Physical Activity and Sedentary Behavior Measured Objectively and Subjectively in Overweight and Obese Adults With Schizophrenia or Schizoaffective Disorders

Carol A. Janney, PhD[a,c]; Rohan Ganguli, MD[c,d]; Gong Tang, PhD[b]; Jane A. Cauley, DrPH[a]; Robert G. Holleman, MPH[e]; Caroline R. Richardson, MD[e,f]; and Andrea M. Kriska, PhD[a,*]

ABSTRACT

Objective: Describe objective and subjective physical activity levels and time spent being sedentary in adults with schizophrenia or schizoaffective disorders (SZO/SA).

Method: Baseline physical activity and sedentary behaviors were assessed among 46 overweight and obese community-dwelling adults (aged 18–70 years; BMI > 27 kg/m^2) diagnosed with SZO/SA by *DSM-IV-TR*, with mild symptom severity (Positive and Negative Syndrome Scale score < 90) who were interested in losing weight and participated in the Weight Assessment and Intervention in Schizophrenia Treatment (WAIST) study from 2004 to 2008. Objective physical activity levels, measured using actigraphs, in WAIST were compared to a nationally representative sample of users (n = 46) and nonusers (n = 46) of mental health service (MHS) from the National Health and Nutrition Examination Survey (NHANES 2003–2004) matched by sex, BMI, and age.

Results: On average, adults with SZO/SA wore actigraphs more than 15 h/d for 7 days averaging 151,000 counts/d. The majority of monitoring time (81%) was classified as sedentary (approximately 13 h/d). Moderate/vigorous and light physical activity accounted for only 2% (19 min/d) and 17% (157 min/d) of monitoring time/d, respectively. Primary source of activity was household activities (409 ± 438 min/wk). Fifty-three percent reported walking for transportation or leisure. Adults with SZO/SA were significantly less active (176 min/d) and more sedentary (756 min/d) than NHANES users of MHS (293 and 640 min/d, respectively) and nonusers of MHS (338 and 552 min/d, respectively) ($P < .01$).

Conclusions: Overweight and obese adults with SZO/SA were extremely sedentary; engaged in unstructured, intermittent, low-intensity physical activity; and significantly less active than NHANES users and nonusers of MHS. This sedentary lifestyle is significantly lower than those of other inactive US populations, is costly for the individual and community, and highlights the need for physical activity promotion and interventions in this high risk population.

J Clin Psychiatry 2015;76(10):e1277–e1284
dx.doi.org/10.4088/JCP.14m09330

[a]Department of Epidemiology and [b]Department of Biostatistics, Graduate School of Public Health, University of Pittsburgh, Pennsylvania
[c]Western Psychiatric Institute and Clinic, University of Pittsburgh School of Medicine, Pennsylvania
[d]Department of Psychiatry, University of Toronto, Canada
[e]VA Health Services Research & Development Center for Clinical Management Research, VA Ann Arbor Healthcare System, Ann Arbor, Michigan
[f]Department of Family Medicine, University of Michigan Health Systems and Health Services Research & Development Center for Excellence, Ann Arbor
**Corresponding author:* Andrea Kriska, PhD, Graduate School of Public Health, 505B, University of Pittsburgh, 130 DeSoto Street, Pittsburgh, PA 15261 (KriskaA@edc.pitt.edu).

Schizophrenia and schizoaffective disorders are associated with significant comorbidities, such as hypertension, diabetes, cardiovascular disease, and obesity,[1–3] unhealthy lifestyles,[4,5] and increased morbidity and mortality compared to the general population.[6–8] Physical activity may be one avenue to reduce the risk of these comorbidities in adults with schizophrenia or schizoaffective disorders (SZO/SA) since physical activity has been shown to reduce the risk of chronic diseases, disabilities,[9] and premature mortality[10–14] in the general population.

Smaller studies using objective measures of physical activity suggest that individuals with SZO/SA have low levels of moderate to vigorous physical activity.[15,16] Previous studies tended to narrowly define the population as patients with SZO/SA who had diabetes and were also overweight or obese,[17] or to broadly define the sample as patients with severe mental illness including SZO/SA, bipolar disorder, and major depression.[18] In addition, the estimates of physical activity have primarily focused on high-intensity activities[17,18] and not low-intensity activities such as walking and housework.

To address these limitations, the assessments of physical activity as part of the Weight Assessment and Intervention in Schizophrenia Treatment (WAIST)[19] study were designed to provide a comprehensive profile of physical activity using subjective and objective measures in a larger sample of overweight and obese adults with SZO/SA who were participating in the clinical trial. This profile should aid clinicians in prescribing physical activity as a means to reduce the risk of common comorbidities and in developing effective physical activity interventions in this vulnerable population. The objectives of this report are (1) to describe objectively measured physical activity and sedentary behavior among overweight and obese adults with SZO/SA, and (2) to compare objective physical activity levels and sedentary behavior of adults with SZO/SA to users and nonusers of mental health service (MHS) from the National Health and Nutrition Examination Survey (NHANES) matched on sex, age, and BMI. It was hypothesized that adults with SZO/SA would have significantly lower physical activity levels than NHANES users of MHS (who represent a broader and less severe spectrum of mental health disorders) and nonusers of MHS.

METHOD

Studies

This report is based on data from the WAIST study and the National Health and Nutrition Examination Survey (NHANES

Clinical Points

- Little information exists on physical activity and sedentary behavior, measured objectively, for adults diagnosed with schizophrenia or schizoaffective disorders.
- Overweight and obese adults with schizophrenia or schizoaffective disorders have extremely sedentary lifestyles and should be encouraged to increase their physical activities.

2003–2004). Briefly, the randomized control trial WAIST study (NCT00177905) was designed to assess the efficacy of a group-based behavioral intervention treatment for weight reduction compared to social skills training or usual care in overweight and obese but clinically stable patients with SZO/SA. In addition, the participants had to live in the community, agree to attend 20 group behavioral sessions, and complete homework. Inclusion and exclusion criteria for the WAIST study reflected the goals of the randomized control trial and have been described previously.[19] Eligibility criteria for study enrollment included: aged 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* Axis I Disorders,[20] medical charts, and corroborating information from reliable informants such as family members or friends), 2 or fewer antipsychotic medications, Positive and Negative Syndrome Scale (PANSS)[21] < 90, body mass index (BMI) > 27 kg/m^2, and a participant-expressed desire to lose weight. Study exclusion criteria included: inability to give informed consent, moderate or severe mental retardation, current enrollment in another weight management program, current treatment with medication to reduce weight, unstable medical illnesses that may have affected body weight, history of myocardial infarction or coronary heart failure, end-stage renal disease, unstable thyroid disease, prominent cardiovascular risks that may have jeopardized participant's safety in a weight reduction program that included some exercising, and women who were breast-feeding. Participants were not excluded if they were receiving additional psychotropic medications such as antidepressants, mood stabilizers, and antianxiety medications. However, information on concomitant medications was not recorded separately in the study. Exclusion criteria were intentionally kept to a minimum in order to increase the generalizability of the findings. WAIST study recruitment occurred from 2004 to 2008. The study was approved by the University of Pittsburgh Biomedical Institutional Review Board, and informed consent was obtained from all participants.

Actigraphy monitoring was considered a supplemental study to the WAIST study. This current study was restricted to the baseline screening assessments that occurred prior to randomization of the WAIST subsample that was offered actigraphy monitoring.[19,22] Initially, low compliance with actigraphy monitoring occurred due to lost or misplaced actigraphs or refusal to wear the device. Hence, the supplemental protocol was modified, and participants were considered eligible for actigraphy monitoring only if (1) they had a rating of 5 or greater on the Observer Related Compliance Rating (available from the author upon request) and (2) the staff considered them psychiatrically compliant with appointments to the outpatient clinic and under "regular" care with a psychiatrist or therapist (being seen more often than once every 3 months). This report is based on the subsample (n = 55) of WAIST participants (n = 254) offered actigraphy monitoring.

NHANES 2003–2004 was a cross-sectional observational study using a stratified, multistage probability design to obtain a nationally representative sample of the civilian, noninstitutionalized, US population.[23] To match the eligibility criteria of WAIST, the NHANES sample was restricted to participants aged 18–70 years with ≥ 3 days of valid actigraph data and a BMI > 27 kg/m^2.

Objective Physical Activity Assessment in the WAIST Study and NHANES

In both studies, ActiGraph AM-7164 monitoring devices (ActiGraph, Ft Walton Beach, Florida) were used to objectively measure physical activity.[24] With accelerometry, movement is quantified on the arbitrary intensity scale[25] of counts per minute (cpm). ActiGraphs were set to measure the duration and intensity of uniaxial movement within 1-minute epochs.[25] Participants were instructed to wear the accelerometer over their right hip for 7 consecutive days during their waking hours. If there were no activity counts for ≥ 60 minutes, the accelerometer was considered not worn for that time interval. Analyses were restricted to participants who wore the accelerometers for ≥ 10 hours a day for ≥ 3 days to comply with best practices for using physical activity monitors in population-based research.[26,27] Each minute epoch was assigned an activity level based on the number of counts per minute: sedentary (≤ 100 cpm), light (101–1,951 cpm), moderate/vigorous (≥ 1,952 cpm), and total activity (> 100 cpm).[28–30] Calibration studies have classified cooking, ironing, washing dishes, and sitting activities as sedentary; childcare, grocery shopping, light calisthenics, vacuuming, gardening, and golf as light activity; and fast walking, running, and cycling as moderate/vigorous activity.[31]

Daily totals of sedentary behavior and activity levels (min/d) were averaged. Percentages of monitoring time were calculated by dividing the minutes engaged in each category by the total monitoring minutes for each participant. Weekly totals (min/d) of moderate (1,952–5,724 cpm) and vigorous (≥ 5,725 cpm) intensity activity were calculated to compare with published physical activity guidelines for patients with schizophrenia.[32]

Subjective Physical Activity Assessment in the WAIST Study

The Modifiable Activity Questionnaire (MAQ) was modified to focus on relatively lower-intensity physical activities[22] since few adults with SZO/SA reported moderate or vigorous physical activities in the study's development phase. Participants reported the number of minutes they

Table 1. Comparison of Overweight and Obese Adults With Schizophrenia or Schizoaffective Disorder in WAIST Study With Adult Users and Nonusers of MHS in NHANES 2003–2004 Matched by Sex, Closest BMI, and Age (n = 46 per Group)

	WAIST Study Adults With Schizophrenia or Schizoaffective Disorder	NHANES Users of MHS	NHANES Nonusers of MHS
Age, y (mean ± SD)	45.6 ± 9.8	44.4 ± 12.7	45.5 ± 13.7
P value		.60[a]	.98[b]
BMI, kg/m^2 (mean ± SD)	37.9 ± 8.1	37.4 ± 7.0	37.7 ± 7.5
P value		.40[a]	.14[b]
BMI categories, n (%)			
Overweight (25.0–29.9 kg/m^2)	4 (9)	4 (9)	4 (9)
Obesity Class I (30.0–34.9 kg/m^2)	14 (30)	17 (31)	14 (30)
Obesity Class II (35.0–39.9 kg/m^2)	17 (37)	16 (35)	17 (37)
Obesity Class III (≥ 40 kg/m^2)	11 (24)	9 (20)	11 (24)
P value		.94	1.00
Men, n (%)	17 (37)	17 (37)	17 (37)
P value		1.00[a]	1.00[b]
Current smoker,[c] n (%)	16 (34.8)	10 (21.8)	9 (21.4)[e]
P value		.23[a]	.21[b,d]
Race, n (%)			
White	19 (41.3)	21 (45.7)	20 (43.5)
Black/other	27 (58.7)	25 (54.3)	26 (56.5)
P value		.71[a]	.82[b]
General health status, n (%)			
Excellent, very good, or good	23 (50.0)	25 (54.4)	31 (67.4)
Fair or poor	21 (45.7)	21 (45.7)	14 (30.4)
Missing[d]	2 (4.4)	0 (0)	1 (2.2)
P value		1.00[a]	.15[b]
Objective physical activity			
Monitoring			
No. of days (mean ± SD)	7.4 ± 2.8	6.0 ± 1.0	5.8 ± 1.3
P value		.01[a]	.005[b]
min/d (mean ± SD)	933 ± 149	933 ± 159	890 ± 103
P value		.98[a]	.14[b]
Sedentary			
min/d, (mean ± SD)	756 ± 140	640 ± 149	552 ± 115
P value		.004 [a]	.0007[b]
% of wear time	81 ± 6	69 ± 10	62 ± 10
P value		.0004[a]	.002[b]
Light activity			
min/d (mean ± SD)	157 ± 48	279 ± 99	324 ± 85
P value		.0004[a]	.002[b]
% of wear time	17 ± 5	30 ± 10	37 ± 9
P value		.0004[a]	.003[b]
Moderate/vigorous activity			
min/d (mean ± SD)	19 ± 12	14 ± 13	14 ± 14
P value		0.08[a]	0.12[b]
% of wear time	2 ± 1	2 ± 1	2 ± 1
P value		.11[a]	.12[b]
Total activity			
min/d (mean ± SD)	176 ± 54	293 ± 101	338 ± 91
P value		.0005[a]	.001[b]
% of wear time	19 ± 6	31 ± 10	38 ± 10
P value		.0004[a]	.002[b]
Activity			
Counts/d (mean ± SD)	151,036 ± 60,998	185,112 ± 77,037	211,667 ± 89,022
P value		.03[a]	.002[b]
Counts/min (mean ± SD)	163 ± 64	200 ± 85	236 ± 87
P value		.03[a]	.0004[b]

[a]Based on conditional logistic regression model comparing WAIST study participants matched by sex, closest BMI, and ties by age to users of MHS in NHANES 2003–2004.
[b]Based on conditional logistic regression model comparing WAIST study participants matched by sex, closest BMI, and ties by age to nonusers of MHS in NHANES 2003–2004.
[c]WAIST study participants were classified as current smokers (≥ 1 cigarette per day) or nonsmokers (< 1 cigarette per day) based on self-reports. NHANES participants were classified as current smokers if cotinine levels were equal to or greater than 10 ng/dL and as nonsmokers if cotinine levels were less than 10 ng/dL.
[d]Missing category excluded from analyses.
[e]Missing n = 4.
Abbreviations: BMI = body mass index, MHS = mental health service, NHANES = National Health and Nutrition Examination Survey, SD = standard deviation, WAIST = Weight Assessment and Intervention in Schizophrenia Treatment study.

engaged in specified physical activities for ≥ 10 minutes during the preceding week. Occupational activities, housework, gardening/yard work, caretaking, transportation, and leisure activities were summed to obtain total physical activity in minutes per week for the preceding week. For those participants that reported extreme values in selected activities, the minutes per week for those activities were truncated to the second-highest reported value in the sample.[22] As a reliability measure, intraclass coefficients ranged from 0.74 to 0.98[33–36] for the MAQ.

Psychiatric Symptoms and Antipsychotic Medications

Clinicians subjectively rated the psychopathology (previous week), severity of current symptoms, and current function of the adults with SZO/SA by means of the PANSS and the Global Assessment of Functioning (GAF),[37] respectively. Self-reported, general health status[38] was dichotomized as 1 = poor and fair or 0 = good, very good, and excellent. On the basis of self-report and review of medical records, participants were classified as taking none, 1, or 2 antipsychotic medications. Height and weight were measured using hospital-quality scales and were used to calculate BMI (kg/m^2).

Comparison Groups for WAIST and NHANES

For this report (N = 138), the WAIST analytic sample consisted of all participants with ≥ 3 days of valid actigraphy data (n = 46). NHANES users (n = 46) and nonusers (n = 46) of MHS were defined as adults who did and did not report seeing or talking to a mental health professional such as a psychologist, psychiatrist, psychiatric nurse, or clinical social worker about their mental health during the past 12 months, respectively.

Analyses

Kruskal-Wallis analyses of variance were performed to detect demographic differences in the WAIST study. Spearman correlations were used to examine the associations between the subjective and objective physical activity measures. WAIST participants were matched 1:1 to NHANES users and nonusers of

Table 2. Subjective Physical Activity, Modified MAQ (min/wk) for Overweight and Obese Adults With Schizophrenia or Schizoaffective Disorder (WAIST Study) (n = 46)

Subjective Physical Activity	Mean ± SD	Median	25th, 75th Percentile	Range
Occupational[a]	10.0 ± 67.1	0	0, 0	0, 450
Housework	408.7 ± 438.4	213	99, 580	0, 1725
Gardening/yardwork	10.8 ± 37.0	0	0, 0	0, 210
Caretaking	4.6 ± 31.0	0	0, 0	0, 210
Transportation	29.9 ± 62.0	0	0, 30	0, 300
Leisure[a]	115.5 ± 171.9	20	0, 180	0, 840
Total physical activity[b]	576.4 ± 555.0	372.5	239, 920	0, 2160
Total physical activity w/o occupational activities[a]	559.1 ± 528.3	345.0	90, 225	0, 2160
Total physical activity w/o household activities[b]	159.6 ± 204.7	90.0	0, 840	0, 255

[a]Missing 1 patient.
[b]Missing 2 patients.
Abbreviations: MAQ = Modifiable Activity Questionnaire, SD = standard deviation, WAIST = Weight Assessment and Intervention in Schizophrenia Treatment study, w/o = without.

MHS by sex and closest BMI, with BMI ties determined by the closest age to account for potential residual effects of these demographic variables on actigraphy comparisons. Matching was conducted by C.A.J. prior to obtaining information (blinded) on the physical activity levels of WAIST or NHANES participants. After matching, BMI differences averaged 0.21 ± 1.10 kg/m^2 (median = 0.005; range, −0.22 to 7.35) between WAIST participants and NHANES nonusers of MHS, and 0.54 ± 2.83 kg/m^2 (median = 0.01; range, −1.63 to 17.60) between WAIST participants and NHANES users of MHS. Age differences averaged 0.07 ± 15.9 years (median = 2.0; range, −36.0 to 33.0) between matched WAIST participants and NHANES nonusers of MHS, and 1.2 ± 16.2 years (median 2.0; range, −36.0 to 33.0) between matched WAIST participants and NHANES users of MHS. Conditional logistic regression models were used to determine if the actigraphy measures and demographics differed between the WAIST participants matched to the NHANES (1) users of MHS and (2) nonusers of MHS. Descriptive summaries and statistical analyses were performed using Stata (release 9, StataCorp, College Station, Texas) and SAS (version 9.2, SAS Institute, Triangle Park, North Carolina).

RESULTS

Overall, 84% (46 of 55 participants) provided at least 3 days of valid actigraphy data. Nine participants were excluded for the following reasons: only 1 or 2 days of valid actigraphy data (n = 2), no usable data (n = 5; 2 of these were attributed to technical problems with the battery), refusal to wear the accelerometer (n = 1), and lost ActiGraph (n = 1). No statistically or clinically significant differences were noted for demographics, self-reported health status, or psychiatric symptoms between participants with (n = 46) and without (n = 9) 3 days of valid actigraphy monitoring (data not shown).

The majority of the WAIST analytic sample was middle-aged (40–65 years), women, and obese (n = 42, 91%) (Table 1) with the mean BMI representing class II obesity. Few participants were married (1/46, 2%) or employed (8/46, 17%). Participants were generally low-functioning adults (59 ± 8 GAF score) with limited education (high school education or a general education diploma [high school equivalent] [20/38, 53%]). Generally, participants lived in group or community housing. The majority of the participants (27/46, 59%) were classified as experiencing mild mental illness at baseline (PANSS ≤ 60). PANSS scores for total, positive subscale, negative subscale, and general psychopathology subscale were a mean ± SD of 58.8 ± 15.9, 13.3 ± 4.9, 15.5 ± 5.6, and 30.0 ± 7.7, respectively. All of the participants were prescribed medications for SZO/SA with the majority (n = 38, 83%) prescribed a single, atypical antipsychotic medication (aripiprazole n = 3; clozapine n = 5, olanzapine n = 9, quetiapine n = 7, risperidone n = 12, and ziprasidone n = 2). The remaining 8 participants (17%) were prescribed 2 antipsychotic medications.

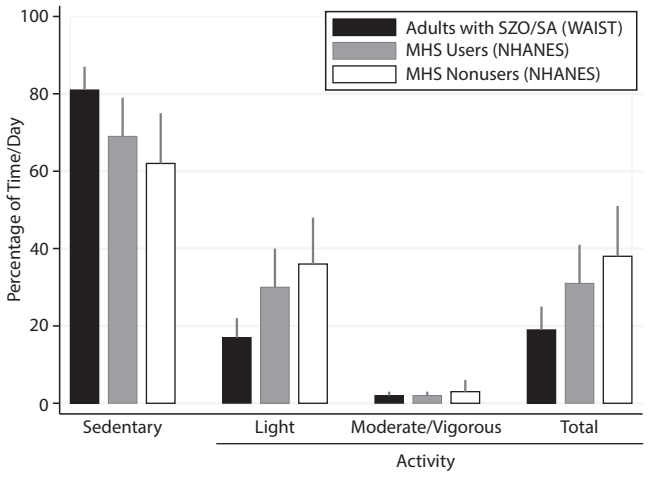
On average, adults with SZO/SA wore actigraphs more than 15 h/d, 7 d/wk (Table 1) averaging 151,000 counts/d or 163 counts/min. The majority of monitoring time was classified as sedentary (approximately 13 h/d or 81% of monitoring time). On average, moderate/vigorous and light physical activity accounted for only 2% (19 min/d) and 17% (157 min/d) of monitoring time/d, respectively. No associations between men and women ($P \geq .39$), whites and blacks ($P \geq .29$), or age ($P > .17$) were noted for the objective measures of physical activity (data not shown).

For substantial health benefits, 75 minutes of moderate- to vigorous-intensity aerobic activity per week or at least 150 min/wk of moderate-intensity activity is recommended for patients with schizophrenia.[32] None of the WAIST participants achieved 75 minutes of moderate- to vigorous-intensity aerobic activity per week. However, 26% (n = 12) of the participants achieved at least 150 min/wk of moderate-intensity activity. Only 2 (2%) participants achieved more extensive health benefits defined as 300 minutes or more per week of moderate intensity activity for patients with schizophrenia.[32]

On the basis of the modified MAQ, housework was the primary source of physical activity accounting for 60% of total minutes per week of physical activity (Table 2). Specific household activities reported by more than 10% of participants were shopping (36/46, 78%), housework (light, 36/46, 78%; heavy, 26/46, 57%), laundry (35/46, 76%), food preparation (25/46, 54%), dish washing (36/46, 78%), and light home repairs (6/46, 13%). While 53% (n = 24) reported walking for transportation or exercise, other leisure physical activities were reported by less than 10% of WAIST participants.

No associations ($P \geq .27$) were observed between subjective (modified MAQ: minutes per day or metabolic equivalents per day for total activity) and objective (actigraphy: minutes per day or percentage of wear time for total activity or activity intensity levels) measures of physical activity among adults with SZO/SA (data not shown).[22]

Figure 1. Percentage of Time/Day Engaged in Sedentary and Physical Activity Behaviors for Overweight and Obese Adults With Schizophrenia or Schizoaffective Disorder in the WAIST Study Matched by Sex, Closest BMI, and Age With Adult Users and Nonusers of Mental Health Service in NHANES 2003–2004 (n = 46 per Group)



Abbreviations: MHS = mental health service, NHANES = National Health and Nutrition Examination Survey, SZO/SA = schizophrenia/schizoaffective disorders, WAIST = Weight Assessment and Intervention in Schizophrenia Treatment study.

Matched Comparison of WAIST Actigraphy Participants (n = 46) With NHANES Users and Nonusers of MHS

No statistical or clinically significant differences were noted between WAIST participants and NHANES users and nonusers of MHS for age, BMI, sex, current smoking status, and race ($P \geq .15$) after matching by sex, BMI, and age. As expected, WAIST participants tended to report general health status as fair or poor more frequently than NHANES nonusers of MHS (46% vs 30%, respectively) ($P = .15$).

ActiGraphs were worn by adults with SZO/SA approximately 1 day longer than NHANES users and nonusers of MHS (Table 1, $P < .01$). However, no differences were noted in average number of monitoring minutes per day between groups. Actigraphy results for physical activity and sedentary behavior did not differ whether minutes per day or percentage of wear time was used for the analyses.

Overall, adults with SZO/SA were significantly less active and more sedentary (minutes per day or percentage of wear time) than NHANES users ($P \leq .03$) and nonusers of MHS ($P < .01$) (Table 1). Light activity and total activity (minutes per day or percentage of wear time) of adults with SZO/SA were approximately one-half the monitoring time of NHANES users of MHS (approximately 2.5 vs 5 hours for light activity, and 3 vs 6 hours for total activity, respectively). Moderate/vigorous activity was low and averaged only 2%–3% of monitoring time for all groups. Except for moderate/vigorous activity, consistent trends in physical activity and sedentary behavior were observed among the groups (Figure 1). Specifically, adults with SZO/SA were less active than NHANES users of MHS who were less active than nonusers of MHS for light and total activity. Conversely, adults with SZO/SA were more sedentary than NHANES users of MHS who were more sedentary than nonusers of MHS. Less than one-third of the participants (adults with SZO/SA [n = 15, 33%], NHANES users of MHS [n = 11, 24%] and nonusers of MHS [n = 8, 17%]) achieved 150 min/wk of moderate/vigorous activity as recommended by national physical activity guidelines.

DISCUSSION

Our study demonstrated that overweight and obese adults with SZO/SA with mild to moderate psychiatric symptoms were significantly less active and more sedentary than NHANES users and nonusers of MHS matched by sex, BMI, and age. Overall, activity levels of the overweight and obese adults with SZO/SA were approximately half the activity levels of NHANES users and nonusers. Regardless of whether physical activity was measured subjectively or objectively, overweight and obese adults with SZO/SA were extremely sedentary and primarily engaged in unstructured, intermittent, and low-intensity activities such as walking and housework. Occupational activities were limited due to the low employment rate. As previously reported, fitness, as measured by maximal oxygen consumption, has also been found to be extremely low in this same population.[39] These findings provide justification for physical activity interventions targeting adults with SZO/SA as a possible means to decrease the elevated risk of common medical comorbidities observed in this high-risk population. Previous investigators have demonstrated that lifestyle interventions in people with psychotic illnesses can increase physical fitness.[40,41]

In the general population, common comorbidities (diabetes, dyslipidemia, hypertension, or heart disease) have been shown to be associated with a sedentary lifestyle,[42–46] and physical activity has been shown to be an effective intervention.[9,46] This study provides quantitative evidence that adults with SZO/SA have sedentary lifestyles and suggests that physical activity may be one avenue to address these common medical comorbidities, functional impairments, and premature morbidity and mortality observed among adults with SZO/SA.

Our finding, in the largest sample so far, compares favorably with 2 smaller actigraphy studies, both reporting 2%–4% of the monitoring time as active for patients with schizophrenia.[15,17] In contrast, 1 study (n = 16)[16] found adults with SZO had approximately twice the objective physical activity levels (counts/min, light activity, and moderate/vigorous activity) compared to WAIST participants (n = 46). Although speculative, the difference may be due to climate (Pittsburgh, Pennsylania, with 4 distinct seasons vs San Diego, California, with a relatively mild and constant climate) or the samples (Lindamer and colleagues' sample[16] had no known current, severe medical conditions; greater percentage Caucasian [82%] and ever married [52%]; less severe psychiatric symptoms; and no BMI restrictions[16]).

Our findings are also consistent with previous studies using self-reported physical activity in adults with SZO/

SA. Briefly, adults with SZO/SA were inactive[8,16,47–49] and less active than controls[16,48–50] or national populations,[8] and few achieved national guidelines for recommended levels of physical activity[51,52] or participated in vigorous or strenuous physical activity.[8,16,47,48,52,53] Similar to the WAIST study, the vast majority of adults with SZO/SA engaged in light to low-moderate physical activities such as walking.[8,47,48,53–55]

Adults with SZO/SA usually face multiple barriers, rather than a single barrier, for engaging in physical activity. For this population, clinicians promoting physical activity may first want to focus on and address barriers to walking since walking was the physical activity of choice among the majority of adults with SZO/SA in WAIST. Although not assessed in this study, additional factors may be influencing physical activity levels of overweight and obese adults with SZO/SA. Several environmental influences such as lack of sidewalks, parks, and safe neighborhoods in urban settings have been shown to negatively impact physical activity in the general population.[56] Availability of community resources including low-cost recreational facilities or peer-run agencies providing services for individuals with severe mental illness may also influence physical activity levels and may be another means to increase physical activity in this vulnerable population. Other barriers for adults with SZO/SA include social factors (lack of social support, stigma, avoidance of social situations[32]); emotional factors (mood, stress, motivation); symptoms of SZO/SA or medical comorbidities; and side effects of medications, including sedation, transportation factors, and financial factors.[32] These barriers may significantly impair the abilities of these adults and complicate attempts to decrease their sedentary behavior and increase their physical activity.

Strengths of the WAIST study assessments of physical activity included objective and subjective measure of physical activity in adults with SZO/SA with all participants meeting diagnostic criteria for SZO/SA. Actigraphy protocol and methodology for the WAIST study replicated that of NHANES, permitting objective physical activity comparisons between well-defined populations. It should be noted that 84% of adults with SZO/SA (WAIST) provided usable actigraphy data that compares favorably with the 79%–80% reported in population-based studies for adults.[28,57] Even though accelerometry is considered the best practice for objectively measuring physical activity in population-based research,[26,27] single, waist-mounted, uniaxial accelerometry underestimates physical activity that involves upper-body movement or the additional energy cost of load carrying.[31] However, the accelerometry cut points are based on walking,[31] which is the most prevalent form of leisure-time physical activity in the United States[58,59] and occurs in occupational and transportation activity.

Overall, WAIST participants were representative of community-dwelling, overweight and obese adults with SZO/SA who received care from community mental health centers where a large proportion of persons with severe mental illness receive treatment. Adults with SZO/SA are probably a small proportion of the NHANES users of MHS since the prevalence of mood, anxiety, and personality disorders is far greater in those living in the community than is the prevalence of schizophrenia. With respect to BMI, the WAIST sample may be more representative of adults with SZO/SA since, in comparison, only 27% of Canadians with schizophrenia had BMIs within the acceptable range.[60]

In summary, overweight and obese adults with SZO/SA were sedentary; engaged in unstructured, intermittent, low-intensity physical activity such as walking and housework; and less active than NHANES users and nonusers of MHS. This extremely sedentary lifestyle is alarming, significantly lower than other inactive US populations, costly for the individual and community, and warrants immediate action. Interventions should focus on decreasing sedentary time in addition to promoting all aspects of physical activity in overweight and obese adults with SZO/SA. From a clinical perspective, both mental health and medical professionals should emphasize and incorporate the importance of increasing physical activity and decreasing sedentary behavior in their clinical care of this vulnerable population.

Submitted: June 19, 2014; accepted October 6, 2014.

Drug names: aripiprazole (Abilify), clozapine (Clozaril, FazaClo, and others), olanzapine (Zyprexa), quetiapine (Seroquel), risperidone (Risperdal and others), ziprasidone (Geodon).

Author contributions: 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. Dr Tang provided statistical consultation for the study. Drs Ganguli, Richardson, Tang, Cauley, and Kriska and Mr Holleman provided critical review of the manuscript.

Potential conflicts of interest: In the past, **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 Janssen Pharmaceutical, Lilly, Bristol Myers-Squibb, and Pfizer. All other authors declare that they have no conflicts of interest.

Funding/support: The WAIST study was funded by NIMH grant R01 MH66068 (PI Rohan Ganguli, Consultant Andrea Kriska). Fitness testing in the WAIST study was funded by NIH grant 5M01RR00056 (General Clinical Research Center) (PI David Kelley) and NIH grant 1P30DK46204 (Obesity and Nutrition Research Center) (PI David Kelley) at the University of Pittsburgh. The actigraphy programming for the WAIST and NHANES 2003–2004 studies was partially supported by Career Development Awards from NHLBI (K23HL075098) (Richardson) and NIA (K01AG025962) (Strath). The Evelyn H. Wei Scholarship Award in Epidemiology from the Department of Epidemiology at the University of Pittsburgh, Pennsylvania, provided partial tuition assistance for the dissertation work (Janney).

Role of the sponsors: The supporters had no role in the study design, data collection, analysis, or reporting of the data.

Disclaimer: The views expressed in this article are those of the authors and do not necessarily represent the views of the Department of Veterans Affairs.

Additional information: The WAIST study is registered at ClinicalTrials.gov identifier: NCT00177905.

REFERENCES

1. Faulkner G, Gorcynski P, Arbour-Nicitopoulos K. Exercise as an adjunct treatment for schizophrenia. In: Faulkner GEJ, Taylor AH, Dishman RK, et al, eds. *Exercise, Health and Mental Health: Emerging Relationships*. 1st ed. New York, NY: Routledge; 2005:27–47.
2. Ganguli R. Behavioral therapy for weight loss in patients with schizophrenia. *J Clin Psychiatry*. 2007;68(suppl 4):19–25.
3. Hennekens CH. Increasing global burden of cardiovascular disease in general populations and patients with schizophrenia. *J Clin Psychiatry*. 2007;68(suppl 4):4–7.
4. Chwastiak LA, Rosenheck RA, Kazis LE.

Association of psychiatric illness and obesity, physical inactivity, and smoking among a national sample of veterans. *Psychosomatics*. 2011;52(3):230–236.

5. Scott D, Happell B. The high prevalence of poor physical health and unhealthy lifestyle behaviours in individuals with severe mental illness. *Issues Ment Health Nurs*. 2011;32(9):589–597.
6. Barnett AH, Mackin P, Chaudhry I, et al. Minimising metabolic and cardiovascular risk in schizophrenia: diabetes, obesity and dyslipidaemia. *J Psychopharmacol*. 2007;21(4):357–373.
7. Van Gaal LF. Long-term health considerations in schizophrenia: metabolic effects and the role of abdominal adiposity. *Eur Neuropsychopharmacol*. 2006;16(suppl 3):S142–S148.
8. Joukamaa M, Heliövaara M, Knekt P, et al. Schizophrenia, neuroleptic medication and mortality. *Br J Psychiatry*. 2006;188(2):122–127.
9. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc*. 2007;39(8):1423–1434.
10. Wannamethee SG, Shaper AG, Walker M. Changes in physical activity, mortality, and incidence of coronary heart disease in older men. *Lancet*. 1998;351(9116):1603–1608.
11. Rodriguez BL, Curb JD, Burchfiel CM, et al. Physical activity and 23-year incidence of coronary heart disease morbidity and mortality among middle-aged men. The Honolulu Heart Program. *Circulation*. 1994;89(6):2540–2544.
12. Sherman SE, D'Agostino RB, Silbershatz H, et al. Comparison of past versus recent physical activity in the prevention of premature death and coronary artery disease. *Am Heart J*. 1999;138(5, pt 1):900–907.
13. Kujala UM, Kaprio J, Sarna S, et al. Relationship of leisure-time physical activity and mortality: the Finnish twin cohort. *JAMA*. 1998;279(6):440–444.
14. Carlsson S, Andersson T, Lichtenstein P, et al. Physical activity and mortality: is the association explained by genetic selection? *Am J Epidemiol*. 2007;166(3):255–259.
15. Gothelf D, Falk B, Singer P, et al. Weight gain associated with increased food intake and low habitual activity levels in male adolescent schizophrenic inpatients treated with olanzapine. *Am J Psychiatry*. 2002;159(6):1055–1057.
16. Lindamer LA, McKibbin C, Norman GJ, et al. Assessment of physical activity in middle-aged and older adults with schizophrenia. *Schizophr Res*. 2008;104(1–3):294–301.
17. McKibbin CL, Patterson TL, Norman G, et al. A lifestyle intervention for older schizophrenia patients with diabetes mellitus: a randomized controlled trial. *Schizophr Res*. 2006;86(1–3):36–44.
18. Jerome GJ, Young DR, Dalcin A, et al. Physical activity levels of persons with mental illness attending psychiatric rehabilitation programs. *Schizophr Res*. 2009;108(1–3):252–257.
19. Janney CA, Ganguli R, Richardson CR, et al. Sedentary behavior and psychiatric symptoms in overweight and obese adults with schizophrenia and schizoaffective disorders (WAIST Study). *Schizophr Res*. 2013;145(1–3):63–68.
20. First MB, Spitzer RL, Gibbon M, et al. *Structured Clinical Interview for DSM-IV Axis I Disorders, Clinican Version (SCID-CV)*. Washington, DC: American Psychiatric Press, Inc; 1996.
21. Kay SR, Fiszbein A, Opler LA. The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophr Bull*. 1987;13(2):261–276.
22. Janney CA. *Physical Activity in Overweight and Obese Adults With Schizophrenia or Schizoaffective Disorders* [dissertation]. Pittsburgh, PA: University of Pittsburgh; 2012.
23. NHANES 2003–2004 Public Data General Release File Documentation. 2005. CDC web site. http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/general_data_release_doc_03-04.pdf. Accessed April 12, 2007.
24. National Health and Nutrition Examination Survey 2003–2004, data documentation, codebook, and frequencies. Physical activity monitor (PAXRAW_C). http://wwwn.cdc.gov/Nchs/Nhanes/2003-2004/PAXRAW_C.htmn. Last revised: December, 2007. Accessed April 12, 2007.
25. Chen KY, Bassett DR Jr. The technology of accelerometry-based activity monitors: current and future. *Med Sci Sports Exerc*. 2005;37(suppl):S490–S500.
26. Matthews CE, Hagströmer M, Pober DM, et al. Best practices for using physical activity monitors in population-based research. *Med Sci Sports Exerc*. 2012;44(suppl 1):S68–S76.
27. Trost SG, McIver KL, Pate RR. Conducting accelerometer-based activity assessments in field-based research. *Med Sci Sports Exerc*. 2005;37(suppl):S531–S543.
28. Hagströmer M, Oja P, Sjöström M. Physical activity and inactivity in an adult population assessed by accelerometry. *Med Sci Sports Exerc*. 2007;39(9):1502–1508.
29. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. *Am J Epidemiol*. 2008;167(7):875–881.
30. Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc accelerometer. *Med Sci Sports Exerc*. 1998;30(5):777–781.
31. Matthew CE. Calibration of accelerometer output for adults. *Med Sci Sports Exerc*. 2005;37(suppl):S512–S522.
32. Vancampfort D, De Hert M, Skjerven LH, et al. International Organization of Physical Therapy in Mental Health consensus on physical activity within multidisciplinary rehabilitation programmes for minimising cardio-metabolic risk in patients with schizophrenia. *Disabil Rehabil*. 2012; 34(1):1–12.
33. Pettee Gabriel K, McClain JJ, Lee CD, et al. Evaluation of physical activity measures used in middle-aged women. *Med Sci Sports Exerc*. 2009;41(7):1403–1412.
34. Momenan AA, Delshad M, Sarbazi N, et al. Reliability and validity of the Modifiable Activity Questionnaire (MAQ) in an Iranian urban adult population. *Arch Iran Med*. 2012;15(5):279–282.
35. Kriska AM. Modifiable Activity Questionnaire. *Med Sci Sports Exerc*. 1997;29:S73–S8.
36. Pettee Gabriel K, McClain JJ, Schmid KK, et al. Reliability and convergent validity of the past-week Modifiable Activity Questionnaire. *Public Health Nutr*. 2011;14(3):435–442.
37. First M. Diagnostic and Statistical Manual,Text Revision (*DSM-IV-TR*, 2000). In: First MB, ed. *STAT!Ref Online Electronic Medical Library*:Washington, DC: American Psychiatric Association; 2000.
38. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36),1: conceptual framework and item selection. *Med Care*. 1992;30(6):473–483.
39. Strassnig M, Brar JS, Ganguli R. Low cardiorespiratory fitness and physical functional capacity in obese patients with schizophrenia. *Schizophr Res*. 2011;126(1–3):103–109.
40. Daumit GL, Dalcin AT, Jerome GJ, et al. A behavioral weight-loss intervention for persons with serious mental illness in psychiatric rehabilitation centers. *Int J Obes (Lond)*. 2011;35(8):1114–1123.
41. Heggelund J, Nilsberg GE, Hoff J, et al. Effects of high aerobic intensity training in patients with schizophrenia: a controlled trial. *Nord J Psychiatry*. 2011;65(4):269–275.
42. Hu FB, Li TY, Colditz GA, et al. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA*. 2003;289(14):1785–1791.
43. Ford ES, Kohl HW 3rd, Mokdad AH, et al. Sedentary behavior, physical activity, and the metabolic syndrome among US adults. *Obes Res*. 2005;13(3):608–614.
44. Dietz WH. The role of lifestyle in health: the epidemiology and consequences of inactivity. *Proc Nutr Soc*. 1996;55(3): 829–840.
45. Epstein LH, Roemmich JN. Reducing sedentary behavior: role in modifying physical activity. *Exerc Sport Sci Rev*. 2001;29(3):103–108.
46. US Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Chronic Disease and Health Promotion; 1996.
47. Chuang HT, Mansell C, Patten SB. Lifestyle characteristics of psychiatric outpatients. *Can J Psychiatry*. 2008;53(4):260–266.
48. Osborn DPJ, Nazareth I, King MB. Physical activity, dietary habits and Coronary Heart Disease risk factor knowledge amongst people with severe mental illness: a cross sectional comparative study in primary care. *Soc Psychiatry Psychiatr Epidemiol*. 2007;42(10):787–793.
49. Vancampfort D, Probst M, Scheewe T, et al. Relationships between physical fitness, physical activity, smoking and metabolic and mental health parameters in people with schizophrenia. *Psychiatry Res*. 2013;207(1–2):25–32.
50. Vancampfort D, Probst M, Scheewe T, et al. Lack of physical activity during leisure time contributes to an impaired health related quality of life in patients with schizophrenia. *Schizophr Res*. 2011;129(2–3):122–127.
51. Dickerson FB, Brown CH, Daumit GL, et al. Health status of individuals with serious mental illness. *Schizophr Bull*. 2006;32(3):584–589.
52. Faulkner G, Cohn T, Remington G. Validation of a physical activity assessment tool for individuals with schizophrenia. *Schizophr Res*. 2006;82(2–3):225–231.
53. Brown S, Birtwistle J, Roe L, et al. The unhealthy lifestyle of people with schizophrenia. *Psychol Med*. 1999;29(3):697–701.
54. McLeod HJ, Jaques S, Deane FP. Base rates of physical activity in Australians with schizophrenia. *Psychiatr Rehabil J*. 2009;32(4):269–275.
55. Menza M, Vreeland B, Minsky S, et al. Managing atypical antipsychotic-associated weight gain: 12-month data on a multimodal weight control program. *J Clin Psychiatry*. 2004;65(4):471–477.

56. Soundy A, Stubbs B, Probst M, et al. Barriers to and facilitators of physical activity among persons with schizophrenia: a survey of physical therapists. *Psychiatr Serv*. 2014;65(5):693–696.
57. Janney CA, Richardson CR, Holleman RG, et al. Gender, mental health service use and objectively measured physical activity: data from the National Health and Nutrition Examination Survey (NHANES 2003–2004). *Ment Health Phys Act*. 2008;1(1):9–16.
58. Centers for Disease Control and Prevention (CDC). Vital signs: walking among adults—United States, 2005 and 2010. *MMWR Morb Mortal Wkly Rep*. 2012;61(31):595–601.
59. Kruger J, Ham SA, Berrigan D, et al. Prevalence of transportation and leisure walking among US adults. *Prev Med*. 2008;47(3):329–334.
60. Coodin S. Body mass index in persons with schizophrenia. *Can J Psychiatry*. 2001;46(6):549–555.