Schizophrenia Research 222 (2020) 423–428

Contents lists available at ScienceDirect

Schizophrenia Research

journal homepage: www.elsevier.com/locate/schres

The role of physical pain in global functioning of people with serious mental illness

Samuel J. Abplanalp [a,*], Kim T. Mueser [a,b,c,d], Daniel Fulford [a,b,d]

[a] College of Health and Rehabilitation Sciences: Sargent College, Boston University, 635 Commonwealth Ave, Boston, MA 02215, United States of America
[b] Department of Psychological and Brain Sciences, Boston University, 64 Cummington Mall, Boston, MA 02215, United States of America
[c] Center for Psychiatric Rehabilitation, Boston University, 940 Commonwealth Ave, West Boston, MA 02215, United States of America
[d] Department of Occupational Therapy, Boston University, 635 Commonwealth Ave, Boston, MA 02215, United States of America

ARTICLE INFO

Article history:
Received 2 May 2019
Received in revised form 16 January 2020
Accepted 28 March 2020
Available online 1 June 2020

Keywords:
Schizophrenia
Major depression
Bipolar disorder
Pain
Functioning

ABSTRACT

While people with serious mental illness (SMI) endorse clinical pain at rates on par or exceeding those in the general population, the association between pain and functioning remains unclear. In this paper we present data on the cross-sectional association between clinical pain and global functioning in a large, mixed diagnostic sample of people with SMI. Eight-hundred ninety-eight people diagnosed with bipolar disorder, major depressive disorder, or schizophrenia were administered the Global Assessment Scale and the 12-item Short Form Survey, which includes an assessment of the extent to which the experience of pain interfered with daily activities over the past month. People with major depressive disorder reported higher pain interference than those with schizophrenia and bipolar disorder. The presence of physical health conditions and psychiatric symptoms were also assessed. After controlling for age, gender, psychiatric symptoms, education level, and physical health problems, pain interference in the past month was associated with significantly lower global functioning. The findings suggest that the experience of pain is associated with poorer global functioning across major SMI diagnoses. Moreover, the impact of pain in global functioning appears independent of physical health problems, and thus may warrant routine screening from mental health providers.

1. Introduction

In the general population, clinical pain has a major impact on global functioning—including reduced employment, decreased social activity, and psychiatric symptoms (e.g., depression and anxiety) (Dueñas et al., 2016). Furthermore, people with high levels of clinical pain have worse social outcomes over time than those experiencing mild or moderate pain (Karayannis et al., 2019; Hengstebeck et al., 2017). The association between pain and functioning in people with diagnosed mental illness is less studied.

In people with serious mental illness (SMI; i.e., bipolar disorder, severe major depressive disorder, or schizophrenia spectrum disorders), pain may be a significantly under-recognized problem. Identifying pain in persons with SMI presents challenges, as many mental health care providers are not well-trained in assessing or distinguishing physical and emotional symptoms arising in the context of pain. Relatedly, providers may not recognize pain symptoms due to other, more salient symptoms of primary psychiatric disorders (Elman et al., 2011). Relatively little research has been conducted on the correlates of clinical pain in the SMI population. This limited knowledge is problematic, as people with SMI have high rates of physical health conditions (e.g., cardiovascular disease, diabetes, obesity) that are often associated with severe clinical pain (Correll et al., 2017; Gardner-Sood et al., 2015; Simon et al., 2006).

The majority of research focused on clinical pain in SMI has been in depression. Research indicates that 65% of people with major depressive disorder are diagnosed with at least one pain-related condition (e.g., joint pain, back pain, migraine) in their lifetime (Bair et al., 2003), compared to rates of 29% and 35% in bipolar disorder and schizophrenia, respectively (Stubbs et al., 2015a; Stubbs et al., 2014). Despite differences in prevalence rates, clinical pain is associated with negative outcomes across disorders. For example, research suggests comorbid pain and major depression contribute to reduced health-related quality of life, decreased physical health, and high rates of unemployment compared to healthy controls and those presenting with only pain or depression (Kroenke et al., 2010). Similarly, clinical pain in bipolar disorder is associated with reduced health-related quality of life (Miller et al., 2012) and increased risk of suicide (Ratcliffe et al., 2008). Regarding pain in schizophrenia, studies consistently demonstrate reduced acute pain sensitivity (Stubbs et al., 2015b). This may lead to painful conditions going unreported. Furthermore, when clinical

* Corresponding author.
E-mail address: samabp@bu.edu (S.J. Abplanalp).

https://doi.org/10.1016/j.schres.2020.03.062
0920-9964/

pain is reported, the evidence suggests that it contributes to worse outcomes, including worse health related quality of life (Stubbs et al., 2015c), lower levels of physical activity (Stubbs et al., 2017), and more severe anxiety and depressive symptoms (Fond et al., 2018).

While clinical pain can have a deleterious impact on quality of life, the extent to which the experience of pain explains additional variance in global functioning above and beyond the effects of symptoms in SMI is unknown. This may be particularly important in schizophrenia, where reduced pain sensitivity may contribute to delays in the identification and treatment of physical health disorders accompanied by pain. Delays in identification could then result in a worsening of physical health disorders and associated pain, which could lead to comorbid physical health disorders and worse prognosis.

The primary aims of this exploratory study were to: (i) compare the prevalence rates of pain interference between different diagnostic groups within a sample of people with serious mental illness; (ii) examine associations between pain interference and relevant covariates, including sociodemographic variables, psychiatric symptoms, substance use, and physical health conditions; and (iii) examine associations between pain interference and global functioning across diagnoses after accounting for these covariates.

2. Methods

2.1. Participants

The participants were 898 persons with SMI receiving treatment at five treatment centers in the U.S. Northeast, including 624 persons with schizophrenia or schizoaffective disorder, 165 persons with bipolar disorder, and 109 persons with major depressive disorder. The sample was drawn from a larger investigation (N = 1152) of health outcomes among people with SMI that included other psychiatric diagnoses such as posttraumatic stress disorder and substance use disorders (e.g., Lu et al., 2008; Rosenberg et al., 2007; Mueser et al., 2004; Rosenberg et al., 2001). The current paper is a secondary exploratory analysis of research questions not formulated in the original investigation. Participants completed the study between June 1997 and December 1998. All participants were receiving treatment through the public mental health systems of Connecticut, Maryland, New Hampshire, or North Carolina, and study procedures were approved by all relevant institutional review boards. The settings from which they were recruited were diverse and included mental health centers located in rural, urban, and small metropolitan areas.

2.2. Psychiatric diagnoses

Diagnoses were determined with the Structured Clinical Interview for DSM-IV (SCID; First et al., 1996) for 219 participants (19% of the sample), and chart diagnoses for the remaining sample. Diagnosis information included prior diagnosis from a clinician; medical records have been shown to be a reliable and valid source of diagnostic information about persons with SMI (Cradock et al., 2001; Lurie et al., 1992). Good agreement was found between SCID and chart diagnoses for those participants assessed by the SCID ($\kappa = 0.72$).

2.2.1. Pain interference

Pain interference was measured using one item from the 12-item Short Form Survey (SF-12; Ware et al., 1996), a well-validated measure of physical and mental health. The item assessed the following: "During the past 4 weeks, how much did pain interfere with your normal work (including both outside the home and housework)" with possible responses on a 5-point scale from 1 ("Extremely") to 5 ("Not at all"); to aid in interpretation, we reversed scored the item. Single-item rating scales are considered psychometrically sound as standard assessments of pain-related outcomes (Hoffman et al., 2010; Hawker et al., 2011). High scores on this item have been associated with higher rates of anxiety and depressive symptoms (Arola et al., 2010), older age (Thomas et al., 2004), and social isolation (Peat et al., 2004) in general population samples. While this item measures functional interference from pain, in the current study we used it as a general proxy for the experience of physical pain, consistent with prior work. This item has been used to measure pain experience in medical populations (e.g., in older adults, people recovering from spinal surgery; Thomas et al., 2004; Putzke et al., 2002) and as a measure of convergent validity (Coplan et al., 2004).

2.2.2. Physical health conditions

The presence of physical health conditions was assessed with items from the Piedmont Health Survey (Regier et al., 1990). Participants were asked if they had been diagnosed with any chronic medical problems, including asthma, diabetes, heart trouble, hypertension, arthritis, cancer, lung disease, ulcers, stroke, epilepsy, head injury, and infectious diseases (e.g., sexually transmitted diseases, hepatitis). The proportion of physical problems endorsed out of the full list of possible problems was used in analyses.

2.2.3. Psychiatric symptoms

Psychiatric symptoms were assessed by selected items from the Brief Psychiatric Rating Scale-Expanded version (BPRS; Lukoff et al., 1986). The BPRS is a widely used interview for assessing psychiatric symptoms among persons with SMI, with items rated on a 7-point scale, ranging from *1* ("none") to *7* ("extremely severe"). Because of interview length and concerns about client burden, only the observational items on the BPRS were collected. These included items assessing blunted affect, motor hyperactivity, conceptual disorganization, excitement, tension, distractibility, emotional withdraw, uncooperativeness, motor retardation, and mannerisms and posturing.

2.2.4. Education level

We included education level as a measure of premorbid functioning. Education level has been used as an indicator of premorbid functioning in both the general population (Franzen et al., 1997) and in people with SMI (Swanson et al., 1998). Research also suggests that lower levels of education are associated with poorer outcomes in people with SMI, including more severe psychiatric symptoms (Swanson et al., 1998) and reduced cognitive functioning (Silver et al., 2003). For the current study, we categorized education status as less than high school (1), high school graduate or GED (2), and more than high school (3).

2.2.5. Substance use

Research suggests alcohol and other drugs (e.g., cannabis) can affect pain sensitivity (De Vita et al., 2018; Ditre et al., 2017; Thompson et al., 2017; Keogh and Witt, 2001). Current alcohol and drug use were identified by the Dartmouth Assessment of Lifestyle Instrument (DALI; Rosenberg et al., 1998). The DALI is an 18-item screening tool for substance use disorders that was specifically developed and validated for persons with serious mental illness, with an example item being, "How many drinks can you hold without passing out?" Scores on alcohol use range from −4 to +6, with a score of 2 or greater indicating alcohol use disorder. Scores on drug use range from −4 to +4, with a score of −1 or greater indicating a drug use disorder. The DALI has high classification accuracy for DSM-IV substance use disorders of alcohol, cannabis, and cocaine. Twenty-five percent of our sample met criteria for alcohol use disorder, while 27% met criteria for a drug use disorder. For the current study we used total scores for alcohol and drug use separately.

2.2.6. Global functioning

Global functioning was assessed by the Global Assessment Scale (GAS; Endicott et al., 1976). The GAS mainly assesses social and occupational functioning, as well as symptom severity (e.g., anxiety, depression, delusions), with higher scores reflecting better functioning. The

GAS also measures domains such as warmth and integrity, family relationships, and communication disturbances. As such, the GAS is a broad measure of global functioning that incorporates elements beyond work and social functioning. Scores on this scale range from 0 ("Needs constant supervision for several days to prevent hurting oneself or others") to 100 points ("No symptoms, superior functioning in a wide range of activities"). The measure has good (ICC = 0.76) to excellent (ICC = 0.91) interrater reliability (Endicott et al., 1976).

2.3. Statistical analyses

We used SPSS (Version 24.0) to perform all statistical analyses. First, we examined descriptive statistics and distributions of all variables to assess assumptions of normality. We then computed Spearman's rho correlations within each of the three major diagnostic groups between variables of interest, including age, pain interference, physical health conditions, psychiatric symptoms, education level, and global functioning to help guide inclusion of covariates in regression models. Next, to test our first aim, we conducted a one-way analysis of variance (ANOVA) to compare the three diagnostic groups on mean levels of pain interference. Secondary analyses also included exploring group differences in psychiatric symptoms, proportion of physical health problems endorsed, GAS scores, education level, and age.

To test our second aim, pain interference served as the dependent variable in a hierarchical regression model with age and gender (Block 1), psychiatric symptoms and substance use (Block 2), and proportion of physical health conditions endorsed (Block 3) as independent variables. To test our third aim, we conducted a hierarchical linear regression in the full sample with global functioning as the dependent variable, and age, gender, and education (Block 1), psychiatric symptoms (Block 2), proportion of physical health conditions endorsed (Block 3), and pain interference (Block 4) as independent variables. We included BPRS observational items in our model to statistically control for potential variance in global functioning ratings on the GAS explained by psychiatric symptom severity.

3. Results

Sample characteristics and descriptive statistics are presented in Table 1.

The correlations between the variables of interest within each of the three major diagnostic groups are shown in Table 2. Across the three diagnostic groups, a higher percentage of physical health problems was associated with more pain interference on the SF-12. Further, older age was associated with more pain interference in major depression and schizophrenia, but not in bipolar disorder. Of note, pain interference was not significantly associated with global functioning in people diagnosed with bipolar disorder ($r = 0.02$, $p = 0.95$), but showed small significant associations among people with major depression ($r = -0.21$, $p < 0.05$) and people with schizophrenia ($r = -0.08$, $p < 0.05$).

The one-way ANOVA (see Table 1) revealed a significant main effect of diagnosis on pain interference. Due to the possibility of heterogeneous variances as a result of unbalanced sample sizes, Welch's test was performed as a more robust indicator of group mean differences. The Welch test was statistically significant for pain interference [$F(2, 890) = 15.31$, $p < 0.001$]. Post-hoc pairwise comparisons using Games-Howell correction to account for unequal sample sizes indicated that people with major depression (M = 2.74, SD = 1.47) reported significantly greater clinical pain interference than people with bipolar disorder (M = 2.23, SD = 1.27) or schizophrenia (M = 1.98, SD = 1.22), who did not differ significantly from each other.

In the regression analysis with pain interference as the dependent variable, older age ($B = 0.01$, $p = 0.03$) and a higher proportion of physical health problems ($B = 2.93$, $p < 0.001$) were associated with significantly greater pain interference in the full sample. Psychiatric symptoms and substance use were not significantly associated with pain interference (see Table 3). As people with major depression had significantly higher pain interference than those with bipolar disorder or schizophrenia, we included diagnosis in the model, using major depression as the reference group. Similar results were found for age, proportion of physical health problems, psychiatric symptoms, and substance use. A diagnosis of schizophrenia ($B = -0.68$, $p < 0.001$) or bipolar disorder ($B = -0.55$, $p < 0.001$) was associated with significantly less pain interference compared to major depression (Table 3).

In the second regression analysis with global functioning as the dependent variable, more severe psychiatric symptoms ($B = -3.27$, $p < 0.001$), lower education level ($B = 2.22$, $p < 0.001$), and higher pain interference ($B = -0.75$, $p = 0.03$) were associated with significantly lower global functioning across diagnostic groups. No significant associations were observed for age or proportion of physical health problems. Similar to the previous analyses, we then fit the same model including diagnosis (Table 4). As schizophrenia had the lowest mean global functioning score, we used schizophrenia diagnosis as the reference group. Similar results emerged, indicating significant associations between psychiatric symptoms, education, pain interference, and poor global functioning. Major depression ($B = 7.71 < 0.001$) was associated with significantly better global functioning compared to schizophrenia, but bipolar disorder did not differ significantly from schizophrenia ($B = 1.44$, $p = 0.18$).

4. Discussion

Despite reports indicating high clinical pain in SMI, the association between pain and functional outcomes remains largely understudied. In our study, over half of the sample reported some degree of pain interference, with 33% reporting moderate to extreme levels. Consistent with previous research and confirming our hypothesis, people with major depression reported higher pain interference than people with bipolar disorder or schizophrenia (Stubbs et al., 2014; Stubbs et al., 2015a; Bair et al., 2003). Moreover, pain interference was significantly associated with age (Brooks et al., 2018; Barbour et al., 2016; Molton and Terrill, 2014) and physical health problems (Correll et al., 2017; Vancampfort et al., 2016; Gardner-Sood et al., 2015), also consistent with previous research.

Table 1
Descriptive statistics and diagnostic differences for pain interference, global functioning, psychiatric symptoms, physcial health problems, socio-demographics, and subsatnce use.

Variable mean (SD)	Bipolar disorder	Major depressive disorder	Schizophrenia	*F*	*p*
Pain interference	2.23 (1.27)	2.74 (1.47)[a]	1.98 (1.22)	15.31	<0.001
GAS score	46.80 (12.16)	52.76 (13.12)[a]	44.43 (11.65)	20.68	<0.001
BPRS psychiatric symptoms	1.73 (0.59)	1.59 (0.53)[b]	1.80 (1.22)[b]	6.11	0.002
Percentage of physical health problems	0.18 (0.17)	0.20 (0.17)[b]	0.15 (0.14)[b]	5.46	0.004
Age	42.84 (11.01)	42.15 (11.83)	41.87 (9.47)	0.62	0.54
Education level	2.18 (0.81)	2.17 (0.77)	1.90 (0.85)[a]	10.58	<0.001
Alcohol use	0.53 (2.21)[b]	−0.06 (2.27)	−0.03 (2.02)[b]	4.12	0.02
Drug use	−1.21 (1.23)	−1.32 (1.22)	−1.14 (1.29)	0.99	0.37

Notes: BPRS = Brief Psychiatric Rating Scale; GAS = Global Assessment Scale.
[a] Significantly different than both diagnoses.
[b] Significantly different than other marked diagnosis.

Table 2
Correlations between diagnostic groups and pain interference, global functioning, psychiatric symptoms, physcial health problems, socio-demographics, and substance use.

	Pain interference	GAS score	BPRS psychiatric symptoms	Percentage of physical health problems	Age	Education level	Alcohol use	Drug use
Bipolar disorder								
Pain interference	–	0.02	0.06	0.31**	0.12	−0.05	0.07	−0.03
GAS score	–	–	−0.17*	−0.01	−0.08	0.24**	−0.12	−0.09
BPRS psychiatric symptoms	–	–	–	−0.04	0.06	0.04	−0.06	0.04
Percentage of physical health problems	–	–	–	–	0.22**	−0.06	0.06	−0.05
Age	–	–	–	–	–	−0.02	−0.22**	−0.41**
Education level	–	–	–	–	–	–	−0.02	−0.01
Alcohol use	–	–	–	–	–	–	–	0.16**
Drug use	–	–	–	–	–	–	–	–
Major depressive disorder								
Pain interference	–	−0.21*	−0.08	0.44**	0.34**	0.10	−0.09	−0.10
GAS score	–	–	−0.04	−0.04	−0.03	0.06	−0.01	−0.05
BPRS psychiatric symptoms	–	–	–	−0.05	0.11	−0.17	−0.01	−0.09
Percentage of physical health problems	–	–	–	–	0.22**	−0.06	0.04	−0.07
Age	–	–	–	–	–	0.06	−0.19*	−0.36**
Education level	–	–	–	–	–	–	−0.09	−0.07
Alcohol use	–	–	–	–	–	–	–	0.24*
Drug use	–	–	–	–	–	–	–	–
Schizophrenia								
Pain interference	–	−0.08*	0.04	0.32**	0.11**	0.07	0.02	0.04
GAS score	–	–	−0.21**	0.05	0.02	0.11**	−0.05	−0.06
BPRS psychiatric symptoms	–	–	–	−0.11**	−0.07	−0.09	0.08*	0.05
Percentage of physical health problems	–	–	–	–	0.24**	−0.02	0.06	0.08
Age	–	–	–	–	–	0.09	−0.15**	−0.29**
Education level	–	–	–	–	–	–	−0.05	−0.07
Alcohol use	–	–	–	–	–	–	–	0.30**
Drug use	–	–	–	–	–	–	–	–

Notes: BPRS = Brief Psychiatric Rating Scale; GAS = Global Assessment Scale.
** $p < 0.01$.
* $p < 0.05$.

Of greatest clinical significance were the findings of associations between pain interference and global functioning. Pain interference was related to worse global functioning in schizophrenia and major depressive disorder, but not in those with bipolar disorder. Previous reports have shown associations between clinical pain and low functioning in individuals with major depression (Jefferis et al., 2011; Kroenke et al., 2010). For example, Kroenke et al. (2010) found that people who report comorbid clinical pain and major depression had lower occupational functioning, were less likely to be employed, and had reduced daily physical activity compared to those with major depression who reported no pain. One prior study of people with schizophrenia showed that higher pain intensity was associated with low health related quality of life (Stubbs et al., 2015c). However, this is the first study we are aware of that has shown a relationship between pain interference and global

Table 3
Socio-demographics, psychiatric symptoms, substance use, and physical health problems as predictors of pain interference across diagnostic groups, and when controlling for diagnosis.

	R^2	R^2 change	*B*	*B* (SE)	*t*	*p*
Model 1	0.13**					
Age		0.02	0.01	0.004	2.21*	0.03
Gender			−0.14	0.12	−1.18	0.24
BPRS psychiatric symptoms		0.002	0.05	0.069	0.77	0.44
Alcohol use			0.005	0.02	0.26	0.79
Drug use			−0.002	0.03	−0.07	0.94
Percentage of physical health problems		0.11	2.93	0.29	10.24**	<0.001
Model 2	0.16**					
Age		0.02	0.01	0.004	2.41*	0.016
Gender			−0.130	0.11	−1.11	0.27
BPRS psychiatric symptoms		0.002	0.09	0.068	1.37	0.17
Alcohol use			0.006	0.02	0.30	0.76
Drug use			0.008	0.03	0.25	0.80
Percentage of physical health problems		0.11	2.78	0.28	9.81**	<0.001
Bipolar disorder		0.03	−0.55	0.15	−3.70**	<0.001
Schizophrenia			−0.68	0.12	−5.50**	<0.001

Notes: BPRS = Brief Psychiatric Rating Scale.
** $p < 0.001$.
* $p < 0.05$

Table 4
Socio-demographics, psychiatric symptoms, physical health problems, and pain interference as predictors of global functioning across diagnostic groups, and when controlling for diagnosis.

	R^2	R^2 change	*B*	*B* (SE)	*t*	*p*
Model 1	0.06**					
Age		0.02	−0.016	0.04	−0.39	0.70
Gender			0.32	1.15	1.48	0.78
Education level			2.22	0.49	4.56**	<0.001
BPRS psychiatric symptoms		0.03	−3.27	0.70	−4.69**	<0.001
Percentage of physical health problems		0.001	4.48	3.02	1.48	0.14
Pain interference		0.01	−0.75	0.34	−2.22*	0.03
Model 2	0.10**					
Age		0.02	−0.011	0.041	−0.27	0.80
Gender			0.48	1.13	0.42	0.67
Education level			1.93	0.48	3.99**	<0.001
BPRS psychiatric symptoms		0.03	−2.84	0.69	−4.14**	<0.001
Percentage of physical health problems		0.001	4.17	2.97	1.40	0.16
Pain interference		0.01	−1.13	0.34	−3.35**	<0.001
Bipolar disorder		0.04	1.44	1.06	1.36	0.18
Major depressive disorder			7.71	1.27	6.07**	<0.001

Notes: BPRS = Brief Psychiatric Rating Scale.
** $p < 0.001$.
* $p < 0.05$.

functioning in schizophrenia. This finding is also important given evidence that people with schizophrenia frequently display decreased pain sensitivity (Stubbs et al., 2015b). Despite reduced sensitivity to acute pain, when pain is perceived it appears to impact overall functioning, which may be a consequence of long-term under recognition of pain and painful conditions, which may lead to greater severity and related functional impairment over time.

While other studies have found associations between pain and reduced quality of life in individuals with bipolar disorder (e.g., Miller et al., 2012), we failed to observe an association between pain interference and global functioning in this group. It is possible that other symptoms or features of hypomanic or manic symptoms are stronger contributors to functional impairment than pain interference in bipolar disorder. Another possibility is that our sample of participants with bipolar disorder had a low prevalence of depression, a key correlate of pain; however, depressive symptoms were not assessed in this study. Despite this, the mean difference in pain interference between major depression and bipolar disorder in the current study was small (roughly 0.5 points on a scale of 1 to 5), a difference that may not be clinically meaningful. Thus, future work is needed to parse unique variance in pain-related outcomes explained by depressive and manic symptoms.

Somewhat surprisingly, the proportion of physical health problems endorsed was not associated with global functioning. Pain interference may be a more salient indicator of the impact of physical health on functioning compared to the presence of specific health conditions. This may be particularly true in people with SMI, as research suggests physical health conditions often go unreported and underdiagnosed. Indeed, individuals diagnosed with SMI are often stigmatized when receiving healthcare, which may limit their willingness to describe health related symptoms and the ability of physicians to make appropriate diagnoses (Knaak et al., 2017). Due to the stigma people with SMI face regarding physical healthcare, pain interference should be considered as a routine screening measure to facilitate the identification of painful health conditions that impact functioning.

We also failed to find an association between pain interference and psychiatric symptom severity—both in the full sample and within the three diagnostic groups. It is important to note, however, that only observed psychiatric symptoms were assessed (e.g., blunted affect, excitement). Future work should include measures of other psychiatric symptoms (e.g., distress associated with paranoia, low energy, anhedonia) to examine their role in pain interference in people with SMI, as well as diagnostic specific measures, such as the Young Mania Rating Scale (Young et al., 1978).

There are several limitations of the current study. For one, while the SF-12 pain interference item is not typically considered to be a direct measure of pain, it has been used in other populations to examine the prevalence of pain and inference with functioning (e.g., in older adults, people recovering from spinal surgery; Thomas et al., 2004; Putzke et al., 2002). It has also been used in pain-related scale development studies to measure convergent validity (Coplan et al., 2004). Despite this, future studies should examine the broader dimensions of persons with SMI, such as pain prevalence, pain location, pain duration, and pain intensity. An additional limitation is the number of statistical tests we conducted. It is possible that some results were spurious due to the multiple tests conducted. Given these analyses were exploratory, however, we did not consider it appropriate to apply more conservative thresholds for determining statistical significance. Lastly, we did not have information on important confounders that may affect pain sensitivity, such as psychotropic medication (Polatin and Dersh, 2004) and obesity (Okifuji and Hare, 2015).

Despite these limitations, this is the first study that we are aware of that has shown an association between pain interference and poor global functioning in individuals with SMI while controlling for key variables such as education level, psychiatric symptoms, and physical health conditions. Our findings suggest that the experience of pain, but not the presence of physical health problems, may be related to global functioning deficits in persons with SMI. Regarding clinical implications, pain interference—and the presence of pain more broadly—should be screened and evaluated during clinical interventions for people with SMI. As we have shown here, pain interference is associated with poor global functioning, which is a common target for interventions in people with SMI. Therefore, assessing different pain-related variables may aid in evaluating the effectiveness of a particular intervention. Though more research is needed to appropriately examine the impact of pain in people with SMI, it may be an important target for future intervention. Interventions focusing on pain management and pain coping could lower the rates of clinical pain and its effect on functioning in persons with SMI. As pain is a complex and multifaceted experience, specific interventions designed for particular disorders may need to be developed to capture the high rates of heterogeneity found throughout these disorders and SMI more broadly.

Funding source

This research was supported by National Institutes of Health grants R01-MH50094-03S2 (S. Rosenberg, Ph.D.), P50-MH43703 (D. Steinwachs, Ph.D.), R01-MH48103-05 (M. Swartz, M.D.), P50-MH51410-02 (M. Swartz, M.D.), R24-MH54446-05 (S. Woods, M.D.), R01-MH52872 (S. Essock, Ph.D.), and Department of Veterans Affairs, Health Services Development and Research Service, through program 824 funds and the Cooperative Studies Program (CSP-706-D) (M. Butterfield, M.D.).

Contributors

S.J. Abplanalp wrote the first draft of the manuscript and conducted all statistical analyses. K.T. Mueser and D. Fulford provided feedback on all subsequent drafts. All authors read and approved the final version of the manuscript.

Declaration of competing interest

The authors report no conflicts of interest.

Acknowledgements

The authors thank all of the 5 Site Health and Risk Study Research Committee, which includes, from Connecticut: Jerilynn Lamb-Pagone, R.N., M.S.N.; Maryland: Lisa J. Garber, B.S., Jean S. Gearon, Ph.D., Richard W. Goldberg, Ph.D., John D. Herron, LCSW-C, Raymond S. Hoffman, M.D., and Corina L. Riismandel, B.A.; New Hampshire: Robin A. Boynton, Patricia C. Carty, M.S., Robert E. Drake, M.D., Mark C. Iber, P.A., Ravindra Luckoor, M.D., Gemma R. Skillman, Ph.D., Robert M. Vidaver, M.D., and Rosemarie S. Wolfe, M.S.; North Carolina: Mary E. Becker, M.S., Hayden B. Bosworth, Ph.D., Barbara J. Burns, Ph.D., Richard Frothingham, M.D., Ronnie D. Homer, Ph.D., Lauren M. Mclntyre, Ph.D., Keith G. Meador, M.D., M.P.H., Patricia M. Spivey, B.A., Karen M. Stechuchak, M.S., and Jeffrey W. Swanson, Ph.D

References

Arola, H., Nicholls, E., Mallen, C., Thomas, E., 2010. Self-reported pain interference and symptoms of anxiety and depression in community-dwelling older adults: can a temporal relationship be determined? Eur. J. Pain 14 (9), 966–971.

Bair, M.J., Robinson, R.L., Katon, W., Kroenke, K., 2003. Depression and pain comorbidity: a literature review. Arch. Intern. Med. 163 (20), 2433–2445.

Barbour, K.E., Boring, M., Helmick, C.G., Murphy, L.B., Qin, J., 2016. Prevalence of severe joint pain among adults with doctor-diagnosed arthritis—United States, 2002–2014. MMWR Morb. Mortal. Wkly Rep. 65 (39), 1052–1056.

Brooks, J.M., Umucu, E., Huck, G.E., Fortuna, K., Sánchez, J., Chiu, C.-Y., Bartels, S.J., 2018. Sociodemographic characteristics, health conditions, and functional impairment among older adults with serious mental illness reporting moderate-to-severe pain. Psychiatr Rehabil J 41 (3), 224–233.

Coplan, P.M., Schmader, K., Nikas, A., Chan, I.S.F., Choo, P., Levin, M.J., Johnson, G., Bauer, M., Williams, H.M., Kaplan, K.M., Guess, H.A., Oxman, M.N., 2004. Development of a measure of the burden of pain due to herpes zoster and postherpetic neuralgia for prevention trials: adaptation of the brief pain inventory. J. Pain 5 (6), 344–356.

Correll, C.U., Solmi, M., Veronese, N., Bortolato, B., Rosson, S., Santonastaso, P., Thapa-Chhetri, N., Fornaro, M., Gallicchio, D., Collantoni, E., Pigato, G., Favaro, A., Monaco, F., Kohler, C., Vancampfort, D., Ward, P.B., Gaughran, F., Carvalho, A.F., Stubbs, B., 2017. Prevalence, incidence and mortality from cardiovascular disease in patients with pooled and specific severe mental illness: a large-scale meta-analysis of 3,211,768 patients and 113,383,368 controls. World Psychiatry 16 (2), 163–180.

Cradock, J., Young, A.S., Sullivan, G., 2001. The accuracy of medical record documentation in schizophrenia. J Behav Health Serv Res 28 (4), 456–465.

De Vita, M.J., Moskal, D., Maisto, S.A., Ansell, E.B., 2018. Association of Cannabinoid administration with experimental pain in healthy adults: a systematic review and meta-analysis. JAMA Psychiatry 75 (11), 1118–1127.
Ditre, J.W., Zale, E.L., Heckman, B.W., Hendricks, P.S., 2017. A measure of perceived pain and tobacco smoking interrelations: pilot validation of the pain and smoking inventory. Cogn. Behav. Ther. 46 (4), 339–351.
Dueñas, M., Ojeda, B., Salazar, A., Mico, J.A., Failde, I., 2016. A review of chronic pain impact on patients, their social environment and the health care system. J. Pain Res. 9, 457–467.
Elman, I., Zubieta, J., Borsook, D., 2011. The missing P in psychiatric training: why it is important to teach pain to psychiatrists. Arch. Gen. Psychiatry 68 (1), 12–20.
Endicott, J., Spitzer, R.L., Fleiss, J.L., Cohen, J., 1976. The global assessment scale: a procedure for measuring overall severity of psychiatric disturbance. Arch. Gen. Psychiatry 33 (6), 766–771.
First, M.B., Spitzer, R.L., Gibbon, M., Williams, J.B.W., 1996. Structured Clinical Interview for DSM-IV Axis-I Disorders–Patient Edition (SCIDI/P Version 2.0). New York State Psychiatric Institute, Biometrics Research Department, New York.
Fond, G., Boyer, L., Andrianarisoa, M., Godin, O., Bulzacka, E., Berna, F., Brunel, L., Coulon, N., Aouizerate, B., Capdevielle, D., Chereau, I., D'amato, T., Denizot, H., Dubertret, C., Dubreucq, J., Faget, C., Leignier, S., Mallet, J., Misdrahi, D., Rey, R., Lancon, C., Passerieux, C., Schandrin, A., Urbach, M., Vidailhet, P., Leboyer, M., Schurhoff, F., Llorca, P., 2018. Self-reported pain in patients with schizophrenia. Results from the national first-step FACE-SZ cohort. Prog. Neuro-Psychopharmacol. Biol. Psychiatry 85, 62–68.
Franzen, M.D., Burgess, E.J., Smith-Seemiller, L., 1997. Methods of estimating premorbid functioning. Arch Clin Neuropsychol 2 (8), 711–738.
Gardner-Sood, P., Lally, J., Smith, S., Atakan, Z., Ismail, K., Greenwood, K.E., Keen, A., O'Brien, C., Onagbesan, O., Fung, C., Papanastasiou, E., Eberhard, J., Patel, A., Ohlsen, R., Stahl, D., David, A., Hopkins, D., Murray, R.M., Gaughran, F., IMPaCT team, 2015. Cardiovascular risk factors and metabolic syndrome in people with established psychotic illnesses: baseline data from the IMPaCT randomized controlled trial. Psychol. Med. 45 (12), 2619–2629.
Hawker, G.A., Mian, S., Kendzerska, T., French, M., 2011. Measures of adult pain: visual analog scale for pain (VAS pain), numeric rating scale for pain (NRS pain), McGill pain questionnaire (MPQ), short-form McGill pain questionnaire (SF-MPQ), chronic pain grade scale (CPGS), short Form-36 bodily pain scale (SF-36 BPS), and measure of intermittent and constant osteoarthritis pain (ICOAP). Arthritis Care Res. 63, S240–S252.
Hengstebeck, E., Roskos, S., Breejen, K., Arnetz, B., Arnetz, J., 2017. Chronic pain disrupts ability to work by interfering with social function: a cross-sectional study. Scand J Pain 17, 397–402.
Hoffman, D.L., Sadosky, A., Dukes, E.M., Alvir, J., 2010. How do changes in pain severity levels correspond to changes in health status and function in patients with painful diabetic peripheral neuropathy? Pain 149 (2), 194–201.
Jefferis, B.J., Nazareth, I., Marston, L., Moreno-Kustner, B., Bellón, J.Á., Svab, I., Rotar, D., Geerlings, M.I., Xavier, M., Goncalves-Pereira, M., Vicente, B., Saldivia, S., Aluoja, A., Kalda, R., King, M., 2011. Associations between unemployment and major depressive disorder: evidence from an international, prospective study (the predict cohort). Soc. Sci. Med. 73 (11), 1627–1634.
Karayannis, N.V., Baumann, I., Sturgeon, J.A., Melloh, M., Mackey, S.C., 2019. The impact of social isolation on pain interference: a longitudinal study. Ann. Behav. Med. 53 (1), 65–74.
Keogh, E., Witt, G., 2001. Hypoalgesic effect of caffeine in normotensive men and women. Psychophysiology 38 (6), 886–895.
Knaak, S., Mantler, E., Szeto, A., 2017. Mental illness-related stigma in healthcare: barriers to access and care and evidence-based solutions. Healthc Manage Forum 30 (2), 111–116.
Kroenke, K., Theobald, D., Wu, J., Loza, J.K., Carpenter, J.S., Tu, W., 2010. The association of depression and pain with health-related quality of life, disability, and health care use in cancer patients. J. Pain Symptom Manag. 40 (3), 327–341.
Lu, W., Mueser, K.T., Rosenberg, S.D., Jankowski, M.K., 2008. Correlates of adverse childhood events in adults with major mood disorders. Psychiatr. Serv. 59, 1018–1026.
Lukoff, D., Nuechterlein, K.H., Ventura, J., 1986. Manual for the expanded brief psychiatric rating scale (BPRS). Schizophr. Bull. 12, 594–602.
Lurie, N., Popkin, M., Dysken, M., Moscovice, I., Finch, M., 1992. Accuracy of diagnoses of schizophrenia in Medicaid claims. Psychiatr. Serv. 43 (1), 69–71.
Miller, C.J., Abraham, K.M., Bajor, L.A., Lai, Z., Kim, H.M., Nord, K.M., Goodrich, D.E., Bauer, M.S., Kilbourne, A.M., 2012. Quality of life among patients with bipolar disorder in primary care versus community mental health settings. J. Affect. Disord. 146 (1), 100–105.
Molton, I.R., Terrill, A.L., 2014. Overview of persistent pain in older adults. Am Psychol 69 (2), 197–207.
Mueser, K.T., Salyers, M.P., Rosenberg, S.D., Goodman, L.A., Essock, S.M., Osher, F.C., Swartz, M.S., Butterfield, M.I., 2004. Interpersonal trauma and posttraumatic stress disorder in patients with severe mental illness: Demographic, clinical, and health correlates. Schizophr. Bull. 30 (1), 45–57.
Okifuji, A., Hare, B.D., 2015. The association between chronic pain and obesity. J. Pain Res. 8, 399–408.
Peat, G., Thomas, E., Handy, J., Croft, P., 2004. Social networks and pain interference with daily activities in middle and old age. Pain 112 (3), 397–405.
Polatin, P.B., Dersh, J., 2004. Psychotropic medication in chronic spinal disorders. Spine J. 4 (4), 436–450.
Putzke, J.D., Richards, J.S., Hicken, B.L., DeVivo, M.J., 2002. Interference due to pain following spinal cord injury: important predictors and impact on quality of life. Pain 100 (3), 231–242.
Ratcliffe, G.E., Enns, M.W., Belik, S., Sareen, J., 2008. Chronic pain conditions and suicidal ideation and suicide attempts: an epidemiologic perspective. Clin. J. Pain 24 (3), 204–210.
Regier, D.A., Farmer, M.E., Rae, D.S., Lock, B.Z., Keith, S.J., Judd, L.L., Goodwin, F.K., 1990. Comorbidity of mental disorders with alcohol and other drug abuse: results from the epidemiologic catchment area (ECA) study. JAMA 25 (19), 2511–2518.
Rosenberg, S.D., Drake, R.E., Wolford, G.L., Mueser, K.T., Oxman, T.E., Vidaver, R.M., Carrieri, K.L., Luckoor, R., 1998. Dartmouth assessment of lifestyle instrument (DALI): a substance use disorder screen for people with severe mental illness. Am.J. Psychiatry. 155 (2), 232–238.
Rosenberg, S.D., Lu, W., Mueser, K.T., Jankowski, M.K., Cournos, F., 2007. Correlates of adverse childhood events among adults with schizophrenia spectrum disorders. Psychiatr Serv 58 (2), 245–253.
Rosenberg, S.D., Trumbetta, S.L., Mueser, K.T., Goodman, L.A., Osher, F.C., Vidaver, R.M., Metzger, D.S., 2001. Determinants of risk behavior for human immunodeficiency virus/acquired immunodeficiency syndrome in people with severe mental illness. Compr. Psychiatry 42 (4), 263–271.
Silver, H., Feldman, P., Bilker, W., Gur, R.C., 2003. Working memory deficit as a Core neuropsychological dysfunction in schizophrenia. Am. J. Psychiatry 160 (10), 1809–1816.
Simon, G.E., Von Korff, M., Saunders, K., Miglioretti, D.L., Crane, P.K., van Belle, G., Kessler, R.C., 2006. Association between obesity and psychiatric disorders in the US adult population. Arch. Gen. Psychiatry 63 (7), 824–830.
Stubbs, B., Mitchell, A.J., De Hert, M., Correll, C.U., Soundy, A., Stroobants, M., Vancampfort, D., 2014. The prevalence and moderators of clinical pain in people with schizophrenia: a systematic review and large scale meta-analysis. Schizophr. Res. 160, 1) 1–8.
Stubbs, B., Eggermont, L., Mitchell, A.J., De Hert, M., Correll, C.U., Soundy, A., Rosenbaum, S., Vancampfort, D., 2015a. The prevalence of pain in bipolar disorder: a systematic review and large-scale meta-analysis. Acta Psychiatr. Scand. 131 (2), 75–88.
Stubbs, B., Thompson, T., Acaster, S., Vancampfort, D., Gaughran, F., Correll, C.U., 2015b. Decreased pain sensitivity among people with schizophrenia: a meta-analysis of experimental pain induction studies. Pain 156 (11), 2121–2131.
Stubbs, B., Gardner-Sood, P., Smith, S., Ismail, K., Greenwood, K., Patel, A., Farmer, R., Gaughran, F., 2015c. Pain is independently associated with reduced health related quality of life in people with psychosis. Psychiatry Res. 230 (2), 585–591.
Stubbs, B., Koyanagi, A., Schuch, F., Firth, J., Rosenbaum, S., Gaughran, F., Mugisha, J., Vancampfort, D., 2017. Physical activity levels and psychosis: a mediation analysis of factors influencing physical activity target achievement among 204 186 people across 46 low- and middle-income countries. Schizophr. Bull. 43 (3), 536–545.
Swanson, C.L., Gur, R.C., Bilker, W., Petty, R.G., Gur, R.E., 1998. Premorbid educational attainment in schizophrenia: association with symptoms, functioning, and neurobehavioral measures. Biol. Psychiatry 44 (8), 739–747.
Thomas, E., Peat, G., Harris, L., Wilkie, R., Croft, P.R., 2004. The prevalence of pain and pain interference in a general population of older adults: cross-sectional findings from the north Staffordshire osteoarthritis project (NorStOP). Pain 110 (1), 361–368.
Thompson, T., Oram, C., Correll, C.U., Tsermentseli, S., Stubbs, B., 2017. Analgesic effects of alcohol: a systematic review and meta-analysis of controlled experimental studies in healthy participants. J. Pain 18 (5), 499–510.
Vancampfort, D., Correll, C.U., Galling, B., Probst, M., De Hert, M., Ward, P.B., Rosenbaum, S., Gaughran, F., Lally, J., Stubbs, B., 2016. Diabetes mellitus in people with schizophrenia, bipolar disorder and major depressive disorder: a systematic review and large scale meta-analysis. World Psychiatry 15 (2), 166–174.
Ware, J.J., Kosinski, M., Keller, S.D., 1996. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. Med. Care 34 (3), 220–233.
Young, R.C., Biggs, J.T., Ziegler, V.E., Meyer, D.A., 1978. A rating scale for mania: reliability, validity and sensitivity. Br. J. Psychiatry 133 (5), 429–435.