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The association between food insecurity and physical activity in adults with serious mental illness living in supportive housing

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ABSTRACT

Rates of food insecurity are high among adults with serious mental illness (SMI); this population also engages in less physical activity than the general population. However, the relationship between food insecurity and physical activity in this group has not been explored. We examined food insecurity prevalence and its association with physical activity in 314 adults with SMI living in supportive housing in New York City and Philadelphia and enrolled in an institutional review board-approved randomized controlled trial of a Peer Group Lifestyle Balance (PGLB) program. We analyzed 2014 baseline survey data, including demographic data and self-reported food security, and four self-reported physical activity outcomes: any physical activity per week (yes/no) and 2) total, 3) moderate, or 4) vigorous physical activity minutes per week. A logistic regression model examined food security as a predictor of any physical activity; zero-inflated negative binomial regression models were used for the other three physical activity outcomes; demographic and clinical predictors were assessed for inclusion in models. Over half of participants (51.7%) reported low or very low levels of food security. Relationships between food insecurity and three physical activity measures (any physical activity, total weekly minutes, and moderate weekly minutes) were non-significant; those with lower food security were more likely to engage in vigorous physical activity. The high food insecurity prevalence highlights the importance of measuring and addressing food security in populations experiencing SMI; measuring physical activity is also important for tailored lifestyle recommendations. Future studies should examine longitudinal changes in food security and physical activity.

1. Introduction

Food insecurity is the disruption of food intake or altered eating patterns due to a lack of resources, and is an increasingly prevalent public health issue in the United States (Myers et al., 2020). In 2019; 13.7 million or 10.5 % of US households were food insecure, meaning they lacked adequate food access for an active and healthy life (<https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx#verylow>). Individuals with food insecurity are more likely to be obese (Leung et al., 2014). The food insecurity-obesity relationship is multifactorial; individuals with food insecurity often have challenges accessing healthy food; frequent cycles of food restriction and overeating; and increased consumption of lower-

cost, energy-dense food (Leung et al., 2014).

Additionally, individuals with food insecurity are also less likely to adhere to physical activity guidelines, which recommend 150 min of moderate, or 75 min of vigorous weekly physical activity (Centers for Disease Control and Prevention). Food insecurity leads to poorer dietary quality, and increased stress and anxiety, which may make physical activity more challenging. This contributes to poorer overall health in individuals who are food-insecure (To et al., 2014 Nov 1).

In particular, adults with serious mental illness (SMI; e.g., schizophrenia, bipolar disorder) are likely to experience food insecurity (Rodgers et al., 2021). In a national sample of adults with SMI, 23.9 % reported low or very low food security; and these food-insecure individuals were less likely to report adequate mental health care (Rodgers

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et al., 2021). The COVID-19 pandemic has further increased the prevalence of food insecurity, particularly among low-income individuals (Afulani et al., 2018) and those with mental health conditions: One survey of individuals with mental illness in May-June 2020 found that 55 % had difficulty meeting social needs, with 90 % of those individuals reporting food insecurity (Afulani et al., 2018).

Additionally, individuals with SMI have other risk factors for obesity: they are more likely to be low-income, experience stressful life events and social isolation (Martin et al., 2016), and to have weight gain from psychiatric medications (Barton et al., 2020). Furthermore, they also engage in less physical activity than the general population (Stubbs et al., 2016). As a result, they are more likely to have cardiovascular disease, and other physical conditions, which contribute to the shorter life expectancy of those with SMI (Janssen et al., 2015).

The influence of food insecurity on physical activity in adults with SMI has not been explored, but is of particular interest, given their high levels of food insecurity and other risk factors for obesity, and given the benefits of regular physical activity for weight regulation, cardiovascular risk reduction, and mental health. Furthermore, food insecurity and physical inactivity are potentially modifiable risk factors for obesity and cardiovascular disease and thus potential targets for interventions and policies. Therefore, this study will examine the prevalence of food insecurity and the association between food insecurity and physical activity level in a racially and ethnically diverse sample of adults with SMI who are overweight or obese living in supportive housing agencies.

2. Materials and methods

This study uses baseline, pre-intervention survey data from a National Institutes of Mental Health-funded randomized-controlled trial assessing the impact of the Peer Group Lifestyle Balance (PGLB) program on weight loss in individuals with SMI living from three supportive housing agencies (affordable housing and comprehensive support services for individuals who are formerly homeless and are living with serious mental illness) in New York City and Philadelphia (clinicaltrials.gov NCT02175641). Participants were 18 and older, English or Spanish speaking with a chart diagnosis of SMI, and BMI ≥ 25 (kg/m²). A total of 314 participants were randomized to PGLB (a 12-month group diet and physical activity program delivered by peer specialists embedded with the agencies) or usual care (e.g., referrals to primary care). The study's primary results have been described elsewhere (Cabassa et al., 2021). Both the [BLIND] and [BLIND] institutional review boards approved the study.

In 2014, all participants completed a baseline interview with a research assistant that included self-reported age, sex, race, and ethnicity, and self-reported physical and mental health conditions. Food insecurity was assessed using the United States Department of Agriculture Adult Food Security Survey Module, a 10-item survey assessing self-reported food hardship in the last 12 months due to a lack of financial resources. Food security was measured as a categorical variable and reported as either high, marginal, low, or very low: high food security indicates no food access challenges, marginal one to two challenges, low as having reduced food quality or variety, and very low as having multiple indicators of disrupted eating patterns at intake (United States Department of Agriculture, 2012).

Physical activity was the primary outcome of this analysis and was assessed using the International Physical Activity Questionnaire Short-Form (IPAQ-SF). (Hallal and Victora, 2004). The IPAQ-SF is a seven-item survey of self-reported minutes of sitting, walking, moderate physical activity, and vigorous physical activity in the last seven days. Moderate physical activities expend three to five times the calories of sitting quietly, such as walking at a moderate or brisk pace, light calisthenics, and moderate housework; vigorous activities expend six times the calories and include walking/running at >5 miles per hour, most competitive sports, and heavy housework or physical labor (Centers for Disease Control and Prevention). The physical activity outcomes for this

analysis were 1) any self-reported physical activity minutes per week, reported as a binary outcome (yes/no) and 2) total, 3) moderate, or 4) vigorous physical activity minutes per week, reported as continuous variables.

Descriptive statistics were used to characterize the population, using means and standard deviations for continuous variables and numbers and percentages for categorical variables. A logistic regression model was used to examine food insecurity as a predictor of any physical activity. The distribution of the total, moderate, and vigorous physical activity minutes were also examined. The distributions were significantly skewed by a number of individuals reporting zero physical activity; therefore, zero-inflated negative binomial regression models were used to build the regression models for these physical activity outcomes. Zero-inflated negative binomial regression uses a binomial probability distribution to model count data with large numbers of zero values; this type of model has been shown to be better-fitting for outcomes such as number of physical activity minutes than traditional regression models (Green, 2021). The coefficients of zero-inflated negative binomial regression models are not easy to interpret; therefore, the coefficients were exponentiated to obtain odds ratios.

To build the models, a correlation matrix was constructed for all demographic, clinical, and health variables, food insecurity, and the physical activity outcomes to assess associations, using correlation coefficients for continuous-continuous relationships, t-tests for categorical-continuous relationship with two means, ANOVA for three or more means, and chi-square for categorical-categorical relationships. Variables with associations of $p < 0.1$ with the study outcomes were added to the regression models in addition to the primary predictor of interest, food security; predictors were assessed for multicollinearity. Significant predictors were retained in the final models, which were built using a stepwise approach. Model fit was assessed using log-likelihood values, with higher values indicating better model fit. A p -value < 0.05 was the threshold for statistical significance. Additionally, for the vigorous physical activity model a sensitivity analysis was conducted excluding an outlier participant reporting 1260 min of vigorous physical activity per week.

3. Results

Demographic information on participants is reported in Table 1. Depression was the most common mental health diagnosis (75.16 %) followed by schizophrenia (56.69 %) and anxiety disorder (50.32 %). The mean BMI of participants was 33.72 (SD = 7.22). Slightly over one-quarter (27.7 %) of participants reported their food security status as very low and another 24.2 % as low.

One-third of participants (33.33 %) reported engaging in no moderate or vigorous physical activity. Most (63.1 %) performed weekly moderate physical activity, and 23.9 % engaged in weekly vigorous physical activity. On average, participants spent 196.79 (303.22) minutes in total physical activity per week (range: 0–1680), 154.12 (243.25) minutes of weekly moderate physical activity (range: 0–1260) and 39.98 (137.98) minutes (range: 0–1260) of weekly vigorous activity.

In bivariate analysis, there were no significant associations between the demographic variables, food security and any weekly physical activity, total weekly physical activity minutes, or moderate weekly physical activity minutes. However, lower levels of food security and age, smoking status, and diagnoses of hypertension, hypercholesterolemia, bipolar disorder, and schizophrenia were significantly associated with minutes of weekly vigorous activity. These variables were added to a zero-inflated negative binomial regression analysis; the final model showed a relationship only between food security and minutes of vigorous physical activity completed per week (Table 2). As food security changed from high to marginal, participants had 2.67 times more vigorous physical activity minutes, from marginal to low 4.06 times more, and low to very low 4.42 times more vigorous physical activity

Table 1
Descriptive statistics.

	N	%	Mean	SD
Demographics				
Age	313		48.65	11.56
Sex				
Male	180	57.32		
Female	133	42.36		
Other	1	0.32		
Race/Ethnicity				
Non-Hispanic white	57	18.3		
Non-Hispanic black	181	57.64		
Hispanic	39	12.42		
Non-Hispanic other	35	11.2		
Education				
Less than high school	117	37.26		
High school and above	193	61.46		
Mental health				
Depression	236	75.16		
Schizophrenia/schizoaffective disorder	178	56.69		
Anxiety disorder	158	50.32		
Bipolar disorder	146	46.5		
Drug abuse/dependence	102	32.48		
SF-12 Mental health component score	313		47.58	10.66
Physical health				
Body mass index (BMI)	314		33.72	7.22
Overweight (BMI 25–29.9)	109	34.70		
Obese (BMI > 30.0)	201	64.00		
Perceived health: Excellent/Very good/Good	189	60.19		
Smoker	196	62.62		
Lifetime self-reported physician-confirmed diagnosis of chronic medical conditions				
Hypertension	173	55.1		
High cholesterol	114	36.31		
Diabetes	102	32.48		
Arthritis	100	31.85		
Food security				
High	71	22.6		
Marginal	59	18.8		
Low	76	24.2		
Very low	87	27.7		
Sedentary behavior and physical activity				
Walking (minutes per week)	309		355.47	365.95
Engaging in any moderate or vigorous physical activity	208	66.67		
Minutes of moderate physical activity engaged per week	309		154.12	243.25
Minutes of vigorous physical activity engaged per week	309		39.98	137.98

minutes. In the sensitivity analysis excluding the outlier participant, the model remained significant.

4. Discussion

Food insecurity was prevalent in this sample of adults with SMI who are overweight or obese. Over half (51.7 %) reported low or very low levels of food security, a much higher rate than the general population (Leung et al., 2014) and higher than several recent studies of food security in individuals with SMI. However, methods of measuring food

security were not consistent across studies (Teasdale et al., 2020; Tripodi et al., 2021). One study examined food insecurity in populations experiencing both homelessness and SMI, which may be more analogous to our sample. O'Campo et al. (O'Campo et al., 2016) followed food security longitudinally over 18 months with a cohort of participants in Canada who were part of a large, multi-center, randomized controlled trial of a Housing First intervention for people experiencing homelessness and SMI. The sample reported baseline food insecurity of 82.5 %. Importantly, 78 % of participants in this group achieved high food security over the 18 month follow up period (O'Campo et al., 2016).

Prior studies have found an association between increased food insecurity and lower levels of physical activity (To et al., 2014). In contrast, our study found non-significant relationships between food insecurity and three physical activity measures: any physical activity, total weekly minutes, and moderate weekly minutes. Paradoxically, individuals in our study with higher levels of food insecurity were more likely to engage in vigorous physical activity. This may be due to the large range of reported vigorous activity values: although most participants reported 0 vigorous activity minutes per week and the average was around 40 min, about 15 percent reported engaging in >40 min of vigorous physical activity per week up to 1280 min per week (three hours per day). Importantly, in this baseline sample, the average number of minutes of moderate physical activity/week met the CDC Physical Activity Guidelines for Americans of 150 min of moderate-intensity aerobic activity/week (Centers for Disease Control and Prevention; Cabassa et al., 2020). Prior analyses of participants' activity found significant difference by sex, age, chronic conditions, self-efficacy for exercise, and locus of control (Cabassa et al., 2020).

A study limitation is self-reported physical activity minutes, and other correlates. Although self-report measures are quicker to obtain and less expensive than sensors, some individuals may over-report their activity when compared to objective measures (Jakicic et al., 2015). Additionally, our sample was drawn from supportive housing residents enrolled in a healthy lifestyle clinical trial, which may suggest that they were actively seeking to improve their physical health, which may limit generalizability to all adults with SMI.

5. Conclusion

This study confirmed high baseline levels of food insecurity in this population of overweight/obese participants with SMI in supportive housing who are primarily from racial and ethnic minority groups. Two additional unexpected findings include adequate mean levels of moderate physical activity and an inverse relationship between food security and vigorous physical activity. There are no reported data regarding physical activity levels in those with SMI that differentiate between populations with and without experiences of homelessness. However, the finding of adequate levels of moderate physical activity in this group may suggest that people with SMI who are also formerly homeless may have retained higher levels of physical activity developed to meet daily survival needs while living without housing. In a similar way, study participants with higher food-insecurity may also be engaged in higher physical activity/walking to meet daily income and service needs.

Recommendations

Table 2
Regression model: Food security and vigorous activity minutes per week.

Parameter	B	Std. Error	95 % Wald confidence interval		Hypothesis test					
			Lower	Upper	X ²	df	p-value	Odds ratio	Lower	Upper
Intercept	−0.857	0.226	−1.299	−0.415	14.454	1	<0.001	0.424	0.273	0.660
Food Security										
High (ref)	0									
Marginal	0.984	0.295	0.405	1.562	11.118	1	<0.001	2.674	1.500	4.768
Low	1.401	0.269	0.872	1.930	26.957	1	<0.001	4.060	2.392	6.889
Very Low	1.487	0.264	0.959	2.005	31.678	1	<0.001	4.423	2.236	7.424

The high prevalence of food insecurity reported in this project highlights the importance of measuring food security in populations experiencing SMI and suggests the need to specifically attend to food security among people with SMI who are overweight or obese. Interventions might include facilitating enrollment in the Supplemental Nutrition Assistance Program and provision of congregate meals, meal delivery programs, or food pantries. Additionally, baseline measurement of physical activity could be important in tailoring health lifestyle recommendations to certain population subgroups. Future analyses are planned to examine longitudinal changes in food security, physical activity, and weight in our study participants.

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CRedit authorship contribution statement

Amy Taylor Cunningham: Data curation, Formal analysis, Software, Visualization, Writing – original draft, Writing – review & editing. **Lara Carson Weinstein:** Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Ana Stefancic:** Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Alexis Silverio:** Data curation, Formal analysis, Software, Visualization, Writing – original draft, Writing – review & editing. **Leopoldo J. Cabassa:** Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2022.102008>.

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