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Clinical determinants of physical activity and sedentary behaviour in individuals with schizophrenia

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ABSTRACT

Introduction: Modifiable lifestyle factors such as physical activity (PA) have ameliorative effects on commonly reported health conditions in schizophrenia like cardiovascular diseases and diabetes. Similarly, reduction in sedentary behaviour (SB) promotes better physical health. However, engaging individuals with schizophrenia in PA and less SB can be challenging because of symptoms of schizophrenia. The aims of the present study are (i) to examine the profiles of PA and SB in individuals with schizophrenia; and (ii) to identify their respective clinical determinants.

Method: 157 individuals with schizophrenia were recruited. PA and SB were examined via the Global Physical Activity Questionnaire (GPAQ). Psychopathology was assessed using the Positive and Negative Syndrome Scale (PANSS). Potential clinical predictors of PA and SB were identified via univariate regression analyses and subsequently included in the final multiple regression models for PA and SB respectively.

Results: 63.7% met the WHO PA guidelines. Work-related activity was the largest domain specific contribution towards PA. Mean duration of SB was approximately 9 h and about 57.3% reported at least 8 h or more of SB daily. Positive symptom was associated with engagement in PA and reduced duration of SB. Negative symptom was associated with greater SB.

Conclusion: With emerging evidence of deleterious health effects of SB independent of PA, it is important to monitor SB in individuals with schizophrenia, particularly those presenting with negative symptoms. While the lack of treatment response for negative symptoms remains a challenge, effort should be made to reduce duration of SB.

1. Introduction

Schizophrenia is a severe and disabling condition marked by positive symptoms, negative symptoms, disorganized behaviour and cognitive impairments. As evidenced in the literature, these aspects of illness substantially affect quality of life and functioning outcomes as well as physical health (Strassnig et al., 2014). Higher risk of mortality and metabolic diseases are widely reported in the schizophrenia population. This disparity in physical health in comparison to the wider population is well documented and a major cause of concern (Fleischman and Lurie, 2012; Hennekens et al., 2005; Ringen et al., 2014). As outlined in a recent Commission (Firth et al., 2019), poor physical health manifests due to poor lifestyle factors such as weak physical fitness and sedentary lifestyle. Modifying behaviour is likely to ameliorate these physical health conditions.

In the general population, physical activity (PA) has been reported to be protective against premature mortality and non-communicable diseases like cardiovascular diseases, type 2 diabetes and cancer (von Hausswolff-Juhlin et al., 2009). In the schizophrenia population, engagement in PA is as effective as other pharmacological interventions in managing weight and metabolic health (Vancampfort et al., 2019) and confer similar benefits as the general population, not limited to improved physical health but further extends to improved symptomatology as seen in the reduction of negative symptoms (Dauwan et al., 2016; Firth et al., 2015; Silva et al., 2015) which tend to be resistant to pharmacological treatment. With increased recognition of the relationship between PA and various health outcomes, PA guidelines for adults are established; at least 150 min/week of moderate-intensity or 75 min/week of vigorous-intensity PA (World Health Organisation (WHO, 2010).

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For individuals with schizophrenia, PA is a complex behaviour influenced by illness-related factors like symptoms, duration of illness, antipsychotic medications and extrapyramidal symptoms (EPS) (Vancampfort et al., 2016). Past studies that explored the relationship between illness-related factors with PA found a negative association between mean 24 h activity on the actigraph with positive symptoms and general psychopathology (Wichniak et al., 2011), while negative symptom was negatively associated with self-reported PA (Nyboe et al., 2016). These illness-related factors alongside commonly reported factors in the general population like age, gender, body mass index (BMI) and chronic metabolic diseases (Ball et al., 2000; Chinn et al., 1999; Moschny et al., 2011; Tergerson and King, 2002) may reduce engagement in PA.

Despite health benefits of PA on physical health, individuals with schizophrenia tend to be more physically inactive when compared to demographically matched controls (Lindamer et al., 2008; Vancampfort et al., 2011; Yamamoto et al., 2011) and are highly sedentary (Stubbs et al., 2016). Physical inactivity and SB are distinct constructs with different operational definitions. Physical inactivity refers to a lack of sufficient PA to meet the recommended PA guidelines. On the other hand, several definitions exist for SB, demonstrating a lack of consensus though work is ongoing to refine its conceptual model and reconcile differences in definitions. The commonly used definition as established by the Sedentary Behaviour Research Network (2012) is any waking behaviour characterized by an energy expenditure of $\leq$1.5 metabolic equivalents (METs) while in a sitting or reclining posture.

There is growing evidence in the general population that SB on its own contributes to ill health (Katzmarzyk, 2010; Young et al., 2016). Unlike PA, for which clinical and public health guidelines are established (World Health Organisation, 2010), there are no quantitative guidelines for SB as its dose-response relationship with mortality risk is unclear. Studies that investigated duration of SB associated with deteriorating health reported variable cut-offs. Sitting duration of at least 8 h daily or more was reported to be significantly associated with higher all-cause mortality independent of PA in a healthy sample (van der Ploeg et al., 2012). Similarly, a meta-analysis found that optimal duration of daily sitting time should be less than 7.5 h (Ku et al., 2018). In contrast, a meta-analysis based on only self-reported measures, reported 4 h daily of SB as the cut-off for increased risk of all-cause mortality in adults which can be attenuated by moderate-to-vigorous PA (Ekelund et al., 2016). Furthermore, individuals with combinations of high durations of sitting time and no weekly PA were reported to have the highest all-cause mortality risk. However, sitting durations of less than 8 h per day while also meeting WHO PA guidelines was found to be protective against all-cause mortality (van der Ploeg et al., 2012).

In individuals with schizophrenia, larger time spent in sedentary activities were reported amongst those experiencing more negative and depressive symptoms, greater cognitive impairments and EPS (Vancampfort et al., 2012b). Greater symptom burden is likely to contribute to a sedentary lifestyle (Vancampfort et al., 2012b) and in turn have deleterious effect on physical health. Numerous studies have investigated the effect of PA on symptom improvement (Dauwan et al., 2016; Gligoroska and Manchevska, 2012; Rosenbaum et al., 2014; Silva et al., 2015). Conversely, symptoms of schizophrenia impact engagement in PA and SB (Chinn et al., 1999; Rastad et al., 2014; Suetani et al., 2016; Vancampfort et al., 2012a). The health effects of PA and SB appear to differ, possibly due to the underlying differences in biological mechanisms (Hamilton et al., 2007). Understanding the relationship between illness-related factors, PA and SB are key to improving overall health. In this paper, we aim to examine patterns of PA and SB in individuals with schizophrenia and identify their respective clinical determinants. Specifically, we hypothesize that negative symptoms would be associated with lower PA and greater duration of SB.

2. Methods

2.1. Participants

In this cross-sectional study, participants were recruited from outpatient clinics at the Institute of Mental Health, Singapore. Participants had to be between 21 to 69 years old with a clinical diagnosis of schizophrenia on the medical records based on ICD-9. Exclusion criteria include pregnancy, history of neurological disorders, eating disorders, mental retardation, and substance dependence or abuse. Ethics approval for this study was obtained from the National Healthcare Group's Domain Specific Review Board. Informed consent was obtained from all participants.

2.2. Physical examination and medical history

Height and weight were taken, and BMI was computed. Details on duration of psychiatric illness, duration of treatment and current medications were recorded from medical records. Antipsychotic doses were converted into total daily chlorpromazine equivalents (Atkins et al., 1997; Barnes and Paton, 2011; Chue et al., 2005; Davis, 1974; Leucht et al., 2014).

2.3. Clinical data

Presence and severity of psychopathology in the past week was measured on the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) administered by trained research assistants. PANSS factor scores were derived based on the 5-factor structure validated from a local Chinese sample (Jiang et al., 2013): negative, positive, excitement, depression and cognitive factors.

2.4. PA and SB

PA was estimated using the interviewer administered Global Physical Activity Questionnaire (GPAQ; World Health Organisation, 2012) which measures domain specific PA (i.e. moderate- and/or vigorous-intensity work, travel-related and leisure activity) in a typical week. Each reported PA must have been undertaken for at least 10 min. The obtained PA data were converted into energy expenditure in the form of metabolic equivalents where moderate-intensity activity is weighted 4 METs and vigorous-intensity activity weighted 8 METs in the calculations (World Health Organisation, 2012). In accordance to the GPAQ analysis guide, we derived the following PA indicators: (i) total PA (the sum of all 3 domains) and (ii) domain specific PA. PA levels were categorized based on the following criteria:

i High: vigorous-intensity activity on $\geq$3 days, achieving a minimum 1500 METmin/week; or $\geq$7 days of any combination of walking, moderate- or vigorous-intensity activities, with a minimum of 3000 METmin/week.
ii Moderate: $\geq$3 days of vigorous-intensity activity for at least 20 min per day; or $\geq$5 days of moderate-intensity activity for at least 30 min per day; or $\geq$5 days with any combination of walking, moderate- or vigorous-intensity activity, amounting to a minimum of 600 METmin/week.
iii Low: none of the above criteria were met.

WHO recommends that adults engage in moderate-intensity activities of at least 600 METmin/week; otherwise deemed physically inactive. GPAQ allows estimation of SB from a single-item measuring overall sitting time in a typical day, excluding duration of sleep. Reliability and validity of the GPAQ has been previously established in the general population (Bull et al., 2009; Herrmann et al., 2013).

2.5. Data analyses

Descriptive data was examined across PA levels. Comparison of sample characteristics and clinical data across PA levels were examined using a one-way ANOVA or the Kruskal-Wallis test for continuous variables and chi-square test for categorical variables. SB was dichotomized to ≥8 h/day versus < 8 h/day to allow comparison with a population of healthy control reported in a previous paper, also based on the GPAQ (Win et al., 2015).

Identification of determinants of PA and SB was done in a 2-step method. First, respective candidate predictors were identified through univariate regression analyses with a $p < .10$ cut-off. These candidate predictors were then entered into a multiple regression model to identify the respective predictors of PA and SB at $p < .05$. Assumptions of all regression models were checked. Linear regression was used for models with SB. As non-normal distributions of residuals were detected in linear regression models predicting total PA, quantile regression was used. Quantile regression allows modelling of conditional quantiles of the outcome variable across its frequency distribution without categorizing participants (Beyerlein, 2014). It makes no assumption on the distribution of residuals and does not have other strict assumptions associated with linear regression (Koenker, 2005). As total PA is positively skewed, we identified predictors of PA at the 25th percentile where most of the data is clustered. Its coefficients are interpreted similarly to those of ordinary linear regression but with respect to the conditional quantile and not the mean of the dependent variable. All analyses were conducted using SPSS version 23 (IBM Corp, 2015) and the quantreg package (Koenker, 2005) on R software version 3.5.2. (R Core Team, 2019).

3. Results

3.1. Profiles of PA and SB

The sample consisted of 157 participants with mean age of about 40 years old (SD = 9.48), and predominantly Chinese (89.2%; Indians: 7%; Malays: 3.8%). Males constituted 56.1% of the sample. Participant characteristics across different levels of PA are presented in Table 1. Low levels of total PA was seen in 42% of our sample while moderate and high levels of PA were 42% and 16%, respectively. The mean total PA was 1679 METmin/week (SD = 2341).

Domain specific PA contributions showed work-related activities (44.8%) as highest followed by travel-related activities (37.9%) and recreational activities (17.3%). A breakdown of domain specific contributions stratified by PA levels and gender is illustrated in Fig. 1. Travel-related activity was consistently the highest contributor across both genders at the low and moderate PA levels whereas work was the highest contributor at the high PA level for both genders. Participation in PA was often lowest in recreational activities across both gender and PA levels.

A large proportion of participants (n = 149, 94.9%) report engagement in some form of PA in a typical week (i.e. total PA: > 0 METmin/week). More than half (n = 100, 63.7%) met WHO PA guidelines, with higher numbers in males (59%). Average daily SB was approximately 9 h (median: 8.5, IQR: 6, 11). 57.3% reported at least 8 h or more of SB daily and 68.2%, 53%, and 40% respectively within each level of PA (from low to high levels).

3.2. Determinants of PA and SB

Univariate regression analyses for PA and SB are presented in Tables 2 and 3 respectively. Positive, excitement, cognitive factor, antipsychotic dose and duration of psychiatric illness were identified as candidate predictors at the 25th percentile of total PA. In the final regression model, positive factor demonstrated a significant positive relationship with total PA (Table 2). For SB, age, duration of illness, positive and negative factors were identified as candidate predictors. In the multiple regression model, higher negative factor score and lower positive factor score were significantly associated with higher duration of SB (Table 3). No evidence of multicollinearity was detected.

Table 1
Participant characteristics and clinical factor scores, by PA levels.

	Low (n = 66) n (%)	Moderate (n = 66) n (%)	High (n = 25) n (%)	p
Gender				0.368
Male	34 (38.6)	37 (42.1)	17 (19.3)	
Female	32 (46.4)	29 (42.0)	8 (11.6)	
Age categories				0.240
21-30	10 (34.5)	13 (44.8)	6 (20.7)	
31-40	26 (48.2)	20 (37.0)	8 (14.8)	
41-50	15 (30.6)	26 (53.1)	8 (16.3)	
≥ 51	15 (60.0)	7 (28.0)	3 (12.0)	
Education level				0.954
Primary school or lower	11 (37.9)	13 (44.8)	5 (17.3)	
Secondary school	18 (45.0)	17 (42.5)	5 (12.5)	
Post-secondary	37 (42.0)	36 (40.9)	15 (17.1)	
Employment status				0.099
Employed	26 (34.7)	33 (44.0)	16 (21.3)	
Unemployed	40 (48.8)	33 (40.2)	9 (11.0)	
	Mean (SD)	Mean (SD)	Mean (SD)	p
BMI (kg/m2)	26.3 (5.2)	25.8 (4.2)	27.3 (5.3)	0.380
Duration of illness (years)	16.7 (8.4)	15.9 (8.8)	15.5 (9.3)	0.780
Duration of psychiatric treatment (years)	16.2 (8.6)	15.2 (8.8)	14.6 (8.4)	0.681
Antipsychotic dose (mg/day)	543.3 (442.3)	394.7 (291.1)	544.1 (591.8)	0.197
PANSS				
Positive factor	6.6 (3.5)	7.7 (4.4)	8.0 (4.8)	0.296
Negative factor	7.9 (2.7)	7.7 (3.3)	7.8 (4.0)	0.947
Excitement factor	4.3 (1.9)	4.0 (1.6)	4.1 (1.4)	0.572
Depression factor	5.7 (2.2)	5.7 (2.4)	5.4 (2.6)	0.888
Cognitive factor	4.2 (1.5)	4.4 (1.9)	4.4 (2.0)	0.817
Duration of SB (hr/day)	9.2 (3.4)	9.0 (4.4)	7.3 (3.9)	0.105

Abbreviations: Body Mass Index (BMI), Positive and Negative Syndrome Scale (PANSS), Sedentary Behaviour (SB).

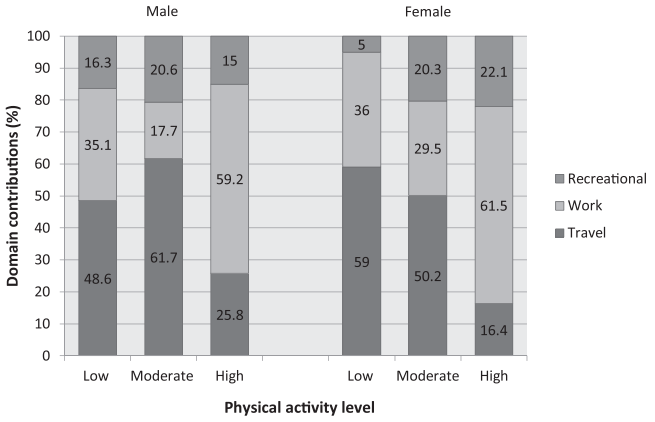

Fig. 1. Proportion of weekly domain contributions by physical activity level categories and gender.

4. Discussion

The present study examined patterns of PA and SB in a sample of community dwelling individuals with schizophrenia. 63.7% individuals with schizophrenia met the WHO PA guideline. Overall, they engaged least in leisure-time recreational activities while the largest

Table 2
Quantile regression analyses of PA.

	Total PA (METmin/wk)			
	Coefficient (τ = .25)	*SE*	*t*	*p*
Univariate analyses				
Age	−4.44	6.45	−0.69	0.492
Gender	40.00	121.11	0.33	0.742
BMI	−10.55	12.12	−0.87	0.385
Duration of illness	−10.43	6.26	−1.67	0.098*
Antipsychotic dose	−0.22	0.11	−2.04	0.043*
Positive factor	24.00	13.86	1.73	0.085*
Negative factor	−10.00	6.59	−1.52	0.131
Excitement factor	−46.67	17.20	−2.71	0.007*
Depression factor	10.00	21.92	0.46	0.649
Cognitive factor	60.00	34.63	1.73	0.085*
Final model				
Duration of illness	−2.30	6.20	−0.37	0.712
Antipsychotic dose	−0.18	0.10	−1.79	0.075
Positive factor	31.85	12.81	2.49	0.014**
Excitement factor	−37.65	22.56	−1.67	0.097
Cognitive factor	52.80	29.25	1.81	0.073

PA: Physical activity; τ: Tau; *SE*: Standard error; *t*: t-statistic *p*: p-value.
* p < 0.10.
** p < 0.05.

Table 3
Linear regression analyses of SB.

	SB (h/day)				
	B	*SE*	*β*	*t*	*p*
Univariate analyses					
Age	0.06	0.03	0.13	1.66	0.100*
Gender	0.14	0.64	0.02	0.22	0.829
BMI	−0.06	0.07	−0.07	−0.89	0.375
Duration of illness	0.07	0.04	0.16	2.01	0.046*
Antipsychotic dose	4.32E-4	7.55E-4	0.05	0.57	0.568
Positive factor	−0.14	0.08	−0.15	−1.90	0.059*
Negative factor	0.21	0.10	0.17	2.09	0.039*
Excitement factor	0.24	0.18	0.10	1.29	0.198
Depression factor	−0.19	0.13	−0.11	−1.42	0.159
Cognitive factor	0.16	0.18	0.07	0.89	0.374
Final model (R^2 = 0.08)					
Age	−0.01	0.05	−0.02	−0.16	0.872
Duration of illness	0.08	0.05	0.18	1.60	0.112
Positive factor	−0.16	0.08	−0.17	−2.12	0.035**
Negative factor	0.20	0.10	0.16	2.00	0.047**

SB: Sedentary behaviour; B: Beta; SE: Standard error; β: Standardized beta weight; t: t-statistic p: p-value.
* p < 0.10.
** p < 0.05.

contributing domain was work-related PA. In contrast, 73% of the general Singapore population met the PA guidelines with travel-related activities (50.9%) being the largest contributing domain followed by recreational activities (24.6%) and work-related activities (24.5%) (Win et al., 2015). Individuals with schizophrenia presented with different patterns of PA and lower proportion met the recommended PA guidelines.

Nevertheless, profiles of PA in our study were similar to past studies. Strassnig and colleagues (2012) reported a mean total PA of 1707 METmin/week based on the short-form International Physical Activity Questionnaire (IPAQ) while another study reported a slightly lower average of 1291 METmin/week (Vancampfort et al., 2013). In a recent study by Suetani and colleagues (2016), the proportion of low versus moderate/high PA levels were 42% and 58% respectively based on the IPAQ, similar to our sample: 41.4% and 58.6% respectively.

A large proportion of our sample (57.3%) had at least 8 h of SB a day, with a median of 8.5 h. In comparison, 37% of the general Singapore population had sitting duration of at least 8 h while the median was 6 h (IQR: 3,8; Win et al., 2015). This is almost 1.5 times lower than the duration of SB in the current study population. Other studies on the schizophrenia population reported mean durations of SB ranging from 7 to 8.5 h/day (Strassnig et al., 2012; Vancampfort et al., 2012b), similar to our findings.

Of individuals who were sufficiently active, 50% had at least 8 h of SB while at least 40% were observed in each of the 3 PA level groups. This is concerning as any health benefits gained from PA might be negated by the deleterious effect on health that comes with at least 8 h of SB. A recent study demonstrated that sitting duration of more than 13 h could undermine benefits of exercise where study participants were found to be resistant to metabolic improvements typically achieved from acute bouts of aerobic exercise (Akins et al., 2019).

Various factors have been reported to contribute to decreased PA engagement and increased SB in individuals with schizophrenia. While we hypothesized negative symptoms to be associated with lower PA and higher SB, our findings supported the latter and further demonstrated associations between positive symptoms with both PA and SB. At the 25th percentile, positive symptom showed a positive relationship with total PA. Positive symptoms are naturally thought to be barriers of PA as they can have distracting effects, interfering with daily tasks. Moreover, based on qualitative reports by staff of inpatient wards and transitional facilities, symptoms like paranoia reduces the likelihood or inhibit participation in PA if it is thought to be fear-inducing. For example, individuals with paranoia were reported to be incapable of going out on group walks because they feel something bad would happen if they left the building (Leutwyler et al., 2013). Nevertheless, there are reports demonstrating positive symptoms as facilitators of PA. A qualitative study found that some individuals use PA as a coping strategy to manage distressing positive symptoms (Faulkner and Biddle, 1999; Leutwyler et al., 2014). Exercising is known to provide relief from positive symptoms while also improving mood and energy levels of individuals with schizophrenia (Firth et al., 2016). Knowing that physical demands of exercise subdue positive symptoms temporarily by distracting their thoughts away from delusions and inhibit intrusive thoughts or voices (Firth et al., 2016; Leutwyler et al., 2014) may motivate these individuals to engage in PA.

In our study, SB was found to be associated with negative symptoms, which is consistent with findings of Vancampfort and colleagues (2012b). Characteristic of negative symptoms, individuals who are very much affected may prefer to be alone and lead sedentary lifestyles such as watching TV or sleeping rather than doing PA especially when it involves other people. Engaging in goal-directed behaviours such as exercise is likely reduced as negative symptoms is associated with lower autonomous motivation towards PA (Strassnig et al., 2014; Vancampfort et al., 2015) thus potentially increasing duration of SB. The inverse relationship between positive symptoms and SB demonstrated in our findings complements the relationship found between positive symptoms with PA. Though no other study has demonstrated this relationship, positive symptoms appear to reduce SB.

Our findings have several limitations. Firstly, assessment of PA and SB via a self-report questionnaire is subjected to recall and/or social desirability bias (Prince et al., 2008). Particularly in our study sample, we observe about 16% of participants reporting high levels of PA. This is rather unusual as it has been found that although individuals with schizophrenia reported same PA levels on various intensity activities as healthy individuals, they were in fact engaging in less than 80% of PA of the healthy population based on actigraphy data, which demonstrates a large over-estimate on self-report measures (Firth et al., 2018). Additionally, severity of symptoms such as delusions, may influence the ability to provide accurate reports on their PA and SB. The significant positive association between positive symptoms and PA could likely be due to measurement error due to over-estimation of their actual PA levels. Therefore, caution should be taken in interpreting findings of

this study. Future studies should consider collecting objective PA data. Secondly, the study recruited only ambulant individuals who turned up at outpatient clinics, hence omitting patients who might be homebound or institutionalised. Furthermore, only individuals capable of giving informed consent were recruited. This would exclude more severely ill individuals from the study, limiting generalizability of study findings. Thirdly, while we know that presence of current or chronic medical comorbidities are common in individuals with schizophrenia and may potentially influence engagement in PA and SB, the study did not account for it. Future studies should consider this as a confounding variable when investigating PA and SB in the schizophrenia population. The study did not include a control group; however, findings from a recently published paper on the general population (Win et al., 2015) allowed general comparisons to be made. The cross-sectional design of the study precludes causal inference between the examined variables with PA and SB.

In conclusion, our findings shed light on the profiles of PA and SB in individuals with schizophrenia and how they compare with the general population. Here, we also identified clinical determinants of PA and SB; negative symptom was associated with greater SB and positive symptom was associated with increased PA and lower SB. Negative symptoms are core features of schizophrenia which are challenging to treat (Remington et al., 2016). While clinicians might be aware of the impact of negative symptoms on functional and psychosocial outcomes, the impact of these symptoms on physical health might go unnoticed. Individuals with schizophrenia also put less importance on their physical health needs, thus needing mental healthcare professionals to engage them in healthy lifestyle behaviour (Gurusamy et al., 2019) through facilitating active interventions like exercise and providing constant encouragement to boost their motivation towards such activities (Gandhi et al., 2019). Understanding the role of symptoms in PA and SB has important implications for successful implementation of interventions aimed at increasing PA participation in practice. As PA and SB have unique health effects, ongoing efforts to improve physical health is needed with particular focus on reducing negative symptoms and SB in individuals with schizophrenia.

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Declaration of Competing Interest

All authors have no conflict of interests to declare.

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