Ecological monitoring of physical activity, emotions and daily life activities in schizophrenia: the DiAPAsOn study

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ABSTRACT

Background Schizophrenia spectrum disorders (SSD) compromise psychosocial functioning, including daily time use, emotional expression and physical activity (PA).

Objective We performed a cohort study aimed at investigating: (1) the differences in PA, daily activities and emotions between patients with SSD and healthy controls (HC); (2) the strength of the association between these variables and clinical features among patients with SSD.

Methods Ninety-nine patients with SSD (53 residential patients, 46 outpatients) and 111 matched HC were assessed for several clinical variables, and levels of functioning by means of standardised clinical measures. Self-reported daily activities and emotions were assessed with a smartphone application for ecological momentary assessment (EMA), and PA levels were assessed with a wearable accelerometer for 7 consecutive days.

Findings Patients with SSD, especially those living in residential facilities, spent more time being sedentary, and self-reported more sedentary and self-care activities, experiencing higher levels of negative emotions compared with HC. Moreover, higher functioning levels among patients were associated with more time spent in moderate-to-vigorous activity.

Conclusions Sedentary behaviour and negative emotions are particularly critical among patients with SSD and are associated with more impaired clinical outcomes.

Clinical implications Mobile-EMA and wearable sensors are useful for monitoring the daily life of patients with SSD and the level of PA. This population needs to be targeted with specific rehabilitative programmes aimed at improving their commitment to structured daily activities.

BACKGROUND

Patients with schizophrenia spectrum disorders (SSD) often show marked impairments in daily time functioning, with adverse consequences for prognosis, number of medical comorbidities and mortality rates. However, despite the importance assigned to the daily time use of patients with SSD, most studies have mainly collected self-reported retrospective data. The use of retrospective self-reports in patients with severe mental disorders is prone to errors related to recall bias and to potentially impaired cognitive capacities.

The integration of innovative methodologies (eg, ecological momentary assessment (EMA)) and wearable devices like accelerometer-based biosensors in research and clinical practice with individuals with SSD is promising. These tools reduce biases, provide longitudinal, objective and time-resolved ecologically valid data (ie, a fine-grained picture of patients’ experiences in their natural contexts), and capture the variability over time and the dynamic patterns of reactivity to the environment. In the last few decades, EMA has been used with patients with SSD for the evaluation of daily emotions or symptomatology, but only a few have used this methodology to assess daily life activities. These studies have generally found that patients with SSD spend more than half (ie, 52%) of the day being inactive/doing nothing, and most activities are performed sitting or lying down. Furthermore, inactivity time is usually higher in patients with SSD when compared with healthy controls.

Some studies have used accelerometer-based biosensors for the monitoring of physical activity (PA) in this population. PA refers to any bodily movement that requires energy expenditure and engages the muscles. It encompasses a wide range of activities, such as walking, running, cycling, swimming, dancing, playing sports and engaging in structured exercise routines. On the contrary, sedentary behaviour refers to activities involving low energy expenditure characterised by sitting, reclining or lying down while engaging in activities such as watching television, working on a computer, using electronic devices or reading. A recent meta-analysis found that individuals with SSD spend a mean of 80.4 min in light PA, 47.1 min in moderate-to-vigorous PA (MVPA) and 1.05 min in vigorous PA per day and usually show lower MVPA levels compared with healthy controls. Moreover, lower PA and sedentary behaviour are...
associated with greater severity of positive symptoms, worse cognitive functioning, illness chronicity, higher antipsychotic dose and poorer quality of life, higher medical comorbidities and increased mortality rates.\textsuperscript{2,16} However, very few studies have monitored patients with SSD with both EMA and wearable accelerometers.\textsuperscript{10,17,18} Only two of them, with very small samples, have investigated the association between ecological indexes and psychiatric functioning and severity\textsuperscript{10,18} and, to the best of our knowledge, no studies have included healthy control participants. More importantly, none of them has considered the treatment setting (ie, residential facilities (RFs) or ambulatory), which is likely to influence both PA and daily activities (eg, in RFs, the presence of a structured day schedule, the continuous interaction with health workers, the joint management of the facilities for cleaning, cooking, etc, may solicit a more intensive daily activity regime).

OBJECTIVES
In the “Daily time use, Physical Activity, quality of care and interpersonal relationships in patients with Schizophrenia spectrum disorders” (DiAPAson) project,\textsuperscript{19} we have studied different topics, including the quality of RFs in Italy,\textsuperscript{20} the associations between time perspective, daily time use and levels of functioning among patients with SSD,\textsuperscript{21} the prescription of antipsychotic medications and its relationship with PA,\textsuperscript{22} the care needs of patients with SSD and its association with daily activities and mood monitored using the EMA,\textsuperscript{23} the sleep-wake patterns\textsuperscript{24}, and the adherence rate to EMA and accelerometer\textsuperscript{25,26} and predictors of EMA adherence.\textsuperscript{26}

The aims of this paper were: (1) to identify possible differences in the amount of PA levels, the frequency of daily activities and the intensity of emotions between residential patients and outpatients with SSD, and healthy controls; and (2) to examine the magnitude of the associations between psychiatric severity/levels of functioning and PA levels, daily activities and emotions in patients with SSD, controlling for age, number of antipsychotic medications, disability level, number of cigarettes and season of measurement. We hypothesised that patients with SSD living in RFs would do more PA (assessed with accelerometer) and would do more self-reported working activities than outpatients, since they live in a highly structured environment and are continuously under staff supervision. We also hypothesised that all patients with SSD, regardless of the treatment setting, would report more negative emotions, as assessed with EMA, than healthy controls. Finally, we expected that more impaired daily functioning would be associated with poorer clinical outcomes.

METHODS
Study setting
This cohort study was conducted in a subsample of sites involved in the Italian national DiAPAson project\textsuperscript{19}: these include seven Departments of Mental Health (DMHs), one clinical research centre (IRCCS) and two RFs. DMHs recruited both outpatients and residential patients, while RFs only recruited residential patients.

Eligibility criteria and recruitment
From October 2020 to October 2021, 137 eligible patients (79 residential patients, 58 outpatients) and 113 healthy controls (matched for age and sex) were initially recruited at the 10 participating centres for ecological monitoring. Inclusion and exclusion criteria are reported in online supplemental materials. Online supplemental figure 1S shows in detail the sampling selection process. To ensure a balanced comparison, healthy controls were sampled using a combination of public advertisements and snowball sampling techniques and matched with the clinical sample based on sex and age group, defined as: 20–24, 25–29, 30–34, 35–39, 40–44, 45–49 and 50–55 years of age. Sample size calculation has been thoroughly described in the study protocol.\textsuperscript{19}

Outpatients were community-dwelling patients with SSD who were approached consecutively at the outpatient units for potential participation until the recruitment target was achieved. Residential patients were recruited by means of an alphabetical list of patients with SSD present on an index-day; based on this list, residential patients were consecutively invited to participate in the study.

Participants were provided with detailed information about the study and had an opportunity to ask questions. Some of the assessment tools were completed by the treating clinician, while research assistants (RAs) helped the participants complete self-reported questionnaires if needed. Standardised clinical measures were used to collect clinical data to minimise methodological biases (see section "Measures"). The ecological monitoring was preceded by a briefing session in which the RA gave instructions about the procedures and how to effectively perform them, and was followed by a debriefing section in which the same RA collected information on study acceptability and feasibility.\textsuperscript{25}
During the debriefing session, outpatients and healthy controls received €25 for travel expense reimbursement.

MEASURES
Sociodemographic, physical and clinical assessments
For each recruited participant, sociodemographic details (see table 1 for a list) were gathered. Psychiatric history of patients was assessed using a structured ad hoc survey aimed at collecting information on the current diagnosis, illness duration and lifetime duration of psychiatric hospitalisations. The Charlson Comorbidity Index was used for the assessment of physical comorbidities of participants. The 24-item Brief Psychiatric Rating Scale (BPRS) was used to assess psychopathology. Negative symptoms severity was assessed with the Brief Negative Symptom Scale (BNSS). The 43-item Specific Levels of Functioning Scale (SLOF) was used for the assessment of levels of functioning. The WHO Disability Assessment Schedule 2.0 (WHODAS 2.0) was used for the assessment of disability level.

Assessment of daily time use and emotions
Self-reported daily time use (i.e., daily activities) and emotions were prospectively assessed with a brief questionnaire on a smartphone-based application for EMA, developed ad hoc for the project. The mobile application included three sections: current activities, social contacts and emotions. EMA emotions were chosen from an official ‘Experience Sampling Method Item Repository’ (https://osf.io/kg376/), which provides detailed info (including psychometric information) about all items used in different EMA studies. Notifications occurred 8 times a day, from 08:00 a.m. to 12:00 p.m., for seven consecutive days. Details about the EMA study are provided in the online supplemental tables 1S and 7S.

Assessment of physical activity and data processing
PA was monitored using the wearable accelerometer-based biosensor ActiGraph GT9X Link (https://theactigraph.com/). The ActiGraph was worn on the non-dominant wrist for seven consecutive days (the same days for the EMA monitoring). See online supplemental materials for detailed information on ActiGraph’s data processing.

Statistical analyses
Data were summarised using mean and SD, median and IQR for quantitative variables, counts and percentages for qualitative ones.

Comparisons of sociodemographic and clinical variables across residential patients, outpatients and control participants were carried out through the $\chi^2$ test for categorical variables and the analysis of variance test for continuous variables.
The 15 daily time use categories were first grouped into 6 categories as follows: sedentary activities (staying sick in bed, thinking, resting and doing nothing), working activities (studying/attending training courses, cleaning, cooking, tidying up the house or car, shopping, taking care of someone or something and voluntary work), leisure activities (hobbies, watching TV or listening to the radio), PA (doing sports or PA/walking), self-care (self-caring and eating/drinking/having breakfast or snack) and religious activities. Then, data on daily time use were synthesised in terms of the daily average number of times each activity was done and compared across the three groups through a Generalised Linear Mixed Model with Poisson distribution after adjusting for smoking and seasonality. Results were reported in terms of rate ratios (RRs) with their 95% CIs.

Positive and negative emotions were computed by averaging positive (happy, relaxed, quiet and full of energy) and negative (sad, tired and nervous) emotions, respectively, and synthesised in terms of the daily average of positive and negative emotions on a 0–100 scale. Similar to daily time use, emotions ratings were compared across participant groups through a Linear Mixed Model with a random intercept (patient) after adjusting for smoke and seasonality. Results were reported in terms of estimated mean differences with corresponding 95% CIs.

### Table 2: Clinical characteristics of residential patients and outpatients

<table>
<thead>
<tr>
<th>Variables</th>
<th>Residential patients n=53</th>
<th>Outpatients n=46</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illness duration (months)</td>
<td>19.9 (10.8)</td>
<td>15.0 (6.9)</td>
<td>0.017</td>
</tr>
<tr>
<td>Median (minimum; maximum)</td>
<td>21.0 (10.0; 40.0)</td>
<td>13.0 (1.0; 34.0)</td>
<td></td>
</tr>
<tr>
<td>Lifetime duration of psychiatric hospitalisation (years), n (%)</td>
<td>43 (93%)</td>
<td>43 (93%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mini Mental State Examination</td>
<td>27.4 (1.5)</td>
<td>27.8 (1.1)</td>
<td>0.13</td>
</tr>
<tr>
<td>Brief Psychiatric Rating Scale</td>
<td>48.6 (13.3)</td>
<td>40.9 (9.6)</td>
<td>0.001</td>
</tr>
<tr>
<td>Brief Negative Symptom Scale</td>
<td>174.4 (21.3)</td>
<td>193.4 (14.6)</td>
<td>0.011</td>
</tr>
<tr>
<td>Specific Levels of Functioning Scale</td>
<td>174.0 (25.0; 212.0)</td>
<td>195.0 (155.0; 215.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>WHO Disability Assessment Schedule 2.0</td>
<td>10.6 (7.5)</td>
<td>9.8 (7.8)</td>
<td>0.6</td>
</tr>
<tr>
<td>Antipsychotic (AP) drugs</td>
<td>2.7 (1.3)</td>
<td>1.8 (1.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Non-APs drugs</td>
<td>3.0 (1.0; 6.0)</td>
<td>2.0 (0.0; 4.0)</td>
<td>0.12</td>
</tr>
</tbody>
</table>

### Table 3: Between-group differences for self-reported daily activities and emotions assessed with EMA

<table>
<thead>
<tr>
<th>Activity</th>
<th>Residential patients n=53</th>
<th>Outpatients n=46</th>
<th>Healthy controls n=111</th>
<th>Residential patients/Outpatients</th>
<th>Residential patients/Healthy controls</th>
<th>Outpatients/Healthy controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary activities</td>
<td>1.23 (0.90 to 1.68)</td>
<td>0.88 (0.61 to 1.26)</td>
<td>0.89 (0.59 to 1.36)</td>
<td>2.50 (1.47 to 4.23)</td>
<td>0.186</td>
<td></td>
</tr>
<tr>
<td>Working activities</td>
<td>0.67 (0.46 to 0.96)</td>
<td>1.62 (1.09 to 2.42)</td>
<td>1.98 (1.36 to 2.91)</td>
<td>1.25 (1.03 to 1.51)</td>
<td>0.064</td>
<td></td>
</tr>
<tr>
<td>Leisure activities</td>
<td>1.24 (0.90 to 1.72)</td>
<td>1.53 (1.01 to 2.34)</td>
<td>1.53 (1.01 to 2.34)</td>
<td>1.25 (1.03 to 1.51)</td>
<td>0.064</td>
<td></td>
</tr>
<tr>
<td>Physical activities</td>
<td>1.02 (0.10 to 2.33)</td>
<td>1.35 (0.10 to 2.34)</td>
<td>1.31 (0.10 to 2.34)</td>
<td>1.25 (1.03 to 1.51)</td>
<td>0.064</td>
<td></td>
</tr>
<tr>
<td>Self-care</td>
<td>1.81 (1.47 to 2.23)</td>
<td>1.53 (1.01 to 2.34)</td>
<td>1.53 (1.01 to 2.34)</td>
<td>1.25 (1.03 to 1.51)</td>
<td>0.064</td>
<td></td>
</tr>
<tr>
<td>Religious activities</td>
<td>0.00 (0.00 to 1.00)</td>
<td>0.00 (0.00 to 1.00)</td>
<td>0.00 (0.00 to 1.00)</td>
<td>0.00 (0.00 to 1.00)</td>
<td>0.00 (0.00 to 1.00)</td>
<td></td>
</tr>
<tr>
<td>Positive emotions</td>
<td>62.0 (55.0 to 69.0)</td>
<td>60.9 (55.0 to 69.0)</td>
<td>60.9 (55.0 to 69.0)</td>
<td>1.03 (1.00 to 1.04)</td>
<td>0.049</td>
<td></td>
</tr>
<tr>
<td>Negative emotions</td>
<td>30.4 (24.0 to 37.2)</td>
<td>30.4 (24.0 to 37.2)</td>
<td>30.4 (24.0 to 37.2)</td>
<td>1.03 (1.00 to 1.04)</td>
<td>0.049</td>
<td></td>
</tr>
</tbody>
</table>

*Models were adjusted for number of cigarettes and season of measurement.
FINDINGS

The final sample included 53 residential patients, 46 outpatients and 111 healthy controls who replied to at least 70% of the EMA notifications and who wore the accelerometer for at least 10 hours for 4 valid days (see online supplemental figure 1S for more details on sampling selection).

Sociodemographic and clinical characteristics

Table 1 shows the main sociodemographic characteristics of the three groups. Table 2 shows the clinical characteristics of the patients’ sample. When compared with outpatients, residential patients reported significantly higher illness duration (p=0.017), lifetime duration of psychiatric hospitalisation (p<0.001), BPRS score (p<0.001), BNSS score (p=0.011) and lower levels of functioning (p<0.001); they also received a significantly higher mean number of antipsychotic medications (p<0.001).

Between-group differences in self-reported daily activities

The three groups significantly differed in daily time spent in sedentary activities, working activities and self-care activities (table 3), even controlling for the number of cigarettes per day and season. Indeed, residential patients were significantly less engaged in working activities when compared with both outpatients (RR 0.41 (95% CI 0.23 to 0.73); p<0.001) and healthy controls (RR 0.25 (95% CI 0.13 to 0.46); p<0.001). In addition, healthy controls were significantly less engaged in sedentary activities when compared with both outpatients (RR 1.78 (95% CI 1.00 to 3.17); p= 0.048) and residential patients (2.50 (95% CI 1.47 to 4.23); p<0.001). Finally, residential patients spent more time in self-care activities than healthy controls (RR 1.63 (95% CI 1.09 to 2.43); p=0.0014). No differences were found between residential patients and outpatients regarding time spent in sedentary activities, working activities and self-care activities. See online supplemental table 6S for details about the differences in the 15 daily activities between the 3 groups.

Between-group differences for self-reported emotions ratings

Controlling for the number of cigarettes per day and season, we found no differences in average ratings of positive emotions between the three groups, while residential patients showed a higher negative emotions intensity when compared with both outpatients (mean difference 6.12 points (95% CI 0.13 to 12.11); p=0.04) and healthy controls (mean difference 7.38 points (95% CI 2.42 to 12.34); p=0.0015). Outpatients and healthy controls did not differ in terms of negative emotions intensity (table 3).

Between-group differences for device-measured physical activity and sedentary behaviour

The three groups significantly differed for all activity levels (both min/day and %) (figure 1 and online supplemental table 3S and figure 2S), with healthy controls showing higher PA levels than the two patient groups, even controlling for daily % of wearing time, the number of cigarettes per day and season. Time spent in different PA levels are expressed in mean min/day.

Sedentary time was significantly higher in residential patients compared with both outpatients and healthy controls, respectively RR 1.16 (95% CI 1.10 to 1.23); p<0.001) and RR 1.15 (95% CI 1.15 to 1.28); p<0.001). Outpatients and healthy controls did not differ from each other for time spent sedentary (RR 1.04 (95% CI 0.99 to 1.10); p=0.10). When expressed in relative terms, the sedentary time represented 48%–51% of total wake time in patient groups, which was also a significantly larger fraction compared with healthy controls (i.e., 40%).

MVPA was significantly higher in healthy controls (91.3 mean min/day) than in both outpatients (64.1 mean min/day) and residential patients (44.6 mean min/day). Outpatients spent a significantly larger fraction of time doing MVPA per day compared with residential patients (RR 0.70 (95% CI 0.53 to 0.92); p= 0.01) and lower time when compared with healthy controls (RR 0.70 (95% CI 0.55 to 0.90); p= 0.004).

Online supplemental tables 4S and 5S show the comparison of activity levels (both min/day and %) in the three groups divided respectively by weekdays and weekends. The findings remained stable even after checking for weekdays/weekends separately.
Table 4 Relationships between ecological indexes and clinical outcomes in patients with SSD*

<table>
<thead>
<tr>
<th>Variables assessed with actigraph</th>
<th>BPRS</th>
<th>BNSS</th>
<th>SLOF</th>
</tr>
</thead>
<tbody>
<tr>
<td>METs</td>
<td>3.5411 (−11.8466 to 5.0528)</td>
<td>2.8353 (−13.7123 to 8.5072)</td>
<td>7.1028 (−5.3459 to 19.7699)</td>
</tr>
<tr>
<td>Sedentary PA (60 min/day*)</td>
<td>0.2862 (−0.8116 to 1.4887)</td>
<td>0.1747 (−1.5613 to 1.3363)</td>
<td>0.5552 (−2.125 to 1.1853)</td>
</tr>
<tr>
<td>Light PA (60 min/day*)</td>
<td>0.4726 (−0.6727 to 1.6214)</td>
<td>0.2356 (−1.7438 to 2.0058)</td>
<td>1.7642 (−3.8915 to 1.2182)</td>
</tr>
<tr>
<td>MVPA (60 min/day*)</td>
<td>1.5889 (−5.7372 to 1.2438)</td>
<td>1.5889 (−5.7372 to 1.2438)</td>
<td>1.5889 (−5.7372 to 1.2438)</td>
</tr>
<tr>
<td>Sedentary PA (%)</td>
<td>0.0195 (−0.1282 to 0.1873)</td>
<td>0.0096 (−0.197 to 0.2105)</td>
<td>0.0031 (−0.2503 to 0.2629)</td>
</tr>
<tr>
<td>Light PA (%)</td>
<td>0.0468 (−0.1549 to 0.2533)</td>
<td>0.0611 (−0.2267 to 0.3325)</td>
<td>0.1941 (−0.4951 to 0.1589)</td>
</tr>
<tr>
<td>MVPA (%)</td>
<td>0.2865 (−0.6719 to 0.063)</td>
<td>0.2827 (−0.6986 to 0.1259)</td>
<td>0.7159 (0.1489 to 1.2729)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables assessed with EMA</th>
<th>Sedentary activities</th>
<th>Working activities</th>
<th>Leisure activities</th>
<th>Physical activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1625 (−2.529 to 2.132)</td>
<td>0.0666 (−4.5877 to 0.9239)</td>
<td>2.0763 (0.6451 to 3.3131)</td>
<td>3.1205 (−9.5155 to 6.9202)</td>
</tr>
<tr>
<td></td>
<td>2.7268 (−0.3225 to 4.91)</td>
<td>0.3838 (−5.3427 to 0.6396)</td>
<td>1.7299 (−0.1926 to 3.3613)</td>
<td>1.7175 (−10.176 to 9.8945)</td>
</tr>
<tr>
<td></td>
<td>3.5702 (−7.9509 to 0.9373)</td>
<td>0.9132 (−2.7 to 8.1434)</td>
<td>4.0101 (−6.3116 to −0.8023)</td>
<td>11.4208 (−17.3502 to 14.4894)</td>
</tr>
<tr>
<td></td>
<td>1.7003 (−0.4252 to 3.2716)</td>
<td>0.4271 (−2.0264 to 2.9407)</td>
<td>1.9917 (−6.9502 to 6.3228)</td>
<td>12.6462 (−20.7503 to 3.246)</td>
</tr>
<tr>
<td></td>
<td>3.8346 (−3.3625 to 1.0411)</td>
<td>3.8346 (−3.3625 to 1.0411)</td>
<td>12.6462 (−20.7503 to 3.246)</td>
<td>12.6462 (−20.7503 to 3.246)</td>
</tr>
<tr>
<td></td>
<td>0.3683 (−1.3586 to 2.0843)</td>
<td>0.7589 (−2.66 to 1.1949)</td>
<td>0.1004 (−2.8699 to 3.4415)</td>
<td>0.1004 (−2.8699 to 3.4415)</td>
</tr>
<tr>
<td></td>
<td>0.0792 (−0.0533 to 0.2057)</td>
<td>0.0285 (−0.1929 to 0.1046)</td>
<td>0.1181 (−0.343 to 0.1043)</td>
<td>0.1181 (−0.343 to 0.1043)</td>
</tr>
</tbody>
</table>

*Controlling for age, medication, disability level, number of cigarettes and season of measurement.

BNSS, Brief Negative Symptoms Scale; BPRS, Brief Psychiatric Rating Scale; EMA, ecological momentary assessment; METs, Metabolic Equivalent of Tasks; MVPA, moderate-to-vigorous activity; PA, physical activity; SLOF, Specific Levels of Functioning Scale; SSD, schizophrenia spectrum disorders.

except for two results. First, we found a significant difference between outpatients and healthy controls in levels of sedentary time (RR 1.11 (95% CI 1.02 to 1.21); p=0.01) only during weekends. Second, the difference in MVPA levels found between residential patients and outpatients disappears if we look only at weekend days (RR 0.76 (95% CI 0.56 to 1.02); p=0.06).

Association between ecological indexes and clinical outcomes

Table 4 shows the results of the association between ecological indexes and clinical outcomes. MVPA was significantly associated only with the SLOF scale, with an increase of 4.95 points (95% CI 0.46 to 10.11) for 60 min/day of MVPA. The amount of self-reported time spent in leisure activities was significantly associated with an increase in the BPRS score (2.07, 95% CI 0.65 to 3.33) and a reduction in SLOF score (−4.01, 95% CI −6.31 to −0.80). No relationships were found between clinical outcomes and intensity of emotions.

DISCUSSION

This study found significant differences between the two groups of patients with SSD and healthy controls for PA levels, emotions intensity and daily use. We also found a significant relationship between selected ecological indexes and levels of psychiatric severity/levels of functioning of individuals with SSD.

Daily time use

Compared with healthy individuals, patients (especially if living in RFs) were generally engaged for more time in sedentary activities and self-care activities and for a lesser time in working activities. Moreover, time spent in leisure activities was associated with higher psychiatric severity and lower levels of functioning. These results are in line with previous EMA studies which found higher self-reported inactivity time in patients with SSD when compared with healthy controls and found an association between specific activities (i.e., work activities and clinical outcomes (i.e., hallucinations, self-rated health, mastery and quality of life).31 32

The marked differences in daily time use between patients with SSD and healthy controls are likely to be at least partly due to the severity and nature of psychiatric symptoms, particularly negative symptoms (eg, those that affect motivation, concentration, organizational and interpersonal skills). Negative symptoms are extremely difficult to treat and they can profoundly compromise the daily functioning of patients with SSD, possibly leading to a large amount of time spent doing nothing. These differences may be also due to the higher proportion of patients not working/studying and with a single status, which may be in turn associated with a psychiatric history, lower psychosocial functioning and fewer relationships. In addition, residential patients showed more severe symptomatology and could also be more restricted on where and the types of activities they did, limiting the opportunity to do different activity types.

Daily emotions

Patients with SSD living in RFs reported higher intensity of negative emotions if compared with healthy controls; on the contrary, there were no differences in subjectively reported negative emotions between outpatients and healthy controls. The higher degree of negative emotions among residential patients was unrelated to their psychiatric symptoms or levels of functioning. This result is partially in line with a meta-analysis of 12 EMA studies, showing that people with SSD consistently report both more negative and less positive emotions than healthy controls; however, in these studies treatment setting was rarely assessed, and was not one of the main variables to be considered. Characteristics of the living environments should be carefully considered whenever the quality of daily emotions is assessed.

Physical activity

Patient groups and healthy controls in this study appear to reach the minimum level of PA required to maintain health, that is, 23 min/day of MVPA. However, when compared with healthy controls, patients with SSD spent more time in sedentary behaviour—as assessed by the accelerometer—and their PA levels were associated with levels of functioning, especially if living in RF.

Our results about residential patients are in line with findings of previous studies, which found that patients with SSD spend on average about 45 min/day engaged in MVPA, or about 5% of the daytime. However, in our study outpatients spent more time engaged in MVPA (i.e., about 64 min/day, 8.5%). This difference enforces the need to do independent analyses based on treatment setting when looking at PA levels of individuals with SSD. Moreover, our findings support studies that
found that individuals with SSD have lower PA levels compared with healthy controls and that these levels are associated with clinically relevant psychiatric outcomes (eg, severity of positive symptoms, illness chronicity, higher antipsychotic dose, depression and poorer quality of life).1–12

The differences in PA levels that we found between patients with SSD and healthy controls may be due to the association with a variety of clinical factors (eg, severe negative symptoms, medication side effects, cognitive and sensory impairments, lack of motivation and energy, cognitive overload, poor education as well as living conditions and environmental factors (eg, stigma and discrimination, lack of supportive social network, limited access to safe spaces, financial constraints, transportation barriers, lack of individualised programmes).13 Addressing these environmental factors and providing targeted support, such as creating safe spaces, offering transportation assistance, providing financial support and designing inclusive and individualised exercise programmes, can help promote PA among individuals with SSD.

Limitations and strengths

The study was conducted during the COVID-19 pandemic, and this may have affected both the PA monitoring and the evaluation of daily time use and emotions. However, since the recruitment of patients and controls took place at the same time, this change is likely to have affected both study groups. Moreover, SSD diagnoses were based only on medical records because of financial and logistic limitations. The measurement of activity at the wrist noses were based only on medical records because of financial and logistic limitations. The measurement of activity at the wrist usually overestimates PA and can hardly distinguish between sitting and standing. This may raise problems in defining sedentary behaviour, since all PA ≤ 1.5 MET was counted as sedentary behaviour without considering body position. However, this is the first study that assessed PA, daily activities and emotions in patients with SSD in different treatment settings and compared them with healthy controls. This study was performed with a multimethod approach that integrated both self-reported and objective, longitudinal measures for the assessment of targeted ecological indexes. Finally, the involvement of 10 recruitment centres makes our findings and the generalisability of the conclusions stronger.

CLINICAL IMPLICATIONS

Rehabilitative programmes implemented in RFs for people with SSD should be improved: many people who live there spend a significant amount of time doing nothing. Staff should be better trained to plan and implement personalised programmes aimed at helping these patients more efficaciously. Programmes of social skill training, structured programmes of PA and interventions to facilitate contact with local communities should be carefully combined to stimulate patients with SSD and improve their subjective well-being and their physical health. The information collected in this study may represent a further step in this direction.

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