirement that all residents pay a fair share of expenses. If resident turnover is high or if vacancies persist, then the remaining residents might have to utilize reserve funds that they will later have to collectively rebuild, or alternatively they might have to immediately assume higher living costs. From this financial perspective, it is clear that the collective success depends on everyone, and everyone, particularly those most suited to help, should *rationally* direct their support to the house members that are most vulnerable.

Hypothetically, the dynamics driven by a collective responsibility could be fundamental to a unique contribution OH makes among the variety of extant sober living environments. On the one hand, residences that involve higher levels of formal structure driving the day-to-day activities may put less of the collective responsibility on each house member. In its own right, this reduced responsibility could be a key to success for those in recovery who are not ready for such responsibility. These recovery environments typically do utilize the value of more stable members to support less stable members. But they may do so in a more contrived and exogenously driven way, as in the designed interventions studied by Reif and colleagues (2014). On the other hand, we would argue that the collective responsibility inherent in OH residences is fundamental to encouragement of a much more organic constellation of support. That is, rather than following an exogenous directive to try to help a peer, the collective dependency for survival could be endogenously driving house members to do *whatever is necessary* to support their peers towards success, and therefore support themselves. Our analysis included only OH residences, and also did not address what might be the underlying force driving high QOL individuals and low QOL individuals to connect with each other. However, future research could explore ways to test for these distinctive mechanisms, and in which scenarios each of the identified mechanisms are optimal.

Moreover, our speculation about the importance of mutual dependency could be measured and analyzed more directly with a measure of collective responsibility or ownership and its relationship to recovery outcomes.

The term “social integration” is used to describe the multiple types of social linkages among residents—friendships, mentoring, helping, etc.—which influence current life satisfaction and a concomitant willingness to remain in the home. Friendship is an indicator of the supportive social relationships that can protect people in recovery from relapse and improve overall alcohol and substance use recovery rates (Groh, Jason, Davis, Olson, & Ferrari, 2007). A highly integrated individual has strong friendship, trust, and role model relationships with other house residents, who provide resources and support recovery. For example, having at least one other resident as a friend does seem to increase length of stay to six or more months (Brereton et al., 2014; Jason et al., 2012). Conversely, an individual isolated from the residential social network perceives few recovery resources and may be prone to drop out. Indeed, only approximately 50% of OH residents remain in these houses for six months or more (Jason, Olson, et al., 2007). The current study clarifies the social integration mechanism further by suggesting that low-QOL individuals—who are more likely to be new residents or variously otherwise struggling with their recovery—are particularly likely to be “adopted” by higher QOL individuals, and this may be a major reason why such friendships are so crucial for newer residents. That Oxford Houses comprise a system where this socially atypical (but in the recovery home context, highly desirable) relationship process can take place in practice also speaks to the value of the OH model as an effective pathway to sustained recovery.

Of the two non-null models we fit and examined in our analysis, the point estimates of *both* were suggestive of a heterophilic pattern. However, our second specification (*Model 2*) appeared to fit the data better than our first (*Model 1*) according to goodness-of-fit statistics. Based on our understanding of the models and the predicted mixing patterns shown in Fig. 1, we would have expected *Model 1* to be able to identify a pattern similar to that shown for *Model 2* (Fig. 1), but it did not. One possible explanation is that while the similarity effect of *Model 1* compares the QOL of ego and alter such that more distance implies a stronger effect, the “higher” effect of *Model 2* ignores *how much* higher the QOL of ego is than alter. It might be that this is simply a better fit with the data. Substantively, this might suggest that high QOL residents recognize a level of relapse risk in their peers that does not disappear simply because a peer begins to perceive a somewhat higher QOL.

As all studies are, this one is limited in several respects. First, the importance of our findings is premised on the assumption that friendship ties between individuals with high QOL and those with low QOL are beneficial to recovery. We did not test this assumption in our data, but the peer-oriented recovery literature indeed suggests such relationships are likely to benefit recovery (e.g., see the review by Reif et al., 2014).

Second, we examined only OH recovery homes. Therefore, our findings may not generalize to more traditional staff-run sober living environments. In fact, we would hypothesize that the observed relationship patterns would be less likely to emerge in traditional recovery homes primarily because they do not encourage a collective ownership of the group’s

recovery success in the distinctive way OH does. That said, the literature clearly recognizes the value of such ties, and so they may be encouraged in ways other than through a collective ownership mechanism in non-OH residences. Moreover, even the sample of participating OHs cannot be considered formally representative of the entire population. Due to the lack of basic demographic data on all approximately 2000 such homes, along with their geographical dispersal and practical budget constraints, probability sampling would not have been feasible. This is, of course, a typical problem for behavioral studies, which rarely rely on probability sampling. Nevertheless, it would be informative for future studies to compare social integration mechanisms such as QOL-based selection across a wider variety of recovery homes, and this goal would be easier to achieve if OH and similar organizations were to obtain comprehensive data on key aspects of the populations they serve.

Third, our approach to pooling the data from all houses (known in the RSiena manual as the approach using structural zeros to constrain the model to disallow cross-house ties) assumes house-specific rate parameters are all equal. The rate parameters, among others in the model, could realistically vary across houses, which would imply our model is misspecified. But because only three waves of data were available at the time of this study, the model degrees of freedom were limited allowing only simple model specifications.

Fourth, while friendship is likely to be a multidimensional relationship, our measure of friendship is a single item measure that is likely to miss some nuance regarding the studied relationships. This is a general problem in the social network literature as the respondent burden for even a single item is rather high, and grows quickly with the size of the network and the instrument as more potential alters must be considered and as each one requires more data input.

Finally, additional questions remain. Although QOL differentiated friendship relationships, it is still unclear how QOL is dynamically related to other indicators of recovery, as well as what both high and low- QOL individuals gain from these relationships—though we have offered some plausible hypotheses. Future studies should relate these and other network mechanisms to both short and longer term recovery outcomes, in order to identify predictors of what occurs when residents leave recovery housing and re-integrate back into their communities. Such studies will need to follow participants for longer periods of time.

In conclusion, while our findings should be replicated first, they could have real-world policy implications for sober living best practices as well as patient-centered decision making and future research. Specifically regarding the current study, we presented evidence suggesting that, contrary to the usual findings that friendships tend to sort according to similarity in status and personal resource characteristics of individuals, OH residents are instead more likely to select alters whose QOL is *different* from their own. Thus, the OH model somehow encourages friendship ties that are known to constitute effective recovery supports (Reif et al., 2014). Our findings therefore point to a potential recovery-beneficial mechanism underlying OH. Similar studies need to be completed to determine whether similar patterns emerge in other types of sober living residences, and the mechanisms by which various contexts produce the patterns. This avenue of research could support improvement in our collective understanding of the interaction between the characteristics of

people in recovery and those of specific recovery contexts, which may facilitate the development of policies that lead to enhancements in patient-centered decision making for those in recovery from substance use disorders.

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Fig. 1.

Expected friendship probabilities predicted by the *null model*, *model 1*, and *model 2*.

Brighter boxes imply a greater relative probability of friendship between an ego and alter with the respective QOL levels.

Table 1

Person-level and house-level characteristics of the analytic sample (1 or more surveys) at each wave.

Variable	Wave 1 (<i>n</i> = 229)		Wave 2 (<i>n</i> = 176)		Wave 3 (<i>n</i> = 204)	
	M	(SD)	M	(SD)	M	(SD)
Person-level(continuous)						
Age	38.4	(10.8)	38.7	(10.7)	38.2	(10.5)
Quality of life	1.3	(0.7)	1.2	(0.6)	1.3	(0.6)
House-levelnetwork ^a						
Outdegree	3.3	(1.3)	2.7	(1.2)	3.1	(1.5)
Density	0.60	(0.13)	0.60	(0.13)	0.58	(0.13)
Tie count	19	(12.9)	13.3	(11.2)	18.2	(15.3)
Minimum with in-house response rate	43%	-	40%	-	57%	-
Percent of houses with at least 80% response rate	81%	-	75%	-	85%	-
Variable	Wave 1 (<i>n</i> = 229)		Wave 2 (<i>n</i> = 176)		Wave 3 (<i>n</i> = 204)	
	N	%	N	%	N	%
Person-level (categorical)						
Race/ethnicity						
White (non-Hispanic)	188	82.1%	141	80.1%	167	82.3%
Black (non-Hispanic)	21	9.2%	15	8.5%	17	8.4%
Hispanic	15	6.6%	17	9.7%	14	6.9%
Hispanic	15	6.6%	17	9.7%	14	6.9%
Gender						
Male	126	55.3%	94	53.4%	109	54.0%
Female	102	44.7%	82	46.6%	93	46.0%

^a Outdegree, density, and ties calculated at the house level and averaged across houses.

Table 2

Tie level descriptive statistics.

Statistic	Wave		
	1	2	3
Possible ties	1369	884	1208
Tie density ^a	0.60	0.62	0.60
Tie transitions ^b			
0→0	-	551	1022
0→1	-	58	21
1→0	-	46	22
1→1	-	229	143
Jaccard coefficient	-	0.69	0.77
Participants joined	-	63	115
Participants departed	-	116	87

^aDensity is the proportion of possible ties that are present.^bThe count of tie transitions of type characterized by the row label occurring between the specified wave and the prior wave.

Table 3

Stochastic actor model effects, formulas, and interpretations.

Effect short name ^a	Formula ^b	Interpretation
Network model		
1. Rate	λ_i	Expected number of latent tie changes between waves for best friend choices
2. Outdegree <i>density</i>	$\sum_j x_{ij}$	Number of alters chosen by ego
3. Reciprocity <i>recip</i>	$\sum_j x_{ij} x_{ji}$	Number of alters chosen by ego who also chose ego
4. Transitive triplets <i>transTrip1</i>	$x_{ij} \sum_h x_{ih} x_{hj}$	i creates or maintain i→j, given i→h and h→j (i.e., triadic closure)
5. Indegree popularity <i>inPop</i>	$\sum_{j,h} x_{ij} x_{jh}$	Number of in-choices (popularity) of i's alters.
6. Outdegree activity <i>outPop</i>	$\sum_{j,h} x_{ij} x_{jh} +$	Number of out-choices sent by i's alters.
7. QOL ego <i>egoX</i>	$v_i x_i +$	Effect of ego's QOL on ego's number of outchoices.
8. QOL alter <i>altX</i>	$\sum_j x_{ij} v_j$	Effect of alter's QOL on tendency to be chosen by any ego.
9. QOL similarity <i>simX</i>	$\sum_j x_{ij} (sim_{ij}^v - \overline{sim}^v)$, Where $sim_{ij}^v = \frac{\Delta - v_i - v_j }{\Delta}$, $\overline{sim}^v$ is average sim_{ij}^v , $\Delta = \max_{i,j} v_i - v_j $	Similarity between i and j on QOL
10. Higher QOL <i>higher</i>	$\sum_j x_{ij} g(d)$ where $d = v_i - v_j$ and $g(d) = 0$ for $d < 0$, 0.5 for $d = 0$, 1 for $d > 0$	Indicator variable; 1 if QOL ego > QOL alter.
11. QOL ego×Higher QOL	Multiplicative interaction of effects 7 and 10.	Allows the 'higher' effect to depend on ego's absolute QOL.

^aRSiena "short name" (identifies effect type; Ripley et al., 2018).^bFormula Notation: *i* is ego (chooser), *j* is alter (chosen), x_{ij} is a relationship between *i* and *j* (1 if *i* chose *j*, 0 otherwise), v_j is the value of covariate QOL for individual *i*, "+" for an index indicates marginal sum.

Table 4

Coefficients, confidence intervals, and fit metrics of the three stochastic actor-oriented models of network dynamics.

Model effect name	Null model		Model 1		Model 2	
	Est.	95% CI	Est.	95% CI	Est.	95% CI
Outdegree (density)	2.70	(-0.48, 5.87)	3.32	(-0.40, 7.05)	3.33	(-4.01, 10.68)
Transitive triplets	0.32	(-0.03, 0.67)	0.38	(0.11, 0.66)	0.43	(0.02, 0.83)
Indegree - popularity	-0.33	(-0.84, 0.17)	-0.36	(-0.78, 0.06)	-0.28	(-0.62, 0.07)
Outdegree - activity	-0.21	(-0.53, 0.10)	-0.28	(-0.62, 0.05)	-0.38	(-0.99, 0.24)
QOL ego			0.73	(0.01, 1.46)	-1.24	(-3.25, 0.78)
QOL alter			-0.10	(-0.63, 0.44)		
QOL similarity			-0.82	(-1.77, 0.12)	0.53	(-1.02, 2.08)
Higher QOL					3.29	(0.29, 6.30)
Model fit metrics						
	Metric	<i>p</i>	Metric	<i>p</i>	Metric	<i>p</i>
MHD						
Indegree distribution	7.16	0.56	7.90	0.45	9.17	0.37
Outdegree distribution	8.65	0.67	10.55	0.40	10.89	0.28
Triad census	46.14	0.05	42.66	0.08	33.31	0.24
QOL mixing matrix	29.20	0.27	21.97	0.20	10.31	0.77
Pseudo R ²	0.12	–	0.14	–	0.17	–

MHD: Mahalanobis distance between model and observed data (lower implies better fit).