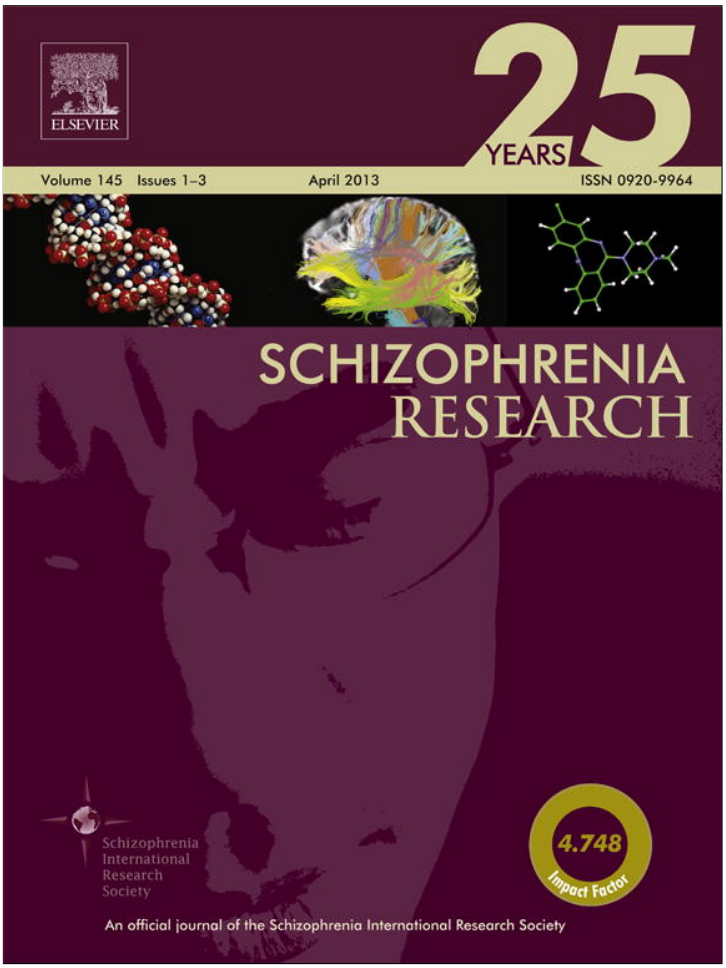

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Sedentary behavior and psychiatric symptoms in overweight and obese adults with schizophrenia and schizoaffective disorders (WAIST Study)

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ABSTRACT

Objective: Examine the association between sedentary behavior and psychiatric symptoms among overweight and obese adults with schizophrenia or schizoaffective disorders (SZO/SA).
Design: Randomized clinical trial; Weight Assessment and Intervention in Schizophrenia Treatment (WAIST) Study: baseline data collected 2005–2008.
Setting: University of Pittsburgh Medical Center, Pittsburgh, PA, USA.
Participants: Community-dwelling adults diagnosed with SZO/SA, with mild symptom severity [Positive and Negative Syndrome Scale (PANSS)<90], who were interested in losing weight, age 18–70 years, BMI>27 kg/m^2.
Measurements: Objectively measured sedentary behavior by accelerometry, and psychopathology assessed by PANSS. Participants wore the actigraphs for 7 consecutive days during their waking hours. Sedentary behavior was defined as ≤100 counts per minute during wear-time and excluded sleep and non-wear time.
Results: On average, 81% of the participant's monitoring time or 756 min/day was classified as sedentary behavior using accelerometry. No association was observed between sedentary behaviors and PANSS psychiatric symptoms [total ($p \geq 0.75$), positive ($p \geq 0.81$), negative ($p \geq 0.59$) and general psychopathology ($p \geq 0.65$) subscales]. No association was observed between sedentary behaviors and age, race, gender and BMI.
Conclusion: From a clinical and public health perspective, the amount of time (approximately 13 h) and percentage of time (81% excluding non-wear time associated with sleeping) engaged in sedentary behavior among overweight and obese adults in this population is alarming, and points to an urgent need for interventions to decrease sedentary behaviors. The lack of associations between sedentary behavior and psychiatric symptoms may be due to a ceiling effect for sedentary behavior.

1. Introduction

Sedentary behavior, independent of moderate-vigorous physical activity, has been shown to be an independent risk factor for mortality (Katzmarzyk et al., 2009; Dunstan et al., 2010; Patel et al., 2010; Koster et al., 2012; van der Ploeg et al., 2012), cardiovascular health (Katzmarzyk et al., 2009; Dunstan et al., 2010; Patel et al., 2010; Healy et al., 2011), diabetes (Helmerhorst et al., 2009; Henderson et al., 2012), metabolic syndrome (Ford et al., 2005; Healy et al., 2008; Bankoski et al., 2011; Hsu et al., 2011) and obesity (Levine et al., 2005) in the general population. Little is known about objectively measured sedentary behavior in adults with schizophrenia and schizoaffective disorders (SZO/SA), a population at higher risk for medical co-morbidities than the general population (Faulkner, 2005; Joukamaa et al., 2006; Van Gaal, 2006; Barnett et al., 2007). Based on subjective measures of sedentary behavior, in-patients with schizophrenia self-reported more sitting time (approximately 2.3 h/day, $p = 0.001$) than age-, gender-, and BMI-matched healthy controls (Vancampfort et al., 2012a). Since adults with SZO/SA engage in little, if any, moderate-vigorous activities (Gothelf et al., 2002; Faulkner et al., 2006; Sharpe et al., 2006; Roick et al., 2007; Lindamer et al., 2008; Vancampfort et al., 2012b), interventions to decrease sedentary time may be more effective than those that promote physical activity in this population. Feasibly, sedentary behavior may be one factor increasing the risk of these common co-morbidities in adults with schizophrenia or schizoaffective disorder. In addition, factors that may influence objectively measured sedentary behavior in adults with schizophrenia and schizoaffective disorders are not known. Of

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particular interest is whether objectively measured sedentary behavior differs by the type and severity of the psychiatric symptoms in this population.

Sedentary behavior has been defined as sitting, reclining, or lying down during waking hours and expending less than 1.5 times the metabolic rate (Matthews et al., 2008; Pate et al., 2008; Owen et al., 2011). Common sedentary behaviors would include watching television, using the computer, playing electronic games, hand crafts, riding a bus, driving, and eating meals. However, these sedentary behaviors have been difficult to measure subjectively and prone to considerable reporting error. With the recent interest in sedentary behaviors, researchers have begun objectively measuring sedentary time using accelerometers (Pate et al., 2008). In one study of a representative sample of US adults, the average time spent in sedentary behavior ranged from 7.3 to 9.3 h per day depending on age and gender (Matthews et al., 2008). Sedentary behavior, defined as <760 cpm and including non-wear time for sleeping, was significantly greater among male (~40 min/day, $p \leq 0.05$) but not female users of mental health services compared to male and female non-users of mental health services, respectively (Janney et al., 2008).

The Weight Assessment and Intervention in Schizophrenia Treatment Study (WAIST) study was a randomized, parallel group, clinical trial designed to assess the efficacy of a group-based behavioral treatment for weight reduction compared to social skills training or usual care in overweight or obese (BMI > 27 kg/m^2) adults with SZO/SA. Baseline data from the WAIST Study participants provided a unique opportunity to measure sedentary behavior objectively in overweight and obese adults SZO/SA. The aim of this report is to investigate the association between objectively measured sedentary behavior and psychiatric symptoms in overweight and obese adults with SZO/SA.

2. Methods

WAIST study participants were individuals with a diagnosis of schizophrenia or schizoaffective disorder who were in outpatient treatment. Inclusion was limited to those with a body mass index (BMI) greater than 27 kg/m^2, and who expressed a desire to lose weight. Participants were recruited from ambulatory psychiatric clinics in Pittsburgh and surrounding communities. Recruitment was accomplished by the following methods: investigators and research team members made presentations to staff in the ambulatory clinics; distributed posters and flyers (approved by the IRB), which allowed subjects to contact the research team if they were interested in participating; we also screened an IRB-approved hospital research registry for participants who might meet the inclusion criteria. Recruitment occurred between 2004 and 2008. The study was approved by the University of Pittsburgh Biomedical Institutional Review Board (IRB), and informed consent was obtained from all participants.

This report is restricted to the baseline screening assessments that occurred prior to randomization. Eligibility criteria for enrollment in the study included: age 18–70 years, DSM-IV-TR schizophrenia or schizoaffective disorder (verified by at least 2 out of 3 study psychiatrists using data from a modified Structured Clinical Interview for DSM-IV (SCID) (First et al., 1996), medical charts, and corroborating information from reliable informants). Subjects were accepted if treated with novel or conventional antipsychotic medications, Positive and Negative Symptom Scale (PANSS) score < 90, no psychiatric hospitalization in the 30 days prior to enrollment, and no medical contraindication to participation in weight reduction/exercise program. Female subjects, of child-bearing potential, were enrolled if they said they were using a medically accepted means of contraception. Study exclusion criteria included: inability to give informed consent, moderate mental retardation, currently enrolled in another weight management program, or currently being treated with medication to reduce weight. We also excluded individuals with unstable medical illnesses that may have affected body weight or make study procedures hazardous for participants, including history of myocardial infarction or unstable coronary heart disease, end-stage renal disease, or unstable thyroid disease as determined by an internist consulting to the study.

Only a subsample of the WAIST Study participants was offered actigraphy monitoring. Due to initially low compliance with actigraphy monitoring, only participants who had a rating of 5 or greater on the Observer Related Compliance Rating (ORCR) *and* the staff considered psychiatrically compliant with appointments to the outpatient clinic and under "regular" care with a psychiatrists/therapist (being seen more often than once every 3 months) were considered eligible for actigraphy monitoring.

The ActiGraph AM-7164 monitoring device (ActiGraph, Ft. Walton Beach, FL) (Department of Health and Human Services Center for Disease Control and Prevention, 2006) was used to objectively measure physical activity. The ActiGraphs were set to measure the duration and intensity of uniaxial movement within one-minute epochs. Participants were instructed to clip the accelerometer over their right hip and wear the device for seven consecutive days during their waking hours only. If there were no activity counts for ≥60 min, the accelerometer was considered not worn for that interval of time. For this report, analyses were restricted to those participants who wore the accelerometers for at least 10 h a day for three or more days (actigraphy cohort). Each minute epoch was assigned an activity level based on the number of counts per minute (cpm); sedentary (≤100 cpm), light (101–1951 cpm), moderate/vigorous (≥1952 cpm) and physically active (≥101 cpm). Daily totals of sedentary behavior and activity levels (minutes/day) were averaged. Percentage of monitoring time for sedentary behavior and physical activity was calculated by dividing the minutes engaged in each category by the total monitoring minutes for each participant. The various actigraphy measures exclude non-wear time including sleep time.

Physical activity was subjectively assessed using a very modified, past week version of the Modifiable Activity Questionnaire (MAQ), an interviewer administered questionnaire (Kriska et al., 1990; Kriska and Casperson, 1997; Janney, 2012). Graded exercise stress testing (GXT) was optional and has been previously described and summarized by Strassnig and associate (Strassnig et al., 2011). Participants with VO_2max below the twentieth percentile for normative values for VO_2max (mL/kg/min) by age and sex were considered unfit, and participants with VO_2max above or equal to the twentieth percentile for normative values for VO_2max (mL/kg/min) by age and sex were considered fit (American College of Sports Medicine, 2010).

The PANSS (Kay et al., 1987) was used to assess psychopathology in the study participants for the previous week. The PANSS is administered as a clinician interview or semi-structured interview by a trained rater and takes approximately 30 to 40 min to complete. Based on a 7-point scale (1 = absent, 2 = minimal, 3 = mild, 4 = moderate, 5 = moderate severe, 6 = severe, 7 = extreme), the clinician rates the patient on 30 items; 7 positive symptoms (delusions, conceptual disorganization, hallucinatory behavior, excitement, grandiosity, suspiciousness/persecution, and hostility), 7 negative symptoms (blunted affect, emotional withdrawal, poor rapport, passive/apathetic social withdrawal, difficulty in abstract thinking, lack of spontaneity and flow of conversation, and stereotyped thinking), and 16 general psychopathology (somatic concern, anxiety, guilt feelings, tensions, mannerisms and posturing, depression, motor retardation, uncooperativeness, unusual thought content, disorientation, poor attention, lack of judgment and insight, disturbance of volition, poor impulse control, preoccupation, and active social avoidance). The scores from the 30 items are summed to obtain the PANSS score that can range from 30 to 210. In addition, the 3 PANSS subscales were calculated corresponding to the 7 positive symptoms, 7 negative symptoms, and 16 general psychopathology symptoms.

Clinicians subjectively rated the severity of the participant's mental illness (1 = not ill, 2 = very mild, 3 = mild, 4 = moderate, 5 = severe, 7 = extremely severe) at the time of the assessment compared to the clinician's experience with previous patients with the same diagnosis

using the CGIS (Guy et al., 1970; Guy, 1976). For the analyses, participants were classified as experiencing mild (0 = not ill, very mild, or mild illness) (reference group) or severe (1 = moderate, severe, and extremely severe illness) symptoms based on the CGIS. The clinician also rated the participant on a predefined hypothetical continuum of mental health-illness based on the participant's psychological, social and occupational functioning using the Global Assessment of Functioning (GAF)(First, 2000). Functional impairments due to physical or environmental limitations were not considered.

At baseline, participants self-reported their date of birth, gender, race/ethnicity, number of cigarettes smoked per day, and general health status (SF12). Participants were classified as current smokers (≥1 cigarette per day) or non-smokers (<1 cigarette per day). For the analyses, general health status was dichotomized as good (0 = good, very good, or excellent) (reference group) or poor (1 = poor or fair). Based on self-report and review of medical records, participants were classified as taking a single antipsychotic (Aripiprazole, Clozapine, Olanzapine, Quetiapine, Risperidone, Haloperidol and Ziprasidone) or polypharmacy (more than one antipsychotic medication). Participants taking a single antipsychotic medication were also classified by the medication's weight gaining properties [high (Clozapine and Olanzapine), moderate (Quetiapine, Risperidone, and Haloperidol), low/none (Aripiprazole and Ziprasidone)] as reported in the literature (Allison and Casey, 2001; Citrome and Yeomans, 2005). Height and weight were measured using hospital quality weight and height scales. BMI (kg/m^2) was calculated as weight (kg) divided by height squared.

Chi-Square tests for categorical variables and Kruskal–Wallis nonparametric tests for continuous variables were used to compare the actigraphy cohort (n = 46) with non-participants for actigraphy (n = 203). Spearman correlations were used to examine the associations between sedentary behavior and psychiatric symptoms. Analyses were performed using Stata (release 9, StataCorp, College Station, TX) and SAS (version 9.2, SAS Institute, Triangle Park, NC).

3. Results

Fifty-five participants were consented for the actigraphy study, and 84% (n = 46) provided at least three days of valid actigraphy data. Nine participants were excluded from the analyses for the following reasons; one participant refused to wear the accelerometer, one participant lost the Actigraph during the monitoring period, 5 participants did not provide any useable data for the monitoring period (2 out of 5 were attributed to technical problems with the battery), and 2 participants provided only 1 or 2 days of valid actigraphy data. No statistically or clinically significant differences were noted for BMI, demographics, self-reported health status, or clinician rated function and psychiatric symptoms between participants with (n = 46) and without (n = 9) 3 days of valid actigraphy monitoring, and between participants with 3 days of valid actigraphy monitoring (n = 46) and non-participants in actigraphy monitoring (n = 203)(data not shown). Only the negative subscale for the PANSS was significantly greater among the actigraphy cohort (15.5 ± 5.6, n = 46) compared to the non-participants in the actigraphy monitoring (13.5 ± 3.9, n = 203) (p = 0.04).

Similar to the WAIST Study participants (n = 252), the actigraphy cohort were low functioning adults with limited education (high school education or general education diploma) and their primary source of income being social security disability. Few participants were married (2%) or employed (17%). Partially due to study eligibility criteria (BMI ≥ 27.0 kg/m^2), the majority of participants were classified as obese (67%, 30.0 ≤ BMI < 40.0) or extremely obese (24%, BMI ≥ 40.0). In addition, the majority of the participants were rated as experiencing mild to moderate psychiatric symptoms by the clinician's and participant's evaluation (Table 1). The majority of participants (72%) were prescribed a single antipsychotic medication with weight gaining properties.

On average, the actigraphy cohort wore the actigraphs for 7.4 (SD 2.8) days and 933 (SD 149) min/day (Table 2). The majority of the monitoring time was spent in sedentary behaviors (approximately 13 h per day, 756 (SD 140) min/day). Sedentary behavior accounted for 81% (SD 6%), ranging from 62% to 91%, of the monitoring time for adults with schizophrenia and schizoaffective disorders (Fig. 1). Physical activity was very limited and primarily comprised of light physical activities (101–1951 cpm) (approximately 17% of the monitoring time) rather than moderate-vigorous physical activities (≥1952 cpm) (approximately 2% of the monitoring time).

No association was observed between objective measures of sedentary behaviors and psychiatric symptoms (PANSS total or subscales: p ≥ 0.59, Table 3). Generally, the individual PANSS items were not correlated with the objective measures of sedentary behaviors (data not shown). Only the individual PANSS items for anxiety ($r_s = 0.22$, p = 0.15 for sedentary minutes and $r_s = 0.15$, p = 0.32 for percentage of sedentary time) and tensions ($r_s = 0.25$, p = 0.09 for sedentary minutes and $r_s = 0.30$, p = 0.04 for percentage of sedentary time) approached statistical significance with the measures of sedentary behaviors. In addition, no association was observed between the various objective measures of physical activity and psychiatric symptoms (PANSS total or subscales: p ≥ 0.37, Table 3).

Sedentary behaviors were not significantly correlated with age ($r_s = 0.21$, p = 0.16 for sedentary minutes/day and $r_s = 0.08$, p = 0.60 for percentage of sedentary time) or BMI($r_s = -0.08$, p = 0.58 for sedentary minutes/day and $r_s = -0.04$, p = 0.77 for percentage of sedentary time). No clinically or statistically significant differences in sedentary behaviors were noted for gender (males 758 ± 136 min/day and females 756 ± 144 min/day, p = 0.95 for sedentary time and males 81.8% ± 5.5% and females 80.6 ± 5.7%, p = 0.56 for percentage of sedentary time) or race (whites 803 ± 148 min/day and blacks 724 ± 129 min/day, p = 0.07 for sedentary time and whites 81.1% ± 5.1% and blacks 80.7 ± 6.0%, p = 0.09 for percentage of sedentary time). In addition, age (p = 0.25 and p = 0.80), BMI (p = 0.79 and p = 0.88), race (p = 0.09 and p = 0.63), and gender (p = 0.67 and p = 0.47) were not significant predictors of sedentary behaviors (minutes/day or percentage of time, respectively) in the multivariable models.

4. Discussion

Overweight and obese adults with SZO/SA in our sample spent over 12 h per day, or more than 80% of their monitoring time, in sedentary behavior. Since the participants were extremely sedentary, it is not surprising that no association was observed between objective sedentary behaviors and psychiatric symptoms that characterize SZO/SA.

In contrast to our findings, self-reported sedentary behavior was positively associated with the majority of psychiatric symptoms (total score, negative symptoms, depressive symptoms, cognitive symptoms, and extrapyramidal side-effects) (Vancampfort et al., 2012a). Measuring sedentary behavior subjectively versus objectively may account for these positive findings. However, only weak associations have been reported between self-reported sitting time and objectively measured sedentary behavior(Rosenberg et al., 2008) suggesting that 1) specific surrogate behaviors may not be representative of overall sedentary behavior, 2) the measurement of sedentary behavior by accelerometer-derived estimates may differ from self-reported estimates, and 3) positive associations between self-reported sedentary behavior and psychiatric symptoms (Vancampfort et al., 2012a) may be due to reporting error and/or differential recall rather than a true association. Additional studies are necessary to confirm these hypotheses.

Sedentary behavior assessed objectively was considerably greater among adults with SZO/SA in the WAIST Study (81% of monitoring time) compared to previously reported studies in adult population-based studies(~57% of the monitoring time) in the US (Matthews et al., 2008), Sweden (Hagstromer et al., 2007), and Australia (Healy et al., 2008). Interestingly, objective sedentary behavior was approximately

Table 1
Demographics and mental health scores for overweight and obese adults with schizophrenia or schizoaffective disorder by actigraphy monitoring (WAIST Study) (n = 249[a]).

Variable Mean (std)	Actigraphy cohort (n = 46)	Non-participants in actigraphy study (n = 203)	p-Value
Age (yrs)	45.6 (9.8)	44.9 (10.7)	0.75
BMI (kg/m^2)	37.9 (8.1)	37.9 (8.0)	0.94
Male [N (%)]	17 (37.0)	71 (35.0)	0.80[b]
Current smoker [N (%)]	16 (34.8)	94 (46.3)	0.16[b]
Race [N (%)]			0.17[b,c]
White	19 (41.3)	106 (52.2)	
Black	26 (56.5)	92 (45.3)	
Other	1 (2.2)	5 (2.5)	
Living situation			0.69[b,d,e]
Hospital	1 (2.2)	4 (2.0)	
Skilled nursing facility	2 (4.4)	19 (9.4)	
Intermediate care facility	5 (10.9)	13 (6.4)	
Supervised group living	11 (23.9)	35 (17.2)	
Transitional group home	11 (23.9)	38 (18.7)	
Family foster care	11 (23.9)	55 (27.1)	
Supervised cooperative apartment	5 (10.9)	32 (15.8)	
Board and care home	0 (0.0)	1 (0.5)	
Missing	0 (0.0)	6 (3.0)	
Antipsychotic medication [N (%)]			0.96[b]
Single	38 (82.6)	167 (82.3)	
Two	8 (17.4)	36 (17.7)	
Weight gaining properties of single antipsychotic medication [N (%)]	33 (86.8)		0.10[e]
Yes (Clozapine, Olanzapine, Haloperidol, Quetiapine, and Risperidone)	33 (86.8)	123 (73.7)	
None/low (Aripiprazole and Ziprasidone)	5 (13.2)	44 (26.4)7	
Positive and Negative Syndrome Scale (PANSS)			
Total	58.8 (15.9)	54.9 (10.6)	0.26
Positive subscale	13.3 (4.9)	13.1 (3.8)	0.94
Negative subscale	15.5 (5.6)	13.5 (3.9)	0.04
General psychopathology subscale	30.0 (7.7)	28.3 (6.1)	0.22
Global Assessment of Functioning Scale (GAF) Scores	58.5 (8.2)[f]	59.7 (7.4)[g]	0.50
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.95[b,d]
Normal, not mentally ill; very mild; or mild mental illness	20 (43.5)	79 (38.9)	
Moderate or severe mental illness	24 (52.2)	97 (47.8)	
Not assessed	2 (4.4)	27 (13.3)	
General health status [N (%)]			0.98[b,d]
Excellent, very good, or good	23 (50.0)	101 (49.8)	
Fair or poor	21 (45.7)	93 (45.8)	
Missing	2 (4.4)	9 (4.4)	
Modified MAQ Total Physical Activity (min/week)	576 (555)[f]	613 (710)[h]	0.83
Physical Fitness (VO2max) (mL/kg/min)	15.7 (6.2)[i]	15.0 (5.8)[j]	0.72

[a] n = 9 for consented participants with 0–2 valid actigraphy monitoring days; size of category considered insufficient to include in analyses or summary table.
[b] Chi-square test.
[c] Other race excluded from the Chi-square test due to insufficient sample size.
[d] Not assessed and missing excluded from the Chi-square test due to insufficient sample size.
[e] Exact Test.
[f] n = 44.
[g] n = 178.
[h] n = 190.
[i] n = 27.
[j] n = 76.

Table 2
Objective sedentary behavior and physical activity by actigraphy in overweight and obese adults with schizophrenia and schizoaffective disorders in the actigraphy cohort (n = 46).

	Mean ± STD	Median	Range	25th and 75th percentile
Sedentary (min/day)	756.5 ± 139.6	709.4	490.8, 1125.5	658.0, 830.6
Sedentary (% of actigraphy wear time)	81.0 ± 5.6	82.3	62.2, 91.2	77.4, 84.7
Total Physical Activity (min/day)	176.1 ± 54.4	159.8	88.7, 298.6	134.3, 210.8
Total Physical Activity (% of actigraphy wear time)	19.0 ± 5.6	17.7	8.8, 38.8	15.3, 22.6
Moderate-vigorous physical activity (min/day)	18.6 ± 11.8	17.8	2.0, 53.0	10.0, 23.0
Moderate-vigorous physical activity (% of actigraphy wear time)	2.0 ± 1.2	1.8	0.2, 6.4	1.2, 2.6
Light physical activity (min/day)	157.5 ± 47.9	153.7	78.3, 280.2	120.3, 179.0
Light physical activity (% of actigraphy wear time)	17.0 ± 5.0	16.0	7.7, 35.5	13.3, 19.9
Counts/day	151, 036 ± 60, 998	138,420	51,852, 313,684	105,533, 198,801
Counts/min	163.2 ± 64.2	156.8	62.4, 327.9	113.4, 205.0
Monitoring time (days)	7.4 ± 2.8	7.0	3.0, 13.0	5.0, 9.0
Monitoring time (min/day)	933 ± 149	923	721, 1286	817, 1011

3 h more per day in the WAIST Study participants than a smaller sample of community dwelling adults(n = 16) SZO/SA who were psychiatrically stable(Lindamer et al., 2008). Although speculative, the difference in objective sedentary behavior may be partially due to climate and the eligibility criteria for the 2 studies. Specifically, the WAIST Study was conducted in Pittsburgh, PA with 4 distinct seasons, and Lindamer's study was conducted in San Diego, CA with a relatively mild and constant climate (Lindamer et al., 2008). Also, Lindamer's study recruited mentally and physically healthier adults with SZO/SA than the WAIST Study.

A major strength of the current study is that sedentary behavior was measured objectively using widely accepted and established methodology in the largest sample of adults with schizophrenia and schizoaffective disorder, to date. In addition, the study only enrolled adults with SZO/SA rather than adults with severe mental illness. Feasibly, sedentary behavior may differ among adults with severe mental illness due to known differences in the symptomology, prognosis, and treatment of mood disorders (major depression and bipolar disorder) and SZO/SA.

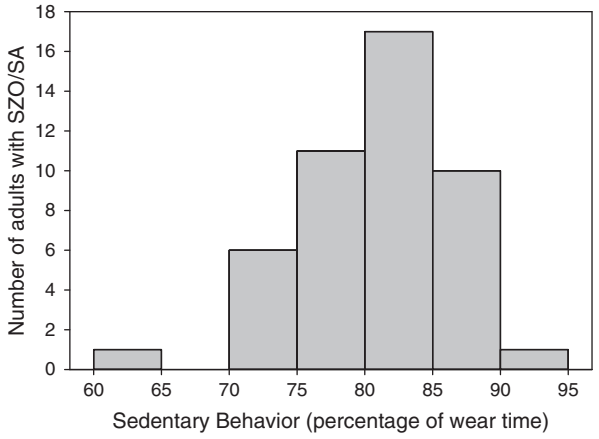

Fig. 1. Histogram of sedentary behavior (percentage of wear time) for overweight and obese adults with schizophrenia or schizoaffective disorder in the WAIST Study (n = 46).

Table 3
Spearman correlations (p-value) between PANSS Total and subscale scores and sedentary behavior and physical activity for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) (n = 46).

Actigraphy	PANSS score			
Variable	Total	Positive	Negative	General
Sedentary time	−0.001	−0.04	0.004	0.02
[min/day]	(0.99)	(0.81)	(0.98)	(0.89)
Sedentary	0.05	0.03	0.08	0.07
[% of actigraphy wear time]	(0.75)	(0.87)	(0.59)	(0.65)
Physical activity	−0.07	−0.04	−0.12	−0.08
[min/day]	(0.64)	(0.81)	(0.41)	(0.59)
Physical activity	−0.05	−0.03	−0.08	−0.07
[% of actigraphy wear time]	(0.75)	(0.87)	(0.59)	(0.65)
Moderate-vigorous physical activity	−0.04	−0.12	0.03	−0.01
[min/day]	(0.82)	(0.43)	(0.83)	(0.92)
Moderate-vigorous physical activity	−0.04	−0.11	0.03	−0.03
[% of actigraphy wear time]	(0.79)	(0.48)	(0.87)	(0.85)
Light physical activity	−0.07	−0.03	−0.14	−0.09
[min/day]	(0.62)	(0.85)	(0.37)	(0.54)
Light physical activity	−0.06	−0.01	−0.13	−0.09
[% of actigraphy wear time]	(0.69)	(0.94)	(0.41)	(0.55)
Counts/day	−0.09	−0.12	−0.08	−0.08
	(0.56)	(0.42)	(0.61)	(0.60)
Counts/min	−0.06	−0.13	−0.04	−0.05
	(0.68)	(0.37)	(0.77)	(0.73)
Monitoring time	−0.16	0.02	−0.18	−0.21
[days]	(0.28)	(0.88)	(0.23)	(0.16)
Monitoring time	−0.01	−0.05	−0.03	0.003
[min/day]	(0.93)	(0.75)	(0.85)	(0.99)

It should be noted that the generalizability of this study is limited to adult outpatients with mild to moderate symptomology for SZO/SA. Even though study enrollment was restricted to BMI ≥ 27 kg/m^2, the WAIST Study is probably representative of the majority of adults SZO/SA due to the high rates of obesity in this population. Coodin estimated that only 27% of Canadians with schizophrenia had BMIs within the acceptable range (18–25 kg/m^2) (Coodin, 2001). We expected the actigraphy cohort to be less sedentary, more active, and mentally and physically healthier than the non-participants of actigraphy monitoring. Unexpectedly, there was no difference in demographics, psychiatric symptoms, function, general health status, or subjective physical activity between those who did and did not participate in actigraphy monitoring in the WAIST Study. This finding suggests that the actigraphy cohort's sedentary behavior may be representative of overweight and obese adults with schizophrenia and schizoaffective disorders, and that the participation rates for activity monitoring may have been limited more by the researchers' perception rather than the participant's actual ability to comply with activity monitor procedures.

To our knowledge, this is the first study to examine objectively measured sedentary behavior and psychiatric symptoms specific (attributed) to SZO/SA. Whether the elevated sedentary behavior in adults with SZO/SA can be attributed to the disorder, the medications, and/or comorbidities associated with these disorders cannot be determined in this cross-sectional study and warrants further investigation. Alternatively, the lack of association between psychiatric symptoms and sedentary behavior may be due to a ceiling effect for sedentary behavior in this population and/or low power given the relatively small sample size (n = 46) of the current study.

From a public health perspective, the percentage of time engaged in sedentary behavior (averaging 81% of monitoring time and excluding non-wear time associated with sleeping) in overweight and obese adults with mild or moderate schizophrenia or schizoaffective disorder is alarming. Public health campaigns and mental health services may want to focus on decreasing sedentary behavior as one avenue to reduce the risk of common comorbidities, such as obesity, diabetes, and cardiovascular disease, often experienced by adults with SZO/SA. Interventions to reduce sedentary behavior may want to focus on increasing light physical activities or interspersing light physical activities during traditionally sedentary behaviors such as watching television or using the computer rather than targeting or tailoring the intervention to specific psychiatric symptoms or the severity of the psychiatric disorder. It is notable that most of the therapeutic activities in mental health treatment settings would also be classified as sedentary and mental health clinicians and administrators might want to consider therapeutic activities which include physical activity.

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Contributors

Dr. Janney developed and designed the study concept and design. Dr. Ganguli and Dr. Kriska were responsible for the design and acquisition of the data for the WAIST Study. Mr. Holleman and Dr. Richardson processed the accelerometry data. Dr. Janney performed the statistical analyses and wrote the manuscript. Drs. Ganguli, Richardson, Tang, Cauley, and Kriska and Mr. Holleman provided critical review of the manuscript.

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Conflict of interest

Dr. Janney has received research support from Actigraph. Dr. Ganguli currently has no relevant conflicts of interest, but has in the past received research grant support or honoraria from Jassen pharmaceutical, Lilly, Bristo Myers-Squibb, and Pfizer. All other authors declare that they have no conflicts of interest.

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