Comparison of schizophrenia outpatients in residential care facilities with those living with someone: Study of mental and physical health, cognitive functioning, and biomarkers of aging

Ellen E. Lee[a,b], Averria Sirkin Martin[a,b], Christopher N. Kaufmann[b,c], Jinyuan Liu[b,d], Julie Kangas[a], Rebecca E. Daly[a,b], Xin M. Tu[a,b,d], Colin A. Depp[a,b], Dilip V. Jeste[a,b,e,*]

[a] Department of Psychiatry, University of California San Diego, La Jolla, CA, United States
[b] Sam and Rose Stein Institute for Research on Aging, University of California San Diego, La Jolla, CA, United States
[c] Division of Geriatrics and Gerontology, Department of Medicine, University of California San Diego, La Jolla, CA, United States
[d] Department of Family Medicine and Public Health, University of California San Diego, La Jolla, CA, United States
[e] Department of Neurosciences, University of California San Diego, United States

A B S T R A C T

This paper aims to compare mental and physical health, cognitive functioning, and selected biomarkers of aging reflecting metabolic pathology and inflammation, in outpatients with schizophrenia from two residential settings: residential care facilities (RCFs) and living with someone in a house/apartment. This cross-sectional study examined community-dwelling adults with schizophrenia either in RCFs ($N = 100$) or in a house/apartment with someone ($N = 76$), recruited for two NIH-funded studies in San Diego. Assessments included measures of mental/physical health, cognitive function, and metabolic (glycosylated hemoglobin, cholesterol) and inflammatory (C-Reactive Protein, Tumor Necrosis Factor-alpha, Interleukin-6) biomarkers of aging. General logistic models were used to analyze factors associated with residential status.

RCF residents had several indicators of worse prognosis (never being married, higher daily antipsychotic dosages, increased comorbidities and higher Framingham risk for coronary heart disease) than individuals living with someone. However, RCF residents had better mental well-being and lower BMI, as well as comparable biomarkers of aging as those living with someone. While the cross-sectional nature of the study does not allow us to infer causality, it is possible that the supportive environment of RCFs may have a positive impact on mental and physical health of persons with schizophrenia. Longitudinal follow-up studies are needed to test this hypothesis.

1. Introduction

Following widespread deinstitutionalization that began in the mid-1950s, spurred by the discovery and increasing use of antipsychotic medications and the subsequent community psychiatry movement, many individuals with schizophrenia moved to live with their families. In recent decades, however, the proportion of seriously mentally ill individuals living with families has been declining (Goldman, 1982; Tsai et al., 2011), and this has coincided with an increase in homelessness and/or incarceration among those with serious mental illness (SMI). Today, a majority of outpatients with schizophrenia in the US live with someone (friend or family), alone in an apartment or in a single room occupancy hotel, or in non-medical residential care facilities (Center for Mental Health Services, 2006; Davis et al., 2012;

Fleishman, 2004; Torrey, 1995). While independent living is often a goal of schizophrenia treatment, as Cohen et al. (2015) noted, community integration may be the more appropriate goal.

Non-medical residential care facilities (RCFs; known as "Board-and-Care-Homes" in California, and as group homes, family care homes, etc. in other states) are a common residential setting for many people with schizophrenia and other SMI, especially those with limited social supports and greater supervision and care needs. Although RCF regulation varies across states, most states mandate minimum levels of service to be eligible for licensure. The national Substance Abuse and Mental Health Services Administration (SAMHSA) criteria for RCFs include specialization in serving persons with SMI; provision of 3 meals/day; 24-h staff supervision; stay of >30 days; and assistance with medications, hygiene, and transportation (Ireys et al., 2006). If licensed, RCFs

---

charge a government-determined rate, often paid using a substantial portion of the residents' federal disability supplemental security income. It is estimated that one-sixth of the people with SMI may be residing in RCFs (Torrey, 1995) and the proportion in RCFs is expected to grow as the proportion living with families continues to decline (Cabassa et al., 2015; Craig and Lin, 1981; Goldman, 1982; Solari et al., 2014; Somers et al., 2017; Tsai et al., 2011). RCFs are a fairly stable form of housing in most states, with 78% of residents living there for >13 months (Ireys et al., 2006). The quality of the diet varies somewhat among different RCFs, which employ their own cooking staff (Siegel et al., 2006). While alcohol and other substance use is not permitted in RCFs, the specific policies regarding substance use may vary among the different RCFs. A majority of RCFs in San Diego County employ a zero tolerance policy and will evict residents for alcohol and substance use (Department of Social Services, 2019). There is also variability in the amount of structured activities provided in RCFs; with some offering daily groups and outings and others having limited options (Nelson et al., 1997). The RCF staff provide transportation to medical and psychiatric appointments for the residents, and most RCFs have physicians who would travel to the facility to treat patients on a monthly basis (Weiner et al., 2010).

The literature on residential settings for people with SMI, especially RCFs, is limited and mixed on the beneficial effects on the residents. A 2006 Cochrane review of the effects of supported housing for persons with SMI found no randomized controlled trials that compared adults with severe mental disorders who lived in supported housing schemes and standard care (Chilvers et al., 2006). Another Cochrane review by Kisely et al. examined randomized controlled trials of compulsory community treatment and included three studies (Burns et al., 2013; Steadman et al., 2001; Swartz et al., 1999) which compared compulsory community treatment with either standard voluntary care or intermittent supervised discharge, and reported no significant difference in outcomes with the different treatments. The Kisely review highlighted the difficulty in carrying out such randomized trials as illustrated by a high number of research protocol violations due to the legal constraints (since clinical decision-making may not be governed primarily by the randomization) and difficulty adhering to the randomized intervention because of the large number of involved parties (i.e., multiple mental health services and service providers as well as family). Thus the reviews reveal difficulties in conducting randomized controlled trials to compare effects on interventions in patients with SMI discharged into the community. This suggests a need for cross-sectional non-randomized studies of people with SMI discharged from the hospital into different community settings as a practical (although imperfect) way of comparing functional outcomes according to living situation.

Furthermore, the impact of RCFs on mental and physical health outcomes remains unclear. In 2001, our group reported that, among outpatients with schizophrenia ages 40 and over, RCF residents were less likely to have been married, and had earlier illness onset, worse cognitive impairment, and poorer health-related quality of well-being compared to persons who lived alone or with someone else (Auslander et al., 2001). Most of the published studies have compared RCF residents with those living in supported apartment settings, living alone, or living independently (either alone or with others), while few have specifically examined persons living with someone in an apartment or house (who may also be receiving some informal level of care) as a comparison group. Residential settings clearly impact lifestyle factors such as physical activity, nutrition, and smoking that contribute to poor health in persons with SMI. Residency-based interventions to improve lifestyle factors for RCF residents are particularly attractive due to the RCF's provision of meals and activities, though greater understanding of how RCF residents may differ from other community-dwelling persons with schizophrenia in terms of sociodemographic and clinical factors is warranted.

The objective of this study was to compare sociodemographics, psychopathology, cognition, mental and physical health, and selected

biomarkers of aging between outpatients with schizophrenia living in RCFs and those residing with someone in a house/apartment. This would help determine relative benefits and shortcomings of these two common residential settings for people with SMI. To our knowledge, no published study has compared clinical and biological measures in non-homeless, non-incarcerated adults with schizophrenia residing in different settings. The present cross-sectional study sought to compare sociodemographic, psychopathology, cognition, mental and physical health factors and biomarkers of aging (specifically reflecting metabolic pathology and inflammation) in outpatients with schizophrenia residing in RCFs and outpatients residing with someone in a house/apartment. We hypothesized that RCF residents would have worse psychopathology, mental health, cognition, physical health, and biomarkers of aging than individuals living in a house or apartment with someone else.

2. Methods

2.1. Participants

This report includes baseline data from persons with schizophrenia or schizoaffective disorder, age 26–79 years, who participated in two studies funded by the National Institute of Mental Health and conducted at the University of California San Diego. Study 1 is a completed clinical trial comparing metabolic, cardiovascular, and cerebrovascular side effects of commonly used atypical antipsychotics in persons (*n* = 60) over age 40, conducted during the years 2005–2010 (Jin et al., 2010). Study 2 is an ongoing longitudinal investigation of accelerated biological aging in subjects with schizophrenia (*n* = 116) aged 26 to 65 years, operational since 2012 (Joseph et al., 2015; Lee et al., 2016). One participant who was homeless was excluded from the present data analyses. All participants were English-speaking outpatients without other major neuropsychiatric disorders or disabling physical conditions. Participants with schizophrenia were recruited from outpatient clinics operated by San Diego County Adult and Older Adult Mental Health Services, UCSD Medical Center, the Veterans Affairs San Diego Healthcare system, and private physicians as well as RCFs throughout San Diego County.

2.2. Board-and-care homes

The 29 RCFs included in this study were fairly representative of those in San Diego County, in terms of services and policies. All of the RCFs featured in this study were licensed and varied in size from 6 to 144 beds, with an average capacity of 35 residents. Medication adherence was not monitored in this cross-sectional baseline sample; however, all subjects with schizophrenia were outpatients on stable medication regimens.

Similarly, while the research participants were not randomized to a residential situation (as it would be extremely impractical to do for reasons listed below), all the study subjects were participating in the same NIMH-funded research studies in which residential status was not an inclusion or exclusion criterion. The subjects were recruited through clinics and advertisements to obtain a sample of outpatients with chronic schizophrenia, who were all on stable doses of antipsychotics, to participate in studies of functioning.

2.3. Clinical characteristics

Sociodemographic characteristics were obtained through interviews by trained study staff and included age, sex, race, education, marital status, and current smoking habits. Severity of psychopathology was measured with the Scales for Assessment of Positive Symptoms and Negative Symptoms (SAPS and SANS) (Andreasen, 1983, 1984; Andreasen and Olsen, 1982).

Mental health measures included mental well-being (mental health

composite score from the Short Form Health Survey – 36 item or SF-36), everyday functioning (UCSD performance-based skills assessment or UPSA), happiness (Center for Epidemiologic Studies – Happiness Scale), Calgary Depression Rating Scale (CDRS), perceived stress (Perceived Stress Scale), optimism (Life Orientation Test-Revised), and resilience (Connor-Davidson resilience scale) (Addington et al., 1990; Campbell-Sills and Stein, 2007; Cohen et al., 1983; Connor and Davidson, 2003; Mausbach et al., 2007; Radloff, 1977; Scheier et al., 1994; Ware and Sherbourne, 1992). We chose to use the SF-36 mental composite score as the primary measure of functioning, as this scale has been widely used and shown to be a feasible-to-administer, reliable, stable, and valid measure of well-being in persons with schizophrenia in a number of studies (Leese et al., 2008; Pukrop et al., 2003; Russo et al., 1998). Executive functioning was assessed with the Delis–Kaplan Executive Function System or D-KEFS (Delis et al., 2001). The executive functioning composite score was the mean of the z-scores derived from three D-KEFS tests (Trail Letter-Number Sequencing, Color Word Inhibition (Switching) and Letter Fluency) (Palmer et al., 2014).

Physical health measures included physical well-being (physical health composite score from the SF-26), physical comorbidity (Cumulative Illness Rating Scale), body mass index (BMI), waist circumference, waist-to-hip ratio, as well as systolic and diastolic blood pressure (Linn et al., 1968; Ware and Sherbourne, 1992).

2.4. Biomarkers of aging

The following biomarkers of inflammation and metabolic pathology were selected: insulin, glucose, glycosylated hemoglobin, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol, hs-CRP, TNF-α and IL-6 (Hong et al., 2016; Joseph et al., 2015; Lee et al., 2016). All of these are considered to be major biomarkers of aging as they are reported to worsen with age in the general population and in persons with schizophrenia (Jeste and Nasrallah, 2003; Kirkpatrick and Kennedy, 2018; Kirkpatrick et al., 2008; Nguyen et al., 2018).

All assays were run on fasting blood samples drawn at study baseline. Fasting serum insulin levels were measured at the UC San Diego Core lab using serum samples that were frozen at −80° and assayed using standard methods in duplicate (Quantitative Chemiluminescent Immunoassay). Reference levels for this assay are 3–19 μ IU/mL. Fasting blood glucose, glycosylated hemoglobin, HDL and LDL cholesterol and triglycerides assays were conducted at the UC San Diego Clinical and Translational Research Institute (CTRI) lab using standard laboratory assays.

Plasma hs-CRP levels were obtained with a commercially available (MSD, Rockville, MD) ELISA at the UC San Diego CTRI lab, from whole blood samples. To obtain Plasma TNF-α and IL-6 levels, we used Meso Scale Discovery MULTI-SPOT® Assay System on a SECTOR Imager 2400 instrument (Rockville, MD, USA). Levels were measured with V-PLEX Human Biomarker panels (Catalog # K151A0H-2). The inflammatory biomarkers were obtained primarily in persons from Study 2.

2.5. Statistical analyses

Continuous variables were assessed for violation of distribution assumptions (skew and kurtosis) and were log-transformed as necessary. Biomarker levels were log-transformed for all analyses. Independent samples *t*-tests and Chi-square tests were used to compare the two groups of patients in different residential settings. Additional comparisons between the participant characteristics in Study 1 and Study 2 were performed prior to including both groups in the overall analyses.

We conducted logistic regression models to examine the factors associated with residential status. Each regression started with all factors that had ≤30% of values missing. Multiple imputation was used for missing values (Schafer, 1997). The least absolute shrinkage and selection operator (LASSO) was used to trim the model and statistical

significance was computed for the predictors/covariates that remained in the trimmed model (Chen et al., 2016). We used backward elimination approach to trim models for all factors. This approach yields less biased estimates than the forward selection method (Wang et al., 2017). The variance inflation factor (VIF) was calculated to detect any potential multicollinearity (Seber and Lee, 2003).

We present effect sizes and *p*-values for all of these statistical tests, and interpret greater than medium effect sizes (i.e., Cohen's $d \geq 0.45$ or $r \geq 0.30$) as meaningful. Significance was defined as Type I error alpha = 0.05 (two-tailed) for all analyses, and False Discovery Rate (FDR) was used to account for multiple comparisons to ensure overall Type I error = 0.05.

3. Results

Of the 176 subjects, 100 patients (44.6%) were living in RCFs and 76 (33.9%) with someone in a house or apartment. In most instances, the living situations had been stable over a period exceeding one year. The groups were comparable in age, gender, years of education, and race/ethnicity. Most of the participants had onset of SZ prior to or at age 40 years (93% of RCF residents vs. 86% of those living with someone, $X^2 = 2.6$, $p = 0.11$.) Sixty participants were from Study 1 and 116 participants were from Study 2. Overall, the Study 1 participants were older ($t(174) = 6.45$, $p < 0.001$, $d = 1.04$), had lower daily antipsychotic doses ($t(155) = -2.96$, $p = 0.004$, $d = -0.60$), and reported better mental well-being ($t(162) = 2.31$, $p = 0.02$, $d = -0.39$) than the Study 2 participants. The Study 1 participants also had higher insulin levels ($t(154) = 3.5$, $p = 0.001$, $d = 0.63$). The study groups did not differ significantly on any other measures.

Compared to those who lived with other people in a house/apartment, RCF residents were less likely to have been married. The RCF residents also smoked more packs of cigarettes and were on higher current daily antipsychotic doses (Table 1). RCF residents had more executive functioning impairments. On the other hand, RCF residents reported better mental well-being, greater happiness, and lower severity of depression. RCF residents had a lower BMI than patients who lived with someone. Other measures of physical health, body composition, and blood pressure did not differ between the two groups. RCF residents had lower HDL ("good") cholesterol levels, but comparable levels of other metabolic and inflammatory markers.

We examined the association of sociodemographic and various clinical variables with residential status and, using LASSO and linear regression analysis. Backward elimination was used to determine the additional factors to include in the model of residential status. The final model is shown in Table 2, with medium-large effect sizes for each variable. We found the following factors to be significantly associated with living in an RCF (compared to living with someone in a house/apartment in the community): never married status, higher doses of antipsychotic medications, better mental well-being, increased physical comorbidities, higher Framingham relative risk score for coronary heart disease, and lower BMI. Thus, better mental well-being was significantly associated with living in an RCF, independent of the antipsychotic medication dose. Antipsychotic medication adherence (compliance) is not assessed in either RCFs or in people living in the community.

4. Discussion

Consistent with our hypotheses, individuals residing in RCFs had some indicators of worse prognosis: higher antipsychotic daily doses and worse executive functioning, compared to individuals living with someone in a house/apartment. However, despite these worse prognostic indicators, RCF residents had lower severity of depressive symptoms, were happier, and reported better mental and physical well-being than those living with someone. In addition, the RCF residents had levels of biomarkers of aging that were comparable with those

Table 1
Comparison of persons with schizophrenia in two residential settings.

	Residing in residential care facilities			Residing with someone in a house or apartment						
	N	Mean or %	Std Dev	N	Mean or %	Std Dev	t / χ2	df	p	Cohen's d
Sociodemographic variables										
Age (years)	100	51.1	10.2	76	51.1	12.0	−0.005	174	1.00	<0.01
Sex (% women)		34.0			46.1		2.63	1	0.11	
Race (%)							2.45	3	0.48	
Caucasian		54.0			47.4					
African-American		16.0			18.4					
Hispanic		21.0			28.9					
Other		9.0			5.3					
Education (years)	100	12.1	1.7	76	12.5	2.8	−0.986	115.2	0.33	−0.15
Ever married (% yes)		32.0			57.9		11.8	1	**0.001**	
Current marital status (%)							27.8	2	**<0.001**	
Married or co-habitating		1.0			25.3					
Single		69.4			41.3					
Separated/divorced/widowed		29.6			33.3					
Current smoking (packs per day)	100	0.55	0.60	74	0.31	0.51	2.70	172	**0.008**	0.42
Psychopathology										
Age of illness onset (years)	95	24.4	9.44	76	26.5	12.23	−1.24	138.5	0.22	−0.19
Antipsychotic daily dose	88	2.10	1.43	69	1.20	1.24	4.15	155	**<0.001**	0.67
Positive symptoms (SAPS)[a]	73	5.99	4.11	43	6.53	4.22	−0.69	114	0.49	−0.13
Negative symptoms (SANS)[a]	73	7.70	4.82	43	6.40	3.80	1.52	114	0.13	0.30
Cognition										
Executive functioning (D-KEFS)[a]	73	−0.65	0.69	43	−0.37	0.79	−2.00	114	**0.05**	−0.38
Mental health										
Depression (CDRS)[a]	72	2.33	3.11	43	4.09	3.72	−2.60	76.5	**0.01**	−0.51
Perceived stress[a]	71	17.4	6.07	43	19.6	6.43	−1.89	112	0.06	−0.36
Optimism (LOT-R)[a]	71	20.7	3.67	43	19.6	4.17	1.46	112	0.15	0.28
Resilience (CD-RISC)[a]	70	23.6	8.08	43	22.4	7.98	0.83	111	0.41	0.16
Mental well-being (SF-36)	93	47.1	10.3	71	43.6	11.51	2.02	162	**0.05**	0.32
Everyday functioning (UPSA)	69	64.3	17.6	42	71.0	21.3	−1.80	109	0.07	−0.34
Happiness (CESD-H)[a]	71	7.90	3.30	43	6.56	3.50	2.06	112	**0.04**	0.39
Physical health										
Physical well-being (SF-36)	93	42.9	9.26	71	43.1	11.6	−0.16	162	0.88	−0.02
Physical comorbidity (CIRS)	94	7.00	4.42	75	6.16	4.67	1.20	167	0.23	0.18
Framingham Risk Score (CHD)	87	1.77	1.01	64	1.40	0.92	2.27	149	**0.02**	0.53
BMI (Kg/m^2)	98	30.6	6.6	74	33.5	8.1	−2.56	170	**0.01**	−0.39
Biomarkers of aging (metabolic)										
Fasting glucose (mg/dL)	93	106.0	51.8	67	115.1	59.1	−1.20	158	0.23	−0.19
Fasting insulin (mIU/L)	91	14.9	15.2	65	17.1	16.8	−0.93	154	0.35	−0.15
Hemoglobin A1C (%)	80	6.01	1.28	69	5.99	1.40	0.24	147	0.81	0.04
HDL cholesterol (mg/dL)	96	42.8	12.1	71	49.1	16.6	−2.28	134.7	**0.02**	−0.36
LDL cholesterol (mg/dL)	93	101.3	35.7	69	106.0	31.7	−1.27	159.5	0.21	−0.20
Triglycerides (mg/dL)	96	163.2	100.5	71	160.0	99.6	0.34	165	0.73	0.05
Biomarkers of aging (inflammatory)										
CRP (mg/L)[a]	97	6.4	15.8	73	4.7	8.9	1.49	168	0.14	0.33
TNF-α (pg/mL)[a]	72	3.17	1.19	41	3.08	1.18	0.26	111	0.80	0.05
Interleukin-6 (pg/mL)[a]	72	1.06	0.98	41	1.29	0.98	−1.42	111	0.16	−0.27

Abbreviations: SAPS/ SANS = Assessment of Positive Symptoms and Negative Symptoms; CDRS = Calgary Depression Rating Scale; CHD = Coronary Heart Disease. LOT-R = Life Orientation Test-Revised; CD-RISC = Connor-Davidson Resilience Scale 10-item; D-KEFS = Delis–Kaplan Executive Function System, SF-36- Short-Form Health Survey; UPSA = UCSD Performance-based Skills Assessment; CESD-H = Center for Epidemiologic Studies-Depression; Happiness Scale; CIRS = Cumulative Illness Rating Scale; BMI = body mass index; mg/dL = milligrams per deciliter; mIU/L = milli-international units per liter; HDL = High-density lipoprotein; LDL = Low-density lipoprotein; hs-CRP = high sensitivity C-Reactive Protein; pg/mL = picograms per milliliter; TNF = Tumor Necrosis Factor.
For the following scales, higher scores reflect better functioning/performance: D-KEFS, LOT-R, CD-RISC, SF-36, UPSA, CESD-H.
For the following scales, higher scores reflect worse functioning/performance: SAPS, SANS, CDRS, Perceived Stress, CIRS.
[a] Only assessed in the participants in Study 2 (Accelerated biological aging in schizophrenia).

living with someone.

Our findings were consistent with previous studies of RCF residents compared to residents living independently (Auslander et al., 2001; Mausbach et al., 2008; Nelson et al., 1997). The 2001 Auslander et al. study examined 251 adults (40+ years old) with schizophrenia, either living in RCFs or living either alone or with someone in a house/apartment. A larger proportion of the RCF residents had never been married and had worse global cognitive performance (i.e., initiation/ perseveration, conceptualization, construction, attention and memory.) The 2008 Mausbach et al. paper studied 434 adults with schizophrenia (average age 50 years) who lived in either non-independent (RCFs and skilled nursing facilities or SNFs) or independent (living alone in apartments/homes or single-room occupancies) settings. The Mausbach paper includes residents of SNFs with the RCF residents, despite the

likely differences in physical comorbidities and age. Similar to the Auslander study, the Mausbach et al. paper reported that RCF/SNF residents had higher doses of antipsychotics compared to those living independently. The Nelson et al. group studied 77 adults (mean age 38 years) living in RCFs and supportive apartments (1–3 person apartments with on-call staff) in Canada. The Canadian RCFs were very similar to US RCFs: 8–28 residents, around-the-clock staffing, shared bedrooms, and provision of meals and other support services. RCF residents were less likely to be married. Thus, these findings may be generalizable to RCFs outside of California.

Some other studies have reported that RCF residents were younger (Gupta et al., 2003), more likely to be male (Gilmer et al., 2003), less educated (Gupta et al., 2003; Mausbach et al., 2008), or had an earlier age of onset of schizophrenia (Auslander et al., 2001; Weiner et al.,

Table 2
General linear models of the factors associated with residential status.

| | Factors associated with living in an RCF | | | | |
	B	*SE*	*Z*	*p*	*Odds*
Never married	1.03	0.37	2.78	0.006	2.8
Antipsychotic dose	−0.35	0.15	−2.28	0.02	0.70
Mental well-being	−0.04	0.02	−2.46	0.01	0.96
Framingham risk	−0.75	0.22	−3.38	<0.001	0.47
BMI	0.09	0.03	3.13	0.002	1.10
LDL cholesterol level	2.97	1.35	2.19	0.03	19.4
CRP level	−0.79	0.35	−2.24	0.02	0.45

B = Parameter estimate.
SE = Standard error.
BMI = body mass index.
LDL = low-density lipoprotein.
CRP = C-reactive protein.

2010) compared to those living independently. Our study did not confirm these findings. It is important to note that none of these other studies specifically compared RCF residents with those who lived with someone in a house or apartment. Two studies included persons in supported housing that provided some level of supervision and sometimes roommates as the comparison group (Nelson et al., 1997; Weiner et al., 2010). In a few studies, the independent living comparison group either included persons who lived alone as well as those who lived with someone (Auslander et al., 2001; Gilmer et al., 2003; Gupta et al., 2003) or was limited to those living alone (Mausbach et al., 2008). Furthermore, Gupta et al. (2003) included nursing home residents in the RCF group and only focused on older populations, whereas Nelson et al. (1997) and Weiner et al. (2010) included persons with mental illnesses other than schizophrenia.

Surprisingly, our findings reflected that persons living in RCFs were doing as well as or better in several measures of mental and physical health. Some studies have reported that RCF residents had fewer hospitalizations (Gilmer et al., 2003), more regular psychiatric care (Gilmer et al., 2003), and greater social support (Nelson et al., 1997; Weiner et al., 2010) than independent living comparison groups. Findings on psychological well-being are mixed, with reports of similar or improved life satisfaction and similar or less severe depression (Gupta et al., 2003; Nelson et al., 1997; Weiner et al., 2010). Published reports have not directly compared persons living in RCFs with those living with someone else, in order to examine the possible impact of RCF services on outcomes without the potential confounding influence of social networks, social isolation, or loneliness (Cohen and Sokolovsky, 1979; Pjescic et al., 2014; Shioda et al., 2016; Tremeau et al., 2016). To our knowledge, no other studies have compared mental and physical health measures as well as biomarkers of aging between RCF residents and those living with someone in an independent setting (house or apartment).

RCFs provide useful services for a population with particularly severe mental illnesses, seeking to help these individuals achieve mental and physical well-being and health that are comparable to, if not better than, those in persons with schizophrenia living with others. Possible reasons include the availability of 24-h staff support, three meals daily, assistance with medication adherence and primary care, communal living environment, rules forbidding alcohol or substance use, and greater access to organized activities. Although the implicit goal of most treatments is to equip residents for eventual independent living, the current findings emphasize that independent living without commensurate social and medical supports is likely to have an adverse impact on overall health and well-being. Persons with schizophrenia, even those residing in RCFs, continue to have increased morbidity and premature mortality compared to the general population (Lee et al., 2017; Saha et al., 2007). We believe that interventions to improve physical health may be based in RCFs as they are a model of low-cost care that remains a relatively untapped resource in improving the well-being of

people with SMI.

The association between living arrangement and clinical status could be bidirectional – i.e., the living arrangement might affect symptomatology and *vice versa*. Future research should seek to understand the potential positive as well as negative impact of living facilities on clinical course of the illness, so as to design and develop policies that enhance psychiatric and medical care. Scientifically, it would be ideal to conduct a formal intervention trial in patients with schizophrenia who are discharged from the hospital, in which the patients are randomized to RCFs or to living in a house or apartment with someone in the community, functioning is assessed before and after the intervention, standardized treatment regimens are used, and medication adherence as well as household levels of expressed emotions are measured. Unfortunately, such a trial may not be pragmatic and unlikely to be funded by a federal agency or even approved by an Institutional Review Board.

Limitations of this study include the cross-sectional design with a non-random sample of persons with schizophrenia who met criteria for and completed the baseline assessment for our parent research studies, and the exclusion of homeless and incarcerated persons as well as those living alone in the community. We chose to focus on comparing persons with chronic schizophrenia who lived in RCFs with those who lived with someone in a house/apartment in the community, excluding those lived alone and those who were homeless or incarcerated because these groups are considerably different from the two groups in our study in multiple ways (income, healthcare, everyday functioning, etc.). While we do not have data on with whom the persons with schizophrenia were living in the community, we know that 25% of the members of that group were married/co-habitating with a partner, compared to 1% in the RCF group. Medication adherence was not assessed in these participants. Certain assessments were only available in the participants from one of the two studies. Although RCFs were largely similar to one another due to their state licensing (requiring 24-h supervision, medication services, and meal provision), geographic location (San Diego county), and resident population (adults with serious mental illnesses), there might be some heterogeneity in their operation including quality of staffing, which is difficult to measure. As we did not recruit patients for the parent studies based on their living situation, our results may not be generalizable to all adults with schizophrenia. In the present report, the participants from the two parent studies differed significantly by age. Other study group differences such as antipsychotic daily dose, mental well-being, and insulin level may also be age-related. There is also the possibility of Type I error because of multiple comparisons, though we used FDR-adjusted *p*-values for the general linear model results.

Notwithstanding the limitations, these findings provide a profile of the clinical health characteristics of individuals in RCFs compared to community-dwelling adults with schizophrenia living with someone, in a relatively large sample and using comprehensive clinical and biomarker data. RCFs seem to impact mental and physical health in persons with schizophrenia, and may warrant greater regulatory oversight and funding support. There are a number of unlicensed RCFs nationwide (Fleishman, 2004). We recommend that a requirement for licensing of all RCFs should involve increasing physical activities, offering healthy meals, and reducing smoking among the residents. Obviously, more financial resources will need to be made available to RCFs to enable them to offer better services.

Recently, several studies of lifestyle interventions (e.g., physical activity, nutrition) for outpatients with schizophrenia have been published (Bartels et al., 2015; Daumit et al., 2013; Sajatovic et al., 2011). Bartels and colleagues tested a 12-month physical activity intervention in 133 overweight/obese adults with SMI (27% in supervised or supportive house, mean age 44 years.) Daumit et al. conducted a randomized controlled trial of 18-month behavioral weight-loss intervention (focused on exercise and diet) in 279 overweight/obese adults with SMI (55% living in residential program or with a care provider, mean age 45

years). The Sajatovic et al. study used a 12-week peer support intervention to improve diabetes outcomes in 12 adults with SMI and diabetes (58% lived with someone, median age 50 years). All these interventions had a positive impact on the SMI patients' physical health. Thus, while the Bartels et al. intervention took place at a local YMCA fitness club, this type of intervention could be scalable within an RCF, with group classes and fitness equipment within the RCF. Similarly, the Daumit et al. intervention capitalized on the resources available through outpatient community programs – i.e., staff to facilitate classes and exercise sessions and provision of meals which were modified to be healthier. Such interventions would be well-suited for the RCF environment, which has similar staff support and meal provision. Lastly, the Sajatovic et al. intervention used nurse educator and peer-led groups to help participants better manage their diabetes. These groups would also be feasible within an RCF where many of the residents are at high risk for diabetes due to lifestyle and medication-related factors. Thus, all of these interventions would be feasible and impactful within an RCF setting.

While the cross-sectional nature of the study does not allow us to infer causality, it is possible that the supportive environment of RCFs may have a positive impact on mental and physical health of persons with schizophrenia. Longitudinal follow-up studies are needed to test this hypothesis.

Declaration of interest

The authors declare no relevant conflicts of interest.

Funding support

Acknowledgments

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2019.02.067.

References

Addington, D., Addington, J., Schissel, B., 1990. A depression rating scale for schizophrenics. Schizophr. Res. 3 (4), 247–251.

Andreasen, N.C., 1983. Scale for the Assessment of Negative Symptoms (SANS). University of Iowa, Iowa City, IA.

Andreasen, N.C., 1984. Scale for the Assessment of Positive Symptoms (SAPS). University of Iowa, Iowa City, IA.

Andreasen, N.C., Olsen, S., 1982. Negative v positive schizophrenia. Definition and validation. Arch. Gen. Psychiatry 39 (7), 789–794.

Auslander, L.A., Lindamer, L.L., Delapena, J., Harless, K., Polichar, D., Patterson, T.L., et al., 2001. A comparison of community-dwelling older schizophrenia patients by residential status. Acta Psychiatr. Scand. 103 (5), 380–386.

Bartels, S.J., Pratt, S.I., Aschbrenner, K.A., Barre, L.K., Naslund, J.A., Wolfe, R., et al., 2015. Pragmatic replication trial of health promotion coaching for obesity in serious mental illness and maintenance of outcomes. Am. J. Psychiatry 172 (4), 344–352.

Burns, T., Rugkasa, J., Molodynski, A., Dawson, J., Yeeles, K., Vazquez-Montes, M., et al., 2013. Community treatment orders for patients with psychosis (OCTET): a randomised controlled trial. Lancet 381 (9878), 1627–1633.

Cabassa, L.J., Stefancic, A., O'Hara, K., El-Bassel, N., Lewis-Fernandez, R., Luchsinger, J.A., et al., 2015. Peer-led healthy lifestyle program in supportive housing: study protocol for a randomized controlled trial. Trials 16, 388.

Campbell-Sills, L., Stein, M.B., 2007. Psychometric analysis and refinement of the Connor-davidson Resilience Scale (CD-RISC): validation of a 10-item measure of resilience. J. Trauma Stress 20 (6), 1019–1028.

Center for Mental Health Services, 2006. In: Manderscheid, R.W., Berry, J.T. (Eds.), Mental Health, United States, 2004. Substance Abuse and Mental Health Services Administration, Rockville, MD.

Chen, T., Wu, P., Tang, W., Zhang, H., Feng, C., Kowalski, J., et al., 2016. Variable selection for distribution-free models for longitudinal zero-inflated count responses. Stat. Med. 35 (16), 2770–2785.

Chilvers, R., Macdonald, G.M., Hayes, A.A., 2006. Supported housing for people with severe mental disorders. Cochrane Database Syst. Rev.(4), Cd000453.

Cohen, C.I., Meesters, P.D., Zhao, J., 2015. New perspectives on schizophrenia in later life: implications for treatment, policy, and research. Lancet Psychiatry 2 (4), 340–350.

Cohen, C.I., Sokolovsky, J., 1979. Health-seeking behavior and social networks of the aged living in single-room occupancy hotels. J. Am. Geriatr. Soc. 27 (6), 270–278.

Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. J. Health Soc. Behav. 24 (4), 385–396.

Connor, K.M., Davidson, J.R., 2003. Development of a new resilience scale: the Connor-Davidson Resilience Scale (CD-RISC). Depress. Anxiety 18 (2), 76–82.

Craig, T.J., Lin, S.P., 1981. Death and deinstitutionalization. Am. J. Psychiatry 138 (2), 224–227.

Daumit, G.L., Dickerson, F.B., Wang, N.Y., Dalcin, A., Jerome, G.J., Anderson, C.A., et al., 2013. A behavioral weight-loss intervention in persons with serious mental illness. N. Engl. J. Med. 368 (17), 1594–1602.

Davis, L., Fulginiti, A., Kriegel, L., Brekke, J.S., 2012. Deinstitutionalization? Where have all the people gone? Curr. Psychiatry Rep. 14 (3), 259–269.

Delis, D., Kaplan, E., Kramer, J., 2001. Delis-Kaplan Executive Function Scale (D-KEFS): Examiner's Manual. The Psychological Corporation, San Antonio, TX.

Department of Social Services, 2019. Adult and Senior Care Program, CA.GOV.

Fleishman, M., 2004. The problem: how many patients live in residential care facilities? Psychiatr. Serv. 55 (6), 620–622.

Gilmer, T.P., Folsom, D.P., Hawthorne, W., Lindamer, L.A., Hough, R.L., Garcia, P., et al., 2003. Assisted living and use of health services among medicaid beneficiaries with schizophrenia. J. Ment. Health Policy Econ. 6 (2), 59–65.

Goldman, H.H., 1982. Mental illness and family burden: a public health perspective. Hosp. Community Psychiatry 33 (7), 557–560.

Gupta, S., Steinmeyer, C., Frank, B., Lockwood, K., Lentz, B., Schultz, K., 2003. Older patients with schizophrenia: nature of dwelling status and symptom severity. Am. J. Psychiatry 160 (2), 383–384.

Hong, S., Lee, E.E., Martin, A.S., Soontornniyomkij, B., Soontornniyomkij, V., Achim, C.L., et al., 2016. Abnormalities in chemokine levels in schizophrenia and their clinical correlates. Schizophr Res. 181, 63–69.

Ireys, H., Achman, L., Takyi, A., 2006. State Regulation of Residential Facilities for Adults with Mental Illnesses. In: DHHS (Ed.), Center for Mental Health Services, Rockville, MD.

Jeste, D.V., Nasrallah, H.A., 2003. Schizophrenia and aging. Am. J. Geriatr. Psychiatry 11 (6), 584–588.

Jin, H., Meyer, J., Mudaliar, S., Henry, R., Khandrika, S., Glorioso, D.K., et al., 2010. Use of clinical markers to identify metabolic syndrome in antipsychotic-treated patients. J. Clin. Psychiatry 71 (10) 1,478-1278.

Joseph, J., Depp, C., Martin, A.S., Daly, R.E., Glorioso, D.K., Palmer, B.W., et al., 2015. Associations of high sensitivity C-reactive protein levels in schizophrenia and comparison groups. Schizophr. Res. 168 (1–2), 456–460.

Kirkpatrick, B., Kennedy, B.K., 2018. Accelerated aging in schizophrenia and related disorders: future research. Schizophr. Res. 196, 4–8.

Kirkpatrick, B., Messias, E., Harvey, P.D., Fernandez-Egea, E., Bowie, C.R., 2008. Is schizophrenia a syndrome of accelerated aging? Schizophr. Bull. 34 (6), 1024–1032.

Lee, E.E., Hong, S., Martin, A.S., Eyler, L.T., Jeste, D.V., 2016. Inflammation in schizophrenia: cytokine levels and their relationships to demographic and clinical variables. Am. J. Geriatr. Psychiatry 25 (1), 50–61.

Lee, E.E., Liu, J., Tu, X., Palmer, B.W., Eyler, L.T., Jeste, D.V., 2017. A widening longevity gap between people with schizophrenia and general population: a literature review and call for action. Schizophr. Res. 196, 9–13.

Leese, M., Schene, A., Koeter, M., Meijer, K., Bindman, J., Mazzi, M., et al., 2008. SF-36 scales, and simple sums of scales, were reliable quality-of-life summaries for patients with schizophrenia. J. Clin. Epidemiol. 61 (6), 588–596.

Linn, B.S., Linn, M.W., Gurel, L., 1968. Cumulative illness rating scale. J. Am. Geriatr. Soc. 16 (5), 622–626.

Mausbach, B.T., Bowie, C.R., Harvey, P.D., Twamley, E.W., Goldman, S.R., Jeste, D.V., et al., 2008. Usefulness of the UCSD Performance-Based Skills Assessment (UPSA) for predicting residential independence in patients with chronic schizophrenia. J. Psychiatr. Res. 42 (4), 320–327.

Mausbach, B.T., Harvey, P.D., Goldman, S.R., Jeste, D.V., Patterson, T.L., 2007. Development of a brief scale of everyday functioning in persons with serious mental illness. Schizophr. Bull. 33 (6), 1364–1372.

Nelson, G., Hall, G.B., Walsh-Bowers, R., 1997. A comparative evaluation of supportive apartments, group homes, and board-and-care homes for psychiatric consumer/survivors. J. Community Psychol. 25 (2), 167–188.

Nguyen, T.T., Eyler, L.T., Jeste, D.V., 2018. Systemic biomarkers of accelerated aging in schizophrenia: a critical review and future directions. Schizophr. Bull. 44 (2), 398–408.

Palmer, B.W., Martin, A.S., Depp, C.A., Glorioso, D.K., Jeste, D.V., 2014. Wellness within illness: happiness in schizophrenia. Schizophr. Res. 159 (1), 151–156.

Pjescic, K.D., Nenadovic, M.M., Jasovic-Gasic, M., Trajkovic, G., Kostic, M., Ristic-Dimitrijevic, R., 2014. Influence of psycho-social factors on the emergence of depression and suicidal risk in patients with schizophrenia. Psychiatr. Danub. 26 (3), 226–230.

Pukrop, R., Schlaak, V., Moller-Leimkuhler, A.M., Albus, M., Czernik, A., Klosterkotter, J., et al., 2003. Reliability and validity of Quality of Life assessed by the Short-Form 36 and the Modular System for Quality of Life in patients with schizophrenia and patients with depression. Psychiatry Res. 119 (1–2), 63–79.

Radloff, L., 1977. The CES-D scale: a self report depression scale for research in the general population. Appl. Psychol. Meas. (1), 385–401.

Russo, J., Trujillo, C.A., Wingerson, D., Decker, K., Ries, R., Wetzler, H., et al., 1998. The MOS 36-Item Short Form Health Survey: reliability, validity, and preliminary findings in schizophrenic outpatients. Med. Care 36 (5), 752–756.

Saha, S., Chant, D., McGrath, J., 2007. A systematic review of mortality in schizophrenia: is the differential mortality gap worsening over time? Arch. Gen. Psychiatry 64 (10), 1123–1131.

Sajatovic, M., Dawson, N.V., Perzynski, A.T., Blixen, C.E., Bialko, C.S., McKibbin, C.L., et al., 2011. Best practices: optimizing care for people with serious mental illness and comorbid diabetes. Psychiatr. Serv. 62 (9), 1001–1003.

Schafer, J.L., 1997. Analysis of Incomplete Multivariate Data. Chapman & Hall, London.

Scheier, M.F., Carver, C.S., Bridges, M.W., 1994. Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the Life Orientation Test. J. Pers. Soc. Psychol. 67 (6), 1063–1078.

Seber, G., Lee, A., 2003. Linear Regression Analysis, Second ed. John Wiley & Sons, Inc., Hoboken, NJ.

Shioda, A., Tadaka, E., Okochi, A., 2016. Loneliness and related factors among people with schizophrenia in Japan: a cross-sectional study. J. Psychiatr. Ment. Health Nurs. 23 (6–7), 399–408.

Siegel, C.E., Samuels, J., Tang, D.I., Berg, I., Jones, K., Hopper, K., 2006. Tenant outcomes in supported housing and community residences in New York City. Psychiatr. Serv. 57 (7), 982–991.

Solari, C.D., Cortes, A., Henry, M., Matthews, N., Morris, S., 2014. The 2013 Annual Homeless Assessment Report to Congress. US Department of Housing and Urban Development, Washington, D.C.

Somers, J.M., Moniruzzaman, A., Patterson, M., Currie, L., Rezansoff, S.N., Palepu, A., et al., 2017. A randomized trial examining housing first in congregate and scattered site formats. PLoS One 12 (1), e0168745.

Steadman, H.J., Gounis, K., Dennis, D., Hopper, K., Roche, B., Swartz, M., et al., 2001. Assessing the New York City involuntary outpatient commitment pilot program. Psychiatr. Serv. 52 (3), 330–336.

Swartz, M.S., Swanson, J.W., Wagner, H.R., Burns, B.J., Hiday, V.A., Borum, R., 1999. Can involuntary outpatient commitment reduce hospital recidivism?: Findings from a randomized trial with severely mentally ill individuals. Am. J. Psychiatry 156 (12), 1968–1975.

Torrey, E.F., 1995. Surviving Schizophrenia: A Manual for Families, Consumers and Providers, Third ed. HarperCollins Publishers, New York, NY.

Tremeau, F., Antonius, D., Malaspina, D., Goff, D.C., Javitt, D.C., 2016. Loneliness in schizophrenia and its possible correlates. An exploratory study. Psychiatry Res. 246, 211–217.

Tsai, J., Stroup, T.S., Rosenheck, R., 2011. Housing arrangements among a national sample of adults with chronic schizophrenia living in the United States: a descriptive study. J. Community Psychol. (39), 76–88.

Wang, H., Peng, J., Wang, B., Lu, X., Zheng, J.Z., Wang, K., et al., 2017. Inconsistency between univariate and multiple logistic regressions. Shanghai Arch. Psychiatry 29 (2), 124–128.

Ware Jr., J.E., Sherbourne, C.D., 1992. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med. Care 30 (6), 473–483.

Weiner, A., Roe, D., Mashiach-Eizenberg, M., Baloush-Kleinman, V., Maoz, H., Yanos, P.T., 2010. Housing model for persons with serious mental illness moderates the relation between loneliness and quality of life. Community Ment. Health J. 46 (4), 389–397.