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Exploring the Relationship Between Movement Disorders and Physical Activity in Patients With Schizophrenia: An Actigraphy Study

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Low physical activity (PA) and sedentary behavior (SB) are major contributors to mental health burden and increased somatic comorbidity and mortality in people with schizophrenia and related psychoses. Movement disorders are highly prevalent in schizophrenia populations and are related to impaired functioning and poor clinical outcome. However, the relationship between movement disorders and PA and SB has remained largely unexplored. Therefore, we aimed to examine the relationship between movement disorders (akathisia, dyskinesia, dystonia, and parkinsonism) and PA and SB in 216 patients with schizophrenia and related psychoses. Actigraphy, the St. Hans Rating Scale for extrapyramidal syndromes, and psychopathological ratings (PANSS-r) were applied. Data were analyzed using multiple linear regression, adjusting for sex, age, negative symptoms, and defined daily dose of prescribed antipsychotics. Parkinsonism was significantly associated with decreased PA ($\beta = -0.21$, $P < .01$) and increased SB ($\beta = 0.26$, $P < .001$). For dystonia, only the relationship with SB was significant ($\beta = 0.15$, $P < .05$). Akathisia was associated with more PA ($\beta = 0.14$, $P < .05$) and less SB ($\beta = -0.15$, $P < .05$). For dyskinesia, the relationships were non-significant. In a prediction model, akathisia, dystonia, parkinsonism and age significantly predicted PA ($F(5,209) = 16.6$, $P < .001$, $R^2_{Adjusted} = 0.27$) and SB ($F(4,210) = 13.4$, $P < .001$, $R^2_{Adjusted} = 0.19$). These findings suggest that movement disorders, in particular parkinsonism, are associated with reduced PA and increased SB in patients with psychotic disorders. Future studies should take movement disorders into account when examining PA and SB, to establish the clinical value of movement disorders in activating people with psychotic disorders to improve their mental and somatic health.

Key words: psychosis/extrapyramidal symptoms/parkinsonism/sedentary/behavior/somatic health

Introduction

There is an urgent need to improve low physical activity (PA) and sedentary behavior (SB) in people with schizophrenia and related psychoses, as these are major contributors to poor health outcomes and increased mortality rate. People with schizophrenia have a 2- to 3-fold higher mortality rate compared to the general population, corresponding to a 15-year reduced life expectancy,[1,2] which is primarily due to the increased prevalence of physical health problems, such as obesity, diabetes, metabolic syndrome, cardiovascular disease, and cancer.[3,4] Reduced PA and SB, defined as any waking behavior characterized by an energy expenditure ≤1.5 times the basal metabolic rate while in a sitting or reclining posture,[5] are prevalent in people with schizophrenia and independently associated with cardiometabolic comorbidity and increased mortality.[6–8] In turn, the efficacy of PA interventions for cardiometabolic health, psychiatric symptoms, quality of life, global and cognitive functioning, and physical health have been demonstrated in recent meta-reviews.[9–11]

Patients with schizophrenia that are residents of a hospital or sheltered living environment demonstrate low PA and high SB,[12–15] which can be explained by a multitude of interacting factors. First of all, the inpatient psychiatric setting itself has been considered "obesogenic," due to regulated inactivity and increased energy intake.[16] Furthermore, long-term exposure to antipsychotics is common in patients with schizophrenia, increasing the risk of cardiovascular and metabolic side-effects,

which are considered as major contributors to increased physical morbidity and mortality.[17–19] Moreover, antipsychotics are known to induce movement disorders, common and debilitating side-effects that severely impact quality of life.[20–22] The occurrence of drug-induced movement disorders is high in long-term hospitalized patients with schizophrenia; around two-thirds of these patients are suffering from at least one drug-induced movement disorder, such as akathisia, dyskinesia, dystonia, tremor, and parkinsonism.[23–25] Movement disorders have been related to psychiatric symptom severity, negative symptoms, cognitive dysfunction, and poor psychosocial functioning in antipsychotic-naïve psychotic and high-risk populations,[26–31] suggesting a relationship between movement disorders and an unfavorable clinical outcome in people with schizophrenia and related psychoses.[32–35]

Although the clinical relevance of movement disorders in people with schizophrenia and related psychoses has been clearly established, the role of movement disorders in PA and SB has remained largely unexplored. Systematic reviews and mediation analyses identified various clinical (eg, illness duration, negative symptoms, depression, cognition), intrapersonal (eg, low self-efficacy, lack of knowledge of cardiovascular risk factors, no belief in health benefits of PA), biological (eg, cardiometabolic comorbidity, side-effects of antipsychotics), social and demographic factors (eg, male sex) that can be related to impaired PA in people with schizophrenia, suggesting that PA is a complex behavior caused by multiple interacting factors.[36,37] A deeper understanding of clinical correlates of PA may contribute to better treatment strategies to improve PA and the poor somatic health status in people with schizophrenia and related psychoses. Movement disorders may be one of these multiple interacting factors leading to impaired physical activity, as movement disorders are related to clinical correlates (ie, negative symptoms, cognitive deficits, and psychosocial functioning)[26–31] that are related to reduced PA.[36,37] Also, movement disorders may lead to reduced PA because of their nature to hamper or reduce movements, this accounts for the hypokinetic movement disorders in particular. Conversely, engaging in less PA might ameliorate movement disorders in psychiatric patients. In this study, we aimed to investigate the association of movement disorders with physical activity and SB in patients with chronic schizophrenia and related psychoses, taking other clinical correlates, such as antipsychotic medication and negative symptoms, into account.

Methods

Participants

To explore the relationship of movement disorders to PA and SB, we pooled data on actigraphy data from previous[15] and ongoing studies patients with severe mental illness. Patients were included if they were ≥18 years old and lived at the wards for long-term mental healthcare (ie, ≥1 year hospitalization) or sheltered housing facilities of a mental health care institution (GGz Centraal, the Netherlands). The studies were approved by the Central Committee on Research Involving Human Subjects (CCMO). Informed consent was provided prior to study inclusion. For the current study, we included subjects with a diagnosis of schizophrenia or related psychotic disorder (ie, schizoaffective disorder, schizophreniform disorder, and psychotic disorder Not Otherwise Specified [NOS]), sufficient actigraphy data, and available data on movement disorders.

Demographic and Clinical Characteristics

Demographic and clinical characteristics (eg, gender, age, years of hospitalization, diagnosis, and medication) were derived retrospectively from the clinical records. Diagnosis was established by a board-certified psychiatrist according to the DSM-IV-TR. Antipsychotic medication use was converted into defined daily dose (DDD) according to the Anatomical Therapeutic Chemical (ATC) Classification System.[38] Antipsychotics were divided into first-generation and second-generation antipsychotics. Psychotic symptoms were screened by the Dutch version of the Positive and Negative Syndrome Scale Remission tool (PANSS-r) within a semi-structured interview. This instrument is validated for both in- and outpatients with schizophrenia and includes 8 core symptoms of the diagnosis schizophrenia (two general psychopathology items and 3 items of both positive and negative symptoms), scored from 1 (absent) to 7 (extreme).[39–42]

Movement Disorders

Movement disorders were assessed on the St. Hans Rating Scale (SHRS), a validated combined rating scale for the evaluation of drug-induced akathisia, dyskinesia, dystonia and parkinsonism with good inter- and intrarater reliability.[43] The rating scale was translated into Dutch with some minor adaptations: (1) the global dystonia scale was replaced with 4 dystonia items (neck, eyes, fingers, and swallowing) to differentiate between the types of dystonia, and (2) the dyskinesia "active" (patient is active: talking, writing, or performing a voluntary movement) and "passive" (patient is sitting unoccupied and undisturbed) scale were merged into one scale to score the most severe dyskinesia that was observed during the examination. Raters were trained and supervised by an expert clinician (PvH and/or DT). The items of each movement disorder were rated on a 7 point scale between 0 ("absent") and 6 ("severe") and the scores of the different items were added up to calculate the sum score for each movement disorder. Also, cutoff values were used for case-definition of movement disorders: for akathisia, a score of at least "mild" on the motor and

psychic akathisia subscales[43]; for dyskinesia, a rating of at least (1) "mild-moderate" on one item, or (2) "mild" on two items, in accordance with the Schooler and Kane criteria for tardive dyskinesia[44]; for dystonia, a rating of at least "mild" on one item[43]; and for parkinsonism, case-definition was defined as a rating of at least (1) "mild" on the tremor or rigidity item, (2) "mild" on two items, or (3) "mild-moderate" on one item.[25]

Actigraphy

SB and PA were measured by the ActiGraph GT3X+ (ActiGraph, Pensacola, Florida, VS), a triaxial accelerometer worn on the right hip. Participants were instructed to wear the GT3X during wakeful periods from Wednesday until Sunday, in order to include both weekdays and weekend days. A wear time of more than 6 hours/day for at least 3 days was used as the criterion for a valid measurement. Data were analyzed using the ActiGraph software ActiLife 6.8.0 and calculated into average total activity counts per hour (TAC/h) as a continuous and detailed outcome variable of PA, where more counts indicate a higher level of PA. SB, light-intensity physical activity (LPA), and moderate to vigorous activity (MVPA) were reported as a percentage of valid wear time, using predefined TAC/h cutoffs. A detailed description of used settings and criteria is described elsewhere.[15] The GT3X+ is a valid instrument with high inter- and intra-instrumental reliability.[45–47]

Statistical Analyses

All statistical tests were conducted using R version 3.6.1.[48] First, a descriptive analysis was performed to explore patient clinical and demographic characteristics, including data on movement disorders, antipsychotic use, and actigraphy data. Continuous variables were examined for normality and homogeneity by comparing means with medians and standard deviations and by analyzing frequency histograms and normality plots.

To investigate the relationship between movement disorders (akathisia, dyskinesia, dystonia, and parkinsonism) and actigraphy data we performed multiple linear regression analysis. Linearity between independent and dependent variables were examined by scatterplots. We built separate models for each movement disorder, with the SHRS sum score of the movement disorder as the independent variable and total activity counts per hour as the dependent variable. Furthermore, we explored the associations between each movement disorder and proportions of time spent sedentary and in LPA and MVPA. The possible confounding effect of age, sex, antipsychotic dosage (total DDD of first and/or second-generation antipsychotics), and negative symptoms (PANSS-r) was assessed by using stepwise forward selection. Confounding was defined as a change of ≥10% in the regression coefficient of the independent variable of interest (eg, parkinsonism). The strongest confounder was added to the model to control for, until there were no variables left causing ≥10% change in the regression coefficient. Associations were considered significant at a .05 two-tailed significance level. We inspected plots of residuals against predicted values and the distributions of residuals by histograms and normality plots for all models, to check the assumption of homogeneity of variance of residuals.

After building separate regression models for each movement disorder, we combined akathisia, dyskinesia, dystonia, and parkinsonism to build a prediction model for PA. The 4 movement disorders and potential confounders were added as independent variables and total activity counts and SB were added as dependent variables, respectively. Stepwise backward elimination using Akaike's Information Criterion (AIC) was used to determine predictors with the stepAIC function from the MASS package in R.[49] To assess for multicollinearity, changes in models were observed, and correlations between movement disorders and the variance inflation factor (VIF) were inspected, where VIF > 10 indicated a potential problem for multicollinearity.

Missing data was inspected by comparing groups of missing and non-missing data on antipsychotics using Chi-squared or independent *t*-tests. Because detailed data on antipsychotic dosage was missing in a considerable proportion (30%; 65/216), multivariate imputation by chained equations of missing data was performed using the MICE package from R.[50] The Little's MCAR test was performed to test the null hypothesis that data is Missing Completely At Random (MCAR)[51] and missing values were replaced by creating a set of 50 independent values using predictive mean matching, the preferred approach for multiple imputation that produces the least biased estimates.[52] Pooled parameter estimates were used to examine the confounding effect of antipsychotic dosage in the above-mentioned regression models for the complete (n = 216) dataset. Furthermore, we performed the above-mentioned regression models within the datasets with complete (n = 151) and incomplete (n = 65) data on antipsychotic medication and compared the results.

Results

Sample

A total of 216 subjects with schizophrenia or related psychoses were included for analysis, as presented in table 1. The majority of patients were male (62%) and had a diagnosis of schizophrenia (82%). Mean age was 55.2 years (range 24–89 years). Almost all (99%) patients used antipsychotics, either first generation (20%), second generation (60%) or both (19%). Median DDD of antipsychotics was 1.6 (IQR 1.0–2.2). Patients spent the vast majority of their waking time sedentary (82%)

Table 1. Demographic and Clinical Characteristics

	Cases (n = 216)
Age, mean (SD)	55.2 (13.0)
Sex (male), *n* (%)	133 (61.6%)
DSM-IV Diagnosis, *n* (%)	
Schizophrenia	177 (81.9%)
Other psychotic disorder[a]	39 (18.1%)
Positive PANSS-r, median (IQR)	3.00 (3.00–12.00)
Negative PANSS-r, mean (SD)	7.44 (4.97)
Antipsychotic treatment[b]	
None, *n* (%)	2 (1.3%)
First generation only, *n* (%)	30 (19.9%)
Second generation only, *n* (%)	90 (59.9%)
Both, *n* (%)	29 (19.2%)
DDD antipsychotic treatment, median (IQR)	1.62 (1.00–2.22)
Movement disorders	
Akathisia[c]	
Frequency, *n* (%)	43 (20.0%)
SHRS score (range 0–12), mean (SD)	4.9 (2.6)
Dyskinesia	
Frequency, *n* (%)	100 (46.3%)
SHRS score (range 0–48), median (IQR)	6.0 (2.0–9.0)
Dystonia	
Frequency, *n* (%)	49 (22.7%)
SHRS score (range 0–24), mean (SD)	4.1 (2.4)
Parkinsonism	
Frequency, *n* (%)	183 (84.7%)
SHRS score (range 0–48), mean (SD)	12.1 (8.1)
Accelerometer-measured physical activity	
Total activity counts per hour, mean (SD)	28,340 (16,984)
Sedentary behavior (%), mean (SD)	81.7 (8.7)
LPA (%), mean (SD)	11.5 (6.0)
MVPA (%), median (IQR)	5.8 (3.2–9.3)

Note: DDD, Defined Daily Dose; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, 4th edition; IQR, interquartile range; LPA, light physical activity; MVPA, moderate to vigorous physical activity; PANSS-r, Positive and Negative Syndrome Scale Remission tool; SD, standard deviation; SHRS, St. Hans Rating Scale. Median and IQR were reported instead of mean and SD when data was non-normally distributed.
[a]Other diagnoses were schizoaffective disorder, schizophreniform disorder, and psychotic disorder Not Otherwise Specified.
[b]Total number of observations 151, due to 65 (30%) missing values.
[c]Total number of observations 215, due to 1 missing value.

and showed MVPA in 5.8% of total awake wear time. Prevalence rates of movement disorders, based on SHRS cutoff values, were 20% for akathisia, 46% for dyskinesia, 23% for dystonia, and 85% for parkinsonism.

Movement Disorders in Relation to PA

Results of multiple regression models for the association of akathisia, dyskinesia, dystonia, and parkinsonism with PA correlates are presented in table 2. All associations were controlled for confounding by age and the parkinsonism models were also controlled for confounding by negative symptoms (PANSS-r), which were the remaining confounders after stepwise forward selection for the regression models. Parkinsonism was significantly associated with all actigraphy correlates. Increased parkinsonism scores were negatively related to total activity counts ($\beta = -0.21$, $P < .01$), and to proportions of MVPA ($\beta = -0.22$, $P < .001$) and LPA ($\beta = -0.20$, $P < .01$). Inversely, parkinsonism was positively related to time spent in SB ($\beta = 0.26$, $P < .001$). For dystonia, the same pattern was observed, with only the associations between dystonia scores and proportions of LPA ($\beta = -0.15$, $P < .05$) and SB ($\beta = 0.15$, $P < .05$) being significant. For akathisia, the directions of the regression coefficients with actigraphy data were reverse, with higher akathisia scores being related to higher total activity counts ($\beta = 0.14$, $P < .05$), increased LPA ($\beta = 0.14$, $P < .05$), and decreased SB ($\beta = -0.15$, $P < .05$). Associations between dyskinesia and physical activity correlates were nonsignificant. Antipsychotic dosage (DDD) did not have a significant confounding effect in the regression models ($P > 0.10$ and <10% change in the regression coefficient of the independent variable), neither after multiple imputation of missing data on antipsychotics (n = 65, 30% of cases).

Prediction Model

Table 3 shows the results of the multiple regression model for the prediction of total activity counts and SB, respectively. Akathisia, dystonia, parkinsonism and age significantly predicted total activity counts per hour ($F = 16.6$, df = 5, and 209, $P < .001$, adjusted $R^2 = 0.27$) and SB ($F = 13.4$, df = 4, and 210, $P < .001$, adjusted $R^2 = 0.19$). In accordance with previous associations, age, dystonia, and parkinsonism predicted lower levels of activity and higher levels of SB, whereas akathisia predicted the opposite.

Discussion

Main Findings

To our knowledge, this is the first study that investigates the association between movement disorders and actigraphy data of PA and SB in patients with chronic schizophrenia and related psychoses. Our main finding was that parkinsonism was significantly associated with reduced PA and increased SB. For dystonia, this association was weaker and only significant with SB and proportions of LPA. Akathisia was inversely related to actigraphy data, ie, increased akathisia ratings were significantly related to increased PA and to decreased SB. Associations between dyskinesia and actigraphy data were not significant. In a prediction model combining all movement disorders with clinical characteristics, parkinsonism, akathisia, dystonia, and age significantly predicted PA and SB.

A secondary finding was the high prevalence of movement disorders (akathisia, 20%; dyskinesia, 46%; dystonia, 23%; parkinsonism, 85%) in patients with

Table 2. Multiple Linear Regression Models Estimating the Association Between Movement Disorders and Physical Activity Correlates (n = 216)

Outcome: Accelerometer-Measured Physical Activity								
	Total Activity Counts		Sedentary Behavior		MVPA		LPA	
	B (95% CI)	β	B (95% CI)	β	B (95% CI)	β	B (95% CI)	β
Akathisia[a,b]	**775.8*(116.9–1434.7)**	**0.14**	**−0.43*(−0.79 to −0.07)**	**−0.15**	0.16 (−0.02–0.34)	0.11	**0.27*(0.01–0.53)**	**0.14**
Dyskinesia[a]	−70.8 (−446.1–304.5)	−0.02	−0.01 (−0.22–0.19)	−0.01	−0.03 (−0.14 to 0.07)	−0.04	0.04 (−0.10–0.19)	0.04
Dystonia[a]	−937.1 (−1925.3–51.1)	−0.11	**0.65*(0.11–1.18)**	**0.15**	−0.21 (−0.48–0.07)	−0.09	**−0.44*(−0.82 to −0.05)**	**−0.15**
Parkinsonism[c]	**−408.9**(−660.7 to −157.2)**	**−0.21**	**0.26***(0.13–0.40)**	**0.26**	**−0.12***(−0.19 to −0.05)**	**−0.22**	**−0.14**(−0.24 to −0.04)**	**−0.20**

Note: CI, confidence interval; LPA, light physical activity; MVPA, moderate to vigorous physical activity. Significant (p<0.05) results are shown in bold.
[a]Models are controlled for confounding by age.
[b]Total number of observations 215, due to 1 missing value.
[c]Models are controlled for confounding by age and negative symptoms of the Positive and Negative Syndrome Scale Remission tool (PANSS-r).
*P < .05; **P < .01; ***P < .001.

Table 3. Multiple Regression Model Using Backward Elimination[a] for Total Accelerometer-Measured Activity Counts per Hour and Sedentary Behavior (% of Total Wear Time) (N = 215)[b]

	Outcome: Accelerometer-Measured Physical Activity			
	Total Activity Counts		Sedentary Behavior	
Predictors	B (95% CI)	β	B (95% CI)	β
Age	**−424.81***(−586.1 to −263.5)**	**−0.33**	**0.13**(0.04–0.21)**	**0.19**
Akathisia	**1037.01**(391.8–1682.3)**	**0.19**	**−0.61***(−0.96 to −0.26)**	**−0.22**
Dystonia	−804.33 (−1802.0–193.4)	−0.10	0.51 (−0.03–1.05)	0.12
Parkinsonism	**−437.15**(−695.6 to −178.8)**	**−0.22**	**0.27***(0.13–0.41)**	**0.27**
Adjusted R^2		0.27		0.19

Note: [a]Inserted potential predictors: age, sex, akathisia, dyskinesia, dystonia, parkinsonism, and negative symptoms of the Positive and Negative Syndrome Scale Remission tool (PANSS-r). Stepwise backward elimination using Akaike's Information Criterion (AIC) to determine predictors.
[b]215 instead of 216 observations due to 1 missing value of akathisia.
*P < .05 **P < .01 ***P < .001. Significant (P < .05) results are shown in bold.

schizophrenia and related psychoses, which can be explained by chronicity of illness. The sample existed of long-stay psychiatric patients with relatively high age (mean ± SD; 55 ± 13 years) staying at a long-term ward or a sheltered housing facility of a mental health care institution. Previous studies found comparable ratings of movement disorders in long-term hospitalized patients with schizophrenia or related psychoses.[23–25]

Thirdly, our analyses showed that first- and/or second-generation antipsychotic dosage did not affect the relationship between movement disorders and PA. These results are in line with previous studies, that suggested that the type of antipsychotic and antipsychotic dosage dose did not contribute to the variance of activity data in actigraphy.[53–56]

Although side-effects of antipsychotic medication in general (eg, motor, sedative, or metabolic side-effects) are often reported barriers to PA,[57–59] only limited evidence is available on the relationship between movement disorders and PA in psychiatric populations. A systematic review on correlates of PA in people with schizophrenia identified one study examining the relationship between movement disorders and physical activity.[36] In this study, extrapyramidal symptoms rated on the Psychosis Evaluation tool for Common use by Caregivers (PECC) were significantly related to psychomotor slowing (worsened plate-tapping scores) and lower PA on the International Physical Activity Questionnaire (IPAQ) in 100 patients with schizophrenia.[60] A more recent study form Lee and colleagues[61] examined PA in 50 outpatients with chronic schizophrenia and its related clinical factors, also measured on the IPAQ. The physically inactive group showed significantly higher extrapyramidal symptom scores, measured on the Drug-Induced Extrapyramidal Symptom Scale (DIEPSS). Furthermore, linear regression analysis showed that the DIEPSS score independently explained the amount of PA ($B = -264.88$, $t = -3.60$, $P = .001$) and SB time ($B = 0.35$, $t = 2.27$, $P = .028$). A limitation of these studies is the use of questionnaires for the assessment of PA, as these have shown limited validity in psychiatric populations and tend to overestimate physical activity and underestimate SB.[62,63] In the current study, we used actigraphy to measure PA patterns to overcome these problems. While most actigraphy studies in schizophrenia populations used wrist-worn actigraphy devices, some studies have used actigraphy devices worn on the chest, hip, or limbs.[64] In the current study, the ActiGraph GT3X+ was worn at the right hip. The GT3X+ is validated at hip, wrist, and ankle sites during activities of daily living, showing high intraclass correlations (0.857–0.994) between these sites.[65]

The relationship between movement disorders and PA could be partially explained by negative symptoms and/or neurocognitive functioning. Given that (1) movement disorders are correlated with negative symptoms and neurocognitive impairment,[26,28,29,31,32] (2) negative symptoms and neurocognitive impairment are associated with reduced PA,[36,37] and (3) PA is linked to movement disorders,[60,61] there seems to be a close and complex relationship between movement disorders, negative symptoms, neurocognitive functioning and PA. This is supported by our data, where negative symptoms are identified as a confounder on the relationship between parkinsonism and actigraphy data. Importantly, this relationship remained significant after correcting for negative symptoms. Neurocognitive functioning has, unfortunately, not been assessed, but similar relationships may be assumed.

Other explanations for our findings may be more direct relationships between movement disorders and PA. Movement disorders may hamper or reduce movement and thereby lead to reduced PA, except for akathisia which might increase physical activity. Conversely, engaging in less physical activity might ameliorate movement disorders (except for akathisia). However, the findings should be interpreted carefully, since the current study is cross-sectional by design and can therefore not establish cause and effect.

Clinical Relevance

These findings suggest that movement disorders, in particular parkinsonism, are related to reduced PA in people with schizophrenia and related psychoses. This emphasizes the need for the identification and management of movement disorders, not only because they pose a significant burden on patients, but also because they can be related to PA. Despite their high prevalence and severe impact on patients' lives, movement disorders remain often unrecognized and inappropriately managed in patients with schizophrenia and related psychoses.[66] Movement disorders induced by antipsychotics can be managed either by dose reduction (or cessation), by switching to a drug with a lower affinity to D2 receptors (eg, quetiapine, olanzapine, aripiprazole, or clozapine) or by symptomatic treatment, such as anticholinergics (eg, biperiden).[66,67] Antipsychotic dose reduction is endorsed by the newest guidelines and treatment algorithms as it can reduce dose-dependent side-effects as movement disorders, cardiovascular disturbances and neurocognitive impairment, without worsening, or even with improvement, of psychiatric symptom severity.[68] Apart from pharmacological management of movement disorders, PA interventions may be adapted for those patients with movement disorders, eg, by offering individualized PA programs, or supervision of a physiotherapist or qualified exercise professional, which are recommended treatment strategies for PA interventions in patients with severe mental illness in general.[10]

Strengths and Limitations

The major strength of the current study is the large amount of objectively measured activity data in 216 patients with chronic schizophrenia and related psychoses. In that way, detailed information on movement disorders and PA of a large representative sample of patients with chronic psychotic illness was obtained. Some limitations, however, should be noted.

Firstly, it should be noted that the sample in this study consists of patients with high chronicity of illness, therefore results may not be applicable to early psychosis populations. Patients in the early stage of psychoses generally display higher levels of PA[69] and lower prevalence rates of movement disorders,[70] and relationships between movement disorders and PA may be different. Future studies should determine whether present results are also applicable to patients with early psychosis.

Secondly, data on antipsychotic dosage was missing in a considerable proportion of patients. This may have distorted the results of our regression models. By using different approaches, ie, comparing regression models for complete and incomplete datasets and using multiple imputation of missing data, we have tried to reduce bias in the estimation of parameters.

Thirdly, we did not include extensive measurement of negative symptoms or assessment of neurocognitive functioning. Negative symptoms were assessed on 3 items of the PANSS-r. Although these items have been identified as clinically valid symptomatic remission criteria in schizophrenia populations,[42] more extensive tools for the assessment of negative symptoms have been proposed. Also, neurocognitive/psychomotor test batteries could have led to a more comprehensive understanding of clinical correlates of PA in psychotic disorders.

Fourthly, catatonia ratings were not performed in this study. Catatonia is a psychomotor syndrome consisting of hyper- and hypokinetic motor phenomena, affective symptoms and behavioral symptoms, which has been related to negative symptoms and other movement disorders in patients with schizophrenia.[71] It could have been another important motor abnormality to account for in our study. Over the recent years, research interest in (sensori)motor abnormalities as an intrinsic component of the psychotic illness has grown steadily, as stated in this consensus paper.[72] Preferably, assessments of as many different domains of motor abnormalities as possible, including parkinsonism, dyskinesia, akathisia, dystonia, neurological soft signs and catatonia, is recommended to further examine motor functioning in people with schizophrenia and related psychoses.

Lastly, because of the cross-sectional design or this study, causal relationships cannot be implied. Longitudinal prospective and intervention studies are needed to examine the causal relationship between movement disorders, PA, and other clinical correlates.

Conclusions and Future Directions

In a large group of patients with chronic schizophrenia and related psychoses, movement disorders were related to PA patterns. Parkinsonism and, to a lesser extent, dystonia were associated with reduced PA and increased SB, whereas akathisia was related to increased PA and reduced SB. These findings highlight the clinical relevance of movement disorders in people with schizophrenia and related psychoses in studying the complex behavior of PA.

Future studies should further examine the role of (psycho)motor, cognitive and other clinical factors in PA and SB in order to provide effective treatment strategies for patients with schizophrenia. Also, future research should focus on developing and implementing PA interventions that take patient related factors into account. In that way, people with schizophrenia and related psychoses could benefit from effective and personalized interventions to improve PA, and their somatic and mental health.

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