PHYSICAL ACTIVITY IN OVERWEIGHT AND OBESE ADULTS WITH SCHIZOPHRENIA AND SCHIZOAFFECTIVE DISORDERS

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PHYSICAL ACTIVITY IN OVERWEIGHT AND OBESE ADULTS WITH SCHIZOPHRENIA AND SCHIZOAFFECTIVE DISORDERS

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Objectives: Provide a comprehensive profile of physical activity in overweight and obese adults with schizophrenia or schizoaffective disorders (SZO/SA), and compare physical activity levels measured objectively with accelerometry in overweight and obese adults with SZO/SA with users of mental health services (NHANES 2003-2004).
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, experiencing mild psychiatric symptoms (PANSS<90), interested in losing weight, age 18-70 years, BMI>27 kg/m^2.
Measurements: Self-reported physical activity questionnaire, objectively measured physical activity (accelerometry), and physical fitness.
Results: Household activities were the primary source of activity (women 474, men 284 mins/wk, $p<0.001$). Walking for transportation or leisure was reported by 64% (n=163) of participants. Occupational activities were limited due to low employment rate (~15%). Other than household activities, no differences in subjective physical activity were noted by gender, race, or age groups. On average, 81%, 17%, and 2% of the participant's monitoring time was classified as sedentary, light, and moderate-vigorous activity, respectively, using accelerometry. Total (mins/day and counts/min) and light activity (mins/day) but not moderate-vigorous activity (mins/day) were significantly greater in users of mental health services than adults with SZO/SA ($p<0.01$). Only 2 of 105 were classified as fit. No association was observed between objective and subjective physical activity and physical fitness. Subjective physical activity was associated with function and general health status but not psychiatric symptoms.
Conclusion: Overweight and obese adults with SZO/SA were extremely sedentary; unfit; engaged in unstructured, intermittent, low-intensity physical activity; less active than users of

mental health services. Physical activities were generally limited to walking for transportation or leisure, and household activities.

Public Health Significance: These findings provide the first quantitative and comprehensive profile of physical activity in adults with SZO/SA. 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.

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1.0 OVERVIEW

Schizophrenia and schizoaffective disorders are severe chronic mental illnesses that afflict approximately 1% of the US population (1). Positive symptoms of schizophrenia represent an excess or distortion of normal function and include delusions, hallucinations, disorganized speech, and grossly disorganized or catatonic behavior(2). Conversely, the negative symptoms of schizophrenia refer to a reduction or loss of normal function(2) manifested as affective flattening, alogia, or avolition (3). In addition, the cognitive deficits of schizophrenia involve attention problems, poor executive functioning pertaining to planning and organizing, and impaired working memory(1). These cognitive impairments often result in significant social and occupational dysfunction for individuals with schizophrenia(1, 3). With schizoaffective disorders, individuals experience major depression, mania or a mixed episode (symptoms of depression and mania simultaneously) along with the positive, negative, and/or cognitive symptoms of schizophrenia(3).

Treatment of schizophrenia and schizoaffective disorder includes pharmacotherapy with antipsychotic medication and may be combined with psychosocial interventions(4). However, adjunctive treatments or strategies are still needed to reduce the risk of relapse and the significant residual symptoms associated with schizophrenia(4).

It has been suggested that physical activity may improve the quality of life of adults with schizophrenia or schizoaffective disorder by providing physical and psychological benefits(4). Although limited, research on the psychiatric benefits of physical activity in adults with schizophrenia or schizoaffective disorder suggests that it may alleviate the negative symptoms of schizophrenia by reducing depression, decreasing social withdrawal and isolation, and increasing self-esteem(4). In addition, physical activity may provide an effective coping strategy for the positive symptoms of schizophrenia(4) that involve a loss of contact with reality such as hallucinations, delusions, and thought and movement disorders.

In the general population, physical activity has been shown to reduce the risk of chronic diseases, including cardiovascular disease and diabetes, disabilities (5), and premature mortality(6-10). Physical activity has also been shown to prevent weight gain, and is recommended as a component of weight loss and weight loss maintenance programs(11). Since schizophrenia and schizoaffective disorders are associated with significant co-morbidities such as hypertension, diabetes, cardiovascular disease and obesity(4), unhealthy lifestyles(12), and increased morbidity and mortality(13-15), physical activity may be one avenue to reduce the risk of these co-morbidities in adults with schizophrenia or schizoaffective disorder. Since the degree of obesity and overweight among adults with schizophrenia or schizoaffective disorder equals or exceeds the epidemic levels observed in the general US population(16), physical activity may be especially beneficial for those adults with schizophrenia or schizoaffective disorders who are overweight or obese by reducing the risk of cardiovascular disease, diabetes, and premature mortality.

Although limited, previous studies using objective and subjective measures of physical activity suggest that individuals with schizophrenia or schizoaffective disorder have low levels of moderate to vigorous physical activity. For the most part, these studies have been limited by the following: small sample sizes (17, 18), providing global rather comprehensive estimates of physical activity that primarily focused on high intensity physical activities(19, 20), the samples were either too homogenous such as patients with schizophrenia or schizoaffective disorder who had diabetes and were also overweight or obese(19), or heterogeneous such as patients with severe mental illness including schizophrenia, schizoaffective disorder, bipolar disorder, and major depression (20), and limited the assessment to subjective or objective measures of physical activity rather than measuring both to provide a comprehensive profile of physical activity that includes the quantity, intensity, pattern, and type of physical activity in adults with schizophrenia and/or schizoaffective disorders.

The Weight Assessment and Intervention in Schizophrenia Treatment Study (WAIST) provided the unique opportunity to profile physical activity levels in overweight and obese adults with schizophrenia or schizoaffective disorders enrolled in a clinical trial to investigate lifestyle interventions for weight reduction. Briefly, overweight and obese adults with schizophrenia or schizoaffective disorders were randomized to one of three treatment groups: group-based behavioral treatment for weight reduction (BT), social skills training (SST) or usual care (UC).

At baseline, physical activity was measured objectively with accelerometry and subjectively with a modified version of an established physical activity questionnaire, the Modified Activity Questionnaire (MAQ), to provide a comprehensive profile of physical activity of overweight and obese adults with schizophrenia or schizoaffective disorder.

The first objective of the current investigation is to thoroughly describe physical activity levels of overweight and obese adults with schizophrenia and schizoaffective disorders by objective and subjective measures of physical activity. This comprehensive profile of physical activity will be a novel contribution to the schizophrenia and schizoaffective disorders literature. It is hypothesized that overweight and obese adults with schizophrenia and schizoaffective disorders will be relatively sedentary and primarily engage in unstructured and low-intensity physical activities such as walking and daily household activities. Within overweight and obese adults with schizophrenia and schizoaffective disorder, physical activity levels are expected to have an inverse relationship with cognitive, social and occupational impairment or dysfunction i.e. as impairment increases physical activity decreases.

The second objective of this report is to compare physical activity levels measured objectively by accelerometry in overweight and obese adults with schizophrenia and schizoaffective disorder with the general US population based on data from the National Health and Nutrition Examination Survey (NHANES) 2003-2004. It is hypothesized that the physical activity levels of overweight and obese adults with schizophrenia and schizoaffective disorder will be significantly less than overweight and obese adults in the general US population. In addition, the NHANES sample will be stratified by whether or not they reported using mental health services during the preceding 12 months. Physical activity levels of adults with schizophrenia or schizoaffective disorders will then be compared with adult users and non-users of mental health services. It is hypothesized that physical activity will be associated with the severity and the diagnosis of the mental health disorder. In other words, adults with severe mental illness such as schizophrenia and schizoaffective disorder are expected to have significantly lower physical activity levels than users of mental health services who represent a broader spectrum of mental health disorders.

The findings from this study will provide a comprehensive profile of physical activity patterns and levels in overweight and obese adults with schizophrenia or schizoaffective disorder. This population is at high risk for medical comorbidities and has not been thoroughly

studied before and would be expected to derive considerable benefit from physical activity interventions. Furthermore, physical activity levels of overweight and obese adults with schizophrenia and schizoaffective disorder will be compared with a representative sample of the general US population who are overweight or obese to begin to investigate whether physical activity levels differ by psychiatric diagnoses and use of mental health services. Collectively, this descriptive information will aid not only in the design and implementation of effective physical activity interventions for mental and physical health but also in the justification of physical activity research and promotion strategies among overweight and obese adults with schizophrenia or schizoaffective disorder.

2.0 INTRODUCTION

2.1 SCHIZOPHRENIA AND SCHIZOAFFECTIVE DISORDER

Both schizophrenia and schizoaffective disorders are considered serious mental illnesses. Schizophrenia is diagnosed when two or more of the following active symptoms occur for at least one month;

"(1) delusions

(2) hallucinations

(3) disorganized speech (e.g., frequent derailment or incoherence)

(4) grossly disorganized or catatonic behavior

(5) negative symptoms, i.e., affective flattening, alogia, or avolition"(3).

These active symptoms must also be accompanied by social and/or occupational dysfunction that may involve work, interpersonal relations, or self-care. In addition, active, prodromal, or residual symptoms must persist for at least 6 months to meet the diagnostic criteria for schizophrenia(3). Usually the active symptoms are described as either positive or negative symptoms(2). As the name implies, positive symptoms represent an excess or distortion of normal function such as delusions, hallucinations, disorganized speech, and grossly disorganized or catatonic behavior(2). Negative symptoms refer to a loss of a normal function such as lack of emotion, low energy, low or no motivation, affective blunting, difficulty or inability to speak, social isolation and/or lack of social skills(2). A schizoaffective disorder is defined by periods of overlapping psychotic symptoms and mood symptoms (depression, mania, or mixed episode) AND periods of psychotic symptoms in the absence of mood symptoms(3).

Treatment of these disorders includes pharmacotherapy with antipsychotic medication and may be combined with psychosocial interventions(4). However, adjunctive treatments or strategies are still needed to reduce relapse and the residual symptoms associated with schizophrenia(4). In addition, adults with schizophrenia or schizoaffective disorder often experience significant social and occupational dysfunction(3), and high rates of physical

comorbidities such as hypertension, diabetes, cardiovascular disease and obesity(4). High rates of nicotine dependence is also observed with 80% to 90% of the individuals with schizophrenia smoking cigarettes(3).

Age of onset is typically early to mid-20s for men and late 20s for women(3). Later onset of the first active symptoms of schizophrenia are associated with better outcome including fewer structural brain abnormalities, negative signs and symptoms, and cognitive impairments(3). Schizophrenia and schizoaffective disorders are chronic mental health conditions and complete remission seldom occurs(3). However, the disease course is variable, and individuals may experience relatively stable symptoms, relapses and remissions of symptoms, or progressive worsening of symptoms(3). Generally, the positive symptoms are more responsive to treatment than the negative symptoms(3).

2.2 PHYSICAL ACTIVITY AND SCHIZOPHRENIA AND SCHIZOAFFECTIVE DISORDERS

As outlined and reviewed by Taylor and Faulkner(4, 21), the role of physical activity on the physical and mental health of individuals with schizophrenia and schizoaffective disorders has not been extensively studied and is still emerging. Published research on exercise as an adjunct treatment for schizophrenia has been limited to feasibility or pilot studies with methodological flaws such as small sample sizes, poor compliance, or failure to measure physical activity levels(4). The evidence from these preliminary studies suggest that physical activity may alleviate some of the negative symptoms of schizophrenia and provide a useful coping mechanism for some of the positive symptoms of schizophrenia(4). As for physical health, individuals with schizophrenia or schizoaffective disorder have a high rate of cardiovascular disease, diabetes, obesity, and premature mortality(4, 12-15). These comorbid conditions are strongly related to physical inactivity(5-10), and physical activity may be one avenue to reduce the risk of these comorbid conditions and improve the health and quality of life of individuals with schizophrenia and schizoaffective disorder. A detailed review of the literature regarding physical activity and schizophrenia and schizoaffective disorders is provided in the next section of this report (Review of the Literature).

3.0 REVIEW OF THE LITERATURE

3.1 PHYSICAL ACTIVITY ASSESSMENT

"Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure"(22). Physical activity may include occupational, household, sports, and leisure or recreational activities. A variety of methods have been used to measure physical activity in free-living individuals. The most frequently used subjective and objective measures of physical activity are physical activity questionnaires and accelerometers or pedometers, respectively, and are often used in unison to provide a comprehensive profile of physical activity in free-living individuals.

3.1.1 Subjective Assessment of Physical Activity

A variety of self-reported physical activity questionnaires have been developed to assess physical activity in free-living individuals. The complexity of the self-reported physical activity assessment can vary from a single question(23, 24) to a very detailed report of the type, frequency, intensity and duration of physical activity(25-27). Some surveys assess only sports or leisure physical activities(28-31) while other surveys measure daily physical activity including occupational, household, transportation and leisure physical activities(32-34). Several published reviews have extensively discussed the strengths, limitations, validity and reliability of self-reported physical activity assessments(25, 27, 35, 36). Briefly, the advantages of self-reported physical activity include

- minimal subject burden;
- non-reactive assessment of physical activity;
- inexpensive;
- practical;
- minimal time required for data collection and processing;
- availability of a variety of self-reported surveys that have achieved acceptable levels of reliability and validity(25);

- availability of published articles on self-reported physical activity levels that permit comparisons across studies and populations;
- ability to measure components of occupational, leisure, household and transportation-related physical activities particularly those of moderate to vigorous intensity;
- the ability to measure structured activities of moderate to vigorous intensity well;
- the ability to tailor the survey to address specific activities of the target population;
- the ability to translate the survey into other languages;
- assessment of water activities, bicycling, weight lifting and other activities difficult to assess with accelerometry or pedometers;
- relatively simple classification of individuals into activity categories;
- assessment of physical activity over a variety of time frames (past 24 hours, past week, past year, childhood activity, historical activity, habitual activity); and
- ability of the survey to be interviewer- or self-administered.

However, self-reported physical activity surveys also have several limitations including

- recall and social desirability bias with participants tending to overestimate the frequency, duration, and intensity of their physical activity;
- inability of children or cognitively impaired individuals to report their physical activity;
- inability to accurately or reliably assess low-intensity, intermittent, or unstructured physical activities; and
- appropriate assessment of physical activity in diverse populations may require different questionnaires resulting in different measures of physical activity that are not comparable.

3.1.2 Objective Assessments of Physical Activity

The objective assessment of physical activity has been measured in a variety of ways including behavioral observation, occupational classification, heart rate monitoring, gait assessment, direct calorimetry, indirect calorimetry, doubly labeled water, and motion sensors(37). Generally, motion sensors and heart rate monitoring are considered the only feasible objective assessments of physical activity in free-living individuals. The other objective assessments of physical activity such as doubly labeled water, direct and indirect calorimetry, and behavioral observation are considered too expensive, impractical, and invasive and/or exceed acceptable levels of

subject burden for free-living individuals and epidemiological studies. Occupational classification of physical activity would be inappropriate in adults with severe mental illness since the majority of adults with schizophrenia or schizoaffective disorder are unemployed or on disability. As discussed and reviewed by Freedson and Miller(38), heart rate monitoring is a physiological marker of physical activity. However, heart rate monitoring may not be appropriate for measuring physical activity levels or intensities in free-living individuals since heart rate is influenced by high ambient temperatures, high humidity, emotional stress as well as exercise(38).

Motion sensors (pedometers and accelerometers) are generally preferred for the objective assessment of physical activity in free-living individuals (38). Pedometers count the number of steps taken daily by measuring vertical acceleration at the hip while walking. Generally, pedometers are considered useful as a motivational tool in walking intervention studies and health promotion campaigns because participants can self-monitor their walking behavior(38, 39). Although inexpensive, pedometers are considered less accurate than accelerometers, and generally not considered suitable for research in the assessment of habitual physical activity (38-40). For research, accelerometers are preferred for objectively measured free-living physical activity.

As the name implies, accelerometers measure the body's acceleration or change in speed with respect to time (m/s^2)(40, 41). Uniaxial accelerometers measure movement in a single plane (usually vertical) usually at the hip(26). With accelerometry, the intensity, frequency, duration and pattern of physical activity can be measured and stored for extended periods of time (days or weeks) in free-living individuals. In addition, the accelerometers measure low-intensity, intermittent, and unstructured physical activities such as running to catch a bus, walking to the mailbox, vacuuming, or climbing stairs that can be difficult for participant's to estimate. Activity is quantified by counts or steps in user-specified epochs (usually one minute) (26, 40, 41).

Accelerometry addresses some of the limitations of self-reported physical activity. Specifically, accelerometry allows measurement of 1) low-intensity, intermittent, and unstructured physical activities such as walking that are difficult for participants to self-report (42), 2) physical activity over extended time periods (days or weeks) (38), and 3) objective physical activity avoiding overestimates of the time and intensity of physical activity that tends

to occur with subjective measures of physical activity. Accelerometry has been shown to be both reliable and valid (43-45), and is often used as the validity criterion for self-reported measures of physical activity (35, 46). Other advantages of accelerometers include

- its small size;
- lightweight;
- wireless;
- non-invasive;
- non-intrusive with minimal subject burden for participants to wear over extended time periods;
- tamper-proof and durable;
- less susceptible to reactivity since data is stored but not displayed during the monitoring period;
- published and replicated research on validity and reliability;
- well-defined and established research methodology for data collection and processing for clinical and research applications;
- extensive literature of accelerometers used in a variety of populations including children and the elderly; and
- the ability to measure intermittent as well as continuous activity.

However, accelerometers have several limitations including

- the ability to only measure movement in certain planes (cycling, weight lifting, and upper-extremity activities are not accurately assessed when the accelerometer is attached to the hip) (39);
- inability to measure water activities since the accelerometers are not water-proof; inability to estimate expenditure accurately (39);
- inability to measure non-ambulatory activity such as seated or stationary activities (38);
- unwillingness of participants to wear accelerometer at all occasions such as parties, weddings, sports competitions, and other events; and
- dependency on the participant's willingness and compliance in wearing the accelerometry over an extended period of time.

3.2 ASSESSMENT OF PHYSICAL ACTIVITY IN PATIENTS WITH SCHIZOPHRENIA OR SCHIZOAFFECTIVE DISORDER

Although limited, previous studies have used subjective and objective measures of physical activity in individuals with schizophrenia and schizoaffective disorder. These published studies suggest that the assessment of physical activity is challenging in adults with schizophrenia and schizoaffective disorder since the majority are relatively sedentary, primarily engage in unstructured and low-intensity physical activities that are likely difficult to recall, and may have cognitive impairments. The findings from these earlier studies that reported subjective and/or objective assessments of physical activity in individuals with schizophrenia or schizoaffective disorder are summarized and reviewed in the sections below and Tables 3.1-3.4.

3.2.1 Subjective Assessment of Physical Activity in Patients with Schizophrenia and Schizoaffective Disorder

The reliability and validity of subjective assessments of physical activity in adults with schizophrenia or schizoaffective disorder have only been published for the Yale Physical Activity Scale (YPAS)(18) and the Short-Form of the International Physical Activity Questionnaire (IPAQ)(47). The IPAQ primarily measures moderate to vigorous intensity physical activities while the YPAS assesses the full spectrum of physical activities from light to vigorous intensity that may occur at work, home or during leisure time activities. Faulkner and associates found one-week test-retest reliability for the IPAQ in adults with schizophrenia (n=35) to be comparable to values reported in the general population (Spearman correlation coefficients = 0.70 for total MET mins/wk $^{-1}$, 0.68 for total minutes of PA per week, 0.69 for vigorous PA, 0.50 for moderate PA, and 0.68 for walking per week, $p<0.01$ for all). In contrast, one week test-retest reliability of YPAS in adults with schizophrenia (n=19), aged 40 and older, were lower than normal comparisons (n=10) for seven out of eight activity summary measures [activity time (h/wk) (r=0.62 versus r=0.90), energy (kcal/wk) (r=0.60 versus r=0.91), vigorous activity index (r=0.40 versus r=0.69), leisurely walking index (r=0.04 versus r=0.95), moving index (r=0.10 versus r=0.60), standing index (r=0.34 versus r=0.58), and total activity index (r=0.36 versus r=0.64) but not sitting index (r=0.36 versus r=0.29)] in a study conducted by Lindamer and associates(18). Only modest correlations (r=0.40 to 0.62, $p<0.01$) were reported for YPAS activity time (h/week), total energy expenditure (kcal/week), and vigorous activity index in

adults with schizophrenia or schizoaffective disorder(18). The Pearson correlation coefficients for test-retest reliability for the YPAS leisurely walking (r=0.04) and moving (r=0.10) indices were low compared to adults without schizophrenia (r=0.95 for leisurely walking index and 0.60 for moving index) and suggest that adults with schizophrenia or schizoaffective disorder may not reliably estimate recent walking and moving activity(18). It should also be noted that neither study (Faulkner(47) or Lindamer(18) assessed or reported the severity of schizophrenia or schizoaffective disorders in the study samples, and the sample sizes were small.

Similar to test-retest reliability, concurrent validity using accelerometry as the criterion measure was only acceptable for the IPAQ (ρ=0.37, $p<0.05$)(47) and not the YPAS in adults with schizophrenia or schizoaffective disorder (Pearson correlations not reported, $p>0.05$, n=16)(18) or normal controls except for the moving index and average daily minutes of light activity (r=0.93, $p<0.01$, n=6)(18). It is unfortunate that the investigators did not report correlations between YPAS and accelerometry. Feasibly, the magnitude of correlations may have been comparable but statistical significance was not achieved due to the smaller sample size in the study using the YPAS versus the IPAQ.

With the IPAQ, 75% and >40% of the patients with schizophrenia reported no vigorous activity and no moderate physical activity, respectively(47). Also, 74% of the patients with schizophrenia did not met the current minimal public health guidelines of 150 min/wk of moderate-intensity physical activity(47). It is interesting to note that the YPAS physical activity measures that were considered reliable (activity time (h/week), total energy expenditure (kcal/week), and vigorous activity index) were consistently and statistically ($p<0.01$) lower for patients with schizophrenia compared to the community dwelling controls(18). Furthermore, YPAS estimated lower total energy expenditure for physical activity for diabetic (approximately 2600 kcal/week)(19) than non-diabetic (3174 kcal/week)(18) patients with schizophrenia, aged 40 or older.

Studies by Osborn(48) and Brown(49) assessed physical activity by the Godin Leisure-Time Exercise Questionnaire, a brief self-administered questionnaire that assesses usual leisure-time physical activity over a 7-day period(25, 28). Participants self-report how many times per week they engage in strenuous (running, basketball, vigorous swimming, vigorous bicycling, soccer), moderate (fast walking, tennis, easy bicycling, dancing), or mild (golf, bowling, easy walking) exercise for more than 15 minutes. Few participants with schizophrenia or

schizoaffective disorder reported strenuous physical activity (8% (48) and 0% (49)). The vast majority of participants (55% (48)) reported either mild (45%) or no exercise (36%) (49).

Physical activity patterns during the preceding week were compared in Australians with schizophrenia from mental health services in New South Wales, Victoria, and Queensland (n=125) and the general Australian population (n=3841) using the Active Australia Survey(AAS)(50). The AAS measured the following 4 dimensions of physical activity; 1) types, 2) duration (minutes), 3) intensity (walking, moderate and vigorous), and 4) number of sessions of physical activity over the past 7 days(50). Total activity time per week was calculated by adding time spent walking, time spent in moderate activity, and twice the time spent in vigorous activity. Sufficient physical activity was defined as achieving 150 minutes or more of total activity time during the past week.

Overall, a smaller percentage of Australians with schizophrenia (49%) achieved sufficient physical activity than the general Australian population (57%) (50). Interestingly, the pattern of physical activity also differed between the two populations; a greater proportion of Australians with schizophrenia walked (82.5% versus 72.2%) while a greater proportion of the general Australian population reported moderate (43% versus 29%) or vigorous (38% versus 34%) activity (50). Only time spent in vigorous activity was significantly greater in the general Australian population compared to the Australians with schizophrenia (142 versus 66 mins/wk, respectively) (50). While no difference was noted for minutes walked per week (~115 minutes), the Australians with schizophrenia reported a greater number of walking sessions for shorter time intervals than the general Australian population (50).

Among the Australians with schizophrenia, no statistically significant differences were noted for gender and BMI ($p=0.09$), total activity time ($p=0.33$) or total number of activity sessions ($p=0.85$), age and total activity time ($p=0.92$) or total number of activity sessions ($p=0.63$), and those who did and did not exercise for at least 150 minutes during the past week and BMI ($p=0.28$), number of weeks since their last hospitalization, duration of their last hospitalization, and psychological distress level (p-values not reported)(50). However, significantly fewer hospitalizations during the past three years and severe social problems were noted for those who exercised at least 150 minutes during the past week compared to the participants with schizophrenia who do not ($p<0.05$)(50).

Frequency of leisure physical activity per month was used as one of five health indices to compare adults (aged 18-65) with serious mental illness (n=200) including 50 adults for each of following chart diagnoses; schizophrenia excluding schizoaffective disorder, schizoaffective disorder, major depression, and bipolar disorder) in community-based psychiatric treatment with age, gender, and race-matched respondents from the US general population that participated in NHANES III or NHIS studies(51). If respondents indicated leisure physical activities at least 20 times per month then respondents were classified as meeting recommended levels of exercise as defined by the Healthy People 2010 program of the Centers for Disease Control(51). The prevalence of recommended levels of exercise was 39% in both adults with serious mental illness and the general population comparison group(51). Within the psychiatric sample, adults with schizophrenia or schizoaffective disorder (9 of 100) were less likely to exercise at recommended levels and be nonsmokers than adults with mood disorders (22 of 100, p=0.02)(51). Even though physical activity was one of five components of the primary health indicators, the authors provide no information on how leisure physical activity was defined or assessed. Given the sample sizes (n=100 or 50 per group), it is unfortunate that little information is provided on recommended exercise levels within psychiatric diagnosis. These oversights severely limit the comparison of these results with other studies or providing additional information on the physical activity levels of adults with schizophrenia and/or schizoaffective disorder.

Leisure-time physical activities and participation in routine activities based on items in the Canada's Health Promotion Survey were used to obtain lifestyle profiles of adult psychiatric outpatients attending mental health clinics in Calgary, Canada(52). The study recruited outpatients in the following 3 diagnostic categories; schizophrenia (n=61), bipolar disorder (n=60), and anxiety and/or depression (n=61)(52). The study did not recruit outpatients with no diagnosed mental health disorder. Overall, there was no difference in the frequency of daily participation in vigorous exercise reported between the diagnostic groups (24%, p=0.16)(52). Only 5-8% of each diagnostic group reported engaging in active leisure activity and the vast majority (67-77%) only engaged in sedentary routine activities(52). The primary limitations of this study are that the items selected to assess physical activity from Canada's Health Promotion Survey are not provided and have been field-tested but not formally validated(52).

A cohort of healthy male adolescents between the ages of 16 and 17 was studied based on the compulsory Israeli Draft Board tests. Using the cohort, cases and controls were identified at follow-up, approximately 9 years later. Cases were defined as males diagnosed with schizophrenia and schizoaffective disorder after age 17, and controls were defined as males experiencing no psychiatric symptoms after age 17. To assess recall bias, physical activity self-reported at age 17 was compared to recall of physical activity for age 17 at follow-up (approximate mean age 26 years) for the cases and controls. Trained interviewers score the adolescent's involvement in structured physical activity and interest in physical activity from 1 (lowest) to 5 (highest) at age 17 and at recall for age 17. Although not statistically significant, the cases compared to the controls had slightly lower physical activity scores self-reported at age 17 (2.9 ± 3.1 vs. 3.0 ± 1.0, respectively) and at recall for age 17 (3.1 ± 1.1 vs. 3.4 ± 1.0, respectively)(53). Generally, participants had identical physical activity scores at age 17 and recall for age 17 (59% of the cases with schizophrenia or schizoaffective disorder, and 41% of the controls, $p>0.05$)(53). When scores differed for self-reported physical activity at age 17 and at recall for age 17, males tended to slightly overestimate their recall of physical activity for age 17 (27% of the cases and 41% of the controls, $p>0.05$)(53). Differences in physical activity assessments at age 17 and recall for age 17 were significantly correlated with IQ, immediate memory, and delayed memory(53).

The investigators concluded that memory deficits associated with schizophrenia did not negatively affect the retrospective recall of premorbid adolescence behaviors (social functioning, individual autonomy, organizational ability, physical activity and functioning in structured environments); males with schizophrenia and schizoaffective disorder were as reliable as the healthy controls in self-reporting behaviors for age 17(53). Unfortunately, this conclusion probably should be tempered for physical activity since the recall of physical activity was less robust and more susceptible to recall bias than the other adolescent behaviors based on the published findings and study limitations outlined by the authors. Specifically, the consistency in recalling physical activity for age 17 was associated with IQ and memory impairments, as noted above. In addition, all the patients diagnosed with schizophrenia and schizoaffective disorders were in remission with few positive symptoms. Hence, it is feasible that patients with schizophrenia and schizoaffective disorders with active symptoms, low IQ, and/or memory impairments may not provide reliable self-reported estimates of past physical activity.

The Israeli Draft Board test was also used in a prospective study to compare interest in physical activity at age 17 among males later hospitalized for schizophrenia at least one year later than the draft board test date and healthy controls who were eligible for military service and matched by age and attendance at the same high school as the cases(54). To be eligible for the study, the adolescent males at age 17 had to be apparently healthy with no obvious signs of disease, to have no detectable signs or symptoms of any mental illness or mental retardation, no prior history of psychiatric hospitalization, and no psychiatric hospitalization within 1 year of the draft board test(54). Follow-up from the draft board test date ranged from 4 to 10 years. Interest in physical activity at age 17 was significantly lower for males later hospitalized for schizophrenia than healthy male controls ($p=0.0001$)(54). However, interest in physical activity was not a significant predictor of schizophrenia in the multivariate conditional logistic regression model(54). Poor social functioning, poor organizational ability, and low intellectual functioning were the significant predictors of schizophrenia in the final multivariate conditional logistic regression model(54). The primary limitation of this study is that interest in physical activity at age 17 is not an assessment of physical activity levels, and the investigators did not analyze engagement in structured physical activities at age 17. Despite this limitation, the findings suggest that the low physical activity levels of patients with schizophrenia may not be due to the mental health disorder, per se. Overall, the findings from the two studies based on the Israeli Draft Board tests suggested that prior to diagnosis and symptoms of schizophrenia, male adolescents at age 17 were less active and less interested in physical activity than healthy controls.

Several studies subjectively measured physical activity of adults with schizophrenia although it was not the primary objective of the study(15, 55, 56). In a study to investigate whether the disorder or the antipsychotic medications explain high mortality rates of adults with schizophrenia, Joukamaa and associates report the physical activity levels of 99 Finish adults with schizophrenia in a representative population sample of 7217 Finns aged $\geq$ 30 years(15). Only 7 adults with schizophrenia [2 (4%) women and 5 (11%) men] report regular or high levels of physical activity(15). Similar to previous studies, the majority of adults with schizophrenia report none [33 (62%) women and 19 (42%) men], or occasional or low levels of exercise [18 (34%) women and 21 (47%) men](15). An inverse association between exercise and the

prevalence of schizophrenia was observed for both men and women but was only statistically significant for women(15).

In a descriptive study of the cardiovascular risk and lifestyle of adults with schizophrenia, McCreadie and associates used the Scottish Physical Activity Questionnaire (SPAQ) to measure physical activity levels(55). SPAQ measures the stage of exercise behavior change, and seven day recall of leisure and occupational physical activity of moderate intensity and above(57). In contrast to other studies, the majority of the men (n=41, 57%) and women (n=18, 60%) with schizophrenia considered themselves physically active(55). In a feasibility and efficacy study for weight control of adults with schizophrenia (n=20) or schizoaffective disorder (n=11) using atypical antipsychotic medications and BMI $\geq$ 26 kg/m^2, participants self-reported exercising 53 mins/wk at baseline(56). Unfortunately, neither the McCreadie nor the Menza study(55, 56) defined physically active or exercise making comparisons with other studies difficult.

Collectively, these studies suggest that self-reported physical activity among participants with schizophrenia or schizoaffective disorder is low and significantly less than participants without mental health disorders. The consistency of the findings is noteworthy. Simple as well as complex self-reported measures of physical activity concur with clinical impressions that patients with schizophrenia or schizoaffective disorder are relatively sedentary. While the subjective assessment of physical activity has been shown to be reliable and valid for the assessment of moderate and strenuous physical activity, self-reports are not recommended for assessment of unstructured and low-intensity physical activity in the general adult populations (36, 48, 58). The findings reported by Lindamer and associates also suggested that self-reports of physical activity may not be recommended for adults with schizophrenia(18). Reliability was only acceptable for moderate to vigorous physical activities but not acceptable for walking and low-intensity physical activities in adults with schizophrenia(18). Hence, objective monitoring may be necessary to accurately assess and quantify this unstructured and low intensity physical activity of relatively sedentary adults with schizophrenia or schizoaffective disorder. The evidence from the above studies justifies the additional subject burden, time and expense of objective versus subjective monitoring of physical activity in adults with schizophrenia and schizoaffective disorder.

Objective monitoring of physical activity may also be warranted due to the cognitive symptoms that adults with schizophrenia or schizoaffective disorder often experience. Cognitive

deficits including reality distortions may impair the participant's ability to accurately self-report or recall their physical activity. Cognitive impairment may explain why the reliability and validity of self-reported physical activity using the YPAS was acceptable but lower in adults with schizophrenia than adults without psychiatric disorders(18). With cognitive impairments, adults with schizophrenia and schizoaffective disorder may only be able to accurately and reliably complete simple but not complex physical activity assessments. For instance, a simple assessment may only assess whether or not the patient participated in vigorous physical activity such as swimming, bicycling, or running? A complex assessment may also assess the frequency, duration and intensity of each vigorous physical activity. The simple assessments of physical activity are useful as crude measures of physical activity (e.g. sedentary, insufficiently active, and active) especially for pilot studies or exploratory analyses. However, the complex assessments of physical activity are generally necessary to examine dose-response relationships, change in physical activity especially walking, light- or moderate-intensity physical activity, physical activity patterns, and mechanisms of action, and to generate and test hypotheses.

Table 3-1 Summary of patient characteristics for studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	**N (Men, Women)** ***N by disorder***	**PANSS** **(positive, negative, general psycho-pathology, total)**	**Age (years)** **Mean ± STD** **Range**	**BMI (kg/m^2)**
Brill, 2007 (53)	121 (121,0) *70 SZ or SA* *51 Controls*	SZ/SA: 11 ± 5, 18 ± 9, NR, 60 ± 20 Controls: NR	SZ/SA: 26 ± 4 Controls: 26 ± 3	NR
Davidson, 1999 (54)	9724 (9724,0) *509 SZ* *9215 Controls*	NR	16 and 17 year olds	NR
Faulkner, 2006 (47)	35 (22, 13) *28 SZ,1 SF, 6 SA outpatients*	NR	40 ± 11	31±7
Dickerson, 2006 (51)	200 (95, 105) *50 SZ* *50 SA* *50 Bipolar* *50 Major Depression (MD)* Matched to general population from NHANES3 (n=2890), NHIS (n=3052) by gender, age (±3 yrs), and race	NR	44±9 18-65 SZ/SA: 42 ± 9 Bipolar/MD: 46 ± 8	54% (92/169) with BMI < 30
Brown, 1999 (49)	102 (54, 48) *102 SZ*	NR	53 Middle-aged	BMI: Men n (%), Women n (%) <20: 2 (4), 3 (6) 21-25:17(35), 11 (23) 26-30:21(42), 22 (47) >30: 9(18), 11(23)
Chuang, 2008 (52)	182 (94,88) *61 SZ* *60 BP* *61MDD/Anxiety*	NR	43.0	30.2 SZ 29.2 BP 28.1 MDD/Anxiety BMI≥25, n=50 (82%), SZ BMI≥30, n=29 (47.5%), SZ
Joukamaa, 2006 (15)	7217 (3322,3895) *99 SZ (45,53)* *7118 Non-SZ (3277,3842)*	NR	n=2716; 30-44 yrs n=1609; 45-54 yrs n=1348; 55-64 yrs n=1078; 65-74 yrs n=466; ≥75 yrs	n=359, <20 n=2946, 20-24.9 n=2815, 25-29.9 n=909, 30-34.9 n=188, ≥35
Lindamer, 2008 (18)	81 (48,33); *54 SZ/SA* *27 Normal Comparison (no known psychiatric diagnosis)*	SZ/SA: 13 ± 6, 14 ± 5, 27 ± 7, NR Normals: NR	50.7±6.4 SZ 52.2±8.6 Normals Range: 40 years or older	30.5±7.1 SZ 27.8±4.4 Normals *(p=0.13)*

Table 3-1 (continued) Summary of patient characteristics for studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	**N (Men, Women)** ***N by disorder***	**PANSS** **(positive, negative, general psycho-pathology, total)**	**Age (years)** **Mean ± STD** **Range**	**BMI (kg/m^2)**
McCreadie, 2003 (55)	102 (72,30) *102 SZ*	14 ± 5 19 ± 6 32 ± 7 65 ± 15	45±13	73% overweight or obese n=4, <18.5 n=22, 18.5-24.9 n=44, 25-29.9 n=29, 30-39.9 n=2, ≥40
McKibbin, 2006 (19)	64 (37, 20) diabetic *48 SZ* *9 SA*	DART (n=28) 13.1 ± 4.6 5.2 ± 0.8 3.6 ± 0.6 UCI (n=29) 15.1 ± 5.1 5.6 ± 0.7 4.0 ± 0.7	53.1 ± 10.4 DART 54.8 ± 8.2 UCI	33.6 ± 6.8 DART 32.9 ± 6.2 UCI
McLeod, 2009 (50)	125 (81,44) *125 SZ*	NA	40.3 ± 12.4 *Note: recruited ≥ 18 yrs*	28.9 ± 6.6 0%, <18.5 30%, 18.5-24.9 36%, 25-29.9 34%, ≥30
Menza, 2004 (56)	51 (29,22) *20 SZ* *11 SA* *20 historical controls*	NA	42.6 SZ/SA 47.2 Controls	Study inclusion BMI ≥ 26 34.3 ± 6.3 SZ/SA 32.2 ± NR Controls
Osborn, 2007 (48)	225 *75 SMI (66 SZ, 6 SA, 2 persistent delusional disorder)* *150 no SMI*	Manchester scale median 6, IQR 3-10	47.2 SMI 46.6 non-SMI *Note: recruited 30-75 year olds*	No information

Table 3-2 Summary of studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	Study Design	Physical activity (PA) questionnaire	Physical activity (PA) definition	Physical activity (PA) assessment period	Findings
Brill, 2007 (53)	Case-Control Study	Israeli Draft Board Behavioral Assessment	1 to 5 point scale of extent of involvement in PA. Presumably, 1=low interest in PA, 5=high interest in PA	Contemporary (age 17) and retro-spective (~26 yrs) recall of physical activity	• NS difference in PA at age 17 and recall of PA at age 17 between cases and controls. • Recall PA at age 17 > PA reported at age 17 for all. • NS association between PA and PANSS
Davidson, 1999 (54)	Matched (age, gender, school attended) case-control study Case: hospitalized with SZ diagnosis Control: nonpatient by National Psychiatric Hospitalization Case Registry	Israeli Draft Board Behavioral Assessment	1 to 5 point scale of extent of involvement in extracurricular PA. 1=low interest in PA, 5=high interest in PA	PA at age 17 Follow-up 4-10 years	• SZ < Controls for interest in PA at age 17 ($p \leq 0.0001$) • PA at age 17 not a predictor of future SZ in multivariate conditional logistic regression

SZ = Schizophrenia; SA= Schizoaffective Disorder; SF= Schizophreniform; MD= Major mood disorder; SMI= severe or serious mental illness; PA= physical activity; NS= nonsignificant, $p>0.05$; NR= not reported; NI= no information

Table 3-2 (continued) Summary of studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	Study Design	Physical activity (PA) questionnaire	Physical activity (PA) definition	Physical activity (PA) assessment period	Findings
Faulkner, 2006 (47)	Cross-sectional study	Short-form International Physical Activity Questionnaire (IPAQ)	Minutes/wk and METS/wk for walking, moderate (breathe somewhat harder than normal, take moderate physical effort such as carrying light loads, bicycling at regular pace, or easy swimming), and vigorous (breathe much harder than normal, take hard physical effort such as heavy lifting, digging, aerobics, or fast bicycling) PA.	7 day recall Objective measure-ment of PA by accelerometry (7 day period) for reliability and validity	• Walking most common PA • 26% exercised 150 min/week at moderate intensity • 75% no vigorous PA • 40% no moderate PA • Test-Retest reliability for METS/wk (0.70), min/wk (0.68), vigorous (0.69), moderate (0.50), and walking (0.68) PA. • Validity for min/wk (ρ=0.37, $p<0.05$), METS/wk (ρ=0.33, $p>0.05$)
Dickerson, 2006 (51)	Case-control study: 1:15 matched (age $\pm$ 3 yrs, gender, and race)	NHIS and NHANES III	# of leisure-time PA during previous month	Previous 30 days. Frequency of leisure PA dichotomized as 1) exceeds exercise recommendations ($\geq$20 days/month) 2) less than exercise recommendations (<20 days/min)	• 39% of cases and controls exceeded exercise recommendations (NS) • SZ/SA(9%) < mood disorders (22%) exceeds exercise recommendations and nonsmoker (p=0.02)

SZ = Schizophrenia; SA= Schizoaffective Disorder; SF= Schizophreniform; MD= Major mood disorder; SMI= severe or serious mental illness; PA= physical activity; NS= nonsignificant, $p>0.05$; NR= not reported; NI= no information

Table 3-2 (continued) Summary of studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	Study Design	Physical activity (PA) questionnaire	Physical activity (PA) definition	Physical activity (PA) assessment period	Findings
Brown, 1999 (49)	Cross-sectional	Godin Leisure-Time Exercise Questionnaire	Light PA: gentle walking Moderate PA: brisk walking Strenuous PA: running, most sports	Previous 7days	SZO Men: 36% no PA, 45% only light PA, 19% $\geq$ 1 moderate PA, 0% strenuous PA. SZO Women: 32% no PA, 57% only light PA, 15% $\geq$ 1 moderate PA, 0% strenuous PA.
Chuang, 2008 (52)	Cross-sectional	Selected items from Canada's Health Promotion Survey	Leisure-time physical activity (LPTA)	NR	• No difference in LPTA between 3 diagnoses • 26% report getting as much exercise as needed • 14% never engaged in vigorous PA • 24% daily engagement in vigorous PA • 5-8% engaged in active leisure activities • 67-77% only engaged in sedentary routine activities
Joukamaa, 2006 (15)	Prospective cohort	Mini-Finland Health Survey	3 categories (None, Low level or occasional, High level and regular)	NR	• SZ RR lower for higher rates of pa in men (1.0, 0.72,0.47, trend, NS), women (1.0,0.42,0.16 sig)

SZ = Schizophrenia; SA= Schizoaffective Disorder; SF= Schizophreniform; MD= Major mood disorder; SMI= severe or serious mental illness; PA= physical activity; NS= nonsignificant, $p>0.05$; NR= not reported; NI= no information

Table 3-2 (continued) Summary of studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	Study Design	Physical activity (PA) questionnaire	Physical activity (PA) definition	Physical activity (PA) assessment period	Findings
Lindamer, 2008 (18)	Cross-sectional; 2:1 SZ:Normals Matched on gender and age (±10 years)	Yale Physical Activity Scale (YPAS)	1. Total time spent per week (h/wk) in all physical activities 2. Total energy expenditure (kcal/wk) 3. Vigorous activity index 4. Leisurely walking index 5. Moving index 6. Standing index 7. Sitting index 8. Total activity dimension index	Typical week during the past month	• All activity measures SZ < normals ($p<0.01$ except for leisurely walking $p=0.24$) • SZ ~ normals for sitting index ($p=0.26$) • Test-retest reliability (n=19) was poor (0.04 for leisurely walking and 0.10 moving index, $p\geq0.60$) to modest (0.40 to 0.62 for total time, energy, and vigorous activity, $p<0.01$). • No significant association between YPAS measures and accelerometry
McCreadie, 2003 (55)	Cross-sectional	Scottish Physical Activity Questionnaire (SPAQ)	Not defined in publication or cited reference	7 day recall	• 57% M, 60% F reported being physically active. • 5.8 M, 6.4 F hrs/week PA, NS difference between gender

SZ = Schizophrenia; SA= Schizoaffective Disorder; SF= Schizophreniform; MD= Major mood disorder; SMI= severe or serious mental illness; PA= physical activity; NS= nonsignificant, p>0.05; NR= not reported; NI= no information

Table 3-2 (continued) Summary of studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	Study Design	Physical activity (PA) questionnaire	Physical activity (PA) definition	Physical activity (PA) assessment period	Findings
McKibbin, 2006 (19)	Randomized Clinical Trial; randomized to either Diabetes Awareness and Training (DART, n=32) or Usual Care plus Information (USI, n=32)	Yale Physical Activity Scale (YPAS)	YPAS: Total activity summary index (ASI) YPAS: Total energy expenditure (TEE) (kcal/week)	7 days recall	YPAS Pre-test • ASI 35±20 UCI and 29±22 DART, • TEE 2707±3302 UCI and 2186 ± 2451 DART YPAS Post-test • ASI 24±17 UCI and 29±35 DART, • TEE 1739±1714 UCI and 2510 ± 2151 DART Pre- vs Post-test comparison • DART increased ASI, UCI decreased ASI over intervention (*p=0.02* adjusting for PANSS negative and HAM-D scores) • Trend for group differences for TEE over time (*p=0.04*)
McLeod, 2009 (50)	Cross-sectional	Active Australia Survey (AAS)	1.Ttypes of physical activity 2. Duration of activity episodes (total activity time= walking time + moderate activity time + 2 x vigorous activity time if ≥ 10 minutes per episode) 3. Intensity of the exercise 4. Number of sessions of activity over the previous 7 days	Preceding week	• 49% reported 150 min per week of physical activity • 34% engaged in at least one episode of vigorous activity • 83% engaged in walking

SZ = Schizophrenia; SA= Schizoaffective Disorder; SF= Schizophreniform; MD= Major mood disorder; SMI= severe or serious mental illness; PA= physical activity; NS= nonsignificant, p>0.05; NR= not reported; NI= no information

Table 3-2 (continued) Summary of studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	Study Design	Physical activity (PA) questionnaire	Physical activity (PA) definition	Physical activity (PA) assessment period	Findings
McLeod, 2009 (50) (continued)					• SZ spent less time in vigorous activity (66 vs 142 min) and walked significantly more sessions (p=0.03) than normative data for Australian adults (n=3841). No difference in amount of time in moderate activity (185 vs 168) and walking (119 vs 114 min) for SZO and normative data for Australian adults (p>0.05)(n=3841). • No difference in BMI between SZ who did and did not participate in 150 min of physical activity per week (*p*=0.28) • Fewer mental health hospitalizations in last 3 years for SZ who did vs. did not participate in 15 min of physical activity per week (*p*=<0.05)

SZ = Schizophrenia; SA= Schizoaffective Disorder; SF= Schizophreniform; MD= Major mood disorder; SMI= severe or serious mental illness; PA= physical activity; NS= nonsignificant, p>0.05; NR= not reported; NI= no information

Table 3-2 (continued) Summary of studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	Study Design	Physical activity (PA) questionnaire	Physical activity (PA) definition	Physical activity (PA) assessment period	Findings
McLeod, 2009 (50) (continued)					• No significant differences in number of weeks since last hospitalization, duration of their last hospitalization, or in levels of psychological distress between SZ who did and did not participate in 150 min of physical activity per week • No differences in anxiety or depression/distress between SZ who did and did not participate in 150 min of physical activity per week • No age ($p \geq 0.63$) or gender ($p \geq 0.33$) differences in SZ activity levels • Only overactive, aggressive, and disruptive impairment items were associated with sufficient physical activity levels ($p=0.04$)

SZ = Schizophrenia; SA= Schizoaffective Disorder; SF= Schizophreniform; MD= Major mood disorder; SMI= severe or serious mental illness; PA= physical activity; NS= nonsignificant, p>0.05; NR= not reported; NI= no information

Table 3-2 (continued) Summary of studies reporting subjective assessment of physical activity in individuals with schizophrenia (SZ) or schizoaffective (SA) disorders.

Author, year	Study Design	Physical activity (PA) questionnaire	Physical activity (PA) definition	Physical activity (PA) assessment period	Findings
Menza, 2004 (56)	Intervention study: 12 month weight control	No information	Exercise self-reported total minutes exercise/week for SZ/SA only	One week	• SZ/SA Baseline: 53 min/wk Endpoint: 124 min/wk (*p=0.003*) • Controls: Not assessed
Osborn, 2007 (48)	Cross-sectional	Godin Leisure-Time Exercise Questionnaire	Frequency of mild (easy walking), moderate (fast walking or easy swimming), and strenuous (fast swimming or running) leisure exercise undertaken for more than 15 min at a time, per week Total Godin Score dichotomized 0: <=25; 1: >25 • Any Strenuous • Any strenuous or moderate exercise	One week	• SMI less likely to take strenuous (8 vs 33%, *p=0.001*) or strenuous and moderate exercise (45 vs 63%, *p=0.01*) than non-SMI • Godin median scores (21 SMI vs 27 non-SMI, *p<0.001*) • High Godin score (>25) 35% SMI vs 78% non-SMI, *p=0.01* • Adjusting for SES, PA still predictive of SMI. • Only Manchester mental state predicted high Godin score ○ 0-3 60% ○ 4-6 29% ○ 7-10 33% ○ 10+ 18% ○ *p=0.045*

SZ = Schizophrenia; SA= Schizoaffective Disorder; SF= Schizophreniform; MD= Major mood disorder; SMI= severe or serious mental illness; PA= physical activity; NS= nonsignificant, p>0.05; NR= not reported; NI= no information

3.2.2 Objective Assessment of Physical Activity in Patients with Schizophrenia and Schizoaffective Disorder

Six published studies have used accelerometry to measure physical activity in patients with schizophrenia or schizoaffective disorder. Collectively, these studies have monitored approximately 220 patients with schizophrenia or schizoaffective disorder as summarized in Table 3.3.

Even though physical activity was measured with accelerometry, Faulkner and associates report few details about objectively measured physical activity levels or patterns among 35 patients diagnosed with schizophrenia, schizophreniform, or schizoaffective disorder (47). It is interesting to note that the authors reported only modest Spearman correlations between the objectively and subjectively measured physical activity [total minutes (ρ=0.37; 95% CI: 0.04-0.63) and MET min week^{-1} (ρ=0.33; 95% CI: 0.00-0.60)] as measured by the RT3 accelerometer and the Short-Form of the International Physical Activity Questionnaire (IPAQ), respectively, in patients diagnosed with schizophrenia, schizophreniform, or schizoaffective disorder (47). Feasibly, these modest correlations may reflect either true measurement differences in subjective and objective measures of physical activity, recall bias for self-reported physical activity, or measurement error in objective and/or subjective measurement of physical activity in adults with schizophrenia or schizoaffective disorder.

In a pilot study of 8 males with paranoid schizophrenia, Sharpe and associates found that accelerometry was not a valid measure of energy expenditure (59). Although the pilot study had limited power due to the small sample size, the findings support results reported in other published studies (60-62). Unfortunately, the physical activity levels by accelerometry in this pilot study are not reported hence preventing comparisons with previously published reports or the current study.

Only one study investigated physical activity among inpatients. Specifically, male adolescents treated with olanzapine and diagnosed with schizophrenia(17) were studied. This pilot study found that 9 out of the 10 participants engaged in moderate activity for less than 10 continuous minutes per day. However, this short report provides little additional information on the low habitual physical profile or levels of the male adolescent in patients treated with olanzapine. For instance, the investigators report the daily percentage of time engaged in moderate to very vigorous physical activity as measured by accelerometry rather than standard

accelerometry measurements such as activity counts, steps, or minutes per day engaged in physical activity. This atypical reporting makes comparisons with other studies, populations, and public health guidelines difficult. Also, percentage of time engaged in physical activity may be biased or misleading as an outcome. For instance, 2 participants may both engage in 1 hour of physical activity but the percentage of time engaged in physical activity may differ between the two participants if one participant wears the accelerometry for only 2 hours and the other participant wears the accelerometry for 12 hours. Although the actual time engaged in physical activity is the same for the 2 participants, the percentage of time engaged in physical activity will differ. Another shortcoming of the pilot study is that physical activity was monitored for only 2 days. Standard conventions for objective monitoring of physical activity suggests at least 4 days of monitoring with at least one weekend day. Also, the authors do not mention if the participants were compliant with activity monitoring. Typically, these measurements are only considered valid if the participant wears the accelerometer for at least 10 hours per day.

Similar to the present study, McKibbin and associates investigated a lifestyle intervention for older (age $\geq$ 40 years) ambulatory patients with diabetes mellitus and schizophrenia or schizoaffective disorder (19). The physical activity monitoring, data processing and analysis of the accelerometry data was well-designed and conducted according to conventional research practices; 7 days of monitoring with at least 3 valid days of data ($\geq$ 10 hrs/day). Unfortunately, the cut points for moderate and vigorous physical activities were not defined making comparisons with other studies difficult. Also, accelerometry data was not obtained from 21% (12 out of 57 patients) of the sample due to malfunctions in the accelerometers. Prior to the lifestyle intervention, patients with schizophrenia and schizoaffective disorder averaged between 23 and 25 minutes of moderate and vigorous activity per day. No additional details on the physical activity profile or pattern of middle-aged and older patients with schizophrenia/schizoaffective disorder and diabetes mellitus are provided since the purpose of the paper was to report the feasibility and health changes of a lifestyle intervention in study participants.

Lindamer and associates reported the first detailed physical activity profile based on subjective and objective measures of physical activity in a small sample of middle-aged and older patients with schizophrenia (n=16) compared to age and gender-matched controls with no psychiatric diagnosis (n=6) (18). Based on accelerometry, average daily minutes of moderate

and vigorous activity, average of sedentary hours, or mean activity counts did not differ between the groups. However, these results should be cautiously interpreted due to the small sample size. Patients with schizophrenia averaged lower light activity hours per day than the controls (4.0 vs. 5.4 hrs/day, p=0.01).

In a larger sample (n=55) of overweight and obese adults with severe mental illness [schizophrenia or schizoaffective disorder (n=38), bipolar disorder (n=15, and major depression (n=12)], average mins/wk of moderate to vigorous physical activity measured by accelerometry were greater in male than female (157 vs. 85 min/wk) and younger than older (149 vs. 88 min/wk) participants (20). Initially, compliance with objective monitoring of physical activity was low with only 38% of participants (n=25) wearing the accelerometer for at least 4 days with at least 10 hours of accelerometer data per day (20). Participants who did not initially provide valid accelerometry data were asked to wear the accelerometer again. Overall, valid accelerometry data was obtained from 82% of the sample (20) and approximated activity levels reported in previously reported studies (18, 19). Moderate to vigorous physical activity levels were not correlated with self-reported severity of psychological symptoms, depressive symptoms or cognitive function using the Symptom Checklist-90 (SCL-90), Center for Epidemiologic Studies Depression Scale (CES-D) and the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), respectively (20). Unfortunately, no comparisons or information is provided regarding the physical activity levels of participants by psychiatric diagnosis.

Collectively, these studies suggest that it is possible to objectively measure physical activity in patients with schizophrenia and schizoaffective disorders but that compliance may be lower than in other populations. In addition, these studies provide some preliminary evidence that patients with schizophrenia and schizoaffective disorder have low levels of moderate to vigorous physical activity. It should be emphasized that physical activity was objectively measured but not the primary focus for five out of six reported studies. One study (59)only attempted to validate estimates of energy expenditure by accelerometry with doubly labeled water. Two of the studies (18, 47) used accelerometry to validate self-reported physical activity surveys in patients with schizophrenia and schizoaffective disorders. In the other two studies (17, 19), physical activity was assessed pre- and post-treatment as one of several health characteristics of patients with schizophrenia and schizoaffective disorder. Hence, it is not

surprising that these reports would only provide limited or no information on objectively measured physical activity profiles of patients with schizophrenia or schizoaffective disorder. In the remaining study, the physical activity profile of patients with schizophrenia or schizoaffective disorder was not reported(20). Instead, the physical activity profile of patients with severe mental illness was reported and included patients with schizophrenia and schizoaffective disorder as well as patients with bipolar disorder and major depression (20). Hence, none of these studies provided a comprehensive profile of objectively measured physical activity in patients with schizophrenia and schizoaffective disorder. In addition, these studies have been limited by the following research methodologies; 1) small sample sizes (17, 18), 2) only reported moderate to vigorous physical activity but not overall activity levels, light physical activity or sedentary minutes (19, 20) and 3) the samples were either too homogenous such as patients with schizophrenia or schizoaffective disorder who are diabetic as well as overweight or obese (19), or heterogeneous such as patients with severe mental illness including schizophrenia, schizoaffective disorder, bipolar disorder, and major depression(20). Furthermore, these studies did not examine the association between physical activity and symptoms of schizophrenia or schizoaffective disorder.

Table 3-3 Demographic review of studies reporting objective assessment of physical activity with accelerometry in individuals with schizophrenia or schizoaffective disorders.

Author, yr	**N (Men, Women)** ***N by disorder***	**PANSS** **(positive, negative, general psycho-pathology, total)**	**Age (years)** **Mean ± STD** **Range**	**BMI (kg/m^2)** **Mean ± STD** **Range**
Faulkner, 2006(47)	35 (22, 13) *28 SZ,1 SF, 6 SA outpatients*	NR	40 ± 11	31±7
Gothelf, 2002 (17)	20 (20,0) 20 SZ • 10 olanzapine treated (OT) • 10 halopriodol treated (HT)	NA	17.0 ± 1.6 OT 24.5 ± 5.9 HT	24.5 ± 5.9
Jerome, 2009 (20)	66 (32,34) *~ 38 SZ/SA* *~ 15 Bipolar* *~ 12 MDD* 55 (27,28) with accelerometry	NA	44 Range 20-67 years	Restricted to > 25 14 Overweight 41 Obese
Lindamer, 2008 (18)	81 (48,33); *54 SZ/SA* *27 Normal Comparison (no known psychiatric diagnosis)*	SZ/SA: 13 ± 6, 14 ± 5, 27 ± 7, NR Normals: NR	50.7±6.4 SZ 52.2±8.6 Normals Range: 40 years or older	30.5±7.1 SZ 27.8±4.4 Normals *(p=0.13)*
McKibbin, 2006 (19)	64 (37, 20) diabetic *48 SZ* *9 SA*	DART (n=28) 13.1 ± 4.6 5.2 ± 0.8 3.6 ± 0.6 UCI (n=29) 15.1 ± 5.1 5.6 ± 0.7 4.0 ± 0.7	53.1 ± 10.4 DART 54.8 ± 8.2 UCI *Note: recruited ≥ 40 years*	33.6 ± 6.8 DART 32.9 ± 6.2 UCI
Sharpe, 2006(59)	8 (8, 0) *8 paranoid SZ treated with Clozapine (450 mg/day)*	NA	28	29.8

Table 3-4 Physical activity review of studies reporting objective assessment of physical activity with accelerometry in individuals with schizophrenia or schizoaffective disorders.

Author, yr	Study Design	Accelerometer	Accelerometry definitions of PA	Physical activity (PA) assessment period	Findings
Faulkner, 2006(47)	Cross-sectional study	RT3 triaxial accelerometer (Stayhealthy, Inc)	Total mins/wk of physical activity (>3.3 MET min^{-1}, the estimated level for walking) Total METS per week estimated from the total mins/wk of physical activity	7 days; at least 600 min of registered time per day for at least 5 days with at least one weekend day	• Used as criterion measure for IPAQ • ρ=0.37; *p=0.05*, [95% CI 0.04-0.63] for IPAQ and total min wk^{-1} of physical activity • ρ=0.33; *p>0.05*, [95% CI 0.0-0.60] for IPAQ and METS min wk^{-1} of physical activity
Gothelf, 2002 (17)	Longitudinal	CSA (Computer Science&Application), Shalimar, FLA	1. Light 2. Moderate 3. Vigorous 4. Very vigorous 5. % of time in moderate to very vigorous activity *Note: Cutpoints not provided*	2 days at baseline and 4 weeks later after starting olanzapine treatment; right hip	OT • 4.4% (baseline) and 2.9% (4 wk) of time in moderate to very vigorous activity (*p=0.13*) • 90% < 10 min per day of MVPA • Low physical activity before and after treatment

[a]later renamed CSA AM7164 or Actigraph Accelerometer (model 7164)

Table 3-4 (continued) Physical activity review of studies reporting objective assessment of physical activity with accelerometry in individuals with schizophrenia or schizoaffective disorders.

Author, yr	Study Design	Accelerometer	Accelerometry definitions of PA	Physical activity (PA) assessment period	Findings
Jerome, 2009 (20)	Cross-sectional study	RT3 (Stayhealthy, Inc) triaxial accelerometer	1. Minutes of MVPA (≥ 1316 counts/min) per day 2. Minutes of MVPA in bouts of ≥10 minutes per day 3. Estimated average mins/wk of MVPA	4 days including one weekend day, at least 10 h of wear time for 4 days, worn on right hip	• Only n=25 (38%) compliant wearing accelerometry initially; Final compliance n=55 (83%) • 120 ± 13 min/wk MVPA • 25 ± 6 min/wk MVPA in ≥10 min bouts • 35% meet physical activity guidelines (≥150 min/wk) • 4% meet physical activity guidelines (≥150 min/wk in ≥10 min bouts) • men>women ($p<0.05$) • overweight>obese ($p>0.40$) • younger>older for min/wk but not min/wk in bouts for MVPA • no MVPA difference by CES-D or psychological distress
Lindamer, 2008 (18)	Cross-sectional; 2:1 SZ:Normals Matched on gender and age (±10 years)	Actigraph Accelerometer (model 7164)	0-100 counts/hr sedentary 101-1951 counts/hr light activity 1952-5724 counts/hr moderate ≥5725 counts/hr vigorous	7 days; considered valid data if at least 3 days with 10 hours of monitoring; invalid hour if 0 counts > 30 min	• data from 17 (31%) participants excluded because of monitor malfunctions or too few days; 15 (28%) excluded, not able to match for gender and age • 16 SZ, 6 Normals • SZ/SA (4.0 h/day) <controls (5.4 h/day) for light activity ($p>0.01$) • No difference for moderate (32.0 vs 31.6 min/day), vigorous (4.1 vs 5.4 min/day) or sedentary (8.9 vs 8.2 h/day) minutes, or mean activity counts (337.7 vs 365.3) (SZ vs Normals)($p>0.71$)

[a]later renamed CSA AM7164 or Actigraph Accelerometer (model 7164)

Table 3-4 (continued) Physical activity review of studies reporting objective assessment of physical activity with accelerometry in individuals with schizophrenia or schizoaffective disorders

Author, yr	Study Design	Accelerometer	Accelerometry definitions of PA	Physical activity (PA) assessment period	Findings
McKibbin, 2006 (19)	Randomized Clinical Trial; randomized to either Diabetes Awareness and Training (DART, n=32) or Usual Care plus Information (USI, n=32)	Actigraph Accelerometer (model 7164)	Average minutes of moderate and vigorous activity per day	7 days; valid data >= 3 days, 10 h per day, (lost data for 12 patients due to downloading error)	• Pre vs Post-Intervention 23±20 vs 14±15 UCI 25±24 vs 23±17 DART NS, presumably *p>0.05*
Sharpe, 2006(59)	Cross-sectional study	RT3 triaxial accelerometer	Estimate of energy expenditure for each recorded activity minute	4 consecutive days; 12 h per day	• Over-predicted energy expended on physical activity compared to doubly labeled water (148 ± 413 kcal/day) with RT3 • *r*= -0.83 (p=0.001) for inactivity and activity energy expenditure with RT3 • NS correlation between accelerometry output and activity energy expenditure

[a]later renamed CSA AM7164 or Actigraph Accelerometer (model 7164)

3.2.3 Subjective versus Objective Measures of Physical Assessment in Patients with Schizophrenia or Schizoaffective Disorders

As discussed above, neither subjective nor objective assessment of physical activity is ideal for adults with schizophrenia or schizoaffective disorder. Briefly, subjective measures of physical activity poorly assess unstructured, intermittent, and low-intensity activity such as walking which is the primary activity for adults with schizophrenia and schizoaffective disorder as well as the general population. Even though unstructured, intermittent, and low-intensity physical activity are measured well with objective assessments of physical activity, only subjective assessments of physical activity can identify the actual physical activity (running, bicycling, walking), the type of physical activity (occupation, household, leisure), and quantify activities such as swimming, cycling, or weight lifting that are poorly measured by accelerometers. Also, lower compliance with wearing the accelerometer was noted in the pilot studies in adults with schizophrenia or schizoaffective disorder(18, 20) compared to the general population. This lower compliance rate for accelerometry may jeopardize the feasibility of objective monitoring of physical activity in adults with schizophrenia and schizoaffective disorder for research studies as well as limit the generalizability of any research findings.

The weak to modest correlations between subjective and objective measures of physical activity reported by Lindamer et.al.(18) and Faulkner et al.(47) suggest that objective measures of physical activity may differ from subjective measures of physical activity among patients with schizophrenia or schizoaffective disorder. This finding may not be limited to adults with schizophrenia or schizoaffective disorder. In a recent commentary, Troiano indicated that objective measures of physical activity may substantially differ from subjective measures of physical activity in the general population (63). For example, accelerometry was found to have significantly lower estimates of physical activity levels and different patterns of physical activity than self-reported physical activity in an adult Swedish population (n=1114)(64). Additional research is necessary to confirm these preliminary findings, and to accurately describe and define objectively measured physical activity in various populations. The present study will address this gap in the research literature by quantifying and comparing objective and subjective measures of physical activity levels and patterns among overweight and obese adults with schizophrenia and schizoaffective disorders in a relatively large sample (n=250).

As others have suggested(36, 58),(37) both objective and subjective assessment of physical activity may be necessary to obtain a comprehensive profile of physical activity in free-living adults. For this reason, the proposed study assessed physical activity subjectively using a highly Modified Activity Questionnaire (MAQ) (Appendix 9.1.1) and objectively by accelerometry (Actiwatch) to obtain a comprehensive profile of physical activity in overweight and obese adults with schizophrenia or schizoaffective disorder. As summarized in Table 3.5, the strengths and limitations of the two assessments selected in this study complement each other and should provide the most comprehensive profile of physical activity in overweight and obese adults with schizophrenia and schizoaffective disorder to date.

Table 3-5 Strengths and limitations of physical activity measured objectively by accelerometry (Actiwatch) and subjectively by questionnaire [Modified Activity Questionnaire (MAQ)] in free-living individuals.

Variable	Accelerometry	Questionnaire
Type of assessment	Objective	Subjective
Device	Actiwatch 7164	MAQ
Data collection	Prospective	Recall
Data collection time	7 Days	15-30 Minutes
Recall bias	No	Yes
Reactivity	Yes	No
Subject burden	Moderate	Minimal
Reliability	Yes	Yes
Validity	Yes	Yes
Cost	Expensive	Inexpensive
Activity time period	7 Days	7 Days
Measures intensity/duration/ frequency of activities	Yes	Yes
Measures leisure time activities	Primarily Activity Related To Hip Movement Only	Selected Activities
Measures occupational activities	Primarily Activity Related To Hip Movement Only	Selected Activities
Measures unstructured or low intensity activities	Primarily Activity Related To Hip Movement Only	Poor
Measures housework/household activities	Primarily Activity Related To Hip Movement Only	Selected Activities
Ability to measure swimming and water activities	No	Yes
Ability to measure weight lifting and cycling	Poor	Good
Use in special populations		
Children	Yes	No
Cognitively impaired	Possibly	Yes
Restricted to Wheelchair	No	Yes
Data entry requirements	Low	Moderate
Data processing	High	Low

3.3 CONCLUSION

Although limited, published studies using objective and subjective measures of physical activity suggest that individuals with schizophrenia or schizoaffective disorder have low levels of moderate to vigorous physical activity. For the most part, these studies have been limited by the following research methodologies; 1) small sample sizes (17, 18), 2) moderate to vigorous physical activity reported but not activity counts, light physical activity or sedentary minutes (19, 20), 3) the samples were either too homogenous such as patients with schizophrenia or

schizoaffective disorder who are diabetic and overweight or obese (19), or heterogeneous such as patients with severe mental illness including schizophrenia, schizoaffective disorder, bipolar disorder, and major depression (20), 4) only measured objective or subjective physical activity hence the studies were not able to provide a comprehensive profile of physical activity that includes the quantity, intensity, pattern, and type of physical activity in adults with schizophrenia and/or schizoaffective disorder, and 5) lack of control for confounding factors such as BMI.

This investigation will address these shortcomings by 1) measuring physical activity in a significantly larger sample of adults with schizophrenia or schizoaffective disorders (n~250), 2) measuring physical activity both subjectively and objectively, 3) reporting the full spectrum of intensity (light to moderate/vigorous activity) and types (leisure, occupational, household) of physical activity, 4) quantifying physical activity or inactivity using total activity counts, mins/wk of physical activity or inactivity, or energy expenditure, 5) studying only adults with schizophrenia and schizoaffective disorders rather than adults with severe mental illness, and 6) control for BMI, a possible confounder in previously reported studies. In addition, the project will also examine the association between physical activity and the symptoms and impairments associated with schizophrenia and schizoaffective disorders that previous studies have not examined.

Finally, physical activity levels of adults with schizophrenia and schizoaffective disorder will be compared with a representative sample of adult users of mental health services in the US. This analysis will begin to investigate whether physical activity levels differ by diagnoses and severity of symptoms within mental health populations. Ultimately, this investigation will make significant contributions to the existing literature by providing a comprehensive profile of physical activity in adults with schizophrenia and schizoaffective disorders and by providing an initial framework for determining whether physical activity levels or patterns differ by diagnosis or severity of the mental illness.

3.4 STUDY OBJECTIVES

The first objective of this study is to provide a comprehensive physical activity profile of overweight and obese adults with schizophrenia and schizoaffective disorder. The comprehensive profile will be based on physical activity measured subjectively by questionnaire

and objectively by accelerometry. It is hypothesized that overweight and obese adults with schizophrenia and schizoaffective disorders will be relatively sedentary and primarily engage in unstructured, intermittent, and low-intensity physical activities such as walking and daily household activities. This descriptive profile of physical activity in overweight and obese adults with schizophrenia or schizoaffective disorder will also examine the association between physical activity levels and 1) symptoms of schizophrenia, 2) psychiatric medications, 3) demographics, and 4) quality of life. An inverse relationship is expected between physical activity levels and cognitive, social and occupational impairments or dysfunction in overweight and obese adults with schizophrenia and schizoaffective disorder.

The second objective of this study is to compare physical activity levels measured objectively by accelerometry in adults with schizophrenia and schizoaffective disorder with adults who used mental health services in the general US population. Using accelerometry data from the National Health and Nutrition Examination Survey (NHANES 2003-2004), men and women who used mental health services were relatively sedentary(65). Men who used mental health services were significantly less active than men who did not use mental health services(65). Women, regardless of mental health service use, were significantly less active than men who used mental health services(65). This study will extend these findings by determining if the physical activity levels of adults with schizophrenia or schizoaffective disorder differ from adults who use and do not use mental health services. Feasibly, physical activity levels of adults with mental illness may differ depending on the diagnosis and the severity of the symptoms. In other words, lower physical activity levels may be observed in adults with severe mental illness (schizophrenia and bipolar disorder) and higher physical activity may be expected in adults with less severe mental illness such as anxiety and adjustment disorder.

By objectively measuring physical activity levels, this report will provide not only a comparison of physical activity among adults with schizophrenia and schizoaffective disorder and users and non-users of mental health services but also determine whether physical activity differs by symptoms or function among adults with schizophrenia and schizoaffective disorder. These findings may justify and guide in the development of effective physical activity programs tailored to provide physical and psychologically benefit to overweight and obese adults with schizophrenia and schizoaffective disorder.

4.0 METHODS

4.1. BRIEF OVERVIEW

This report is based on baseline data from the Weight Assessment and Intervention in Schizophrenia Treatment (WAIST) study and the National Health and Nutrition Examination Survey 2003-2004. A brief overview of the two study designs are provided below.

4.1.1 Weight Assessment and Intervention in Schizophrenia Treatment (WAIST) Study

The WAIST study is a randomized, parallel group, clinical trial designed to assess the efficacy of a group-based behavioral treatment for weight reduction (BT) compared to social skills training (SST) or usual care (UC) in overweight or obese (BMI>27 kg/m^2) but clinically stable patients with a diagnosis of DSM-IV-TR schizophrenia or schizoaffective disorder. Eligibility criteria for enrollment in the study included: age 18-70 years, DSM-IV-TR schizophrenia or schizoaffective disorder, BMI>27 kg/m^2 at the time of enrollment, ability to provide informed consent, and spontaneously expressed a desire to lose weight. Subjects were accepted if treated with novel or conventional antipsychotics or if not treated with any antipsychotic medication, 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, currently being treated 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, and prominent cardiovascular risks that may have jeopardized patient's safety in a weight reduction program that included some exercising. Participants were recruited from the outpatient clinics and partial hospital programs at Western Psychiatric Institute and Clinic, University of Pittsburgh Medical

Center, Pittsburgh, PA, from WPIC satellite clinics at Beaver Valley and McKeesport, and from the Safe Harbor Behavioral Health Clinic in Erie, Pennsylvania. Potential participants were informed about the study by a member of their medical team (psychiatrist, therapist, or case manager).

During Phase I, BT and SST groups attended 20 sessions over a 14-week period where the patients were taught 7 topics or techniques relevant to their group assignment. After the conclusion of Phase I, only patients in BT who had lost at least 3% of initial body weight entered Phase II, a 24-month follow-up period with brief 'booster' sessions at two week intervals. At the end of Phase I, SST and UC patients were given the opportunity to participate in a weight reduction group if they so desired.

Physical activity was measured objectively by accelerometry and subjectively by an interview-administered survey at screening prior to randomization and at the end of phase I. Physical fitness was measured by graded exercise stress testing. This report is restricted to the screening assessments that occurred prior to randomization at baseline.

All participants in the WAIST Study were eligible for the subjective measurement of physical activity and physical fitness testing. Only a subsample of the WAIST Study participants were offered actigraphy monitoring. Based on the staff's perception of the participant's compliance to complete the research intervention, the WAIST Study staff evaluated participants at baseline on a subjective rating scale, Observer Related Compliance Rating (ORCR). ORCR scores ranged from 1 to 7. Participants rated 5, 6, or 7 were considered eligible for actigraphy monitoring. Due to initially low compliance with actigraphy monitoring by the participants, the eligibility criteria for actigraphy monitoring was modified. Only participants whom had a rating of 5 or greater on the 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.

4.1.2 National Health and Nutrition Examination Survey (NHANES) 2003 – 2004

NHANES 2003 – 2004 is designed to assess the health and nutritional status of adults and children in the United States by means of interviews and physical examinations. The NHANES interview is composed of demographic, socioeconomic, dietary, and health-related questions.

Medical, dental, and physiological measurements and laboratory tests are administered by highly trained medical personnel during the physical examinations. The National Center for Health Statistics of the Centers for Disease Control conducted NHANES as a cross-sectional observational study using a stratified, multistage probability design to obtain a nationally representative sample of the civilian, non-institutionalized US population(66). From January 2003 through December 2004, NHANES participants that agreed to a medical examination were recruited for physical activity monitoring by accelerometry(67). Only 16% (n=880) of the adult population (n=5620, age 18 years or older) did not participate in the physical activity monitoring for the following reasons: declined the medical examination, declined physical activity monitoring, or had physical impairments limiting walking or wearing the accelerometry and were not eligible to receive an activity monitor (67). Overall, 4740 adults participated in the physical activity monitoring (n=2282 for men and n= 2458 for women). For this report, the NHANES actigraphy sample was restricted by the age eligibility criteria used in the WAIST Study (18-70 years). The NHANES actigraphy sample consisted of 758 men and 832 women between the ages of 18 and 70 years. Another subset of the NHANES actigraphy sample was created based on the BMI (> 27 kg/m^2) and age (18-70 years) eligibility criteria used in the WAIST Study. The NHANES actigraphy subsample consisted of 49 men and 68 women between the ages of 18 and 70 years with BMI >27 kg/m^2.

This report only used a subset of the NHANES 2003-2004 data as outlined in Table 4-1. The methodology associated with this data subset is described in the following sections of this report (Table 4-1).

Table 4-1. Sections describing NHANES 2003-2004's methodology.

Dissertation Sections	NHANES Variable
4.2.2	Objectively measured physical activity (actigraphy)
4.3.4	Users of mental health services
4.4.2	General health status (SF12)
4.6.2	Demographics (age, race, gender)
4.7	Height, Weight, BMI
4.8.2	Smoking Status

4.2. PHYSICAL ACTIVITY MEASURES

4.2.1 Subjectively measured physical activity in the WAIST Study

In the WAIST study, physical activity was subjectively assessed using a very modified, past week version of the Modifiable Activity Questionnaire (MAQ), an interviewer administered questionnaire (33, 46) (Appendix A1). Participants reported the number of minutes they engage in specified occupational, housework, gardening/yard work, caretaking, transportation, and leisure physical activities for ten minutes or longer during the past week. Estimated metabolic cost of the physical activities (METS/wk) were calculated by multiplying the mins/wk engaged in the specified physical activity by the estimated MET value of the activity published in the compendium of physical activities (68) (Appendix A1). For occupational activity, the METS values were estimated as 0 for category A, 4.0 for category B, and 7.0 for category C activities. The six types of physical activities (occupational, housework, gardening/yard work, caretaking, transportation, and leisure) were summed to obtain total physical activity in mins/wk and MET/wk for the past week. In addition, total physical activity excluding occupational activities and total physical activity excluding household activities were created.

Finally, the physical activities were individually classified by intensity as sedentary, light, moderate or vigorous. Minutes per week and MET-minutes per week were calculated for light, moderate, and vigorous activities. For comparison with the accelerometry data, moderate and vigorous estimates were combined and reported as moderate-vigorous mins/wk and MET-mins/wk.

4.2.2 Objectively measured physical activity in WAIST Study and NHANES 2003-2004

Both WAIST and NHANES 2003-2004 studies used the ActiGraph AM-7164 monitoring device (ActiGraph, Ft. Walton Beach, FL)(67) to objectively measure physical activity. The ActiGraph is considered the gold standard of accelerometer measurement and it has been used in over 215 published studies (http://www.theactigraph.com and select research databases). The ActiGraph has been validated with indirect calorimetry, and as expected, higher correlations were observed for treadmill activities ($r = .76$ to $.85$) than simulated lifestyle activities ($r = .48$)(43). High interinstrument reliability was observed in free-living adults (intraclass correlations > 0.97). The ActiGraphs were set to measure the duration and intensity of uniaxial movement within one-

minute epochs. Participants wore the accelerometer on an elasticized belt over the right hip for seven consecutive days(67). If there were no activity counts for ≥ 60 minutes, the accelerometer was considered not worn for that interval of time. For this report, analyses were restricted to those respondents with valid and reliable accelerometry data according to standard NHANES protocol and who wore the accelerometers for at least 10 hours a day for three or more days. Each minute epoch was assigned an activity level based on the number of counts per minute; sedentary (≤ 100 counts), light (101 - 1951 counts), or moderate/vigorous (≥ 1952 counts). For the most part, strenuous physical activities such as running, cycling, brisk walking and other aerobic activities were included in this definition of moderate/vigorous activity. Daily totals of sedentary, light, and moderate-vigorous minutes as well as total activity counts were averaged. The average of total counts per minute was calculated. In addition, percentage of monitoring time for sedentary, light, and moderate-vigorous activities was calculated by dividing the minutes engaged in each category by the total monitoring minutes for each participant.

4.2.3 Fitness measures in the WAIST Study

Graded exercise stress testing (GXT) was optional for participants in the WAIST Study. Volunteers were excluded from GXT if medical clearance was not provided by their primary care physician.

The modified Bruce protocol was used to ascertain cardiosrepiratory fitness and physical function capacity as previously described and summarized by Strassnig and associates (69). Briefly, GXT was performed on a stationary cycle ergometer except for 2 participants who completed the GXT on a treadmill since their weight exceeded 400 pounds, the upper weight limit for safety on a cycle ergometer. Speed remained constant throughout the GXT while resistance was increased at 2 minute intervals. Heart rate, blood pressure, and ratings of perceived exertion (RPE) were measured at defined periods during the GXT. GXT was terminated at voluntary exhaustion or if the participant reported signs or symptoms of exercise intolerance such as muscular fatigue, significant ST depression and ischemia, or complex arrhythmias. GXT outcome measures were 1) cardiorespiratory fitness defined as maximal oxygen uptake (mL/min/kg), 2) peak exercise time in minutes, 3) peak exercise capacity estimated in metabolic equivalents (METs), and 3) maximal RPE during GXT test.

4.3 PSYCHIATRIC AND MENTAL HEALTH ASSESSMENTS

4.3.1 Diagnosis of schizophrenia and schizoaffective disorder in WAIST Study

Diagnosis of schizophrenia and schizoaffective disorder of the study participants was verified by at least 2 out of 3 study psychiatrists using data from a modified Structured Clinical Interview for DSM-IV (SCID)(70), medical charts, and corroborating information from reliable informants.

4.3.2 Positive and Negative Syndrome Scale (PANSS) in WAIST Study

The PANSS (71) 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 minutes to complete. Based on a 7-point scale (1=absent, 2=minimal, 3=mild, 4=moderate, 5=moderate 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)(Appendix A2.1). The scores from the 30 items are summed to obtain the PANSS score that can range from 30 to 210. Although there are different conventions for clinical cut points for the PANSS, the severity of the illness has been categorized as mild, moderate and severe for scores <60, 60-129, and >129, respectively, in this study. Participants were only eligible for this study if their PANSS scores were less than 90 at enrollment.

4.3.3 Clinical Global Impression of Severity (CGI-S) in WAIST Study

With the CGI-S (72, 73), clinicians subjectively rate the severity of the patient'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 (Appendix A2.2).

4.3.4 Use of Mental Health Services in NHANES 2003-2004

During the household interview, the use of mental health services was assessed by asking: "During the past 12 months, that is since (*date*), have you seen or talked to a mental health professional such as a psychologist, psychiatrist, psychiatric nurse, or clinical social worker about your health?" and participants responded yes or no.

4.4 ASSESSMENT OF FUNCTION AND HEALTH STATUS

4.4.1 Global Assessment of Functioning (GAF) Scale in WAIST study

With GAF, the clinician rated the adult patient on a predefined hypothetical continuum of mental health-illness based on the patient's psychological, social and occupational functioning (Appendix A3.1) (3). Functional impairments due to physical or environmental limitations are not considered. The GAF scale ranges from 0-100 and the 11 categories are briefly defined as superior functioning (91-100), absent or minimal symptoms (81-90), transient symptoms (71-80), mild symptoms (61-70), moderate symptoms (51-60), serious symptoms (41-50), impairment in reality testing or communication (31-40), serious impairment in communication and judgment (21-30), some danger of hurting self or others (11-20), persistent danger of hurting self or others (1-10), and inadequate information (0).

4.4.2 General Health Status (SF12) in WAIST Study and NHANES 2003-2004

In both studies, participants self-reported their general health as excellent (1), very good (2), good (3), fair (4), or poor (5) in an interview administered by a trained rater (Appendix A.3.2) (74). For the analyses, general health status was dichotomized as 1= poor and fair, or 0= good, very good, and excellent (reference group).

4.5 ASSESSMENT OF MEDICATIONS IN WAIST STUDY

Subjects needed to have been on a stable dose of medications for at least 30 days prior to enrollment. Study participants were not allowed to be on any weight reduction treatment

including prescription or over-the-counter drugs. Information on medications was obtained from reviewing the subjects' medical records and by subject report.

Study 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(75, 76). Participants with polypharmacy antipsychotic medications were excluded from all analyses involving weight gaining properties.

4.6 ASSESSMENT OF DEMOGRAPHICS

4.6.1 WAIST Study

At baseline, WAIST participants self-reported their date of birth, gender, race/ethnicity (White/Caucasian; Black or African American; American Indian/Alaska Native; more than one race; other; or unknown/not reported), marital status (married and living with spouse; married but not living with spouse; never married; separated, divorced, widowed; don't know/refused), primary employment (unemployed; occupational/vocational therapy; administrative or clerical support; precision production, craft or repair; transportation or material moving; technician and related support; don't know/refused; volunteer; handlers, equipment cleaners, helpers; sales; professional specialty; other services), education [elementary school (grade 6 or less); some secondary school (grade 7 to 11); vocational training; GED/high school equivalent; graduated high school; graduated 2-year college; some college; some graduate/professional school; graduated 4-year college; completed graduate/professional school; don't know/refused], and residence [hospital; 24-hour skilled nursing facility; intermediate care facility; supervised group living; transitional group home (halfway or quarterway house); family foster care; supervised cooperative apartment; unsupervised cooperative apartment; board and care home; boarding house (includes meals, no program or supervision); rooming or boarding house or hotel; private house or apartment; shelter; jail; no current residence; other; no other information] (Appendix A.3.3) (77).

4.6.2. NHANES 2003-2004

Date of birth was used to calculate age at interview. To reduce the risk of disclosures, older adults age 85 years or older were given an age value of 85(78). Highest grade or level of education was coded as less than 9^{th} grade, 9-11^{th} grade education (including 12^{th} grade and no diploma), high school education/GED, some college or associates (AA), and college graduate or higher(78). Respondents self-identified their race as White, Black/African American, Indian (American), Alaska Native, Native Hawaiian, Guamanian, Samoan, Other Pacific Islander, Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, Other Asian, Some other race (specify), don't know, or refused(79). Also respondents were asked if they considered themselves Hispanic and/or Latino and could answer yes, no, don't know or refused(79). Based on these two questions, respondents were classified as white, black, Hispanic, or other.

4.7 ASSESSMENT OF HEIGHT, WEIGHT, AND BMI IN NHANES AND WAIST STUDY

Height and weight were measured using hospital quality weight and height scales for the WAIST Study. In NHANES, weight was measured with a Toledo digital scale that was daily calibrated with 50-lb. calibrated weights by a trained technician (80). During the weighing, the adult participants wore underpants, disposable gowns and foam slippers(80). Weight was measured in pounds and converted in kilograms by an automated computer program(80). If the participant weighed more than 440 lbs. then weight was measured using 2 Seca digital scales with the participant standing with one foot on each scale(80). Height was measured in centimeters with a fixed stadiometer with vertical backboard and moveable headboard(80). The stadiometer was calibrated weekly by a trained technician(80). For both studies, BMI (kg/m^2) was calculated as weight (kg) divided by height squared.

4.8 ASSESSMENT OF SMOKING STATUS

4.8.1 WAIST Study

Participants' self-reported the number of cigarettes per day smoked as part of an interview administered questionnaire. This information was used to classify participants as current smokers ($\geq$ 1 cigarette per day) or non-smokers (< 1 cigarette per day).

4.8.2 NHANES 2003-2004

As a metabolite of nicotine, serum cotinine levels were used to assess respondents exposure to tobacco smoke including active and passive smoking(81). Participants were classified as current smokers if cotinine levels were equal to or greater than 10 ng/dl and as non-smokers if cotinine levels were less than 10 ng/dl.

4.9 CODING FOR ANALYSES

For descriptive summaries, race was summarized in 3 categories; White/Caucasian, Black/African American, and Other (Other, Native American, More Than One Race, Unknown/Not Reported). Due to the small sample size of the other category (n=6) in the WAIST study, analyses were only performed on the White/Caucasian and Black/African American categories. Marital status was recoded into 5 categories; married (living or not living with spouse), never married, separated/divorced, widowed, and don't know/refused. Highest grade or level of education was categorized as less than high school graduate [elementary school (grade 6 or less); some secondary school (grade 7 to 11)], high school graduate [vocational training; GED/high school equivalent; graduated high school], college educated [graduated 2-year college; some college; some graduate/professional school; graduated 4-year college; completed graduate/professional school], or don't know/refused. Employment was categorized as unemployed, employed (occupational/vocational therapy; administrative or clerical support; precision production, craft or repair; transportation or material moving; technician and related support; volunteer; handlers, equipment cleaners, helpers; sales; professional specialty; other services), or don't know/refused. Residence was categorized as private residence (unsupervised cooperative apartment; board only; rooming house; private house or apartment; family foster

care; shelter), group home/supervised care (hospital; 24-hour nursing facility; intermediate care facility; supervised group living; transitional group home; supervised cooperative apartment; board and care home; jail), or no information. Using categories defined by the National Heart, Lung, and Blood Institute, BMI was categorized as overweight (25.0-29.9 kg/m^2), obesity (30.0-39.9 kg/m^2), and extreme obesity ($\geq$40 kg/m^2) (p.179(82)). Age was categorized into the following 3 groups; 18-39 years, 40-49 years, and 50-65 years.

With the MAQ, several participants reported extreme values for selected activities. For these participants, the mins/wk for these selected activities were truncated to the second highest reported value in the sample. Specifically, shopping was recoded 480 mins/wk instead of 4320 mins/wk for participant 001WAI-000028, and light housework was recoded 1680 mins/wk instead of 4200 mins/wk for participant 001WAI-000402. For participant 001WAI-000433, childcare was recoded 0 mins/wk instead of 7200 mins/wk since these childcare activities seemed to be reported under household activities as well. Under caretaking, participant 001WAI-000121 indicated 'take mother for a walk' under the other category. The METS value assigned was 3.5 for 'take mother for a walk' to correspond to the METS value assigned to walking for transportation and leisure.

GXT participants were classified as fit and unfit based on their maximal oxygen fitness and ratings of perceived exertion (RPE). 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 (83). Ratings of Perceived Exertion were dichotomized as fit (12-20) and unfit (6-11).

Categories were created for the psychiatric and mental health status variables for the summary tables and logistic regression. The Positive and Negative Syndrome Scale for severity of illness was coded as none or mild (0) and moderate (1). The Clinical Global Impression of Severity was coded as mild (0=not ill, very mild, or mild illness) (reference group) or severe (1=moderate, severe, and extremely severe illness). General health status was dichotomized as good (0= good, very good, or excellent) 9reference group) or poor (1=poor or fair). Global assessment of functioning was recoded as mild (0=scores greater than or equal to 61) (reference group) or severe (1=scores between 0 and 60).

4.10 DATA ANALYSIS

Descriptive summaries and statistical analyses were performed using Stata (release 9, StataCorp, College Station, TX) and SAS (version 9.2, SAS Institute, Triangle Park, NC). In general, Kruskal-Wallis analyses of variance were performed for the continuous variables. For the categorical variables, Chi-square tests were performed if the cell sizes were adequate. If the cell sizes were small, Fischer's exact tests were performed.

4.10.1 Activity Populations

Definitions for the various populations from the WAIST Study and NHANES used in this report are provided below. The WAIST Study consists of the MAQ, GXT, and Actigraph cohorts. The MAQ cohort is defined as all participants whom were administered the MAQ. The GXT cohort is defined as all participants who volunteered for the graded exercise stress testing, were medically cleared for GXT by their primary care physician, and had complete fitness data. The actigraph cohort is defined as all participants with at least 3 days of valid actigraph data. For NHANES, users of mental health services was defined as adults who reported using a mental health service during the past year, age between 18-70 years, BMI greater than 27 kg/m^2, and had at least 3 days of valid actigraph data.

4.10.2 Analyses for MAQ cohort

Descriptive summaries and statistical analyses are presented separately for 1) men and women, 2) whites and blacks, and 3) age groups. Since the MAQ variables were continuous, Kruskal-Wallis analyses of variance were performed to detect differences in the MAQ cohort between 1) men and women, 2) whites and blacks, and 3) age groups. Due to the small cell counts, Fisher's Exact Test were used to compare participants who were (n=252) and were not (n=6) administered the MAQ for the various categorical variables related to demographic and health information. Kruskal-Wallis nonparametric tests were used to compare participants who were (n=252) and were not (n=6) administered the MAQ for the following continuous variables; age, BMI, PANSS, and GAF score.

4.10.3 Analyses for Actigraph cohort

Descriptive summaries and statistical analyses are presented separately for 1) men and women, 2) whites and blacks, and 3) age groups. Since the actigraph variables were continuous, Kruskal-Wallis analyses of variance were performed to detect differences in the actigraphy variables between 1) men and women, 2) whites and blacks, and 3) age groups in the actigraph cohort. Due to the small cell counts, Fisher's Exact Test were used to compare participants with valid (n=46) and not valid (n=9) actigraphy data for the various categorical variables related to demographic and health information. Kruskal-Wallis nonparametric tests were used to compare participants with valid (n=46) and not valid (n=9) actigraphy data for the following continuous variables; age, BMI, PANSS, and GAF score.

4.10.4 Analyses for GXT cohort

Descriptive summaries and statistical analyses are presented separately for 1) men and women, 2) whites and blacks, and 3) age groups. For the continuous variables (VO_2max, minutes on the treadmill, resting GXT heart rate, peak GXT heart rate, and ratings of perceived exertion), Kruskal-Wallis analyses of variance were performed to detect differences between 1) men and women, 2) whites and blacks, and 3) age groups in the GXT cohort. Chi Square Tests were used to compare 1) categorical variables for ratings of perceived exertion and GXT by gender, race, and age groups, and 2) participants with (n=115) and without (n=143) GXT data for the various categorical variables related to demographic and health information. Kruskal-Wallis nonparametric tests were used to compare participants with (n=115) and without (n=143) GXT data for the following continuous variables; age, BMI, PANSS, and GAF score.

4.10.5 Correlations between subjective and objective physical activity measures and physical fitness

Spearman correlations were calculated to examine the associations between the objective and subjective measures of physical activity and fitness. Spearman correlations were also calculated to examine the associations between the objective and subjective measures of physical activity and fitness and 1) psychiatric symptoms (PANSS), 2) severity of symptoms (CGIS), 3) function (GAF), 4) self-reported health status (SF12), 5) age and 6) BMI.

4.10.6 NHANES 2003-2004

Descriptive statistics were calculated accounting for the weighting and clustering of the complex sampling design of NHANES (84). The NHANES sample with valid and reliable actigraphy data were restricted to age 18-70 years to correspond to the age eligibility criteria for the WAIST Study. Subsequent analyses also restricted the NHANES sample to adults with BMI greater than 27 kg/m^2 to correspond to the BMI eligibility criteria for the WAIST Study. The objective measures of physical activity and sedentary minutes of the users of mental health services from NHANES were compared to adults with schizophrenia or schizoaffective disorder from the WAIST study by means of a t-test for the comparison of two independent samples.

4.10.7 Linear regression modeling

Multivariate linear regression analyses were employed to identify the determinants of psychiatric symptoms (PANSS) and function (GAF) in adults with schizophrenia or schizoaffective disorder. Candidates for the multivariate models were objective measures of physical activity, subjective measures of physical activity, fitness, age, BMI, smoking status, gender, race, and medications. The first step in the model building process involved developing univariate linear regression models for each candidate. Variables were considered candidates for the backwards step-wise selection of the multivariate linear regression model if the p-value was 0.20 or less in the univariate linear regression model. Next, all candidates were entered into a multivariate linear regression model. Variables were removed from the model sequentially based on the p-values. The stepwise approach retained candidates in the multivariate model with p-values less than or equal to 0.10, and removed candidates with p-values greater than 0.10. A p-value of 0.10 was selected to include potential predictors and confounders of each outcome (psychiatric symptom and function). Next, biologically, plausible interactions were added to the main effects model. Interactions were only retained in the multivariate models if the p-value was ≤ 0.05.

4.10.8 Logistic regression modeling

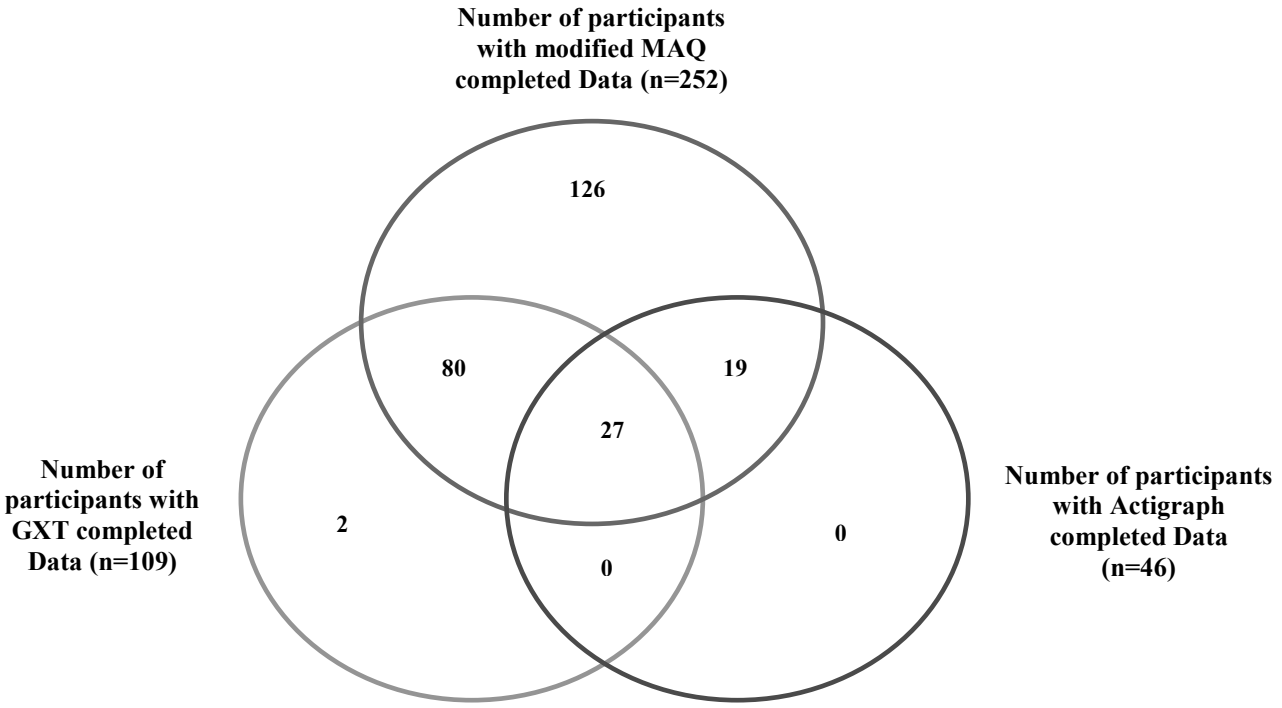
Multivariate logistic regression analyses were employed to identify the determinants of general health status (SF12) and symptom severity (CGIS) in adults with schizophrenia or schizoaffective disorder. Candidates for the multivariate models were objective measures of physical activity, subjective measures of physical activity, age, BMI, smoking status, gender,

race, and medications. The first step in the model building process involved developing univariate logistic regression models for each candidate. Variables were considered candidates for the backwards step-wise selection of the multivariate logistic regression model if the p-value was 0.20 or less in the univariate logistic regression model. Next, all candidates were entered into a multivariate logistic regression model. Variables were removed from the model sequentially based on the p-values. The stepwise approach retained candidates in the multivariate model with p-values less than or equal to 0.10, and removed candidates with p-values greater than 0.10. A p-value of 0.10 was selected to include potential predictors and confounders of each outcome (symptom severity and general health status). Next, biologically, plausible interactions were added to the main effects model. Interactions were only retained in the multivariate models if the p-value was $\leq$ 0.05. Odds ratios and 95% confidence intervals were computed based on the Wald methods.

5.0 RESULTS

5.1 PARTICIPATION RATES

Two hundred and sixty overweight or obese adults with schizophrenia or schizoaffective disorders were recruited to participate in the WAIST Study. After study entry, two participants withdrew their consent during the study and requested their data not be used. Hence, the analytical sample for the WAIST Study consisted of 258 study participants. Four participants only had baseline data and no assessments of physical activity (MAQ and actigraphy) or fitness (GXT). Overall, 254 (98%) study participants had at least one physical activity or fitness assessment at baseline. The MAQ was administered to 252 (98%) participants to assess subjective physical activity levels. One hundred and fifteen (45%) participants volunteered for fitness testing and 55 (21%) participants consented to wear actigraphs. Figure 5-1 provides a summary of the number of participants with completed data for the subjective and objective physical activity measures and physical fitness. The MAQ cohort consisted of 252 participants. The GXT cohort consisted of 109 participants, and the actigraphy cohort consisted of 46 participants. Only 10% (n=27) of the WAIST Study participants had completed data for all measures of physical activity and fitness.



WAIST Study Participants	N=254	Percentage
Modified MAQ only	126	49.6
Modified MAQ and GXT	80	31.5
Modified MAQ and Actigraph	19	7.5
Modified MAQ, GXT, and Actigraph	27	10.6
GXT only	2	0.8
GXT and Actigraph	0	0
Actigraph only	0	0

Figure 5-1 Venn diagram for the number of participants with completed data for modified MAQ, GXT and Actigraphy in the WAIST Study.

5.2 DEMOGRAPHICS AND HEALTH STATUS OF WAIST STUDY PARTICIPANTS

The majority of the WAIST Study participants were middle-aged between 40 to 65 years of age (Appendix Tables A-1 and A-2). Approximately, two-thirds of the sample was comprised of women. White/Caucasians (50%) and Black/African Americans (48%) were equally representative in the study. Partially due to study eligibility criteria (BMI $\geq$ 27.0 kg/m^2), the majority of participants were classified as obese (57%) or extremely obese (31%). Almost half of the participants (114 out of 258 or 44%) reported smoking cigarettes. Few participants were married (8%) or employed (17%). Study participants were generally low functioning adults with limited education (high school education or general education diploma). Approximately, ninety percent of the study participants lived in group or community housing in the Pittsburgh area, specifically the east end. Generally, study participants were unemployed of low socioeconomic status with their primary source of income being social security disability.

Due to study eligibility criteria, study participation was restricted to adults with mild or moderate mental illness as determined by the PANSS. Approximately, two-thirds of the study participants were classified as experiencing mild mental illness at baseline (PANSS $\leq$60). Likewise, the majority of participants were rated as experiencing moderate to mild symptoms based on the clinician's evaluation of psychological, social and occupational function using the GAF (83%) and clinical global impression of mental health severity using the CGI-S (80%) (Appendix Table A-2). Similar to the clinician-rated measures of mental health, the majority of the participants considered their general health status to be good (33%) or fair (32%) (Appendix Table A-2). All of the participants were prescribed medications for schizophrenia or schizoaffective disorder. Due to the study eligibility criteria, polypharmacy medications were limited to 2 antipsychotic medications. However, the majority of the study participants (82%) were prescribed a single atypical antipsychotic medication (Appendix Table A-2). The weight gaining properties of these antipsychotic medications were evenly distributed among the participants taking a single anti-psychotic medication (Appendix Table A-2).

5.3 SUBJECTIVE MEASURE OF PHYSICAL ACTIVITY (MAQ) IN THE WAIST STUDY

5.3.1 Comparison of MAQ cohort and participants not administered the MAQ

The modified MAQ was administered at baseline to 98% (252 of 258) of the WAIST Study participants. Those participants administered the modified MAQ are referred to as the MAQ cohort (n=252) in the remainder of this paper. Descriptive tables for those participants who were and were not administered the modified MAQ are provided in the appendix (Appendix Tables A-1 and A-2) for demographics, psychiatric symptoms, function, and health status.

5.3.2 MAQ Cohort

5.3.2.1 Gender As summarized in Table 5-1, housework is the primary source of physical activity in overweight and obese adults with schizophrenia or schizoaffective disorders and accounted for 68% of the total mins/wk of physical activity. On average, the female participants reported significantly ($p \leq 0.01$) greater mins/wk of housework (474 min/week) than the male participants (284 min/week). Based on the medians, the women reported approximately twice the minutes of housework per week than the men (305 versus 150 mins/wk, respectively). The amount of time spent gardening/yardwork, caretaking, and transportation was not statistically different between men and women ($p \geq 0.10$). Although not statistically significant, male participants reported approximately 30 minutes less of leisure physical activity per week than the female participants.

On average, men reported approximately twice the number of minutes of occupational physical activity than women (75 versus 39 minutes, respectively) (Table 5-1). However, only 15% (39 out of 252) of the MAQ cohort reported being employed. Among those employed, occupational physical activity averaged 364 ± 555 mins/wk (n=35). Among employed participants, there was no statistically significant differences (p=0.36 based on Kruskal-Wallis test) between men (413 ± 525 mins/wk, n=16) and women (324 ± 589 mins/wk, n=19) in occupational physical activity.

Table 5-1 Subjective physical activity [modified MAQ (mins/wk)] for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) by gender (n=252)

modified MAQ (mins/wk)	MAQ Cohort (n=252)	Female (n=162)	Male (n=90)	p-value for Kruskal-Wallis Test
Occupational				0.09
Mean ± STD	52.0 ± 243.3	39.2 ± 226.5	75.0 ± 270.5	
Median	0	0	0	
Range	0, 1800	0, 1800.0	0, 1500.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	245 (13)	157 (5)	88 (2)	
Housework				0.0005
Mean + STD	406.1 ± 502.5	473.9 ± 552.5	284.1 ± 369.6	
Median	242.5	305.0	150.0	
Range	0, 2940	0, 2940.0	0, 2430.0	
25th, 75th percentile	105.5, 507.5	147.0, 585.0	80.0, 300.0	
N (missing)	252 (6)	162 (0)	90 (0)	
Gardening/Yardwork				0.10
Mean + STD	9.9 ± 59.3	8.9 ± 68.1	11.7 ± 39.3	
Median	0	0	0	
Range	0, 840	0, 840.0	0, 240.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	252 (6)	162 (0)	90 (0)	
Caretaking				0.30
Mean + STD	21.6 ± 124.8	22.9 ± 131.2	19.3 ± 113.0	
Median	0	0	0	
Range	0, 1260.0	0, 1260.0	0, 840.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	252 (6)	162 (0)	90 (0)	
Transportation				0.13
Mean + STD	43.2 ± 84.3	42.3 ± 90.7	45.0 ± 71.8	
Median	0	0	20.0	
Range	0, 840.0	0, 840.0	0, 360.0	
25th, 75th percentile	0, 60	0, 60.0	0, 60.0	
N (missing)	252 (6)	162 (0)	90 (0)	
Leisure				0.87
Mean + STD	81.5 ± 144.8	92.3 ± 163.0	62.2 ± 102.9	
Median	15.0	10.0	20.0	
Range	0, 875.0	0, 875.0	0, 540.0	
25th, 75th percentile	0, 100	0, 120.0	0, 90.0	
N (missing)	250 (8)	162 (0)	90 (0)	

Table 5-1 (continued) Subjective physical activity [modified MAQ (mins/wk)] for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) by gender (n=252)

modified MAQ (mins/wk)	MAQ Cohort (n=252)	Female (n=162)	Male (n=90)	p-value for Kruskal-Wallis Test
Total				0.15
Mean + STD	605.2 ± 679.0	669.2 ± 759.5	492.5 ± 491.1	
Median	375.0	440.0	295.0	
Range	0, 3900.0	0, 3900.0	0, 2535.0	
25th, 75th percentile	170.0, 830.0	170.0, 885.0	160.0, 800.0	
N (missing)	243 (15)	155 (7)	88 (2)	
Total w/o occupational activities				0.02
Mean + STD	558.6 ± 689.3	635.3 ± 703.6	422.3 ± 441.4	
Median	629.5	432.5	273.5	
Range	0, 3900.0	0, 3900.0	0, 2535.0	
25th, 75th percentile	160.0,750.0	170.0, 840.0	146.0, 565.0	
N (missing)	250 (8)	160 (2)	90 (0)	
Total w/o household activities				0.42
Mean + STD	174.6 ± 293.5	170.5 ± 295.3	181.7 ± 292.0	
Median	80.0	75.0	85.0	
Range	0, 2130.0	0, 2130.0	0, 1520.0	
25th, 75th percentile	10.0, 210.0	0, 210.0	25.0, 195.0	
N (missing)	243 (15)	155 (7)	88 (2)	

As described in section 4.2.1 of this report, estimated metabolic cost of the physical activities (METS/wk) were calculated by multiplying the mins/wk engaged in the specified physical activity by the estimated MET value of the activity published in the compendium of physical activities (68). Similar physical activity patterns (Appendix Table A-8) were observed for subjective physical activity measured in METS per week as minutes per week for the modified MAQ.

5.3.2.2 Race No statistically or clinically significant differences for the subjective physical activity measures (mins/wk or METS/wk) were observed between black and white participants as summarized in Table 5-2 and Appendix Table A-4. On average, white participants reported approximately twice the number of minutes of occupational activity than blacks (72 versus 35 minutes, respectively) (p=0.09) (Table 5-2). However, a greater percentage of the employed participants were white (59%) than black (26%) or other races (15%), and this may account for the observed average differences in occupational activity between blacks and whites in the MAQ cohort. When the MAQ cohort is restricted to employed participants only, there was no statistically significant differences in occupational physical activity between white (369$\pm$523 minutes, n=23) and black participants (426$\pm$678 minutes, n=10) (p=0.98 based on Kruskal-Wallis test).

Table 5-2 Subjective physical activity [modified MAQ (mins/wk)] for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) by race (n=246)[a].

Modified MAQ (mins/wk)	White (n=124)	Black (n=122)	p-value for Kruskal-Wallis Test
Occupational			0.09
Mean ± STD	71.9 ± 270.2	35.2 ± 219.9	
Median	0	0	
Range	0, 1800.0	0, 1800.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	118 (10)	121 (1)	
Housework			0.39
Mean ± STD	376.7 ± 485.5	436.4 ± 527.4	
Median	220.0	247.5	
Range	0, 2940.0	0, 2700.0	
25th, 75th percentile	105.5, 442.5	115.0, 580.0	
N (missing)	124 (4)	122 (0)	
Gardening/Yard work			0.52
Mean ± STD	14.6 ± 81.5	4.3 ± 18.1	
Median	0	0	
Range	0, 840.0	0, 120.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	124 (4)	122 (0)	
Caretaking			0.75
Mean ± STD	18.1 ± 104.8	26.3 ± 145.1	
Median	0	0	
Range	0, 840.0	0, 1260.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	124 (4)	122 (0)	
Transportation			0.94
Mean ± STD	49.3 ± 101.7	36.2 ± 56.8	
Median	0	5.0	
Range	0, 840.0	0, 360.0	
25th, 75th percentile	0, 60.0	0, 60.0	
N (missing)	124 (4)	122 (0)	
Leisure			0.95
Mean ± STD	74.3 ± 128.7	90.2 ± 162.3	
Median	17.5	5.0	
Range	0, 840.0	0, 875.0	
25th, 75th percentile	0, 90.0	0, 107.5	
N (missing)	124 (4)	120 (2)	

[a] n=1 for other race; size of other race category considered insufficient to include in analyses or summary tables .

Table 5-2 (continued) Subjective physical activity [modified MAQ (mins/wk)] for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) by race (n=246)[a].

Modified MAQ (mins/wk)	White (n=124)	Black (n=122)	p-value for Kruskal-Wallis Test
Total			0.98
Mean ± STD	588.7 ± 644.9	624.8 ± 723.1	
Median	382.5	360.0	
Range	0, 3900.0	0, 3635.0	
25th, 75th percentile	170.0, 790.0	170.0, 895.0	
N (missing)	118 (10)	119 (3)	
Total w/o occupational activities			0.85
Mean + STD	533.0 ± 598.6	586.1 ± 669.5	
Median	357.5	342.5	
Range	0, 3900.0	0, 3635.0	
25th, 75th percentile	165.0, 700.0	165.0, 857.5	
N (missing)	124 (4)	120 (2)	
Total w/o household activities			0.32
Mean + STD	188.4 ± 295.4	163.8 ± 298.2	
Median	87.5	60.0	
Range	0, 1800.0	0, 2130.0	
25th, 75th percentile	20.0, 225.0	0, 180.0	
N (missing)	118 (10)	119 (3)	

[a] n=1 for other race; size of other race category considered insufficient to include in analyses or summary tables .

5.3.2.3 Age groups Generally, self-reported physical activity reported on the modified MAQ (minutes or METS per week) did not significantly differ by age groups (Table 5-3 and Appendix Table A-5). The proportion employed in each age group averaged 12% to 18%. Among the employed, 40-49 years old reported approximately half the number of minutes of occupational physical activity than 18-39 or 50-65 years old (240 versus 462 and 382 mins/wk, respectively) (p=0.45 for Kruskal-Wallis test).

Table 5-3 Subjective physical activity [modified MAQ (mins/wk)] by age groups for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) (n=252)

Modified MAQ (mins/wk)	18-39 yrs (n=70)	40-49 yrs (n=85)	50-65 yrs (n=97)	p-value for Kruskal-Wallis Test
Occupational				0.29
Mean + STD	67.9 ± 277.6	28.9 ± 191.0	61.0 ± 258.6	
Median	0	0	0	
Range	0, 1800.0	0, 1500.0	0, 1800.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	68 (2)	83 (2)	94 (3)	
Housework				0.22
Mean + STD	343.0 ± 450.3	404.0 ± 494.5	453.6 ± 543.6	
Median	195.0	255.0	250.0	
Range	0, 2700.0	0, 2940.0	0, 2940.0	
25th, 75th percentile	75.0, 475.0	90.0, 580.0	130.0, 510.0	
N (missing)	70 (0)	85 (0)	97 (0)	
Gardening/Yard work				0.69
Mean + STD	6.9 ± 28.4	14.2 ± 92.6	8.2 ± 33.1	
Median	0	0	0	
Range	0, 210.0	0, 840.0	0, 240.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	70 (0)	85 (0)	97 (0)	
Caretaking				0.96
Mean + STD	34.0 ± 184.1	17.8 ± 98.7	16.1 ± 87.6	
Median	0	0	0	
Range	0, 1260.0	0, 840.0	0, 660.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	70 (0)	85 (0)	97 (0)	
Transportation				0.37
Mean + STD	43.0 ± 69.3	45.2 ± 111.9	41.7 ± 64.5	
Median	5.0	0	10.0	
Range	0, 360.0	0, 840.0	0, 300.0	
25th, 75th percentile	0, 60.0	0, 60.0	0, 60.0	
N (missing)	70 (0)	85 (0)	97 (0)	
Leisure				0.89
Mean + STD	82.2 ± 139.9	77.9 ± 138.5	84.0 ± 154.7	
Median	20.0	0	17.5	
Range	0, 780.0	0, 840.0	0, 875.0	
25th, 75th percentile	0, 110.0	0, 105.0	0, 90.0	
N (missing)	69 (1)	85 (0)	96 (1)	

Table 5-3 (continued) Subjective physical activity [modified MAQ (mins/wk)] by age groups for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) (n=252)

Modified MAQ (mins/wk)	18-39 yrs (n=70)	40-49 yrs (n=85)	50-65 yrs (n=97)	p-value for Kruskal-Wallis Test
Total				0.41
Mean + STD	568.4 ± 701.7	568.7 ± 630.0	664.2 ± 707.0	
Median	328.0	355.0	430.0	
Range	0, 3635.0	0, 3900.0	0, 3390.0	
25th, 75th percentile	140.0, 790.0	147.0, 815.0	210.0, 895.0	
N (missing)	67, (3)	83 (2)	93 (4)	
Total w/o occupational activities				0.33
Mean ± STD	501.3 ± 649.2	559.1 ± 626.4	599.4 ± 621.3	
Median	315.0	330.0	410.0	
Range	0, 3635.0	0, 3900.0	0, 3270	
25th, 75th percentile	140.0, 615.0	147.0, 815.0	187.5, 835.0	
N (missing)	69 (1)	85 (0)	96 (1)	
Total w/o household activities				0.23
Mean ± STD	198.5 ± 299.3	139.8 ± 231.2	188.3 ± 336.2	
Median	100.0	60.0	85.0	
Range	0, 1800.0	0, 1520.0	0, 2130.0	
25th, 75th percentile	20.0, 230.0	0, 180.0	20.0, 185.0	
N (missing)	67 (3)	83 (2)	93 (4)	

5.3.2.4 Description of physical activities As summarized in Table 5-4, housework was the primary activity for overweight and obese adults with schizophrenia and schizoaffective disorders. Walking for transportation or exercise was reported by 64% of the overweight and obese adults with schizophrenia and schizoaffective disorders. Other leisure physical activities were reported by less than 10% of the WAIST Study participants.

Table 5-4. Frequencies of subjective physical activities for overweight and obese adults with schizophrenia and schizoaffective disorders in the MAQ Cohort (n=252).

Physical Activity	**N (%)**	**Physical Activity**	**N (%)**
Shopping	177 (70.2)	Walking	161 (63.9)
Housework		Transportation only	69 (27.4)
Light	186 (73.8)	Exercise only	44 (17.5)
Heavy	128 (50.8)	Transportation and	48 (19.1)
Laundry	174 (69.1)	exercise	
Home repair		Bicycling	18 (7.1)
Light	16 (6.4)	Transportation only	4 (1.6)
Heavy	6 (2.4)	Leisure only	14 (5.6)
		Transportation and leisure	0 (0)
Food preparation	123 (48.8)	Jogging	5 (2.0)
Food Service	57 (22.6)	Swimming	3 (1.2)
Dish washing	171 (67.9)	Softball/Baseball	2 (0.8)
Gardening	16 (6.3)	Bowling	2 (0.8)
Lawn Mowing	6 (2.4)	Basketball	5 (2.0)
Cleaning Walks/	10 (4.0)	Calisthenics/Toning Exercises	26 (10.3)
Driveway		Wood Chopping	1 (0.4)
Caretaking		Aerobic Dance/Step Aerobics	17 (6.8)[a]
Older or disabled	8 (3.2)	Strength/Weight Training	17 (6.8)
Child	10 (4.0)	Jumping Rope	1 (0.4)[b]
		Yoga	11 (4.4)[b]
		Pilates	2 (0.8)

[a] n=250; [b] n=251

5.3.3 Summary

Assessment of subjective physical activity was feasible for the majority of adults with schizophrenia and schizoaffective disorder. Female participants reported significantly more time in household physical activities than the male participants. Otherwise, there was no difference between male and female participants in total physical activity per week or the various subcategories of physical activity. In addition, there were no clinical or statistically significant differences between race or age groups for any of the subjective measures of physical activity among adults with schizophrenia or schizoaffective disorders.

5.4 OBJECTIVE MEASURE OF PHYSICAL ACTIVITY (ACTIGRAPHY)

5.4.1 WAIST Study

5.4.1.1 Participation rates Initially, the WAIST Study planned to objectively monitor physical activity in all WAIST study participants. However, several problems were experienced in the field. One participant left the Actigraph in the bathroom of a retail store and another participant reported that the Actigraph clip broke and discarded the Actigraph in the garbage. Other participants either lost or misplaced the Actigraph or did not wear the device. Based on these experiences, confidence in the appropriate handling and return of an expensive activity monitor by adults with schizophrenia or schizoaffective disorders was low among the research team. Hence, the study protocol was modified. Study personnel only provided accelerometers to those study participants who were considered relatively stable and not experiencing severe symptoms or significant impairments due to their schizophrenia or schizoaffective disorders.

Fifty-five participants (21.3 %) were consented to wear accelerometers at baseline (Figure 5-2). One participant (id= 39) refused to wear the accelerometer, and one participant lost the Actigraph during the monitoring period (id=227). Three participants (id=2, 21, 437) did not provide any useable data for the monitoring period. Due to technical problems attributed to the battery, no data was retrieved from the accelerometer worn by two participants (id=25, 27).

5.4.1.2 Comparison of participants with valid (≥ 3 days) and non-valid (0-2 days) actigraphy data The majority of the participants (84%) provided at least 3 days of valid accelerometry data (Appendix Table A-6) (Figure 5-2). 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 and without 3 days of valid actigraphy monitoring. Participants who had at least 3 days of valid actigraphy data are referred to as the actigraphy cohort (n=46) for the remainder of this report.

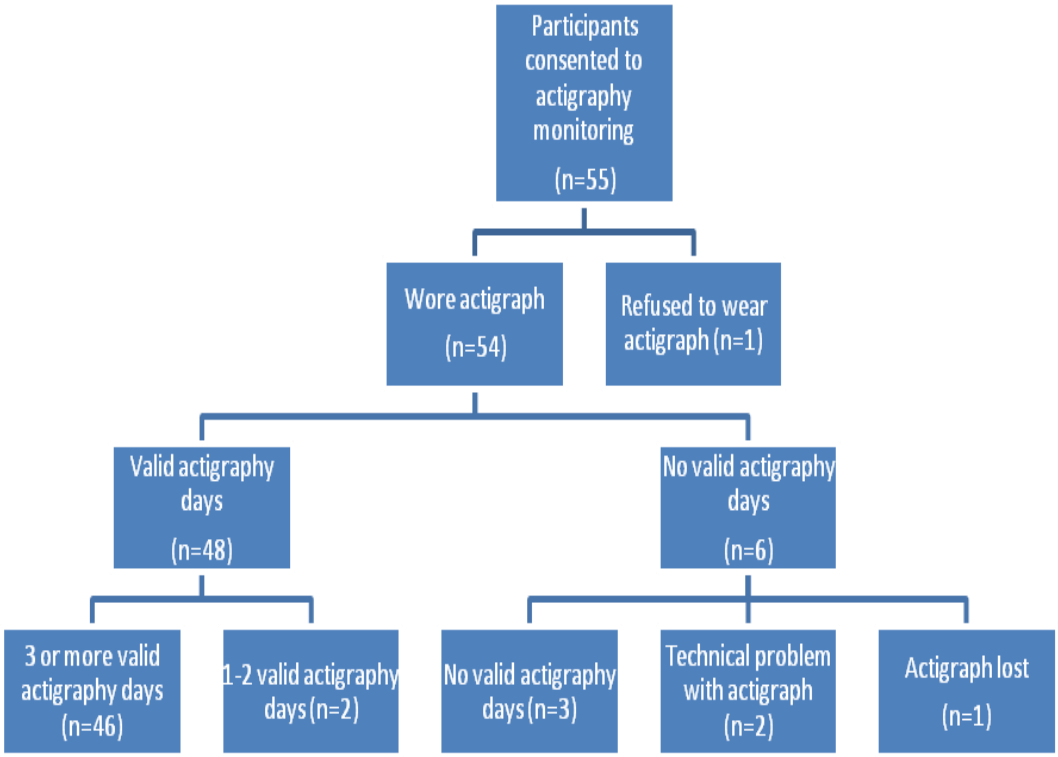


Figure 5-2 Final dispositions for participants consented to actigraphy monitoring in the WAIST Study (n=55).

5.4.1.3 Comparison between Actigraphy cohort and Actigraphy non-participants in the WAIST Study A comparison of demographic information and health scores for adults with schizophrenia or schizoaffective disorder with and without actigraphy monitoring is summarized in Table 5-5. Briefly, no statistically or clinically significant differences were noted between those who did and did not participate in actigraphy monitoring.

Table 5-5 Demographics and mental health scores for overweight and obese adults with schizophrenia or schizoaffective disorder by actigraphy monitoring (WAIST Study) (n=249[a]).

	Actigraphy cohort (n=46)	**Non-actigraphy cohort (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)	
Positive and Negative Syndrome Scale (PANSS)	58.8 (15.9)	54.9 (10.6)	0.26
Global Assessment of Functioning Scale (GAF) Scores	58.5 (8.2)[c]	59.7 (7.4)[d]	0.50
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.95 [b]
Normal, not mentally ill; very mild; or mild mental illness	20 (43.5)	79 (38.9)	
Moderate or severe mental illness	4 (52.2)	97 (47.8)	
Not assessed	2 (4.4)	27 (13.3)	
General Health Status [N (%)]			0.98 [b]
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)	

[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 (n=1) excluded from the Chi-square test due to insufficient sample size

In addition, subjective physical activity measures were not statistically different between those adults who did and did not participate in actigraphy monitoring ($p>0.05$) (Table 5-6). However, there were several interesting non-significant trends worth noting. On average, adults who participated in actigraphy monitoring tended to report more time engaged in leisure activities than those who did not participate in actigraphy monitoring (116 versus 76 minutes, respectively, $p=0.28$). Among those employed, occupational activity averaged 150 and 360 minutes per day ($p=0.62$) for those in the actigraphy cohort (n=3) versus the non-actigraphy cohort (n=30), respectively (data not shown).

Table 5-6 Subjective physical activity [modified MAQ (mins or METS/wk)] for overweight and obese adults with schizophrenia or schizoaffective disorder by actigraphy monitoring (WAIST Study) (n=249[a]).

Modified MAQ Categories	Actigraph (n=46)	No Actigraph (n=197)	p-value[b]
Minutes per/wk			
Occupational	10.0 ± 67.1	36.8 ± 214.0	0.27
Housework	408.7 ± 438.4	381.0 ± 417.5	0.97
Gardening/Yardwork	10.8 ± 37.0	10.3 ± 34.9	0.40
Caretaking	4.6 ± 31.0	3.9 ± 28.6	0.18
Transportation	29.9 ± 62.0	76.0 ± 140.1	0.06
Leisure	115.5 ± 171.9	76.0 ± 140.1	0.28
Total	576.4 ± 555.0	612.6 ± 709.9	0.83
Total w/o occupational activities	559.1 ± 528.3	564.8 ± 657.0	0.65
Total w/o household activities	159.6 ± 204.7	175.9 ± 300.6	0.97
METS per/wk			
Occupational	40.0 ± 268.3	233.7 ± 1024.9	0.27
Housework	1011.7 ± 1093.2	1014.2 ± 1325.7	0.90
Gardening/Yardwork	47.1 ± 168.2	37.2 ± 234.9	0.40
Caretaking	18.3 ± 123.9	89.3 ± 509.2	0.18
Transportation	106.4 ± 217.7	166.2 ± 314.7	0.07
Leisure	474.1 ± 704.1	317.5 ± 633.9	0.30
Total	1698.8 ± 1623.5	1822.5 ± 2192.7	0.71
Total w/o occupational activities	1633.4 ± 1528.1	1619.9 ± 1928.8	0.51
Total w/o household activities	637.0 ± 815.5	701.3 ± 1250.1	0.98

[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] Kruskal-Wallis Test

5.4.2 Actigraphy cohort in the WAIST Study

5.4.2.1 Objective physical activity On average, the actigraphy cohort wore the actigraphs over 15 hours per day, 7 days per week (Table 5-7). Actigraphy counts averaged 151,000 per day or 163/min. The majority of the monitoring time was spent in sedentary activities (approximately 13 hours per day or 81% of the monitoring time). On average, moderate/vigorous and light physical activity accounted only for 2% and 17% of the monitoring time per day, respectively. Adults with schizophrenia or schizoaffective disorder averaged 19 and 157 minutes per day of moderate/vigorous and light physical activity, respectively, as measured by accelerometry.

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Table 5-7 Objective physical activity assessment by actigraphy in overweight and obese adults with schizophrenia and schizoaffective disorders in the actigraphy cohort (n=46).

Actigraphy measurements	Actual actigraphy wear time[a]	Percentage of actigraphy wear time (%)[a]
Sedentary (mins/day)		
Mean ± STD	756 ± 140	81 ± 6
Median	709	82
Range	491, 1125	62, 91
25th and 75th percentile	658, 831	77, 85
Physical Activity (mins/day)		
Total		
Mean ± STD	176 ± 54	19 ± 6
Median	160	18
Range	89, 299	9, 38
25th and 75th percentile	134, 211	15, 23
Moderate/Vigorous		
Mean ± STD	19 ± 12	2 ± 1
Median	18	2
Range	2, 53	0.2, 6
25th and 75th percentile	10, 23	1, 3
Light		
Mean ± STD	157 ± 48	17 ± 5
Median	154	16
Range	78, 280	8, 35
25th and 75th percentile	120, 179	13, 20
Activity		
Counts/day		
Mean ± STD	151036 ± 60998	N/A
Median	138420	
Range	51852, 313684	
25th and 75th percentile	105533, 198801	
Counts/min		
Mean ± STD	163 ± 64	N/A
Median	157	
Range	62, 328	
25th and 75th percentile	113, 205	
Monitoring period		
Days		
Mean ± STD	7.4 ± 2.8	N/A
Median	7.0	
Range	3.0, 13.0	
25th and 75th percentile	5.0, 9.0	
Mins/day		
Mean ± STD	933 ± 149	N/A
Median	923	
Range	721, 1286	
25th and 75th percentile	817, 1011	

5.4.2.1.1 Gender Demographically, the racial composition was significantly different between men and women who participated in actigraphy monitoring (p=0.01) (Appendix Table A-7). The majority with valid actigraphy data were black (72%) among the female participants and white (65%) among the male participants (Appendix Table A-7). In addition, BMI tended to be greater (p=0.17) in women compared to men among those with valid accelerometry data (Appendix Table A-7). Otherwise, there were no statistically or clinically significant differences between males and females with valid actigraphy data for age, smoking status, psychiatric symptoms, functioning, and general health status ($p \geq 0.15$).

Overall, no statistically or clinically significant differences were noted between men and women with respect to activity counts, minutes per day or percentage of monitoring time for total physical activity or the various subcategories of physical activities ($p \geq 0.39$) (Appendix Table A-7).

5.4.2.1.2 Race Statistically significant demographic differences were noted for race; black actigraphy participants were younger, heavier, and a greater percentage female and smokers than the white actigraphy participants ($p \leq 0.05$) (Appendix Table A-8). Also, the majority of black actigraphy cohort (58%) tended to report fair or poor general health compared to the white actigraphy cohort (32%, p=0.08). There were no statistically or clinically significant differences between whites and blacks with valid actigraphy data for psychiatric symptoms or functioning ($p \geq 0.14$). As summarized in Appendix Table A-8, there were no statistically or clinically significant differences between black and white adults for the objective measures of physical activity ($p \geq 0.29$).

5.4.2.1.3 Age groups Statistically significant age differences were noted for BMI ($p<0.01$) with younger participants having greater BMIs than older actigraphy cohort participants (Appendix Table A-9). In addition, the older age group was comprised of fewer blacks (35%) than the younger age groups (73%) (p=0.05) (Appendix Table A-9). There were no statistically or clinically significant differences between age groups with respect to psychiatric symptoms, general health status, or functioning ($p \geq 0.48$). Finally, there were no statistically or clinically significant differences between age groups for the objective measures of physical activity (Appendix Table A-9).

5.4.2.2 Subjective physical activity Subjective assessment of physical activity (modified MAQ) indicated that household activities were the primary source of physical activity for those with valid accelerometry data (Table 5-8 and Appendix Table A-10). On average, adults with schizophrenia and schizoaffective disorder that provided valid accelerometry data self-reported 150 min/week of physical activity (Table 5-8). Among the actigraphy cohort, there were no statistically significant differences in modified MAQ scores (minutes or METS/day) for (Table 5-8 and Appendix Table A-10), race (Appendix Tables A-11 and A12), or age groups (Appendix Tables A-13 and A-14).

Table 5-8 Subjective physical activity [modified MAQ (mins/wk)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by gender (n=46).

Modified MAQ (mins/wk)	Actigraphy Cohort (n=46)	Female (n=29)	Male (n=17)	p-value for Kruskal-Wallis Test
Occupational				0.44
Mean ± STD	10.0 ± 67.1	16.1 ± 85.0	0 ± 0	
Median	0	0	0	
Range	0, 450.0	0, 450.0	0, 0	
25th, 75th per centile	0, 0	0, 0	0, 0	
N (missing)	45 (1)	28 (1)	17 (0)	
Housework				0.41
Mean ± STD	408.7 ± 438.4	456.7 ± 482.4	326.8 ± 349.4	
Median	213.0	245.0	180.0	
Range	0, 1725.0	0, 1725.0	0, 1100.0	
25th, 75th percentile	99.0, 580.0	130.0, 735.0	99.0, 420.0	
N (missing)	46 (0)	29 (0)	17 (0)	
Gardening/Yardwork				0.11
Mean ± STD	10.8 ± 37.0	5.2 ± 22.8	20.3 ± 52.8	
Median	0	0	0	
Range	0, 210.0	0, 120.0	0, 210.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	46 (0)	29 (0)	17 (0)	
Caretaking				0.44
Mean ± STD	4.6 ± 31.0	7.2 ± 39.0	0 ± 0	
Median	0	0	0	
Range	0, 210.0	0, 210.0	0, 0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	46 (0)	29 (0)	17 (0)	

Table 5-8 (continued) Subjective physical activity [modified MAQ (mins/wk)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by gender (n=46).

Modified MAQ (mins/wk)	Actigraphy Cohort (n=46)	Female (n=29)	Male (n=17)	p-value for Kruskal-Wallis Test
Transportation				0.41
Mean ± STD	29.9 ± 62.0	26.2 ± 64.3	36.2 ± 59.1	
Median	0	0	0	
Range	0, 300.0	0, 300.0	0, 200.0	
25th, 75th percentile	0, 30.0	0, 20.0	0, 60.0	
N (missing)	46 (0)	29 (0)	17 (0)	
Leisure				0.55
Mean + STD	115.5 ± 171.9	119.3 ± 188.5	109.2 ± 145.8	
Median	20.0	0	45.0	
Range	0, 840.0	0, 840.0	0, 450.0	
25th, 75th percentile	0, 180.0	0, 230.0	0, 135.0	
N (missing)	45 (1)	28 (1)	17 (0)	
Total				0.69
Mean + STD	576.4 ± 555.0	629.3 ± 632.8	492.5 ± 406.0	
Median	372.5	400.0	328.0	
Range	0, 2160.0	0, 2160.0	0, 1280.0	
25th, 75th percentile	239.0, 920.0	210.0, 1005.0	239.0, 920.0	
N (missing)	44 (2)	27 (2)	17 (0)	
Total w/o occupational activities				0.76
Mean + STD	559.1 ± 528.3	599.5 ± 593.9	492.5 ± 406.0	
Median	345.0	372.5	328.0	
Range	0, 2160.0	0, 2160.0	0, 1280.0	
25th, 75th percentile	90.0, 225.0	227.5, 890.0	239.0, 920.0	
N (missing)	45 (1)	28 (1)	17 (0)	
Total w/o household activities				0.66
Mean + STD	159.6 ± 204.7	168.5 ± 228.1	145.4 ± 166.5	
Median	90.0	60.0	90.0	
Range	0, 840.0	0, 840.0	0, 510.0	
25th, 75th percentile	0, 255.0	0, 270.0	20.0, 165.0	
N (missing)	44 (2)	27 (2)	17 (0)	

5.4.3 Actigraphy comparison between WAIST Study and NHANES 2003-2004

Users of mental health services in NHANES were less obese ($p<0.001$) than adults with schizophrenia or schizoaffective disorder with valid accelerometry data (Table 5-9) despite using the same BMI eligibility criteria as the WAIST Study (BMI $\geq$ 27 kg/m^2). In addition, users of mental health services in NHANES self-reported better general health status ($p<0.01$) than adults with schizophrenia or schizoaffective disorder with valid accelerometry data (Table 5-9). No statistically significant difference in age was observed among users of mental health services and the adults with schizophrenia or schizoaffective disorders.

Actigraphs were worn by the adults with schizophrenia or schizoaffective disorder approximately 1 day more than the users of mental health services. However, there was no statistical or clinical difference in the average number of monitoring minutes per day between the two groups. On average, the actigraphs were worn almost 16 hours per day.

Light physical activity (minutes/day or percentage of wear time), total physical activity (minutes/day or percentage of wear time), and total activity counts (per day or per minute) were statistically greater in users of mental health services than adults with schizophrenia or schizoaffective disorder ($p<0.001$). Light activity and total activity (minutes/day or percentage of wear time) of adults with schizophrenia or schizoaffective disorders was approximately one-half the monitoring time of the users of mental health services (approximately 2.5 versus 5 hours for light activity, and 3 versus 6 hours for total activity, respectively). However, there was no clinically or statistically significant difference in moderate/vigorous activity (minutes/day or percentage of wear time) between users of mental health services and adults with schizophrenia and schizoaffective disorders ($p\geq0.32$). Sedentary time (minutes/day or percentage of wear time) was significantly greater in adults with schizophrenia and schizoaffective disorders than the users of mental health services ($p<0.001$).

Table 5-9 Comparison of adults who used mental health services in NHANES 2003-2004 with overweight and obese adults with schizophrenia or schizoaffective disorder in WAIST study. Age restricted to 18-70 years and BMI>27 kg/m^2.

Variable	NHANES Users of mental health services (n=117)	WAIST Study Adults with schizophrenia or schizoaffective disorder (n=46)	p-value
Age (yrs) [Mean ± STD]	45.2 ± 0.8	45.6 ± 9.8	1.00
BMI (kg/m^2) [Mean ± STD]	34.6 ± 0.8	37.9 ± 8.1	0.001
Men [N (%)]	49 (44.8)	17 (37.0)	0.56
Current Smoker [N (%)]	35 (30.3)	16 (34.8)	0.67
Race [N (%)]			0.002
White	64 (74.7)	19 (41.3)	
Black	30 (13.5)	26 (56.5)	
Other	23 (11.8)	1 (2.2)	
General Health Status [N (%)]			0.12
Excellent, Very Good, or Good	73 (62.4)	23 (50.0)	
Fair or Poor	38 (32.5)	21 (45.7)	
Missing	6 (5.1)	2 (4.4)	
Monitoring [Mean ± STD]			
Days	6.2 ± 0.1	7.4 ± 2.8	0.02
Min/day	963 ± 10	933 ± 149	0.64
Sedentary [Mean ± STD]			
(min/day)	643 ± 18	756 ± 140	<0.0001
% of wear time	66 ± 0.01	81 + 6	<0.0001
Light Activity [Mean ± STD]			
(min/day)	300 ± 6	157 ± 48	<0.0001
% of wear time	32 ± 0.01	17 ± 5	<0.0001
Moderate/Vigorous Activity [Mean ± STD]			
(min/day)	20 ± 2	19 ± 12	0.49
% of wear time	2 ± 0.002	2 ± 1	0.32
Total Activity [Mean ± STD]			
(min/day)	320 ± 7	176 ± 54	<0.0001
% of wear time	34 ± 0.01	19 ± 6	<0.0001
Activity [Mean ± STD]			
counts/day	227116 ± 11105	151036 ± 60998	<0.0001
counts/min	239 ± 17	163 ± 64	<0.0001

5.4.4 Summary

In the WAIST Study, 55 participants were asked to participate in the actigraphy study, and 84% (46 of 55 participants) provided at least three days of valid actigraphy data. No clinical or statistically significant differences were noted between the actigraphy cohort (n=46) and non-participants in the actigraphy monitoring (n=203) with respect to demographics, health status, or subjective measures of physical activity.

The majority of the objective monitoring time was spent in sedentary activities (approximately 13 hours per day or 81% of the monitoring time). Adults with schizophrenia or schizoaffective disorder averaged 19 and 157 minutes per day of moderate/vigorous and light physical activity, respectively, as measured by accelerometry. On average, moderate/vigorous and light physical activity accounted for 2% and 17% of the monitoring period per day, respectively. No clinical or statistically significant differences were noted between males and females, whites and blacks, or the age groups for any of the objective measures of physical activity. Finally, light physical activity time (minutes/day or percentage of wear time), total physical activity time (minutes/day or percentage of wear time), and total activity counts (per day or per minute) were statistically greater in users of mental health services than adults diagnosed with schizophrenia or schizoaffective disorder.

5.5 PHYSICAL FITNESS ($V0_2$ MAX) IN THE WAIST STUDY

5.5.1 Comparison of GXT Cohort and non-participants for GXT Testing

5.5.1.1 Demographics and health status Overall, 45% (115 of 258) of WAIST Study participants volunteered and their primary care physician provided medical clearance for the graded exercise stress testing. The GXT participants were less likely to smoke than the non-GXT participants (37% versus 50%, respectively; p=0.05) (Table 5-10). Otherwise, no statistically or clinically significant differences were noted for age, gender, and severity of schizophrenic symptoms or function as measured by the PANSS, GAF, CGI-S, and SF-12 between those who did and did not participate in the GXT testing (Table 5-10) ($p \geq 0.12$)

Table 5-10 Demographics and mental health scores for overweight and obese adults with schizophrenia or schizoaffective disorder by GXT testing (WAIST Study) (n=252[a]).

Variable	GXT Cohort (n=109[a])	No GXT (n=143)	p-value for Kruskal-Wallis Test
Age (years) [Mean ± std]	45.8 ± 10.0	44.6 ± 10.7	0.59
BMI (kg/m^2) [Mean ± std]	37.0 ± 6.4	38.7 ± 9.0	0.27
Male [N (%)]	45 (41.3)	45 (31.5)	0.12[b]
Race [N (%)]			0.25 [bc]
White	50 (45.9)	74 (51.8)	0.32 [bd]
Black	58 (53.2)	64 (44.8)	
Other	1 (0.9)	5 (3.5)	
Current Smoker [N (%)]	43 (39.5)	71 (49.7)	0.05[b]
Positive and Negative Syndrome Scale (PANSS) [Mean ± std]	55.9 ± 12.1	55.3 ± 11.5	0.59
Global Assessment of Functioning Scale (GAF) Scores [Mean ± std]	59.4 ± 12.1	59.5 ± 7.7	0.99
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.43[e]
Normal, not mentally ill	1 (0.9)	5 (3.5)	
Very mild mental illness	8 (7.3)	5 (3.5)	
Mild mental illness	36 (33.1)	44 (30.8)	
Moderate mental illness	53 (48.6)	67 (46.9)	
Severe mental illness	1 (0.9)	3 (2.1)	
Extremely severe mental illness	0 (0)	0 (0)	
Not assessed	10 (9.2)	19 (13.3)	
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.74 [b]
Normal, not mentally ill; very mild; or mild mental illness	45 (41.3)	54 (37.8)	
Moderate or severe mental illness	54 (49.5)	70 (49.0)	
Not assessed	10 (9.2)	19 (13.3)	
General Health Status [N (%)]			0.60[b]
Excellent	6 (5.5)	6 (4.2)	
Very good	15 (13.8)	17 (11.9)	
Good	41 (37.6)	42 (29.4)	
Fair	31 (28.4)	49 (34.3)	
Poor	12 (11.0)	22 (15.4)	
Missing	4 (3.7)	7 (4.9)	
General Health Status [N (%)]			0.12
Excellent, Very Good, or Good	62 (56.9)	65 (45.5)	
Fair or Poor	43 (39.4)	71 (49.7)	
Missing	4 (3.7)	7 (4.9)	

[a] volunteers for GXT Study with incomplete GXT data (n=6); numbers are insufficient to include in summary table.
[b] Chi-square test; [c] Including Other category; [d] Excluding Other category ; [e] Fischer's Exact test

5.5.1.2 Subjective physical activity (MAQ) Appendix Table A-15 provides a summary of the subjective measures of physical activity (modified MAQ scores for mins/wk or METS per week) for GXT cohort and non-participants for GXT testing. Briefly, none of the subjective measures of physical activity (modified MAQ scores for mins/wk or METS per week) differed

significantly between those who did and did not participate for the GXT testing ($p \geq 0.14$) (Appendix Table A-15).

5.5.1.3 Objective physical activity (Actigraphy) Objective physical activity patterns for the GXT cohort compared to the non-participants for GXT testing are summarized in Appendix Table A-16. Moderate/vigorous physical activity averaged approximately 19 minutes per day or 2.0% of monitoring time in both groups and was not clinically or statistically different between those who did and did not participate in the GXT testing (Appendix Table A-16) ($p \geq 0.58$). In addition, the percentage of monitoring time for sedentary (~80%), light activities (~17%), and total activities (~19%) and activity counts per minute (~160) were not statistically or clinically significant different between the GXT cohort and those who did not participate in GXT testing (Appendix Table A-16) ($p \geq 0.41$). However, the GXT cohort wore the actigraphs approximately 2 hours less per day than those who did not participate in GXT testing ($p=0.01$) (Appendix Table A-16). Hence, the GXT cohort engaged in less cumulative time per day in sedentary (approximately 80 minutes), light (approximately 40 minutes), and total (approximately 40 minutes) physical activities and activity counts per day (~30,000) than participants who did not participate in the GXT testing (Appendix Table A-16) ($p \leq 0.06$). However, the percentage of wear time for sedentary, light and total physical activities, and activity counts per day was not clinically or statistically different between the GXT cohort and non-participants for GXT testing ($p \geq 0.41$).

5.5.2 GXT Cohort in the WAIST Study

5.5.2.1 Fitness testing results

5.5.2.1.1 Gender Less than 2% (2 of 109) of the participants in the GXT cohort were classified as fit based on their maximal oxygen fitness (Table 5-11). Male compared to female participants had significantly greater VO_2Max levels (18 versus 13 mL/kg/min, respectively) as well as minutes on the treadmill (8.9 versus 6.6 minutes, respectively) for the graded exercise testing ($p<0.001$). No clinically or statistically difference was noted for resting or peak GXT Heart Rate or RPE between males and females ($p \geq 0.20$). Due to the observed fitness differences in male and female participants, separate analyses and summary tables by gender were created to examine racial and age group differences in the fitness measures for the GXT cohort.

Table 5-11 Summary of graded exercise test results for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by gender (n=109[a]).

Variable	Graded Exercise Test (n=109)	Female (n=64)	Male (n=45)	p-value for Kruskal-Wallis Test
VO_2 Max (mL/kg/min)				<0.001
Mean ± STD	15.2 ± 6.0	12.8 ± 4.1	18.4 ± 6.6	
Median	14.1	12.2	17.5	
Range	4.5, 38.4	4.5, 21.2	4.5, 38.4	
25th, 75th percentile	11.3, 18.1	10.3, 14.8	14.3, 20.5	
Minutes on Treadmill				0.003
Mean ± STD	7.6 ± 3.4	6.6 ± 2.4	8.9 ± 4.2	
Median	8.0	6.0	8.0	
Range	2.0, 19.0	2.0, 12.0	2.0, 19.0	
25th, 75th percentile	6.0, 8.0	5.0, 8.0	6.0, 10.0	
Resting GXT Heart Rate (bpm)				0.79
Mean ± STD	88.3 ± 13.8	87.8 ± 13.7	89.0 ± 13.9	
Median	88.0	87.5	88.0	
Range	60.0, 126.0	61.0, 126.0	60.0, 120.0	
25th, 75th percentile	78.0, 97.0	77.0, 98.0	79.0, 97.0	
Peak GXT Heart Rate (bpm)				0.51
Mean ± STD	142.1 ± 21.0	139.2 ± 21.2	144.7 ± 20.4	
Median	142.0	142.0	144.0	
Range	72.0, 192.0	72.0, 187.0	112.0, 192.0	
25th, 75th percentile	128.0, 155.0	122.5, 152.0	131.0, 159.0	
Ratings of Perceived Exertion (RPE) N (%)				0.20
9	2 (1.9)	1 (1.7)	1 (2.2)	
10	0 (0)	0 (0)	0 (0)	
11	3 (2.9)	3 (5.0)	0 (0)	
12	1 (1.0)	1 (1.7)	0 (0)	
13	28 (26.7)	18 (30.0)	10 (22.2)	
14	7 (6.7)	6 (10.0)	1 (2.2)	
15	30 (28.6)	17 (28.3)	13 (28.9)	
16	9 (8.6)	3 (5.0)	6 (13.3)	
17	19 (18.1)	9 (15.0)	10 (22.2)	
18	3 (2.9)	1 (1.7)	2 (4.4)	
19	2 (1.9)	0 (0)	2 (4.4)	
20	1 (1.0)	1 (1.7)	0 (0)	
Ratings of Perceived Exertion (RPE) Categories N (%)				0.39[b]
6-12	5 (4.8)	4 (6.7)	1 (2.2)	
13-20	100 (95.2)	60 (93.3)	44 (97.8)	
GXT Categories N (%)				0.17[b]
Unfit	107 (98.2)	64 (100.8)	43 (95.6)	
Fit	2 (1.8)	0 (0)	2 (4.4)	

[a] participants in WAIST Study with incomplete GXT data (n=6); numbers are insufficient to include in summary table.
[b]Fischer's Exact Test

5.5.2.1.2 GXT results by race for male participants Only 2 white males and no black males were classified as fit. Otherwise, no clinically or statistically significant differences were noted for fitness levels, time on the treadmill, resting or peak GXT heart rate or RPE between white and black male participants ($p \geq 0.18$) (Appendix Table A-17).

5.5.2.1.3 GXT results by race for female participants None of the females were classified as fit. On average, fitness levels tended to be higher in white (14.4 mL/kg/min) compared to black (12.2 mL/kg/min) female participants ($p=0.11$). Otherwise, no clinically or statistically significant differences were noted for time on the treadmill, resting or peak GXT heart rate or RPE between white and black female participants ($p \geq 0.45$) (Appendix Table A-18).

5.5.2.1.4 GXT results by age groups for male participants Age trends for male fitness levels are summarized in Appendix Table A-19. One male in the 40-49 age group and one male in the 50-65 age group were classified as fit based on their maximal oxygen fitness. Although not statistically significant, fitness level ($p=0.60$) and time on the treadmill (0.17) tended to be less for males in the 50-65 age group compared to the younger age groups (18-39 and 40-49 years). In contrast, peak GXT heart rate tended to be greater in the 18-39 age group compared to the older age groups (40-49 and 50-65 years)($p=0.11$).

5.5.2.1.5 GXT results by age groups for female participants Age trends for female fitness levels are summarized in Appendix Table A-20. No females were classified as fit based on their maximal oxygen fitness. Statistically significant age declines were observed for time on the treadmill ($p \leq 0.01$) and peak GXT heart rate ($p=0.06$. In addition, fitness levels of the females tended to decline with age, although not statistically significantly ($p=0.11$).

5.5.2.2 Subjective physical activity (modified MAQ) for GXT cohort

5.5.2.2.1 Gender Subjective physical activity patterns for the GXT cohort are summarized in Table 5-12 and Appendix Table A-21. Briefly, female participants reported significantly ($p \leq 0.01$) greater mins/wk of housework (488 min/week) than the male participants (273 min/week). The amount of time spent on occupational, gardening/yard work, caretaking, leisure activities, and transportation was not statistically different between men and women ($p \geq 0.10$).

Differences in total physical activity between male and female participants (500 versus 770 mins/wk, respectively) approached statistically significance (p=0.07) primarily due to the statistically significant gender differences in housework activities.

Table 5-12 Subjective physical activity [modified MAQ (mins/wk)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by gender (n=109).

Variable	GXT Cohort (n=109)	Male (n=45)	Female (n=64)	p-value for Kruskal-Wallis Test
Occupational				0.77
Mean ± STD	82.0 ± 300.4	99.1 ± 333.3	70.2 ± 277.5	
Median	0	0	0	
Range	0, 1800.0	0, 1500.0	0, 1800.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	105 (4)	43 (2)	62 (2)	
Housework				0.005
Mean ± STD	399.3 ± 425.4	272.5 ± 291.6	487.9 ± 480.6	
Median	250.0	160.0	340.0	
Range	0, 2490.0	0, 1320.0	0, 2490.0	
25th, 75th percentile	127.0, 570.0	105.5, 307.5	150.0, 735.0	
N (missing)	107 (2)	44 (1)	63 (1)	
Gardening/Yard work				0.29
Mean ± STD	5.6 ± 27.2	9.5 ± 38.1	2.9 ± 15.6	
Median	0	0	0	
Range	0, 240.0	0, 240.0	0, 120.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	107 (2)	44 (1)	63 (1)	
Caretaking				0.10
Mean + STD	28.6 ± 132.9	19.1 ± 126.6	35.2 ± 137.7	
Median	0	0	0	
Range	0, 900.0	0, 840.0	0, 900.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	107 (2)	44 (1)	63 (1)	
Transportation				0.68
Mean + STD	41.6 ± 68.2	41.6 ± 76.0	41.6 ± 62.7	
Median	0	0	0	
Range	0, 350.0	0, 350.0	0, 300.0	
25th, 75th percentile	0, 60.0	0, 45.0	0, 60.0	
N (missing)	107 (2)	44 (1)	63 (1)	

Table 5-12 (continued) Subjective physical activity [modified MAQ (mins/wk)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by gender (n=109)

Variable	GXT Cohort (n=109)	Male (n=45)	Female (n=64)	p-value for Kruskal-Wallis Test
Leisure				0.26
Mean + STD	97.4 ± 185.6	50.3 ± 101.0	131.3 ± 222.7	
Median	0	5.0	0	
Range	0, 875.0	0, 540.0	0, 875.0	
25th, 75th percentile	0, 90.0	0, 60.0	0, 210.0	
N (missing)	105 (4)	44 (1)	61 (4)	
Total				0.07
Mean + STD	654.4 ± 647.9	497.6 ± 473.4	766.7 ± 731.7	
Median	400.0	285.0	585.0	
Range	0, 3390.0	0, 1580.0	0, 3390.0	
25th, 75th percentile	180.0, 975.0	170.0, 690.0	230.0, 1047.5	
N (missing)	103 (6)	43 (2)	60 (5)	
Total w/o occupational activities				0.02
Mean + STD	563.6 ± 554.0	393.1 ± 380.2	686.6 ± 625.8	
Median	340.0	260.0	520.0	
Range	0, 2630.0	0, 1580.0	0, 2630.0	
25th, 75th percentile	170.0, 815.0	165.0, 556.5	230.0, 998.0	
N (missing)	105 (4)	44 (1)	61 (4)	
Total w/o household activities				0.11
Mean + STD	225.0 ± 370.3	192.4 ± 353.9	248.4 ± 382.8	
Median	90.0	60.0	112.5	
Range	0, 2130.0	0, 1520.0	0, 2130.0	
25th, 75th percentile	0, 270.0	0, 150.0	0, 330.0	
N (missing)	103 (6)	43 (2)	60 (5)	

5.5.2.2.2 Race No statistically significant differences ($p>0.05$) for minutes or METS per week of total physical activity or sub-categories of physical activity were observed between black and white participants in the GXT cohort as summarized in Appendix Tables A-22 and A-23. However, gardening ($p=0.07$ for mins/wk and $p=0.06$ for METS per week), leisure ($p=0.07$ for mins/wk and METS per week) and housework ($p=0.13$ for mins/wk and $p=0.15$ for METS per week) physical activities approached statistical significance and may be clinically relevant. On average, white participants engaged more time in gardening (11 versus 1 minutes) and less time in leisure activities (61 versus 132 minutes) and housework (320 versus 467 minutes) than black participants.

5.5.2.2.3 Age groups Subjective physical activity measures for the GXT cohort by age groups are summarized in Appendix Table A-24 for mins/wk and Appendix Table A-25 for METS per week. No statistically significant differences ($p>0.15$) for minutes or METS of total physical activity or sub-categories of physical activity were observed between age groups in the GXT cohort as summarized in Appendix Tables A-24 and A-25.

Due to the small number of employed participants, occupational mins/wk and METS per week by age group were examined among employed participants of the GXT cohort only. A different pattern of occupational physical activity by age was observed among employed participants of the GXT cohort versus the entire GXT cohort. Among the employed participants, occupational minutes of physical activity averaged 720 min/week (n=1), 343 min/week (n=7), and 686 min/week (n=8) for age groups 18-39, 40-49, and 50-65, respectively, ($p=0.37$). Among the employed participants, occupational METS of physical activity averaged 2880 METS/week (n=1), 1371 METS/week (n=7), and 2925 METS/week (n=8) for age groups 18-39, 40-49, and 50-65, respectively, ($p=0.39$). Overall, the 40-49 age group (5 out of 7 participants or 71%) reported more sedentary jobs than the younger (0 out of 1 participants or 0%) or older age groups (2 out of 8 or 25%) thus accounting for lower mins/wk and METS/week of occupational physical activity in the 40-49 age group.

5.5.2.3 Objective physical activity (Actigraphy) for GXT cohort

5.5.2.3.1 Demographics and health status by gender A total of 27 participants in the GXT cohort had valid actigraphy data. Table 5-13 summarizes the demographics and health status of these 27 male and female participants. Similar to the Actigraph cohort, a greater percentage of the female participants were black (73%) compared to the male participants (31%) ($p=0.06$), and BMI tended to be greater for female compared to male participants ($p=0.08$). In contrast to the Actigraph cohort, self-reported health status was significantly different between male and female participants ($p=0.01$). Female participants tended to report slightly better health status than the male participants. No statistically or clinically significant differences between males and females were noted for age, smoking status, psychiatric symptoms or function ($p\geq0.16$)

Table 5-13 Mean (standard deviation) for demographics and health status at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the GXT cohort with valid actigraphy monitoring by gender (n=27).

Variable	Men (n=12)	Women (n=15)	p-value for Kruskal-Wallis Test
Age (yrs)	48.2 (11.1)	44.9 (9.2)	0.28
BMI (kg/m^2)	35.1 (5.6)	38.8 (6.6)	0.08
Current Smoker [N (%)]	4 (30.8)	5 (33.3)	1.00[a]
Race [N (%)]			0.06[a]
White	8 (61.5)	4 (26.7)	
Black	4 (30.8)	11 (73.3)	
Other	1 (7.7)	0 (0)	
Positive and Negative Syndrome Scale (PANSS)	58.1 (15.9)	61.3 (16.6)	0.53
Global Assessment of Functioning Scale (GAF) Scores	60.9 (9.4)	57.6 (7.4)	0.30
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.16 [a]
Normal, not mentally ill	0 (0)	0 (0)	
Very mild mental illness	1 (7.7)	3 (20.0)	
Mild mental illness	5 (38.5)	3 (20.0)	
Moderate mental illness	5 (38.5)	9 (60.0)	
Severe mental illness	1 (7.7)	0 (0)	
Not assessed	1 (7.7)	0 (0)	
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.83[a]
Normal, not mentally ill; very mild; or mild mental illness	5 (41.7)	6 (40.0)	
Moderate or severe mental illness	6 (50.0)	9 (60.0)	
Not assessed	1 (8.3)	0 (0)	
General Health Status [N (%)]			0.01 [a]
Excellent	0 (0)	0 (0)	
Very good	0 (0)	5 (33.3)	
Good	7 (53.9)	2 (13.3)	
Fair	4 (30.8)	6 (40.0)	
Poor	2 (15.4)	0 (0)	
Missing	0 (0)	2(13.3)	
General Health Status [N (%)]			0.61[a]
Excellent, Very Good, or Good	6 (50.0)	7 (46.7)	
Fair or Poor	6 (50.0)	6 (40.8)	
Missing	0 (0)	2 (13.3)	

[a] Fisher's Exact Test

5.5.2.3.2 Gender Objective physical activity measures for the GXT cohort by gender are summarized in Table 5-14. Although there was no statistical difference in the number of days the male and female participants wore the actigraphs (~7 days for each group), the men wore the actigraphs more minutes per day than the women (~90 minutes per day, p=0.05). This 90 minute difference in monitoring time between the female and male participants accounts for the greater sedentary time observed in the males compared to the females (780 versus 690 mins/wk, respectively). Minutes in light, moderate/vigorous, and total physical activity as well as activity

counts/day were not statistically or clinically different between the males and female participants. Similar to the results in the actigraph cohort, the differences between females and male participants in the percentage of time engaged in sedentary and physical activities were not statistically or clinically significant ($p>0.17$).

Table 5-14 Mean (standard deviation) for valid actigraphy monitoring at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the GXT cohort by gender (n=27).

Variable	Men (n=12)	Women (n=15)	p-value for Kruskal-Wallis Test
Monitoring			
Days	7.7 (2.9)	6.8 (2.6)	0.48
Mins/day	938 (159)	851 (101)	0.05
Sedentary			
Mins/day	780 (148)	690 (72)	0.14
% of wear time	83.1 (5.6)	81.3 (4.0)	0.24
Light Activity			
Mins/day	139 (46)	143 (39)	0.73
% of wear time	14.9 (4.6)	16.6 (3.3)	0.17
Moderate/Vigorous Activity			
Mins/day	19 (14)	18 (10)	0.98
% of wear time	2.0 (1.2)	2.1 (0)	0.63
Total Activity			
Mins/day	158 (57)	161 (48)	0.85
% of wear time	16.9 (5.6)	18.7 (4.0)	0.24
Activity			
Counts/day	145474 (72938)	135988 (568407)	0.85
Counts/min	154.9 (70.9)	157 (54)	0.05

5.5.2.3.3 Demographics and health status by race Demographics and health status for the GXT cohort with objective measures of physical activity by race are summarized in Table 5-15. The differences in black and white participants observed in Table 5-15 are similar to the findings reported for the actigraph cohort. The GXT cohort with objective measures of physical activity is a subset of the actigraph cohort. Briefly, black actigraphy participants were younger and a greater percentage female than the white actigraphy participants ($p\leq0.05$) (Table 5-15). In addition, the clinicians rated the severity of psychiatric symptoms as greater among the black (57%) compared to the white (17%) participants ($p=0.03$). Although not statistically significant, the majority of black actigraphy cohort (57%) tended to report fair or poor general health compared to the white actigraphy cohort (33%, $p=0.61$). There were no statistically or clinically

significant differences between whites and blacks with valid actigraphy data for BMI, smoking status, psychiatric symptoms or functioning ($p \geq 0.19$).

Table 5-15 Mean (standard deviation) for demographics and health status at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the GXT cohort with valid actigraphy by race (n=26)[a].

Variable	White (n=12)	Black (n=14)	p-value for Kruskal-Wallis Test
Age (yrs)	50.8 (8.8)	43.0 (9.0)	0.005
BMI (kg/m^2)	35.8 (5.3)	40.1 (9.4)	0.19
Male [N (%)]	8 (66.7)	4 (26.7)	0.04 [a]
Current Smoker [N (%)]	3 (25.0)	6 (40.0)	0.68 [b]
Positive and Negative Syndrome Scale (PANSS)	60.9 (16.7)	56.2 (16.3)	0.59
Global Assessment of Functioning Scale (GAF) Scores	56.4 (8.9)	59.9 (8.1)	0.24
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.09 [b]
Normal, not mentally ill	0 (0)	0 (0)	
Very mild mental illness	0 (0)	3 (21.4)	
Mild mental illness	2 (16.7)	5 (35.7)	
Moderate mental illness	9 (75.0)	5 (35.7)	
Severe mental illness	1 (8.3)	0 (0)	
Not assessed	0 (0)	1 (7.1)	
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.03
Normal, not mentally ill; very mild; or mild mental illness	2 (16.7)	8 (57.1)	
Moderate or severe mental illness	10 (83.3)	5 (35.7)	
Not assessed	0 (0)	1 (7.1)	
General Health Status [N (%)]			0.63 [b]
Excellent	0 (0)	0 (0)	
Very good	2 (16.7)	3 (21.4)	
Good	5 (41.7)	2 (14.3)	
Fair	3 (25.0)	7 (50.0)	
Poor	1 (8.3)	1 (7.1)	
Missing	1 (8.3)	1 (7.1)	
General Health Status [N (%)]			0.61 [b]
Excellent, Very Good, or Good	7 (58.3)	5 (35.7)	
Fair or Poor	4 (33.3)	8 (57.1)	
Missing	1 (8.3)	1 (7.1)	

[a] Excluding other race (n=1) due to insufficient sample size for analyses or summary table.
[b] Fisher's Exact Test

5.5.2.3.4 Race Objective measures of physical activity by race are summarized in Table 5-16. Although there was no statistical difference in the number of days the black and white participants wore the actigraphs (~7 days for each group), the white participants wore the actigraphs more minutes per day than the black participants (~150 minutes per day, p=0.005). This 150 minute difference in monitoring time can be attributed to more time in sedentary (970

versus 825 mins/wk, respectively) and light activity (155 versus 132 mins/wk, respectively) in the white compared to the black participants. Minutes in moderate/vigorous physical activity were not statistically or clinically different between the black and white participants. The differences between black and white participants in the percentage of time engaged in sedentary and physical activities were not statistically or clinically significant ($p \geq 0.47$). Activity counts/day or activity counts/minute were not statistically different between the black and white participants ($p \geq 0.18$).

Table 5-16 Mean (standard deviation) for valid actigraphy monitoring at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the GXT cohort by race (n=26)[a].

Variable	White (n=12)	Black (n=14)	p-value for Kruskal-Wallis Test
Monitoring days	7.5 (2.8)	7.1 (2.7)	0.88
Mins/day	970 (150)	825 (82)	0.005
Sedentary			
Mins/day	793 (147)	676 (55)	0.06
% of wear time	81.6 (5.6)	82.2 (4.1)	0.88
Light Activity			
Mins/day	154.7 (43.3)	131.9 (38.3)	0.08
% of wear time	16.2 (4.8)	15.8 (3.3)	0.84
Moderate/Vigorous Activity			
Mins/day	22.0 (13.4)	17.2 (9.4)	0.47
% of wear time	2.2 (1.2)	2.0 (1.0)	0.76
Total Activity			
Mins/day	176.6 (54.3)	14.9 (46.3)	0.09
% of wear time	18.4 (5.6)	17.8 (4.1)	0.88
Activity			
Counts/day	160393 (66274)	129210 (56608)	0.18
Counts/min	166.8 (64.6)	154.1 (56.0)	0.47

[a] Excluding other race (n=1) due to insufficient sample size for analyses or summary table.

5.5.2.3.5 Demographics and health status by age groups Demographics and health status for the GXT cohort with objective measures of physical activity by age groups are summarized in Table 5-17. Statistically significant age differences were noted for BMI (p=0.02) with younger participants having greater BMIs than older actigraphy cohort participants (Table 5-17). In addition, the older age group was comprised of fewer smokers (17%) than the younger age

groups (~45%) ($p=0.04$) (Table 5-17). There were no statistically or clinically significant differences between age groups with respect to psychiatric symptoms, general health status, or functioning ($p \geq 0.48$).

Table 5-17 Mean (standard deviation) for demographics and health status at baseline in overweight and obese adults with schizophrenia or schizoaffective disorder by age groups in the GXT cohort with valid actigraphy monitoring (n=27).

Variable	18-39 yrs (n=5)	40-49 yrs (n=10)	50-65 yrs (n=12)	p-value for Kruskal-Wallis Test
Age (yrs)	29.4 (2.6)	44.6 (3.0)	55.3 (4.1)	<0.0001
BMI (kg/m^2)	42.6 (8.9)	38.1 (5.7)	33.8 (3.6)	0.02
Male [N (%)]	2 (40.0)	3 (27.3)	8 (66.7)	0.02 [a]
Current Smoker [N (%)]	2 (40.0)	5 (45.5)	2 (16.7)	0.04 [a]
Race [N (%)]				0.04 [a]
White	1 (20.0)	2 (18.2)	1 (8.3)	
Black	4 (80.0)	9 (81.8)	9 (75.0)	
Other	0 (0)	0 (0)	1 (8.3)	
Positive and Negative Syndrome Scale (PANSS)	50.2 (9.1)	61.3 (16.8)	62.5 (17.1)	0.39
Global Assessment of Functioning Scale (GAF) Scores	61.5 (6.2)	59.9 (9.4)	57.5 (8.3)	0.72
Clinical Global Impression of Severity (CGI-S) [N (%)]				0.08 [a]
Normal, not mentally ill	0 (0)	0 (0)	0 (0)	
Very mild mental illness	0 (0)	3 (30.0)	0 (0)	
Mild mental illness	3 (60.0)	2 (18.2)	3 (25.0)	
Moderate mental illness	1 (20.0)	5 (45.5)	8 (66.7)	
Severe mental illness	0 (0)	0 (0)	1 (8.3)	
Not assessed	1 (20.0)	0 (0)	0 (0)	
Clinical Global Impression of Severity (CGI-S)[N (%)]				0.10[a]
Normal, not mentally ill; very mild; or mild mental illness	3 (60.0)	5 (50.0)	3 (25.0)	
Moderate or severe mental illness	1 (20.0)	5 (50.0)	9 (75.0)	
Not assessed	1 (20.0)	0 (0)	0 (0)	
General Health Status [N (%)]				0.53 [a]
Excellent	0 (0)	0 (0)	0 (0)	
Very good	1 (20.0)	3 (30.0)	1(8.3)	
Good	1 (20.0)	2 (20.0)	5 (41.7)	
Fair	1 (20.0)	5 (50.0)	4 (33.3)	
Poor	1 (20.0)	0 (0)	1 (8.3)	
Missing	1 (20.0)	0 (0)	1 (8.3)	
General Health Status [N (%)]				0.83[a]
Excellent, Very Good, or Good	2 (40.0)	5 (50.0)	6 (50.0)	
Fair or Poor	2 (40.0)	5 (50.0)	5 (41.7)	
Missing	1 (20.0)	0 (0)	1 (8.3)	

[a] Fisher's Exact Test

5.5.2.3.6 Age groups Objective measures of physical activity by age groups for the GXT cohort are summarized in Appendix Table A-26. No statistically or clinically significant differences were observed between the age groups for activity counts or any of the physical activity or sedentary measures ($p \geq 0.19$).

5.5.3 Summary

Fitness testing was conducted in 45% (115 of 254) of the WAIST Study participants. Only 2 participants were classified as fit among the GXT cohort, both were male. Male compared to female participants had significantly greater fitness levels. Subjective and objective measures of physical activity did not clinically or statistically differ between the GXT cohort and non-participants for GXT testing. Within the GXT cohort, female participants reported more household physical activities than the male participants. Objective measures of physical activity (minutes/day or percentage of wear time) were not statistically or clinically different between males and females, whites and blacks, or age groups in the GXT cohort.

5.6 CORRELATIONS IN THE WAIST STUDY

5.6.1 Physical activity and fitness measures

No significant associations ($p \geq 0.27$) were observed between subjective measures of physical activity (MAQ scores), objective measures of physical activity (actigraphy), and physical fitness (VO_2max) (Table 5-18).

Table 5-18 Spearman correlations between subjective and objective physical activity measures

Variable	VO_2max (mL/kg/min)	Modified MAQ Total Activity (mins/wk)	Modified MAQ Total Activity (METS/wk)
Physical Fitness			
VO_2max (mL/kg/min)			
Spearman correlation	-----	0.004	0.03
p-value	-----	0.97	0.73
n	-----	103	103
Objective Physical Activity			
Sedentary (mins/day)			
Spearman correlation	0.19	0.17	0.18
p-value	0.35	0.27	0.25
n	27	44	44
Sedentary (% of wear time)			
Spearman correlation	0.09	0.16	0.10
p-value	0.64	0.31	0.51
n	27	44	44
Light Activity (mins/day)			
Spearman correlation	-0.04	-0.12	-0.06
p-value	0.83	0.44	0.68
n	27	44	44
Light Activity (% of wear time)			
Spearman correlation	-0.21	-0.16	-0.12
p-value	0.30	0.30	0.43
n	27	44	44
Moderate/Vigorous Activity (mins/day)			
Spearman correlation	0.18	-0.03	0.06
p-value	0.36	0.83	0.69
n	27	44	44
Moderate/Vigorous Activity (% of wear time)			
Spearman correlation	0.12	-0.06	0.03
p-value	0.55	0.71	0.83
n	27	44	44
Total Activity (mins/day)			
Spearman correlation	0.03	-0.13	-0.07
p-value	0.87	0.39	0.67
n	27	44	44
Total Activity (% of wear time)			
Spearman correlation	-0.09	-0.16	-0.10
p-value	0.64	0.31	0.50
n	27	44	44
Activity counts/day			
Spearman correlation	0.15	-0.07	0.02
p-value	0.45	0.64	0.87
n	27	44	44
Activity counts/min			
Spearman correlation	0.13	-0.09	-0.01
p-value	0.52	0.56	0.93
n	27	44	44

5.6.2 Psychiatric symptoms, function, and general health status with physical activity and fitness measures

The clinician's assessment of psychiatric symptoms (PANSS, CGI-S) were not associated ($p \geq 0.12$) with the objective or subjective measures of physical activity or physical fitness in adults with schizophrenia or schizoaffective disorders (Table 5-19).

The global assessment of function (GAF) was significantly and positively associated with the subjective [modified MAQ total activity for mins/wk (r_s= 0.16, p=0.02) as well as METS/week (r_s= 0.17, p=0.01)] and physical fitness (r_s=0.23, p=0.02). With respect to accelerometry, only the correlation between function and the percentage of time engaged in light physical activity approached statistical significance (r_s= -0.27, p=0.08).

The participant's assessment of their general health status was negatively associated with the subjective physical activity measures [mins/wk (r_s=-0.15, p=0.02) and METS/week (r_s=-0.17, p=0.01)] (Table 5-19). In general, the adults who reported better health status reported greater activity and the adults who reported poor health status tended to report lower physical activity. No association was observed between the participant's assessment of their general health status and physical fitness (r_s=0.12, p=0.24), and the objective physical activity measures ($p \geq 0.57$) (Table 5-19).

Table 5-19 Spearman correlations between subjective and objective physical activity measures and psychiatric scores, function, and general health status

	Positive and Negative Syndrome Scale (PANSS)	Global Assessment of Functioning Scale (GAF) Score	Clinical Global Impression of Severity (CGI-S)	General Health Status (SF12)
Physical Fitness				
VO_2max (mL/kg/min)				
Spearman correlation	-0.15	0.23	-0.15	0.12
p-value	0.12	0.02	0.13	0.24
n	109	99	99	105
Objective Physical Activity				
Sedentary (mins/day)	-0.001	0.18	-0.06	-0.09
Spearman correlation	0.99	0.25	0.69	0.57
p-value	46	44	44	44
n				
Sedentary (% of wear time)				
Spearman correlation	0.05	0.22	-0.15	0.02
p-value	0.75	0.16	0.32	0.88
n	46	44	44	44
Light Activity (mins/day)				
Spearman correlation	-0.07	-0.20	0.19	.009
p-value	0.62	0.19	0.21	0.96
n	46	44	44	44
Light Activity (% of wear time)				
Spearman correlation	-0.06	-0.27	0.18	-0.3
p-value	0.69	0.08	0.25	0.84
n	46	44	44	44
Moderate/Vigorous Activity (mins/day)				
Spearman correlation	-0.04	0.03	-0.004	-0.03
p-value	0.82	0.87	0.98	0.87
n	46	44	44	44
Moderate/Vigorous Activity (% of wear time)				
Spearman correlation	-0.04	0.007	-0.02	-0.007
p-value	0.79	0.97	0.92	0.96
n	46	44	44	44

Table 5-19 (continued) Spearman correlations between subjective and objective physical activity measures and psychiatric scores, function, and general health status.

	Positive and Negative Syndrome Scale (PANSS)	Global Assessment of Functioning Scale (GAF) Score	Clinical Global Impression of Severity (CGI-S)	General Health Status (SF12)
Total Activity (mins/day)				
Spearman correlation	-0.07	-0.18	0.18	0.04
p-value	0.64	0.24	0.24	0.82
n	46	44	44	44
Total Activity (% of wear time)				
Spearman correlation	-0.05	-0.22	0.15	-0.02
p-value	0.75	0.16	0.32	0.88
n	46	44	44	44
Activity (counts/day)				
Spearman correlation	-0.09	-0.09	0.14	-0.02
p-value	0.56	0.55	0.38	0.88
n	46	44	44	44
Activity (counts/min)				
Spearman correlation	-0.06	-0.13	0.13	0.01
p-value	0.68	0.39	0.41	0.94
n	46	44	44	44
Subjective Physical Activity				
Modified MAQ Total (mins/wk)				
Spearman correlation	0.05	0.16	-0.09	-0.15
p-value	0.41	0.02	0.21	0.02
n	243	217	215	233
Modified MAQ Total (METS/wk)				
Spearman correlation	0.05	0.17	-0.10	-0.15
p-value	0.48	0.01	0.14	0.02
n	243	217	215	233

5.6.3 Age and BMI with physical activity and fitness measures

Age was negatively associated with physical fitness (r_s = -0.20, $p<0.01$) (Table 5-20). In general, maximal oxygen consumption was greater among the younger adults with schizophrenia and schizoaffective disorders than the older adults with schizophrenia and schizoaffective disorders. No association was observed between age and objective or subjective measures of physical activity ($p\geq0.16$).

BMI was negatively associated with physical fitness (r_s = -0.26, $p<0.01$) and approached statistical significance for subjective measures of physical activity (r_s = -0.11, $p<0.10$) (Table 5-20). Finally, no statistically or clinically significant associations were observed between BMI and objective measures of physical activity ($p\geq0.51$) (Table 5-20).

Table 5-20 Spearman correlations between subjective and objective physical activity measures and demographics

Variable	Age (yrs)	BMI (kg/m^2)
Physical Fitness		
VO_2max (mL/kg/min)		
Spearman correlation	-0.20	-0.26
p-value	0.03	0.006
n	109	109
Objective Physical Activity		
Sedentary (mins/day)		
Spearman correlation	0.21	-0.08
p-value	0.16	0.58
n	46	46
Sedentary (% of wear time)		
Spearman correlation	0.08	-0.04
p-value	0.60	0.77
n	46	46
Light Activity (mins/day)		
Spearman correlation	0.05	-0.05
p-value	0.72	0.76
n	46	46
Light Activity (% of wear time)		
Spearman correlation	-0.06	0.01
p-value	0.69	0.94
n	46	46
Moderate/Vigorous Activity (mins/day)		
Spearman correlation	-0.04	0.10
p-value	0.78	0.51
n	46	46
Moderate/Vigorous Activity (% of wear time)	-0.03	0.06
Spearman correlation	0.83	0.70
p-value	46	46
n		

Table 5-20 (continued) Spearman correlations between subjective and objective physical activity measures and demographics

Variable	Age (yrs)	BMI (kg/m^2)
Total Activity (mins/day)		
Spearman correlation	0.06	-0.03
p-value	0.68	0.86
n	46	46
Total Activity (% of wear time)		
Spearman correlation	-0.08	0.04
p-value	0.60	0.77
n	46	46
Activity (counts/day)		
Spearman correlation	0.003	0.02
p-value	0.99	0.91
n	46	46
Activity (counts/min)		
Spearman correlation	-0.08	0.04
p-value	0.61	0.79
n	46	46
Subjective Physical Activity		
Modified MAQ Total (mins/wk)		
Spearman correlation	0.05	-0.11
p-value	0.40	0.10
n	243	243
Modified MAQ Total (METS/wk)		
Spearman correlation	0.03	-0.11
p-value	0.65	0.07
n	243	243

5.6.4 Summary

No association was observed between the subjective and objective physical activity measures and physical fitness. In addition, the clinician's assessment of psychiatric symptoms was not associated with the objective or subjective measures of physical activity or physical fitness in adults with schizophrenia or schizoaffective disorders. Finally, participants with greater function or better general health status tended to report greater levels of physical activity. As expected, age and BMI were negatively associated maximal oxygen consumption. However, no association was observed between age and BMI and objective or subjective measures of physical activity.

5.7 LINEAR REGRESSION FOR SUBJECTIVE PHYSICAL ACTIVITY (MODIFIED MAQ) IN THE WAIST STUDY

5.7.1 Univariate linear regression models for modified MAQ (mins/wk)

Table 5-21 provides a summary of univariate linear regression models for the subjective physical activity measures of total activity (mins/wk), total activity without occupational activity (mins/wk), and total activity without household physical activities (mins/wk). Significant gender variations were noted for total activity and total activity without occupational activities ($p \leq 0.05$). Female participants self-reported approximately 200 mins/wk more of total physical activities and total physical activities without occupational activities than male participants. As previously reported, these activity differences due to gender were attributed to household physical activities. Significant BMI variations were noted for total physical activity without household physical activities ($p=0.04$). Each unit increase in BMI (kg/m^2) was associated with 5 minute decrease in total physical activities excluding household physical activities. Finally, the objective physical activity or fitness measures were not statistically associated with any of the subjective activity measures(mins/wk).

Table 5-21 Univariate models for subjective physical activity (mins/wk) in overweight and obese adults with schizophrenia and schizoaffective disorders in the WAIST Study

	Subjective Physical Activity (Modified MAQ)		
Independent Variable	**Total Activity (mins/wk)**	**Total w/o occupational activities (mins/wk)**	**Total w/o household physical activities (mins/wk)**
Age (years)			
β (SE)	2.5 (4.2)	3.5 (3.9)	-1.7 (1.8)
F Statistics	0.36	0.80	0.89
p-value	0.55	0.37	0.35
n	243	250	243
BMI (kg/m^2)			
β (SE)	-3.5 (5.6)	-1.3 (5.1)	-5.0 (2.4)
F Statistics	0.38	0.07	4.39
p-value	0.54	0.80	0.04
n	243	250	243
Gender (0=male, 1=female)			
β (SE)	176.7 (90.1)	213.0 (82.0)	-11.2 (39.3)
F Statistics	3.85	6.75	0.08
p-value	0.05	0.01	0.78
n	243	250	243
Race (0=White, 1=Black)			
β (SE)	36.1 (89.0)	53.2 (81.2)	-24.5 (38.6)
F Statistics	0.16	0.43	0.40
p-value	0.69	0.51	0.53
n	237	243	237
Smoking status (0=no, 1=current)			
β (SE)	4.9 (87.9)	-16.4 (80.3)	-26.5 (38.0)
F Statistics	0.00	0.04	0.49
p-value	0.96	0.84	0.49
n	243	250	243
Anti-Psychotic Medications Polypharmacy (0=no, 1=yes)			
β (SE)	-53.3 (38.7)	-30.5 (35.2)	-27.4 (16.7)
F Statistics	1.89	0.75	2.69
p-value	0.17	0.39	0.10
n	243	250	243

Table 5-21 (continued) Univariate models for subjective physical activity (mins/wk) in overweight and obese adults with schizophrenia and schizoaffective disorders in the WAIST Study

	Subjective Physical Activity (Modified MAQ)		
Independent Variable	**Total Activity (mins/wk)**	**Total w/o occupational activities (mins/wk)**	**Total w/o household physical activities (mins/wk)**
Weight gaining properties for single anti-psychotic medications (0=low/none, 1=yes)			
β (SE)	-155.6 (113.3)	-80.8 (104.0)	-119.8 (51.0)
F Statistics	1.89	0.60	5.52
p-value	0.17	0.43	0.02
n	202	207	202
Fitness (0=unfit, 1=fit)			
β (SE)	-30.0 (464.9)	62.6 (397.4)	290.6 (264.1)
F Statistics	0.00	0.02	1.21
p-value	0.95	0.88	0.27
n	103	105	103
Maximal Oxygen Consumption (mL/kg/min)			
β (SE)	-1.8 (11.0)	-7.2 (9.2)	9.7 (6.2)
F Statistics	0.03	0.61	2.41
p-value	0.87	0.44	0.12
n	103	105	103
Objective Physical Activity (Activity counts/day) x 100			
β (SE)	-0.27 (1.37)	-1.17 (1.24)	1.13 (0.67)
F Statistics	0.04	0.88	2.88
p-value	0.84	0.35	0.10
n	46	47	46
Activity counts/mins			
β (SE)	-0.45 (1.30)	-1.21 (1.18)	0.83 (0.64)
F Statistics	0.12	1.05	1.69
p-value	0.73	0.31	0.20
n	46	47	46

Table 5-21 (continued) Univariate models for subjective physical activity (mins/wk) in overweight and obese adults with schizophrenia and schizoaffective disorders in the WAIST Study.

	Subjective Physical Activity (Modified MAQ)		
Independent Variable	**Total Activity (mins/wk)**	**Total w/o occupational activities (mins/wk)**	**Total w/o household physical activities (mins/wk)**
Total activity (light, moderate and vigorous) (mins/day)			
β (SE)	-0.73 (1.55)	-1.39 (1.40)	0.08 (0.77)
F Statistics	0.22	0.99	0.95
p-value	0.64	0.32	0.34
n	46	47	46
Total activity (light, moderate and vigorous) (% of monitoring time)			
β (SE)	-1143.8 (1488.9)	-1650.2 (1342.9)	330.3 (752.8)
F Statistics	0.59	1.51	0.19
p-value	0.45	0.23	0.66
n	46	47	46
Sedentary (mins/day)			
β (SE)	0.46 (0.61)	0.48 (0.57)	0.22 (0.31)
F Statistics	0.55	0.71	0.51
p-value	0.46	0.40	0.48
n	46	47	46
Sedentary (% of monitoring time)			
β (SE)	1143.8 (1488.9)	1650.2 (1342.9)	-330.3 (752.4)
F Statistics	0.59	1.51	0.19
p-value	0.45	0.23	0.66
n	46	47	46

5.7.2 Univariate linear regression models for modified MAQ (METS/wk)

Table 5-22 provides a summary of univariate linear regression models for the subjective physical activity measures of total activity (METS/week), total activity without occupational activity (METS/week), and total activity without household physical activities (METS/week). Similar patterns of association were observed with the subjective physical activity measures in METS/week as the subjective physical activity measures in mins/wk for the demographic, fitness and objective physical activity measures (Tables 5-21 and 5-22). Briefly, significant gender variations were noted for total activity without occupational activities ($p \leq 0.05$). Female participants self-reported 362 METS/week more of total physical activities and 505 METS/week of total physical activities without occupational activities than male participants. As previously reported, these activity differences due to gender were attributed to household physical activities. Variations in BMI were noted for total physical activity without household physical activities ($p=0.05$). Each unit increase in BMI was associated with a decrease of approximately 20 METS/week of physical activity.

Finally, the objective physical activity or fitness measures were not statistically associated with 2 out of three subjective activity measures, specifically total activity and total activity without occupational activity ($p \geq 0.34$) . However, subjective physical activity total without household physical activities approached statistically significant associations with fitness ($p=0.16$) and objective total physical activity measured as activity counts per day ($p=0.06$) or activity counts per min ($p=0.13$). The fit participants averaged 1600 METS/week more of total physical activity excluding household physical activities than the unfit participants. Both objective measures of physical activity (activity counts/minute and activity counts/day) were positively associated with total physical activity without household physical activities (METS/day). Each activity count per minute increase was associated with an approximately 4 METS/week increase in total physical activity excluding household physical activities.

5.7.3. Multivariate linear regression model-building and models for modified MAQ (mins or METS/wk)

5.7.3.1 Total subjective physical activity (mins or METS/wk) Candidates for the multivariate model- building process were gender and polypharmacy medications for total physical activity measured subjectively (mins/wk) ($p<0.20$). After the multivariate model-building process,

gender was the only variable significantly associated with total physical activity (mins/wk) ($p \leq 0.05$). None of the candidates in the multivariate model-building process (gender and polypharmacy medications) were found to be significantly associated ($p \leq 0.05$) with total physical activity (METS/wk).

5.7.3.2 Total subjective physical activity excluding occupation activities (mins or METS/wk) Multivariate model-building was not conducted for total activity without occupational physical activities (mins/wk or METS/wk) since gender was the only candidate for the multivariate models ($p<0.05$).

5.7.3.3 Total subjective physical activity excluding household activities (mins or METS/wk) Candidates for the multivariate model- building process for total physical activity excluding household activities measured in METS/wk were exactly the same as total physical activity excluding household activities measured in mins/wk. The candidates for each outcome were BMI, polypharmacy medications, weight gaining properties for single anti-psychotic medications, maximal oxygen consumption, and activity counts/day for total activity without household physical activities (METS/wk or mins/wk) ($p<0.20$). BMI and weight gaining properties for single anti-psychotic medications) were found to be significantly associated ($p \leq 0.05$) with total physical activity excluding household activities (METS/wk and mins/wk) (Table 5-22 and 5-23). Each unit increase in BMI was associated with an approximate decrease of 6 mins/wk or 24 METS/wk of physical activity excluding household activities (Table 5-22 and 5-23). Participants taking a single anti-psychotic medication with weight gaining properties reported approximately 113 mins/wk or 471 METS/wk less physical activity excluding household activities than those who took a single anti-psychotic medication without weight gaining properties (Table 5-22 and 5-23).

Table 5-22 Final multivariate linear model predicting total physical activity excluding household activities (mins/day) in adults with schizophrenia or schizoaffective disorders (n=202).

Variable	β ± SE	F Statistics	p-value
BMI (kg/m^2)	-6.4 ± 3.0	4.52	0.03
Weight gaining properties for single anti-psychotic medications	-113.0 ± 50.7	4.97	0.03
Intercept	515.3 ± 119.3	NA	
R^2 = 4.9%			

Table 5-23 Final multivariate linear model predicting total physical activity excluding household activities (METS/day) in adults with schizophrenia or schizoaffective disorders (n=202).

Variable	β ± SE	F Statistics	p-value
BMI (kg/m^2)	-24.2 ± 12.4	3.81	0.05
Weight gaining properties for single anti-psychotic medications	-471.3 ± 210.1	5.03	0.03
Intercept	2030.8 ± 494.7	NA	
R^2 = 4.5%			

5.8 LINEAR REGRESSION FOR OBJECTIVE PHYSICAL ACTIVITY (ACTIGRAPHY) IN THE WAIST STUDY

5.8.1 Univariate models for objective physical activity (Actigraphy)

Table 5-24 provides a summary of univariate linear regression models for the objective physical activity measures of total activity (counts/day), total activity for light, moderate, and vigorous activities (mins/day), and sedentary time (mins/day). Smoking status was significantly associated with total activity in counts or minutes ($p \leq 0.05$) but not sedentary time ($p=0.77$). Smokers averaged approximately 39,000 more counts per day and 35 minutes/day of physical activity than non-smokers. Race only approached statistical significance ($p=0.06$) for sedentary time/day; whites averaging 80 minutes more of sedentary time than black participants. Neither the subjective physical activity ($p \geq 0.13$) nor fitness ($p \geq 0.09$) measures were statistically associated with the objective activity measures.

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Table 5-24 Univariate linear regression models for objective physical activity measures in the WAIST Study (n=46).

	Objective Physical Activity (Actigraphy)		
Independent Variable	**Total Activity (counts/min)**	**Total activity (light, moderate, and vigorous) (mins/day)**	**Sedentary (mins/day)**
Age (yrs)			
β (SE)	-0.74 (0.98)	0.31 (0.84)	2.9 (2.1)
F Statistics	0.57	0.14	1.93
p-value	0.45	0.71	0.17
n	46	46	46
BMI (kg/m^2)			
β (SE)	0.21 (1.19)	0.35 (1.01)	-1.58 (2.58)
F Statistics	0.03	0.12	0.37
p-value	0.86	0.73	0.54
n	46	46	46
Gender (0=male, 1=female)			
β (SE)	-12.6 (19.7)	14.1 (16.7)	-1.7 (43.1)
F Statistics	0.41	0.71	0.00
p-value	0.53	0.40	0.97
n	46	46	46
Race[a] (0=White, 1=Black)			
β (SE)	0.17 (19.3)[a]	-11.4 (16.4)[a]	-79.6 (41.4)[a]
F Statistics	0.00	0.48	3.7
p-value	0.99	0.49	0.06
n	45	45	45
Smoking status (0=no, 1=current)			
β (SE)	32.1 (19.5)	29.8 (16.4)	-10.7 (43.7)
F Statistics	2.70	3.27	0.06
p-value	0.11	0.08	0.81
n	46	46	46
Anti-Psychotic Medications			
Polypharmacy (0=no, 1=yes)			
β (SE)	14.3 (8.1)	5.3 (7.1)	-25.9 (17.9)
F Statistics	3.11	0.55	2.10
p-value	0.08	0.46	0.15
n	46	46	46

[a] n=45, excluded other race (n=1) due to insufficient sample size for summary or analyses.

Table 5-24 (continued) Univariate linear regression models for objective physical activity measures in the WAIST Study (n=46).

	Objective Physical Activity (Actigraphy)		
Independent Variable	**Total Activity (counts/min)**	**Total activity (light, moderate, and vigorous) (mins/day)**	**Sedentary (mins/day)**
Weight gaining properties for single anti-psychotic medications (0=low/none, 1=yes)			
β (SE)	-4.2 (32.1)	-0.001 (0.29)	-0.08 (2.86)
F Statistics	0.02	0.00	0.00
p-value	0.90	0.97	0.98
n	38	38	39
Fitness (0=unfit, 1=fit)			
β (SE)	-83.9 (61.2)[b]	-73.7 (51.2)[b]	200.6 (116.7)[b]
F Statistics	1.88	2.07	2.94
p-value	0.18	0.16	0.10
n	27	27	27
Maximal Oxygen Consumption (mL/min/kg)			
β (SE)	0.11 (1.96)	-0.96 (1.64)	4.98 (3.69)
F Statistics	0.00	0.34	1.82
p-value	0.95	0.56	0.19
n	27	27	27
Subjective Physical Activity (mins/wk)			
Total			
β (SE)	-1.70 (1.72)[c]	-1.46 (1.48)[c]	3.2 (3.9)[c]
F Statistics	0.93	0.98	0.70
p-value	0.34	0.33	0.41
n	44	44	44
Total Activity (METS/week)/1000			
β (SE)	3.2 (6.1)[c]	-3.47 (5.09)[c]	10.3 (13.3)[c]
F Statistics	0.27	0.47	0.60
p-value	0.60	0.50	0.44
n	45	45	45

[a] n=45, excluded other race (n=1) due to insufficient sample size for summary or analyses.

Table 5-24 (continued) Univariate linear regression models for objective physical activity measures in the WAIST Study (n=46).

	Objective Physical Activity (Actigraphy)		
Independent Variable	**Total Activity (counts/min)**	**Total activity (light, moderate, and vigorous) (mins/day)**	**Sedentary (mins/day)**
Total w/o occupational activities (mins/wk)			
β (SE)	-1.79 (1.83)	-1.63 (1.54)	3.1 (4.0)
F Statistics	0.95	1.12	0.59
p-value	0.33	0.30	0.45
n	45	45	45
Total w/o occupational activities (METS/wk)/1000			
β (SE)	-3.4 (6.4)	-4.2 (5.4)	9.5 (13.8)
F Statistics	0.28	0.61	0.47
p-value	0.60	0.44	0.50
n	45	45	45
Total w/o household activities (mins/wk)			
β (SE)	0.38 (4.84)	0.42 (4.06)	13.9 (10.4)
F Statistics	0.01	0.01	1.78
p-value	0.94	0.92	0.19
n	44	44	44
Total w/o household activities (METS/wk)/1000			
β (SE)	4.9 (12.1)	3.9 (10.2)	31.4 (26.2)
F Statistics	0.16	0.15	1.43
p-value	0.69	0.70	0.24
n	44	44	44

[a] n=45, excluded other race (n=1) due to insufficient sample size for summary or analyses.

Table 5-25 provides a summary of univariate linear regression models for the objective physical activity measures of total activity (counts/day), percentage of time per day engaged in light, moderate or vigorous activities, and percentage of sedentary time per day. Since the percentage time of total activity and sedentary time total 100%, the beta coefficients for percentage time of total activity and sedentary time are the inverses of each other. Smoking status was significantly associated with the three objective physical activity measures ($p \leq 0.07$). Smokers spent a greater percentage of their day physically active and averaged 35,000 counts/day more than the non-smokers. Fitness was positively associated with percentage of time engaged in physical activities and percentage of sedentary time ($p=0.05$). Subjective measures of physical activity (mins/wk or METS/week) were not associated with the percentage of time engaged in total activity or percentage of sedentary time ($p \geq 0.23$) measured objectively.

Table 5-25 Univariate linear regression models for the objective physical activity measures of total activity (counts/day), percentage of time engaged in total physical activities (%/day), and percentage of sedentary time (%/day) (n=46).

	Objective Physical Activity (Actigraphy)		
Independent Variable	**Total (counts/day)**	**Total activity (light, moderate, and vigorous) (% of monitoring time) x 100,000**	**Sedentary (% of monitoring time) x 100,000**
Age (yrs)			
β (SE)	-17.9 (937.8)	- 0.03(0.09)	0.03(0.09)
F Statistics	0.04	0.10	0.10
P	0.85	0.75	0.75
n	46	46	46
BMI (kg/m^2)			
β (SE)	225.0 (1130.6)	0.04(0.10)	-0.04(0.10)
F Statistics	0.04	0.11	0.11
P	0.84	0.74	0.74
n	46	46	46
Gender (0=male, 1=female)			
β (SE)	-9780.8 (18785.3)	1.2(1.7)	-1.2(1.7)
F Statistics	0.27	0.48	0.48
P	0.61	0.49	0.49
n	46	46	46
Race (0=White, 1=Black)			
β (SE)	-13771.2 (18138.0)	0.42(1.71)	-0.42(1.71)
F Statistics	0.58	0.06	0.06
P	0.45	0.81	0.81
n	46	46	46
Smoking status (0=no, 1=current)			
β (SE)	27202.3 (18651.0)	3.3(1.7)	-3.3(1.7)
F Statistics	2.13	3.82	3.82
P	0.15	0.06	0.06
n	46	46	46
Anti-Psychotic Medications Polypharmacy (0=no, 1=yes)			
β (SE)	11043.3 (7823.5)	0.89(0.72)	-0.89(0.72)
F Statistics	1.99	1.50	1.50
P	0.17	0.23	0.23
n	46	46	46
Weight gaining properties for single anti-psychotic medications (0=low/none, 1=yes)			
β (SE)	-20154.9 (29001.8)	82.8(2858.9)	-0.08(2.86)
F Statistics	0.48	0.00	0.00
P	0.49	0.98	0.98
n	37	38	39

Table 5-25 (continued) Univariate linear regression models for the objective physical activity measures of total activity (counts/day), percentage of time engaged in total physical activities (%/day), and percentage of sedentary time (%/day) (n=46).

	Objective Physical Activity (Actigraphy)		
Independent Variable	**Total (counts/day)**	**Total activity (light, moderate, and vigorous) (% of monitoring time) x 100,000**	**Sedentary (% of monitoring time) x 100,000**
Fitness (0=Unfit, 1=Fit)			
β (SE)	-66257.0 (64493.4)	-9.5(4.6)	9.5(4.6)
F Statistics	1.06	4.32	4.32
P	0.31	0.05	0.05
n	27	27	27
Maximal Oxygen Consumption (mL/min/kg)			
β (SE)	259.4 (2037.6)	-142.7 (150.6)	0.14 (0.15)
F Statistics	0.02	0.90	0.90
P	0.90	0.35	0.35
n	27	27	27
Subjective Physical Activity			
Total Activity (mins/wk)			
β (SE)	-13.9 (16.7)	-1.96(153)	1.96(1.53)
F Statistics	0.69	1.64	1.64
P	0.41	0.21	0.21
n	44	44	44
Total Activity(METS/wk)/1000			
β (SE)	-2.0 (5.7)	-0.53(0.53)	0.53(0.53)
F Statistics	0.13	1.03	1.03
P	0.73	0.32	0.32
n	44	44	44
Total w/o occupational activities (mins/wk)			
β (SE)	-15.6 (17.3)	-0.20(0.16)	0.20(0.16)
F Statistics	0.81	1.63	1.63
P	0.37	0.21	0.21
n	45	45	45
Total w/o occupational activities (METS/wk)/1000			
β (SE)	-2.6 (6.0)	-0.57(0.56)	0.57(0.56)
F Statistics	0.19	1.05	1.05
P	0.67	0.31	0.31
n	45	45	45
Total w/o household activities (mins/wk)			
β (SE)	25.3 (45.5)	0.25(0.42)	-0.25(0.42)
F Statistics	0.31	0.36	0.36
P	0.58	0.55	0.55
n	44	44	44
Total w/o household activities (METS/wk)/1000			
β (SE)	10.0 (11.3)	0.34(1.06)	-0.34(1.06)
F Statistics	0.78	0.10	0.10
P	0.38	0.75	0.75
n	43	44	44

5.8.2 Multivariate linear regression model-building and models for objective physical activity (Actigraphy)

5.8.2.1 Total physical activity (counts per day) measured objectively Candidates for the multivariate model-building process for total physical activity (counts per day) were smoking status and polypharmacy medications. The interaction term (smoker status x polypharmacy medication) was significantly associated with total physical activity (counts per day) (p=0.004) (Table 5-26). As depicted in Figure 5-3, smokers were more active than non-smokers regardless of the number of medications taken. In smokers, participants on single medications were more active than participants on polypharmacy medications. Among non-smokers, the converse was observed i.e. participants on polypharmacy medications were more active than participants on single medications. The final multivariate model explained 24.7% of the variance in total physical activities (counts per day).

Table 5-26 Final multivariate linear model predicting total physical activity (counts/day) in adults with schizophrenia or schizoaffective disorders (n=46).

Variable	β ± SE	F Statistics	p-value
Smoker status No (0) Current (1)	 Reference 94096 ± 28574	10.84	0.12
Polypharmacy Medication Single (0) Two (1)	 Reference 30105 ± 9807	9.42	0.19
Interaction between smoker status x polypharmacy medication	-44246 ± 143989	9.44	0.004
Intercept	99427 ± 16987		<0.0001

R^2 = 24.7%

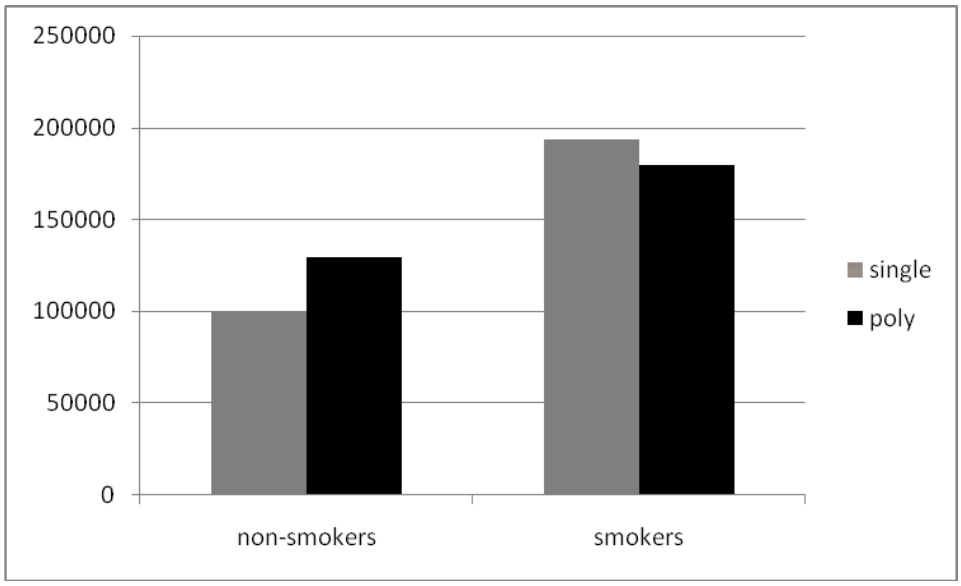

Figure 5-3 Interaction between smoking status and medications in the final multivariate linear model predicting total physical activity (counts/day) in adults with schizophrenia or schizoaffective disorders (n=46).

5.8.2.2 Total physical activity (mins/day) measured objectively Candidates for the multivariate model- building process for objective physical activity measured as total activity (minutes/day) were smoking status and fitness level ($p \leq 0.20$). However, none of these candidates or the interaction term were found to be significantly associated with total activity (mins/day) ($p \leq 0.05$).

Based on the final multivariate model candidates for total physical activity (counts/day), another model containing smoking status, polypharmacy medications, and the associated interaction term was built for total activity (mins/day). All of these candidates were significantly associated with total activity (mins/day) ($p<0.02$) (Table 5-27). The interaction term (smoker status x polypharmacy medication) was significantly associated with total physical activity (mins/day) ($p=0.003$) (Table 5-27). As depicted in Figure 5-4, smokers were more active than non-smokers regardless of the number of medications taken. In smokers, participants on single medications were more active than participants on polypharmacy medications. Among non-smokers, the converse was observed i.e. participants on polypharmacy medications were more active than participants on single medications. The final multivariate model explained 24.8% of the variance in the minutes per day engaged in physical activities.

Table 5-27 Final multivariate linear model predicting total physical activity (mins/day) in adults with schizophrenia or schizoaffective disorders (n=46).

Variable	β ± SE	F Statistics	p-value
Smoker status No (0) Current (1)	 Reference 91.9 ± 25.5	13.01	0.0008
Polypharmacy Medication Single (0) Two (1)	 Reference 22.0 ± 8.8	6.34	0.02
Interaction between smoker status x polypharmacy medication	-39.9 ± 12.8	9.67	0.003
Intercept	99427 ± 16987	NA	<0.001

R^2 = 24.8%

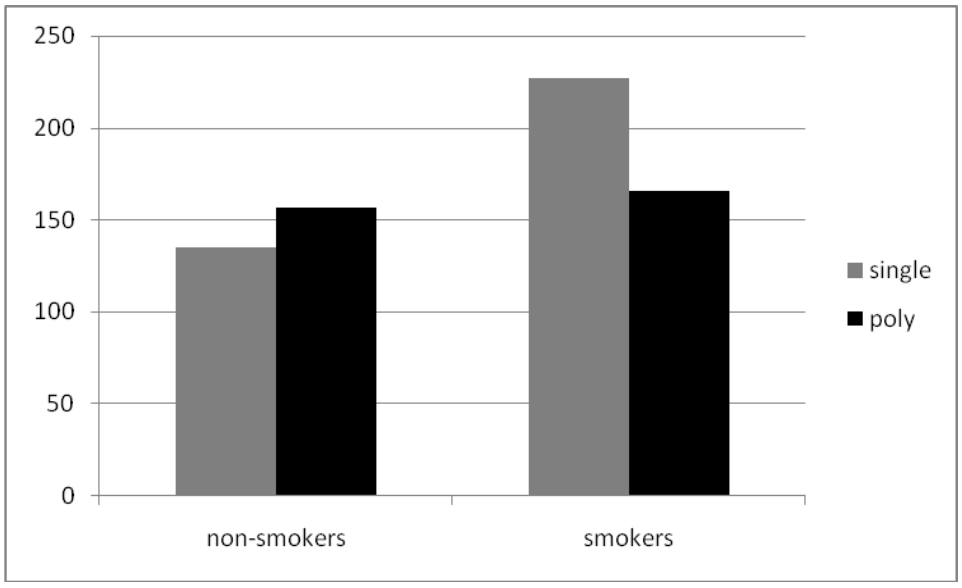

Figure 5-4 Interaction between smoking status and medications in the final multivariate linear model predicting total physical activity (mins/day) in adults with schizophrenia or schizoaffective disorders (n=46).

5.8.2.3 Percentage of time per day engaged in physical activities measured objectively

Fitness level was not considered a candidate for the multivariate model because too few participants were classified as fit (n=2) and the sample size (n=28) was not adequate to support main effects and interaction terms in the multivariate model. Maximal oxygen consumption, the

continuous variable for fitness, was not considered a candidate for the multivariate model because its association with percentage of time per day engaged in physical activities was non-significant (p=0.35).

Candidates for the multivariate model-building process for percentage of time per day engaged in physical activities were smoking status and polypharmacy medications (p<0.23). The interaction term (smoker status x polypharmacy medication) was significantly associated with total physical activity (percentage of time per day) (Table 5-28) (p<0.01). As depicted in Figure 5-5, smokers engaged in physical activity a greater percentage time than non-smokers regardless of the number of medications taken. In smokers, participants on single medications engaged in physical activity a greater percentage time than participants on polypharmacy medications. Among non-smokers, the converse was observed i.e. participants on polypharmacy medications engaged in physical activity a greater percentage time than participants on single medications. The final multivariate model explained 18.0% of the variance in the percentage of time per day engaged in physical activities.

Table 5-28 Final multivariate linear model predicting percentage time per day engaged in physical activity in adults with schizophrenia or schizoaffective disorders (n=46).

Variable	**β ± SE**	**F Statistics**	**p-value**
Smoker status		7.44	0.009
No (0)	Reference		
Current (1)	0.07 ± 0.03		
Polypharmacy Medication		4.49	0.04
Single (0)	Reference		
Two (1)	0.02 ± 0.009		
Interaction between smoker status x polypharmacy medication	-0.03 ± 0.01	4.08	0.05
Intercept	0.15 ± 0.02		<0.0001

R^2 = 18.0%

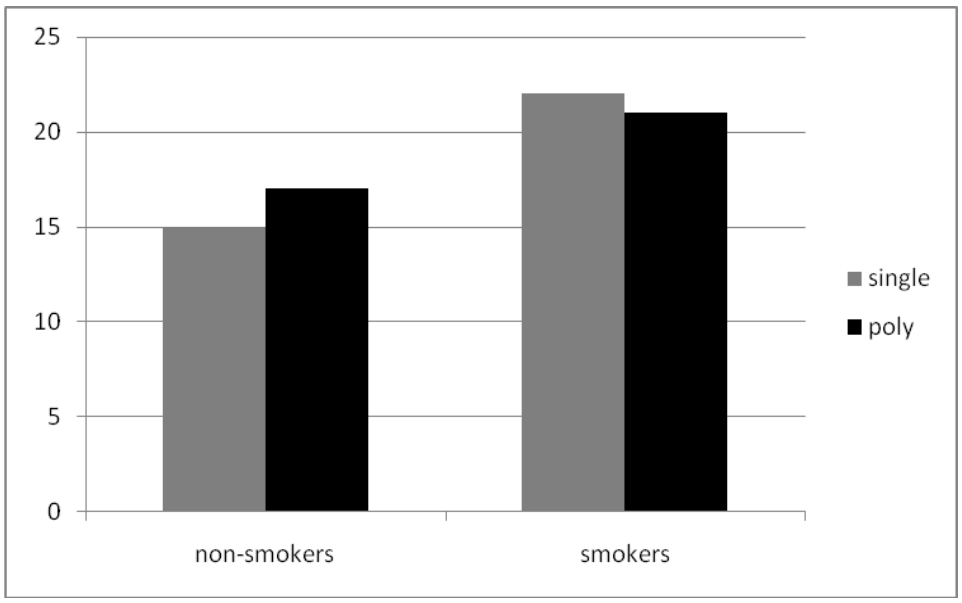

Figure 5-5 Interaction between smoking status and polypharmacy medications for schizophrenia or schizoaffective disorders in the final multivariate linear model predicting percentage of time engaged in physical activity in adults with schizophrenia or schizoaffective disorders (n=46).

5.8.2.4 Sedentary time (mins/day) measured objectively

The candidates for multivariate model-building for sedentary time (mins/day) were age, race, and fitness level ($p \leq 0.20$). In the multivariate model-building process, polypharmacy medications and race were significantly associated with sedentary time. The interaction term between race and polypharmacy medications was not significantly associated with sedentary time ($p=0.66$). The final multivariate model for sedentary time (mins/day) is presented in Table 5-29. Based on the multivariate linear models, blacks were less sedentary than whites (approximately 95 minutes), and participants on polypharmacy medications were less sedentary than participants on single medications (approximately 35 minutes).

Table 5-29 Final multivariate linear model predicting sedentary time (mins/day) by accelerometry in adults with schizophrenia or schizoaffective disorders (n=45).

Variable	β ± SE	F Statistics	p-value
Polypharmacy Medication [a]	-34.1 ± 17.6	3.76	0.06
Race			
White	Reference		
Black	94.5 ± 40.8	5.36	0.03
Intercept	958.6 ± 77.0		<0.0001

[a] dichotomized as 0=single medication or 1= two medications
R^2 = 15.5%

5.8.2.5 Percentage of sedentary time per day measured objectively

Candidates for the multivariate model-building process for percentage of sedentary time per day were smoking status, and polypharmacy medications ($p \leq 0.23$). Since percentage of sedentary time is the inverse of percentage of total physical activity, the candidates for the multivariate models were identical. Fitness level was not considered a candidate for the multivariate model because too few participants were classified as fit and the sample size (n=28) was not adequate to support main effects and interaction terms in the multivariate model. The interaction term (smoker status x polypharmacy medication) approached statistical significance for the percentage of sedentary time per day (Table 5-30) ($p<0.13$). The interaction term was retained in the multivariate model since it explained 5% more of the variance than the multivariate model with only main effects. As depicted Figure 5-6, smokers were less sedentary (more active) than non-smokers regardless of the number of medications taken. In smokers, participants on single medications were less sedentary (more active) than participants on polypharmacy medications. Among non-smokers, the converse was observed i.e. participants on polypharmacy medications were less sedentary (more active) than participants on single medications. The final multivariate model explained 15.1% of the variance in the percentage of sedentary time per day.

Table 5-30 Final multivariate linear model predicting percentage of sedentary time per day in adults with schizophrenia or schizoaffective disorders (n=46).

Variable	β ± SE	F Statistics	p-value
Smoker status		6.59	0.01
No (0)	Reference		
Current (1)	-7.0 ± 1.6		
Polypharmacy Medication		1.82	0.18
Single (0)	Reference		
Two (1)	-1.2 ± 0.9		
Interaction between smoker status x polypharmacy medication	2.1 ± 1.4	2.33	0.13
Intercept	84.1 ± 1.6		<0.0001

R^2 = 15.1%

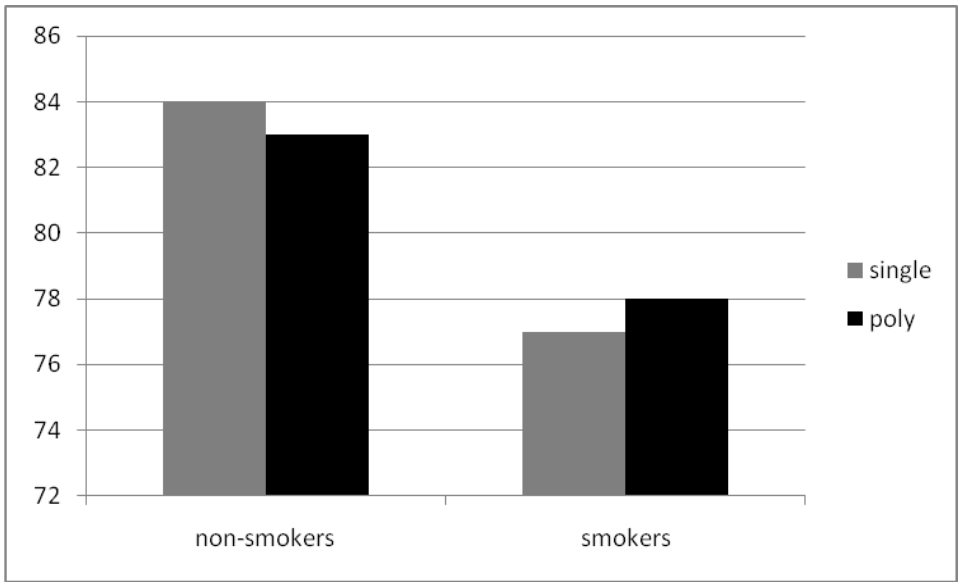

Figure 5-6 Interaction between smoking status and medications in the final multivariate linear model predicting percentage of sedentary time per day in adults with schizophrenia or Schizoaffective disorders (n=46).

5.9. LINEAR REGRESSION FOR POSITIVE AND NEGATIVE SYNDROME SCALE (PANSS) AND GLOBAL ASSESSMENT OF FUNCTIONING (GAF) IN THE WAIST STUDY

5.9.1 Positive and Negative Syndrome Scale (PANSS)

5.9.1.1 Univariate linear regression models for Positive and Negative Syndrome Scale (PANSS) Age was significantly associated with psychiatric symptoms as measured by the PANSS (Table 5-31). Age exhibited a linear relationship with the PANSS total scores meaning that older participants were more likely to have higher PANSS scores or experience more psychiatric symptoms than younger participants. Gender, race, smoking status and polypharmacy medications were not associated with the PANSS score in this sample ($p \geq 0.21$). None of the objective measures of physical activity or fitness levels were associated with PANSS scores ($p \geq 0.58$). The majority of the subjective physical activity measures (METS/week or mins/wk) either approached statistical significance or were significantly associated with the PANSS total scores.

Table 5-31 Univariate linear regression for Positive and Negative Syndrome Scale (PANSS) and Global Assessment of Functioning (GAF) in the WAIST Study.

Independent Variable	**Positive and Negative Syndrome Scale (PANSS) x 100 (n=258)**	**Global Assessment of Functioning (GAF) x 100 (n=231)**
Age (yrs)		
β (SE)	16.6 (7.0)	-8.8 (4.9)
F Statistics	5.71	3.19
p-value	0.02	0.08
n	258	231
BMI (kg/m^2)		
β (SE)	13.0 (9.2)	-4.3 (6.2)
F Statistics	2.00	0.48
p-value	0.16	0.49
n	258	231
Gender (0=male, 1=female)		
β (SE)	102.0 (153.3)	-104.9 (103.5)
F Statistics	0.44	1.03
p-value	0.51	0.31
n	258	231

Table 5-31 (continued) Univariate linear regression for Positive and Negative Syndrome Scale (PANSS) and Global Assessment of Functioning (GAF) in the WAIST Study.

Independent Variable	Positive and Negative Syndrome Scale (PANSS) x 100 (n=258)	Global Assessment of Functioning (GAF) x 100 (n=231)
Race (0=White, 1=Black)		
β (SE)	76.4 (148.8)	-187.0 (100.3)
F Statistics	0.26	3.47
p-value	0.61	0.06
n	252	226
Smoking status (0=no, 1=current)		
β (SE)	-186.0 (147.5)	62.7 (100.3)
F Statistics	1.59	0.39
p-value	0.21	0.53
n	258	231
Anti-Psychotic Medications Polypharmacy (0=no, 1=yes)		
β (SE)	55.2 (64.5)	-21.1 (44.7)
F Statistics	0.73	0.22
p-value	0.39	0.64
n	258	231
Weight gaining properties for single anti-psychotic medications (0=low/none, 1=yes)		
β (SE)	139.8 (189.0)	-216.3 (124.1)
F Statistics	0.55	3.04
p-value	0.46	0.08
n	213	193
Maximal oxygen consumption (mL/min/kg)		
β (SE)	-20.1 (1.95)	18.1 (12.6)
F Statistics	1.06	2.06
p-value	0.31	0.15
n	109	99
Objective physical activity (Activity counts/day)/100		
β (SE)	-2.1(3.7)	-0.37(1.98)
F Statistics	0.32	0.03
p-value	0.58	0.85
n	48	46
Activity counts/minute		
β (SE)	-1.5 (3.5)	-0.95 (1.87)
F Statistics	0.19	0.26
p-value	0.67	0.61
n	48	46
Total activity (light, moderate and vigorous) (mins/day)		
β (SE)	-2.1(4.2)	-1.7(2.2)
F Statistics	0.26	0.59
p-value	0.61	0.44
n	48	46

Table 5-31 (continued) Univariate linear regression for Positive and Negative Syndrome Scale (PANSS) and Global Assessment of Functioning (GAF) in the WAIST Study.

Independent Variable	Positive and Negative Syndrome Scale (PANSS) x 100 (n=258)	Global Assessment of Functioning (GAF) x 100 (n=231)
Total activity (light, moderate and vigorous) (% of monitoring time)		
β (SE)	-15.7(40.7)	-24**.7(21.2)**
F Statistics	0.15	1.37
p-value	0.70	0.25
n	48	46
Sedentary (mins/day)		
β (SE)	-0.18(1.7)	0.66(0.89)
F Statistics	0.01	0.55
p-value	0.92	0.46
n	48	46
Sedentary (% of monitoring time)		
β (SE)	15.7(40.7)	0.02(0.02)
F Statistics	0.15	1.37
p-value	0.70	0.25
n	48	46
Subjective Physical Activity (modified MAQ)		
Total Activity (mins/wk)		
β (SE)	20.1 (11.1)	18.2 (7.3)
F Statistics	3.29	6.26
p-value	0.07	0.01
n	243	217
Total Activity (METS/week)/1000		
β (SE)	45.1 (35.9)	60.3 (24.2)
F Statistics	1.58	6.21
p-value	0.21	0.03
n	243	217
Total w/o occupational activities (mins/wk)		
β (SE)	30.3 (11.7)	16.5 (7.9)
F Statistics	6.71	4.37
p-value	0.01	0.04
n	250	224
Total w/o occupational activities (METS/wk)		
β (SE)	89.5 (39.9)	59.7 (27.8)
F Statistics	5.04	4.62
p-value	0.03	0.03
n	250	224
Total w/o household physical activities (mins/wk)		
β (SE)	-37.9 (25.6)	40.1 (17.3)
F Statistics	2.18	5.39
p-value	0.14	0.02
n	243	217
Total w/o household physical activities (METS/wk)		
β (SE)	-95.3 (62.1)	94.4 (42.6)
F Statistics	2.36	4.91
p-value	0.13	0.03
n	243	217

5.9.1.2 Multivariate linear regression models for Positive and Negative Syndrome Scale (PANSS) Candidates for multivariate model-building process for PANSS were age, BMI, and several of the subjective measures of physical activity ($p<0.20$). Since the subjective measures of physical activity were correlated, total activity (mins/wk) was selected as the candidate for the multivariate model. All three variables (age, BMI, and total activity) were in the final multivariate model for PANSS (Table 5-32). No biologically feasible interactions were significant in the model building process.

In the final multivariate model, age exhibited a positive linear relationship with psychiatric symptoms; older participants were rated with more severe psychiatric symptoms than younger participants. Also, BMI exhibited a positive linear relationship with psychiatric symptoms; participants with greater BMI were rated with more severe psychiatric symptoms than leaner participants. Finally, those participants with greater total physical activity (mins/wk) were rated with more severe psychiatric symptoms than those participants with lower physical activity levels. The final multivariate model (Table 5-32) explained 5.5% the variance of PANSS.

Table 5-32 Final multivariate linear model predicting Positive and Negative Psychiatric Symptoms (PANSS) in adults with schizophrenia or schizoaffective disorders (n=250).

Variable	$\beta \pm$ SE	F Statistics	p-value
Age (yrs)	0.18 ± 0.07	6.33	0.01
BMI	0.16 ± 0.09	2.78	0.10
Subjective total physical activity (mins/wk)	0.29 ± 0.12	6.23	0.01
Intercept	39.8 ± 5.4		

R^2 =5.5 %

5.9.2 Linear Regression for Global Assessment of Functioning (GAF) in the WAIST Study

5.9.2.1 Univariate linear regression models for Global Assessment of Functioning (GAF)

Age approached statistical significance association with function as measured by the GAF (Table 5-31). Age exhibited a negative linear relationship with the GAF total scores meaning that older participants were more likely to have lower GAF scores or more functional impairments. In addition, race approached statistical significance (p=0.06) with function; black participants

having more functional impairments than white participants. Gender, BMI, smoking status and polypharmacy medications were not associated with functioning in this sample ($p \geq 0.24$). None of the objective measures of physical activity or fitness levels (continuous and categorical variables) were associated with function ($p \geq 0.25$). All of the subjective physical activity measures (METS/wk or mins/wk) were significantly associated with the function scores ($p < 0.05$). Specifically, those participants with greater total physical activity were rated with less functional impairments than those participants with lower physical activity levels.

5.9.2.2 Multivariate linear regression model for Global Assessment of Functioning (GAF)

Candidates for multivariate model for GAF were age, race, weight gaining properties for single anti-psychotic medications, and all of the subjective measures of physical activity (METS/week as well as mins/wk) ($p < 0.20$). Due to the high correlations between the subjective measures of physical activity, total subjective physical activity (mins/wk) was selected as the candidate for the multivariate model. Separate multivariate models were built for 1) the MAQ cohort (n=212) and 2) MAQ cohort participants taking single anti-psychotic medications only (n=179). Weight gaining properties for single anti-psychotic medications was not considered a candidate for the multivariate model for the MAQ cohort (n=212).

For the MAQ cohort (n=212), all three variables (age, race, and total subjective physical activity (mins/wk)) as well as race by age interaction term were predictors in the final multivariate model for GAF (Table 5-33). Among black participants, functioning improved with age (Figure 5-7). In contrast, functioning declined with age among the white participants (Figure 5-7). On average, greater functional impairments were found among participants whom reported low levels of physical activity. Conversely, fewer functional impairments were observed among participants whom reported higher levels of physical activity. Overall, the final multivariate model (Table 5-33) explained 11% of the variance of GAF.

Table 5-33 Final multivariate linear model predicting global functioning (GAF) in adults with schizophrenia or schizoaffective disorders (n=212).

Variable	β ± SE	F Statistics	p-value
Age (years)	-0.58 ± 0.15	14.65	0.0002
Race (0=white, 1=black)	-17.4 ± 4.9	12.41	0.0005
Age x Race Interaction	0.35 ± 0.11	10.95	0.001
Subjective total physical activity (mins/wk)	0.19 ± 0.07	7.42	0.007
Intercept	86.2 ± 67.0		<0.0001

R^2 = 10.5%

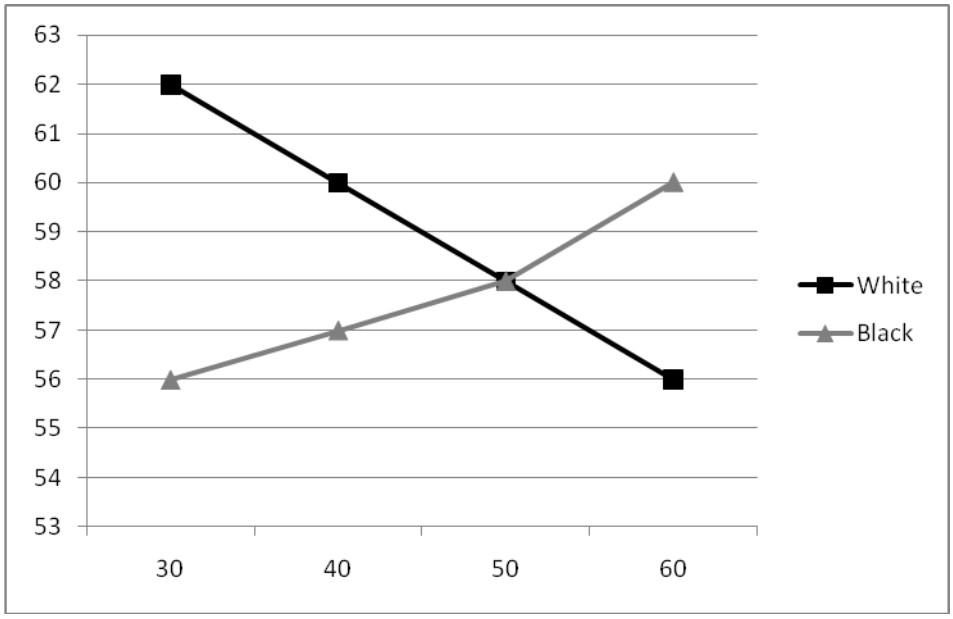

Figure 5-7 Interaction between race and age in the final multivariate linear model predicting global functioning (GAF) in adults with schizophrenia or schizoaffective disorders (n=212).

For the MAQ cohort taking single anti-psychotic medications only (n=179), all four variables (age, race, weight gaining properties for single anti-psychotic medications, and total subjective physical activity (mins/wk)) as well as race by age interaction term were predictors in the final multivariate model for GAF (Table 5-34). On average, greater functional impairments were found among participants whom single anti-psychotic medication was associated with

weight gain. In this subsample, the relationships between age, race and total subjective physical activity with GAF were similar to the model presented in Table 5-33. Overall, the final multivariate model (Table 5-34) explained 14% of the variance of GAF.

Table 5-34 Final multivariate linear model predicting global functioning (GAF) in adults with schizophrenia or schizoaffective disorders for participants taking a single anti-psychotic medication (n=179).

Variable	β ± SE	F Statistics	p-value
Age (years)	-0.48 ± 0.16	14.65	0.003
Race (0=white, 1=black)	-17.0 ± 5.2	12.41	0.001
Age x Race Interaction	0.31 ± 0.11	10.95	0.006
Subjective total physical activity (mins/wk)	0.002 ± 0.0007	7.42	0.02
Weight gaining properties for single anti-psychotic medication (0=low/none, 1=yes)	-2.8 ± 1.2	5.16	0.02
Intercept	86.7 ± 7.4		

R^2 = 13.6%

5.10 LOGISTIC REGRESSION FOR CLINICAL GLOBAL IMPRESSION OF SEVERITY (CGIS) AND GENERAL HEALTH STATUS (SF12) IN THE WAIST STUDY

5.10.1 Logistic regression for Clinical Global Impression of Severity (CGIS)

5.10.1.1 Univariate logistic regression models for Clinical Global Impression of Severity (CGIS) In the univariate and multivariate models for CGIS, age was modeled as a binary variable as indicated by testing the assumption of linearity in the logit. Specifically, the plot of the estimated coefficients versus the age midpoints of each age group suggested a dichotomous variable with the youngest tertile being the reference group (18-39 years) compared to the 2 older tertiles (18-65 years). Older adults with schizophrenia or schizoaffective disorders were 2.6 times more likely to have severe versus mild psychiatric symptoms than the younger adults with schizophrenia and schizoaffective disorders based on the univariate models (Table 5-35).

In the univariate and multivariate models, BMI was modeled as a binary variable as indicated by testing the assumption of linearity in the logit. Specifically, the plot of the estimated coefficients versus the BMI midpoints of each BMI category suggested a dichotomous variable with the overweight group being the reference group (27- 30 kg/m^2) compared to the

obese and extremely obese groups ($\geq$ 30 kg/m^2). Obese or extremely obese adults with schizophrenia or schizoaffective disorders were 2.0 times more likely to have severe versus mild psychiatric symptoms than the overweight adults with schizophrenia and schizoaffective disorders (Table 5-35).

Race was significantly associated with the severity of psychiatric symptoms (p=0.04). Specifically, black adults with schizophrenia and schizoaffective disorders were almost twice as likely to have severe versus mild psychiatric symptoms than white adults with schizophrenia and schizoaffective disorders (Table 5-35**)**.

Gender approached being statistically significantly associated with the severity of psychiatric symptoms (p=0.07). Specifically, female adults with schizophrenia and schizoaffective disorders were almost twice as likely to have severe versus mild psychiatric symptoms than male adults with schizophrenia and schizoaffective disorders (Table 5-35).

Severity of psychiatric symptoms was significantly associated with the weight gaining properties of the single anti-psychotic medications ($p<0.05$) (Table 5-35). Participants taking single anti-psychotic medications with weight gaining properties were more than twice as likely to have severe versus mild psychiatric symptoms than participants not taking single anti-psychotic medications with weight gaining properties (Table 5-35). No statistically significant or clinical meaningful associations were observed between severity of psychiatric symptoms and smoking status, and polypharmacy medications ($p\geq0.30$) (Table 5-35).

None of the objective measures of physical activity or fitness measures were predictive of severity of psychiatric symptoms among adults with schizophrenia or schizoaffective disorders ($p\geq0.24$). Only one subjective measure of physical activity (total physical activity excluding household physical activities in METS/wk or mins/wk) was significantly associated with severity of psychiatric symptoms (p=0.02). Total physical activity excluding household activity was protective against psychiatric symptoms i.e. the more active participants generally experienced less severe psychiatric symptoms than the less active participants.

Table 5-35 Odds ratio and 95% CI based on univariate logistic regression models for Clinical Global Impression of Severity (CGIS)[a] in the WAIST Study.

Independent Variable	CGIS [a] (n=229) Odds ratio (95% CI)
Age Categories	
18-39 years	1.0 (reference)
40-65 years	2.6 (1.4, 4.9)
p-value	0.002
BMI Categories	
Overweight	1.0 (reference)
Obese or Extremely Obese	1.96 (0.87, 4.44)
p-value	0.10
Gender	
Female	1.65 (0.95, 2.84)
Male	1.0 (reference)
p-value	0.07
Race	
White	1.0 (reference)
Black	1.76 (1.03, 3.01)
p-value	0.04
Current smoking status	
Non-smoker	1.0 (reference)
Smoker	0.94 (0.55, 1.59)
p-value	0.81
Anti-psychotic Medications	
Polypharmacy	
No	1.0 (reference)
Yes	1.14 (0.89,1.44)
p-value	0.30
Weight gaining properties for single anti-psychotic medications (0=low/none, 1=yes)(n=191)	
None/low	1.0 (reference)
Yes	2.28 (1.13, 4.61)
p-value	0.02
Weight gaining properties for single anti-psychotic medications (n=191)	
None/low (Aripiprazole and Ziprasidone)	1.0 (reference)
Moderate (Quetiapine, Risperidone, and Haloperidol)	3.56 (1.64, 7.74)
High (Clozapine and Olanzapine)	1.35 (0.62, 2.98)
p-value	0.002
Maximal oxygen consumption (mL/kg/min)(n=99)	0.97 (0.91, 1.04) 0.36

[a] Coded as mild (0=not ill, very mild, or mild illness) (reference group)or severe (1=moderate, severe, and extremely severe illness).

Table 5-35 (continued) Odds ratio and 95% CI based on univariate logistic regression models for Clinical Global Impression of Severity (CGIS)[a] in the WAIST Study.

Independent Variable	CGIS [a] (n=229) Odds ratio (95% CI)
Objective Physical Activity	
Activity counts/day/1000	1.002 (0.99,1.01)
p-value	0.63
Activity counts/minute	1.00 (0.99, 1.01)
p-value	0.52
Total activity (light, moderate and vigorous) (mins/day)	1.006 (0.995, 1.017)
p-value	0.31
Total activity (light, moderate and vigorous) (% of monitoring time) x 100	1.07 (0.96, 1.19)
p-value	0.24
Sedentary (mins/day)	1.0 (1.0,1.003)
p-value	0.68
Sedentary (% of monitoring time) x 100	0.94 (0.84, 1.05)
p-value	0.24
Subjective Physical Activity (MAQ)	
Total Activity (mins/wk)	0.98 (0.94, 1.02)
p-value	0.23
Total Activity (METS/wk)	0.91 (0.79, 1.03)
p-value	0.14
Total w/o occupational activities (mins/wk)	0.99 (0.95, 1.03)
p-value	0.70
Total w/o occupational activities (METS/wk)	0.96 (0.83, 1.11)
p-value	0.62
Total w/o household physical activities (mins/wk)	0.87 (0.78, 0.98)
p-value	0.02
Total w/o household physical activities (METS/wk)	0.72 (0.54, 0.95)
p-value	0.02

[a] Coded as mild (0=not ill, very mild, or mild illness) (reference group)or severe (1=moderate, severe, and extremely severe illness).

5.10.1.2 Multivariate logistic regression model for Clinical Global Impression of Severity (CGIS)

Candidates for the multivariate logistic model for CGIS were age categories, BMI categories, race, gender and total physical activity without household activities (METS/week) ($p<0.20$). These five main effects were included in the multivariate model and backwards step-wise elimination of non-significant main effects was conducted using a p-value cutoff of 0.20. In the backwards step-wise elimination process, race ($p=0.46$, data not shown) was removed first followed by gender ($p=0.28$, data not shown). The remaining 3 variables were associated with the severity of psychiatric symptoms ($p<0.10$). None of the interaction terms between age

categories, BMI categories and total physical activity without household activities (METS/week) were significant (p>0.20, data not shown).

The final predictive logistic model for CGIS contained age and BMI categories and total physical activity without household activities (METS/week) (Table 5-36). The odds of severe psychiatric symptoms increased 2-fold for obese and extremely obese adults with schizophrenia and schizoaffective disorders compared to overweight adults with schizophrenia and schizoaffective disorders. Older adults with schizophrenia and schizoaffective disorders had an approximately 3 times greater likelihood of severe psychiatric symptoms than the younger adults with schizophrenia or schizoaffective disorders. Finally, adults with schizophrenia or schizoaffective disorder that self-reported more occupational and leisure activities had a lower likelihood of severe psychiatric symptoms than adults that self-reported less occupational and leisure activities. In other words, occupational and leisure physical activities were protective against severe psychiatric symptoms.

Table 5-36 Final logistic model predicting Clinical Global Impression of Severity (CGIS) [a] in adults with schizophrenia or schizoaffective disorders (n=215).

Variable	β ± SE	Wald Chi-Square	p-value	Odds Ratio (95% CI)
Age Category				
18-39 years	Reference	--	--	1.00
40-65 years	0.52 ± 0.17	9.5	0.002	2.82 (1.46, 5.45)
BMI Categories				
Overweight	Reference	--	--	1.00
Obese or Extremely Obese	0.37 ± 0.23	2.6	0.10	2.11 (0.86, 5.20)
Subjective physical activity w/o household activities (METS/week)/1000	-0.31 ± 0.14	4.7	0.03	0.73 (0.55, 0.97)
Intercept	-0.08 ± 0.27		0.001	NA

[a] Coded as mild (0=not ill, very mild, or mild illness) (reference group)or severe (1=moderate, severe, and extremely severe illness)

For the MAQ cohort taking single anti-psychotic medications only (n=181), the predictors of severity of psychiatric symptoms were age, weight gaining properties of single anti-psychotic medications, and total subjective physical activity (mins/wk)(Table 5-37). On average, greater severity of psychiatric symptoms were found among participants whom single anti-psychotic medication was associated with weight gain. In this subsample, the relationships between age and total subjective physical activity with CGIS were similar to the model presented in Table 5-37.

Table 5-37 Final logistic model predicting Clinical Global Impression of Severity (CGIS) [a] in adults with schizophrenia or schizoaffective disorders for participants taking a single anti-psychotic medication (n=181).

Variable	β ± SE	Wald Chi-Square	p-value	Odds Ratio (95% CI)
Age Category				
18-39 years	Reference	--	--	1.00
40-65 years	0.90 ± 0.36	6.2	0.01	2.45 (1.21, 4.99)
Weight gaining properties of single anti-psychotic medications				
No	Reference	--	--	1.00
Yes	0.76 ± 0.38	3.9	0.05	2.14 (1.01, 4.54)
Subjective physical activity w/o household activities (METS/week)/1000	-0.31 ± 0.16	4.0	0.05	0.73 (0.54, 1.00)
Intercept	-0.88 ± 0.46	3.6	0.06	NA

[a] Coded as mild (0=not ill, very mild, or mild illness) (reference group)or severe (1=moderate, severe, and extremely severe illness)

5.10.2 Logistic regression for General Health Status (SF12)

5.10.2.1 Univariate logistic models for General Health Status (SF12) Only BMI was significantly associated with health status ($p<0.01$) (Table 5-38). The odds of poor health status increased 5% for every unit increase in BMI. In other words, more obese participants were at greater risk of poor health status than less obese participants. Race ($p=0.11$), medications with weight gaining properties ($p=0.15$) and age categories ($p=0.20$) approached statistical significant associations with general health status. Black participants tended to be at higher odds of poorer

health than white participants (approximately 50% increase in risk). No associations were observed between gender, smoking status, and polypharmacy medications and general health status ($p \geq 0.42$).

None of the fitness or objective measures of physical activity was predictive of general health status among adults with schizophrenia or schizoaffective disorders. Only total physical activity excluding occupational activities was significantly associated with general health status (p=0.05). Specifically, leisure and household activities were protective against poor health status. Neither total physical activity (p=0.12) nor total physical activity excluding household activities (p=0.31) (mins/wk or METS/wk) were significantly associated with general health status.

Table 5-38 Odds ratio and 95% CI based on univariate logistic regression models for General Health Status (SF12)[a] in the WAIST Study (n=247).

Independent Variable	**General Health Status (SF12)[a] (n=247) Odds Ratio (95% CI)**
Age Categories	
18-39 years	1.77 (0.94, 3.33)
40-49 years	1.29 (0.72, 2.33)
50-65 years	1.0 (reference)
p-value	0.20
BMI (kg/m^2)	1.05 (1.01, 1.09)
p-value	0.006
BMI Categories	
Overweight	0.63 (0.27, 1.45)
Obese	0.65 (0.37, 1.14)
Extremely Obese	1.0 (reference)
p-value	0.29
Gender	
Female	0.81 (0.48, 1.36)
Male	1.0 (reference)
p-value	0.42
Race	
White	1.0 (reference)
Black	1.51 (0.91, 2.51)
p-value	0.11
Current smoking status	
Non-smoker	1.0 (reference)
Smoker	1.10 (0.67,1.82))
p-value	0.71

[a] dichotomized as 0=good, very good, and excellent (reference group) or 1= fair or poor.

Table 5-38 (continued) Odds ratio and 95% CI based on univariate logistic regression models for General Health Status (SF12)[a] in the WAIST Study (n=247).

Independent Variable	General Health Status (SF12)[a] (n=247) Odds Ratio (95% CI)
Anti-psychotic medications	
Polypharmacy	1.0 (reference)
No	0.98 (0.78,1.22)
Yes	0.84
p-value	
Weight gaining properties for single anti-psychotic medications (0=low/none, 1=yes)(n=206)	
None/low	1.0 (reference)
Yes	0.90 (0.47, 1.73)
p-value	0.76
Weight gaining properties for single anti-psychotic medications (n=206)	
None/low (Aripiprazole and Ziprasidone)	1.0 (reference)
Moderate (Quetiapine, Risperidone, and Haloperidol)	1.28 (0.63, 2.60)
High (Clozapine and Olanzapine)	0.57 (0.27, 1.20)
p-value	0.05
Maximal Oxygen Consumption (mL/kg/min)	1.02 (0.96, 1.09)
p-value	0.58
Objective Physical Activity	
Activity counts/day/1000	1.00 (1.0,1.0)
p-value	0.28
Activity counts/minute	1.003 (0.994,1.011)
p-value	0.56
Total activity (light, moderate and vigorous) (mins/day)	1.003 (0.99, 1.014)
p-value	0.53
Total activity (light, moderate and vigorous) (% of monitoring time) x 100	1.06 (0.95, 1.18)
p-value	0.28
Sedentary (mins/day)	1.00 (0.99, 1.00)
p-value	0.41
Sedentary (% of monitoring time) x 100	0.94 (0.85, 1.05)
p-value	0.28
Subjective Physical Activity (modified MAQ)	
Total Activity (mins/wk)	0.97 (0.93, 1.01)
p-value	0.12
Total Activity (METS/wk)	0.92 (0.81, 1.04)
p-value	0.17
Total w/o occupational activities (mins/wk)	0.96 (0.91, 0.99)
p-value	0.05
Total w/o occupational activities (METS/wk)	0.86 (0.74, 1.00)
p-value	0.05
Total w/o household physical activities (mins/wk)	0.95 (0.87, 1.05)
p-value	0.31
Total w/o household physical activities (METS/wk)	0.89 (0.71, 1.11)
p-value	0.30

[a] dichotomized as 0=good, very good, and excellent (reference group) or 1= fair or poor.

5.10.2.2 Multivariate logistic regression model for General Health Status (SF12)

Candidates for the multivariate logistic model for SF12 were age categories, race, BMI, and total physical activity without occupational activities (METS/week) ($p<0.20$). These four main effects were included in the multivariate model and backwards step-wise elimination of non-significant main effects was conducted using a cutoff of 0.20 for the p-value. In the backwards step-wise elimination process, age categories were removed first ($p=0.41$, data not shown), followed by race ($p=0.19$, data not shown) and finally total physical activity without occupational activities (METS/week) ($p=0.06$). The final predictive multivariate model for SF12 contained only BMI ($p=0.01$) (Table 5-39). The odds of fair or poor self-reported health status increased 62% for every 10 kg/m^2 increase in BMI among adults with schizophrenia and schizoaffective disorders.

Table 5-39 Final multivariate logistic model predicting SF12[a] in adults with schizophrenia or schizoaffective disorders.

Variable	β ± SE	Wald Chi-Square	p-value	Odds Ratio (95% CI)
BMI (kg/m^2) [b]	0.48 ± 0.18	7.54	0.006	1.62 (1.15, 2.29)
Intercept	-1.92 ± 0.68	8.05	0.005	NA
[a] dichotomized as 0=good, very good, and excellent (reference group) or 1= fair or poor [b] BMI modeled as BMI/10				

5.11 SUMMARY

A summary of the significant predictors for psychiatric symptoms (PANSS and CGI-S), function, and general health status is provided in Table 5-40. Age and BMI were predictors in three of the four outcomes. Only subjective measures of physical activity and not objective measures of physical activity or fitness were significant predictors in the regression models.

Table 5-40. Summary of significant predictors of psychiatric symptoms, function and general health status in the WAIST Study

	Outcomes for regression models			
Predictors	**Positive and Negative Syndrome Scale (PANSS)**	**Clinical Global Impression of Severity (CGIS)**	**Global Assessment of Functioning (GAF)**	**General Health Status (SF12)**
Age	X	X	X	
Race			X	
Age x race interaction			X	
BMI	X	X		X
Subjective total physical activity (mins/wk)			X	
Subjective physical activity w/o occupational (mins/wk)	X			
Subjective physical activity w/o occupational (METS/wk)				X
Subjective physical activity w/o household (METS/wk)		X		

A summary of the significant predictors for subjective and objective measures of physical activity is provided in Table 5-41. Gender was the only significant predictor for the various subjective measures of physical activity, and the physical activity differences were attributed to household activities. Smoking status and polypharmacy medications were the primary significant predictors of objective measures of physical activity and sedentary time.

Table 5-41. Summary of significant predictors of subjective and objective measures of physical activity in the WAIST Study

Outcome	Gender	Smoking Status	Poly-pharmacy Medications	Smoking Status x Polypharmacy Medications Interaction	Race	No significant predictors
Subjective total physical activity (mins/wk)	X					
Subjective total physical activity (METS/wk)						X
Subjective physical activity w/o occupational (mins/wk)	X					
Subjective physical activity w/o occupational (METS/wk)	X					
Subjective physical activity w/o household (mins/wk)						X
Subjective physical activity w/o household (METS/wk)						X
Objective physical activity (counts/day)		X	X	X		
Objective total physical activity (mins/day)		X	X	X		
Objective total physical activity (% time/day)		X	X	X		
Objective sedentary time (mins/day)			X		X	
Objective sedentary time (% time/day)		X	X	X		

6.0 DISCUSSION

6.1 PHYSICAL ACTIVITY OF ADULTS WITH SCHIZOPHRENIA AND SCHIZOAFFECTIVE DISORDERS

6.1.1 WAIST Study

Overall, the present study found that overweight and obese adults with schizophrenia and schizoaffective disorders were sedentary based on a comprehensive profile of physical activity. Regardless if measured subjectively or objectively, physical activity was consistently limited and classified as sedentary or light physical activity among overweight and obese adults with schizophrenia and schizoaffective disorders. In addition, less than 2% (2/105) participants were classified as fit based on ACSM guidelines (83). As expected, adults with schizophrenia and schizoaffective disorders primarily engaged in unstructured, intermittent, and low-intensity activity such as walking and housework. Occupational physical activities were extremely limited due to the low employment rate among the participants.

6.1.2 Findings from published studies compared to the WAIST Study

Regardless of the survey instrument, self-reported physical activity by adults with schizophrenia or schizoaffective disorders were similar in prior studies (15, 18, 47, 49, 52, 85) compared to the WAIST Study. Generally, these previous studies found that adults with schizophrenia or schizoaffective disorders were inactive (15, 18, 52, 85), less active than controls (18, 85) or national populations (15), and few achieved national guidelines for recommended levels of physical activity (47, 51) or participated in vigorous or strenuous physical activity (15, 18, 47, 49, 52, 85). Direct comparisons of physical activity levels across studies is difficult because of the variety of physical activity instruments used in the studies (IPAQ, modified MAQ, YPAS, Godin) as well as the different definitions for physical activity and their corresponding physical activity scores for each physical activity instrument. However, the findings highlight that the vast majority of adults with schizophrenia or schizoaffective disorders engaged in light to low-moderate physical activities such as walking (15, 49, 50, 52, 56, 85). In addition, the studies suggest the possibility of regional differences in physical activity levels among adults with

schizophrenia or schizoaffective disorders i.e. a greater percentage of Australians may engage in walking, moderate and vigorous activities (approximately 60%) (55) and achieve national recommended guidelines for physical activity (49%) (50) than North Americans (less than 20% across studies) (15, 47, 49, 51, 52, 56, 85).

Comparisons with previous studies that have objectively measured physical activity in adults with schizophrenia or schizoaffective disorders is challenging because half of the studies did not report the actigraphy data (59, 86) or define the actigraphy measures (17, 19). Although the actigraphy measures were not defined, the results by Gothelf (17) and McKibbin (19) approximate the findings from the WAIST Study. Gothelf and associates (17) approximate that 4% of the monitoring time was active in male, inpatient adolescents with schizophrenia compared to 2% of the monitoring time in adult outpatients with schizophrenia or schizoaffective disorder in the WAIST Study. McKibbin and associates (19) reported that diabetic adults with schizophrenia or schizoaffective disorder averaged 23 minutes/day of moderate- vigorous activity similar to the 19 minutes/day of moderate-vigorous activity in the WAIST Study participants.

However, two well-designed and reported actigraphy studies (18, 20) found physical activity to be greater in their samples compared to the WAIST Study. In the first study, the assessment of physical activity in middle-aged and older adults with schizophrenia by Lindamer and associates (18) is directly comparable to the WAIST Study since the actigraphy methodology and physical activity definitions were identical and the sample was comprised of psychiatrically stable and free-living adults with schizophrenia. Interestingly, adults with schizophrenia in the Lindamer study (n=16)(18) had approximately twice the physical activity levels (counts per minute, light activity, and moderate/vigorous activities) of adults in the WAIST Study (n=46). Although speculative, the difference in physical activity may be due to climate; 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(18). Also, it is possible that Lindamer's sample (18) may represent healthier adults with schizophrenia than the WAIST Study as suggested by the following characteristics of the Lindamer sample; 1) no known current, severe medical conditions, 2) greater percentage Caucasian (82%) and ever married (52%), 3) low range for psychiatric symptoms that is

typically considered psychiatrically stable (estimated average PANSS score of 44), and 5) no BMI restrictions (18).

In the second study, Jerome and associates found that moderate vigorous activity averaged approximately 17 minutes per day (n=55)(20) which compares favorably with the WAIST Study (19 minutes/day of moderate vigorous activity). In contrast to the WAIST Study, Jerome and associates found that physical activity was significantly greater in men than women and in younger versus older participants (20). The physical activity differences between these 2 studies may be partially due to the differences in the sample characteristics. The WAIST Study was restricted to only adults with schizophrenia and schizoaffective disorder while the Jerome study was composed of adults with severe mental illness defined as schizophrenia or schizoaffective disorder, bipolar disorder, or major depression(20). Unfortunately, physical activity levels by diagnosis were not presented by Jerome and associates (20). Although speculative, physical activity of adults with mood disorders may be greater than physical activity of adults with schizophrenia, or schizoaffective disorder due to the different natures of these disorders. The findings from the self-reported physical activity supports this hypothesis; adults with schizophrenia and schizoaffective disorders reported significantly less physical activity than adults with mood disorders (bipolar disorder or major depression)(51). Also, gender and age differences in diagnosis and prevalence of these severe mental illnesses may be biasing the results. Finally, it should also be noted that Jerome and associates used a less conservative definition of moderate physical activity (1316 counts/minute)(20) than the WAIST Study (1952 counts/minute) and included adults with lower BMIs (>25 versus >27 kg/m^2, respectfully). However, the age ranges were similar in both studies (18-67 years for the Jerome study and 18-65 for the WAIST Study).

In contrast to findings in other populations, the majority of the objective and subjective physical activity measures in the WAIST Study were not significantly associated with age, gender, race, or BMI. However, the WAIST study findings are consistent with other cross-sectional studies in adults with schizophrenia and/or schizoaffective disorders that have reported no association between physical activity and age (50), gender (49, 50, 55), or BMI (50, 51). A floor effect for physical activity levels may account for the non-differential effects of demographics in adults with schizophrenia or schizoaffective disorders. Specifically, the activity levels of adults with schizophrenia and schizoaffective disorders are extremely low and may

represent the minimal activity profile of an extremely sedentary population. This hypothesis is supported by the current findings that adults with schizophrenia and schizoaffective disorder had significantly lower activity levels than users of mental health services in NHANES, a population considered sedentary and exhibiting less physical activity than the general US population (65).

Unexpectedly, objective measures of physical activity were greater in smokers than non-smokers for overweight and obese adults with schizophrenia and schizoaffective disorder. Hypothetically, the smokers may have engaged in more light physical activity than non-smokers to support their cigarette smoking habit. The majority of the participants (90%) lived in community or group homes that may have required them to smoke outside due to no smoking policies. Hence the smoking participants may have acquired more steps or light physical activity to smoke cigarettes outside their home/institution than the non-smoking participants.

Although no association was observed between self-reported physical activity and smoking in the WAIST Study or among adults with severe mental illness (schizophrenia, schizoaffective disorder, bipolar disorder, and major depression) (51), these findings may actually reflect known limitations of subjective measures of physical activity rather than discrepant results. Specifically, physical activities of low-intensity, short duration, and performed intermittently, such as walking to support a smoking habit, are difficult to recall and often under-reported. For example, test-retest reliability of the YPAS for low-intensity activities were unacceptably low (0.04 for leisurely walking and 0.10 for moving) among adults with schizophrenia (n=19) (18). Hence, the sensitivity to measure the light activity associated with smoking may only be possible with objective and not subjective measures of physical activity in adults with schizophrenia and schizoaffective disorders. It should be emphasized that although the smokers exhibited higher activity counts than the non-smokers, the overall level of physical activity among the smokers was still considered extremely sedentary and significantly lower than the users of mental health users.

6.1.3 Association with psychiatric symptoms

No association was observed between the clinician's assessment of psychiatric symptoms (PANSS or CGI-S) and the subjective or objective measures of physical activity or physical fitness. Feasibly, several factors may explain this lack of association. First, the study design restricted the severity of psychiatric symptoms in the sample thus limiting the range of scores for PANSS and CGI-S. All study participants had PANSS scores that were less than 90 corresponding to experiencing only mild or moderate psychiatric symptoms. Second, the range and levels of physical activity and physical fitness levels among adults with schizophrenia and schizoaffective disorders were also extremely limited and may represent a floor effect as discussed above.

However, the WAIST study findings are consistent with other cross-sectional studies in adults with schizophrenia and/or schizoaffective disorders that have reported no association between physical activity and various psychiatric symptoms such as depression and stress (20, 50, 53) and cognitive function (20). A larger sample of adults with schizophrenia or schizoaffective disorder experiencing mild to severe psychiatric symptoms (PANSS scores ranging from 30 to 210) is necessary to fully understand the association or lack of association between physical activity, physical fitness and severity of psychiatric symptoms. Although our results between psychiatric symptoms and physical activity should be considered tentative, the WAIST Study findings provide the largest sample to date to investigate the association between symptoms of schizophrenia and schizoaffective disorders and physical activity.

6.1.4 Association with general health findings

Similar to the general population (87, 88), subjective physical activity and physical fitness exhibited a positive linear association with function in adults with schizophrenia and schizoaffective disorders in the WAIST Study. Only one other study has reported function and physical activity in adults with schizophrenia (50). Similar to the WAIST Study, higher functioning adults with schizophrenia were found to engage in more physical activities than lower functioning adults with schizophrenia (50). In addition, adults with schizophrenia who were rated by clinicians as overactive, aggressive, and disruptive were more likely to get sufficient exercise than those that did not exhibit these behaviors(50). Finally, severe social problems as measured by the Health of the Nation Outcome Scales were associated with

insufficient exercise defined as less than 150 minutes or more physical activity (walking, moderate and vigorous activity) over the preceding week (50).

Unexpectedly, objective total physical activity was not significantly associated with function in the WAIST Study. In addition, sedentary time (minutes/day and percentage of wear time) was not significantly associated with function. Due to the limited sample size (n=44) in the WAIST Study, these results should be cautiously interpreted and warrant further investigation in a larger sample.

Hypothetically, it is possible that the positive and the negative psychiatric symptoms of schizophrenia and schizoaffective disorders may influence physical activity levels and function. For example, adults with schizophrenia or schizoaffective disorder who experience many positive psychiatric symptoms may be more physically active and functioning impaired than those who experience fewer positive psychiatric symptoms. Alternatively, adults with schizophrenia or schizoaffective disorder who experience many negative psychiatric symptoms may be more sedentary and less functioning impaired than those who experience few negative psychiatric symptoms or more positive psychiatric symptoms. Additional analyses are warranted to investigate the effects of positive and negative symptoms on physical activity in adults with schizophrenia or schizoaffective disorders.

Similar to the general population (89, 90), self-reported general health status and subjective physical activity were positively associated; adults with schizophrenia or schizoaffective disorders who self-reported better general health status reported more activity. In the present study, no association was observed between general health status and physical fitness and objective physical activity among adults with schizophrenia and schizoaffective disorders. Previous studies in other populations have generally reported moderate associations between general health status and physical fitness (91) and objective measures of physical activity (92, 93). The lack of association observed between general health status and physical fitness and objective physical activity among adults with schizophrenia and schizoaffective disorders is likely due to the smaller sample size (n=44 for objective physical activity measures and n=105 for physical fitness) and the limited variability in physical fitness and objective measures of physical activity in the WAIST Study.

6.2 MEASUREMENT OF PHYSICAL ACTIVITY IN ADULTS WITH SCHIZOPHRENIA AND SCHIZOAFFECTIVE DISORDERS

The WAIST Study provides evidence that physical activity can be measured subjectively and objectively in overweight and obese adults with schizophrenia and schizoaffective disorders. In addition, physical fitness can be assessed by maximal oxygen consumption in this population.

Selection of the appropriate physical activity or fitness measures for adults with schizophrenia or schizoaffective disorders will depend on the purpose of the assessment. For patient care, subjective physical activity may be preferred to objective physical activity or fitness testing. The subjective assessment of physical activity is inexpensive, feasible in the clinic setting, and provides information on the type and context of the physical activities performed (94). This information may aid the clinician in evaluating the patient's physical activity levels as well as prescribing or promoting physical activity that is tailored to each patient.

Objective physical activity assessment and fitness levels may not be necessary or warranted in the clinical setting. The WAIST Study findings highlight that overweight and obese adults with schizophrenia or schizoaffective disorders are unfit, sedentary and primarily engage in light but not moderate or vigorous physical activities. Since the adults with schizophrenia and schizoaffective disorders were found to be considerably less active than users of mental health services and the general US population objectively, quantifying the low activity or fitness levels of individual patients may not be necessary. Other than being more expensive, time-intensive and burdensome on the patient, the objective physical activity and fitness assessments may provide little additional information that was not obtainable via self-reported physical activity.

Since few of the participants reported employment or vigorous or moderate physical activities, future studies in adults with schizophrenia and/or schizoaffective disorders may want to use a simplified and less complex subjective measure of physical activity than the modified MAQ. In particular, subject burden and data management time could be reduced by focusing minimal time and effort on age-neutral physical activities such as occupational and moderate-vigorous activities that few adults with schizophrenia or schizoaffective disorders self-report. In addition, a validated and reliable survey instrument for older adults may be an appropriate choice for studies of schizophrenia and schizoaffective disorders since both populations (older adults

and adults with schizophrenia and schizoaffective disorders) experience functional and cognitive impairments.

Although the sample sizes are small, it is interesting to note that two studies (18, 86) and the WAIST Study have reported no association between objective and subjective measures of physical activity in adults with schizophrenia or schizoaffective disorders. This lack of association between objective and subjective measures of physical activity is not unique to adults with schizophrenia or schizoaffective disorders and has been reported in other populations as well (95-98). As suggested by Troiano and associates, these findings suggest that objective and subjective measures of physical activity may be measuring different constructs (94). Hence selection of the appropriate measure of physical activity may differ depending on the focus and objectives of the research studies, public health program or campaign, and/or clinical practice.

6.3 LIMITATIONS OF WAIST STUDY

The WAIST study was limited by its ability to objectively measure physical activity in overweight and obese adults with schizophrenia or schizoaffective disorders. Only 21% of the WAIST Study participants were offered the opportunity to wear the actigraphs. Among those consented for objective physical activity monitoring, 84% provided useable actigraphy data in the WAIST Study which compares favorably with the 79-80% reported in population based studies for adults (64, 65). Similar or lower rates for useable actigraphy data have been reported in other studies that have measured physical activity in adults with schizophrenia and/or schizoaffective disorders (31-83%) (18, 20). Other studies in adults with schizophrenia or schizoaffective disorders have reported lost data due to monitor malfunctions or technical reasons (18, 19) as well as refusals to wear the activity monitor (20), or non-compliance with wearing the actigraph for 3 or more days (18, 20). These technical issues highlight the importance of actigraphy training, field experience, and technical expertise to maximize data quality and minimize data collection errors.

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. Generally, we would have expected the actigraphy cohort to be more active, and mentally and physically healthier than the non-

participants. On a positive note, this finding suggests that the actigraphy cohort's activity levels may be representative of overweight and obese adults with schizophrenia and schizoaffective disorders. On a negative note, this finding suggests that the participation rates for activity monitoring may have been limited more by the researcher's perception rather than the participant's actual ability to comply with activity monitor procedures. Feasibly, the researchers may have been more willing to offer objective monitoring of physical activity to the adults with schizophrenia or schizoaffective disorder if a less expensive device such as a pedometer had been used in the WAIST Study.

Paranoia symptoms associated with schizophrenia and schizoaffective disorders may partially explain the lower actigraphy compliance rate in this population. Higher compliance rates may be possible in adults with schizophrenia or schizoaffective disorder if the likelihood of paranoia from wearing 'a little black monitoring box' was reduced. Although speculative, objectively measuring physical activity with an unblinded pedometer rather than a blinded actigraph may improve compliance and adherence in this population. The participant may experience less paranoia wearing a physical activity monitor that is visibly providing feedback while being worn.

Another factor that may explain the lower actigraphy compliance and adherence is the severity of the mental health disorder. Schizophrenia and schizoaffective disorders are considered the most severe mental health diagnoses and associated with functional and cognitive impairments. These functional and cognitive impairments may limit the abilities of participants with schizophrenia or schizoaffective disorders to understand and comply with actigraphy monitoring in a free-living environment. During the active intervention of the WAIST Study, pedometers were used by participants to self-monitor their physical activity. Similar compliance and adherence problems were observed with the pedometers as the actigraphs i.e. pedometers were regularly lost and broken. Widely accepted actigraphy and pedometer procedures and instructions for the general population may need to be modified to accommodate the functional and cognitive impairments of adults with schizophrenia or schizoaffective disorders.

In contrast to objectively measured physical activity, subjective physical activity was measured in 98% of the WAIST Study participants. Administering the modified MAQ by interview rather than completed by the participant may have contributed to this high completion rate. Also, it should be emphasized that training of the interviewers on the administration of any

subjective measure of physical activity is essential for high quality data. Future studies may want to consider certification of interviewers for administration of specific physical activity instruments as recently suggested by Ainsworth and associates (99).

Another limitation of the WAIST Study was that the explicit diagnosis (schizophrenia or schizoaffective disorder) of each participant was not collected. Therefore, it was not possible to examine if physical activity or fitness differed between adults diagnosed with schizophrenia and adults diagnosed with schizoaffective disorder. Since schizoaffective disorder is considered less severe than schizophrenia, it would be interesting to know if physical activity or fitness levels correspond to the severity of the diagnosed mental illness.

It is also important to emphasize that the findings from this study are not representative or generalizable to all adults with schizophrenia or schizoaffective disorders. The primary objective of the WAIST Study was to evaluate the efficacy of weight reduction programs in clinically stable patients with a diagnosis of schizophrenia or schizoaffective disorders. For this reason, the adult sample was restricted to participants with BMI > 27 kg/m^2, age 18-70 years, experiencing mild to moderate psychiatric illness, prescribed two or fewer anti-psychotic medications, not hospitalized, and spontaneously expressed a desire to lose weight. In other words, this study sample represents the mentally healthiest of adults with schizophrenia and schizoaffective disorders.

In addition, adults with schizophrenia or schizoaffective disorder are probably under-represented among the users of mental health services in NHANES 2003-2004. NHANES 2003-2004 restricted the sample to non-institutionalized civilians. Residency in institutions, being homeless, or being incarcerated is not trivial among adults with schizophrenia disorders. One study estimates the prevalence of homelessness was 20% for patients with schizophrenia in San Diego county, US (100). Another study estimates suggested that approximately 10-24% of state, federal and local inmates experience psychotic disorder symptoms such as delusions and hallucinations during incarceration (101). In the WAIST study, 18-36% of the participants would <u>not</u> have been eligible for NHANES 2003-2004 due to their residency in an institution (hospital, skilled nursing facility, intermediate care facility) or being homeless. Neither NHANES 2003-2004 nor the WAIST Study would have included the prison population of adults with schizophrenia and schizoaffective disorders.

As a cross-sectional study, causality cannot be established in the WAIST Study. Longitudinal data on physical activity, BMI and psychiatric symptoms and medications may be useful in determining causal factors for improving the physical and mental health of adults with schizophrenia and schizoaffective disorders. Identification of these causal factors would assist in the planning and promotion of effective health intervention strategies targeting adults with schizophrenia and schizoaffective disorder.

6.4. STRENGTHS OF WAIST STUDY

Several strengths of the WAIST Study should be highlighted. First, only patients who met diagnostic criteria of schizophrenia and schizoaffective disorders as defined in DSM-IV-TR were eligible for the WAIST Study. Using established and accepted criteria for schizophrenia and schizoaffective disorders as well as psychiatric symptoms (PANSS) permits comparison with other studies as well as the opportunity for clinical translation. Second, the WAIST Study used three measures of physical activity and fitness to comprehensively profile the pattern of physical activity in adults with schizophrenia and schizoaffective disorders at baseline. Finally, the sample was relatively large compared to previous published studies thus permitting the exploratory analyses of the association of physical activity with psychiatric symptoms, general health status, function, and demographics among overweight and obese adults with schizophrenia and schizoaffective disorders.

Since psychiatric conditions are diagnosed subjectively without any objective measures, misdiagnosis may be a major bias in some mental health studies. Fortunately, misdiagnosis of adults with schizophrenia and schizoaffective disorder is less common than other mental health conditions for the following reasons; 1) early age of onset (typically adolescence and young adulthood), 2) typical progression of the disorder is deteriorating mental and physical health over time, 3) unique symptomology that easily differentiates schizophrenia and schizoaffective disorders from other mental health disorders, 4) considered the most severe form of mental illness along the spectrum of mental health disorders, and 5) the negative stigma associated with schizophrenia and schizoaffective disorder. Hence, over diagnosis of schizophrenia and schizoaffective disorder is unlikely. Under diagnosis of schizophrenia or schizoaffective disorders may occur in younger adults (age < 25 years) if full DSM-IV criteria for schizophrenia

or schizoaffective disorders has not been experienced or reported by the patient, or clinicians are conservative in their diagnosis. Although speculative, these under-diagnosed adults may have fewer negative and positive psychiatric symptoms and possibly exhibit different patterns of physical activity than the adults in the WAIST Study. Feasibly, the under diagnosed adults with schizophrenia and schizoaffective disorder may have greater occupational activity as well as greater function than the adults in the WAIST Study.

However, the solid study design of the WAIST Study probably minimized misdiagnosis of schizophrenia and schizoaffective disorder. First, the diagnosis for schizophrenia and schizoaffective disorders was defined according to DSM-IV-TR criteria, widely accepted as the gold standard for diagnosis of psychiatric conditions for medical treatment and research. Second, diagnosis was independently evaluated by trained clinicians rather than relying only on medical records or referrals. Finally, the diagnosis of schizophrenia or schizoaffective disorder was verified by 2 out of 3 study psychiatrists.

Overall, WAIST Study participants would be considered "mentally healthier" adults with schizophrenia and schizoaffective disorders than a random sample of adults diagnosed with schizophrenia or schizoaffective disorder. Participation in the WAIST Study was restricted to adults with schizophrenia or schizoaffective disorder who experienced mild to moderate but not severe psychiatric symptoms, were prescribed two or fewer anti-psychotics medications, and were not hospitalized. Generally, severity of the mental illness increases with number of anti-psychotic medications and hospitalization. The assumption that the WAIST Study represented "mentally healthier" adults with schizophrenia or schizoaffective disorders is supported by the clinician's evaluation that the vast majority of participants only experienced mild to moderate functional impairments, and self-reported general health status was good or fair.

Physically compared to mentally, the study sample may be more representative of adults with schizophrenia and schizoaffective disorders. Previous research has shown that adults with schizophrenia and schizoaffective disorders tend to be overweight or obese. For example, the prevalence of obesity was 3.5 times higher in persons with schizophrenia (42%, n=183) than the general Canadian population (12%)(102). In addition, only 27% of Canadians with schizophrenia had BMIs within the acceptable range(102).

Similar to BMI, the age range of the WAIST Study (18-70 years) may be representative of overweight and obese adults with schizophrenia and schizoaffective disorders. Generally, the

age of onset for schizophrenia and schizoaffective disorders is adolescence and early adulthood (prior to age 30). Second, the one-year prevalence of schizophrenic disorders was estimated to be 0.2% for adults 65+ years compared to 1.2% and 1.5% in 18-29 and 30-44 year olds, respectively, in the ECA Study (103). In addition, the odds of being diagnosed with a schizophrenic disorder at age 65+ years is slim (OR=0.12) compared to 18-29 (OR=1.0, reference) and 30-44 (OR=1.81) year olds (103). Finally, only 2% (n=124) of a large cohort of French individuals with schizophrenia (n=5756) were overweight or obese, and 60 years of age or older(104). It is interesting to note that the oldest participant in the WAIST Study was 65 years old even though 70 year olds were eligible for the study.

Also, patients with schizophrenia have been found to have a higher rate of premature death than the general population (104-106). Approximately, two-thirds of the premature deaths are due to natural causes and one-third attributed to suicide(107). Mortality of adults with schizophrenia or schizoaffective disorders has been shown to be 9-12 years earlier, on average, than the general population (105). Since life expectancy of an adult with schizophrenia or schizoaffective disorder is estimated at 57 years for men and 65 years for women(108), the age eligibility criteria used in the WAIST Study (18 to 70 years) should encompass the vast majority of adults with schizophrenia and schizoaffective disorders.

Unlike other psychiatric or medical conditions, psychiatric symptoms of adults with schizophrenia and schizoaffective disorders seldom exhibit sustained recovery(109). Instead the psychiatric symptoms tend to deteriorate over time, and often leads to chronic disability (109). Since nearly all adults with schizophrenia have their first psychotic episode by age 25 (103, 109, 110) and the mean age of onset is 20 years for men and 24 years for women(103), few, if any, are likely to be experiencing only mild and moderate psychiatric symptoms as older adults. Hence, the upper age limit of 70 is less restrictive in this population and may not limit the generalizability of the WAIST Study findings. In other words, the WAIST Study may represent well overweight and obese adults with schizophrenia or schizoaffective disorder experiencing mild or moderate psychiatric symptoms.

6.5 PUBLIC HEALTH IMPLICATIONS

From a public health perspective, the findings from the WAIST Study provide the first comprehensive profile of physical activity levels in overweight and obese adults with schizophrenia or schizoaffective disorder. Overweight and obese adults with schizophrenia or schizoaffective disorder are extremely sedentary and even less active than the general US adult population and users of mental health services. Since inactivity is a risk factor for many chronic diseases that are prevalent in this population, public health campaigns and mental health services should focus on the promotion of physical activity as one avenue to reduce the risk of medical comorbidities often experienced by adults with schizophrenia or schizoaffective disorder.

An alternative health approach may be to decrease sedentary time in adults with schizophrenia or schizoaffective disorders. This approach might be more appealing and effective since sedentary time was extremely high in adults with schizophrenia and schizoaffective disorders. Interventions to reduce sedentary behavior may focus on increasing light physical activities or interspersing light physical activities during traditionally sedentary behaviors. For example, individuals might march in place rather than sit during television commercials.

7.0 SUMMARY AND PUBLIC HEALTH SIGNIFICANCE

My dissertation work has focused on physical activity of adult populations (older men, users of mental health services, and adults with schizophrenia and schizoaffective disorders) whom may experience functional and cognitive impairments. My first report investigated the longitudinal changes in physical activity measured subjectively among older men in the MrOS study(111). Next, I compared physical activity measured objectively among users and non-users of mental health services in a representative sample of the civilian, non-institutionalized US population(65). Finally, I investigated physical activity in overweight and obese adults with schizophrenia and schizoaffective disorders. Using subjective and objective measures of physical activity, the WAIST Study provides the first comprehensive profile of physical activity in overweight and obese adults with schizophrenia and schizoaffective disorder. In addition, the WAIST Study compared physical activity levels measured objectively by accelerometry in adults with schizophrenia and schizoaffective disorder with adults who used mental health services in the general US population.

7.1 PUBLICATIONS FOR FULFILLMENT OF DOCTORAL REQUIREMENTS

A brief summary of the objectives and primary findings for each project is provided below. Copies of the published papers from the first two projects are located in Appendix C.1, C.2 and C.3 of this dissertation.

7.1.1 Summary of "Longitudinal physical activity changes among older men in the MrOS study" (111)(Appendix C.3)

Objective: "To describe the change in physical activity (total, leisure, household, occupational) in men over a mean 5-year follow-up period and to identify sociodemographic and health factors associated with change in physical activity"(111).

Summary of Primary Findings: Over the 5-year follow-up, the majority of community dwelling older men reported declines in total, occupational, leisure, and household physical activities (111). Greater declines in physical activity over time were associated with being older, living alone, smoking cigarettes, poor health, and higher blood pressure. "Although average scores declined, some older men (n=1,335, 26%) reported increasing physical activity levels. Better physical and mental health, living with others, and being younger were associated with the probability of increasing physical activity over time." (111)

7.1.2 Summary of "Gender, mental health service use and objectively measured physical activity: Data from the National Health and Nutrition Examination Survey (NHANES 2003-2004)" (65) (Appendix C.1 and C.2)

Objective: "To examine the relationship between physical activity levels measured objectively by accelerometry and the use of mental health services"(65) in a nationally representative sample of the civilian, non-institutionalized US population.

Summary of Primary Findings: Approximately 8% of the adults self-reported seeing mental health professionals during the past year. "Men who used mental health services were significantly less active than men who did not use mental health services"(65). Men who used mental health services engaged in 38 minutes less of light or moderate-vigorous physical activity per day than men who did not use mental health services. "Physical activity levels of women, regardless of mental health use, were significantly lower than men who did not use mental health services"(65). However, "there was no significant differences in the activity pattern of women who did and did not see a mental health professional during the previous year"(65). Overall, "men and women who used mental health services were relatively sedentary"(65).

7.1.3 Summary of WAIST Study

Objective One: To provide a comprehensive physical activity profile of overweight and obese adults with schizophrenia and schizoaffective disorder.

Objective Two: To compare physical activity levels measured objectively by accelerometry in overweight and obese adults with schizophrenia and schizoaffective disorder with adults who used mental health services in the general US population.

7.1.4 Summary of Primary Findings

Overweight and obese adults with schizophrenia and schizoaffective disorders were sedentary, regardless if physical activity was measured subjectively or objectively. In addition, only 2% (2/105) participants were classified as fit based on national guidelines. As expected, adults with schizophrenia and schizoaffective disorders primarily engaged in unstructured, intermittent, and low-intensity activity such as walking and housework. Occupational physical activities were extremely limited due to the low employment rate among the participants. Overweight and obese adults with schizophrenia and schizoaffective disorder were found to have significantly lower activity levels than users of mental health services in NHANES 2003-2004, a population considered sedentary and exhibiting less physical activity than the general US population.

7.2 PUBLIC HEALTH IMPLICATIONS

My dissertation work underscores that several populations with known functional and cognitive impairments have extremely sedentary lifestyles. In addition, these populations (users of mental health services and overweight and obese adults with schizophrenia and schizoaffective disorders) are significantly less physical activity than the general U.S. population. These low physical activity levels may negatively impact the mental as well as physical health of these populations. The findings from these reports provide the necessary data to justify targeting mental health populations for physical activity interventions. These findings may also aid policy makers, public and medical health professionals, and advocates and consumers for mental health to allocate the necessary resources to effectively and efficiently increase physical activity level in mental health populations.

The burden of schizophrenia is tremendous not only for the individual and but also the society. Worldwide, schizophrenia is ranked third as far as global burden of mental, neurological and substance-use disorders(112). In 2001-2002, healthcare costs of community dwelling U.S. adults with schizophrenia averaged $3726 with ambulatory care and prescriptions accounted for 75% of the expenditures (113). The investigators found that an additional 20% to 90% was added to the annual health care costs of adults with schizophrenia if the patient had a common comorbidity (diabetes, dyslipidemia, hypertension, or heart disease)(113). In other populations, physical activity has been shown to prevent or to reduce the impairments and

medical costs associated with these common medical comorbidities. Public health programs and interventions to increase physical activity and reduce sedentary time in adults with schizophrenia and schizoaffective disorders are necessary to address the elevated morbidity, mortality, and health care costs associated with the high rates of obesity, diabetes, cardiovascular disease and sedentary lifestyles observed in this population.

7.3 FUTURE DIRECTIONS

The WAIST Study findings highlight that all aspects of physical activity is extremely limited in overweight and obese adults with schizophrenia and schizoaffective disorders. The promotion of physical activity in overweight and obese adults with schizophrenia and schizoaffective disorders is not only warranted but also necessary for their health. Since walking was the most prevalent activity among adults with schizophrenia or schizoaffective disorder, interventions may want to focus on reducing sedentary behavior and increasing walking. Walking may be a sustainable physical activity among adults with schizophrenia or schizoaffective disorders for the following reasons: familiar activity that does not require learning new skills, low injury rate (114, 115), relatively inexpensive, convenient, and effective in improving fitness (116-118) and physical health (5-10), and maintaining body weight (11). In this population, interventions focusing on moderate-vigorous activities or occupational activities may not be an effective or efficient use of limited resources due to the low participation rates and the low employment rates, respectively.

Additional research on the reliability and validity of subjective measures of physical activity in adults with schizophrenia and/or schizoaffective disorders are warranted. Published reports have primarily consisted of pilot studies with small sample sizes.

Future research should focus on whether physical activity levels and patterns differ by mental health diagnosis. Hypothetically, physical activity levels may be associated with the severity of the mental illness. Individuals with severe mental illness (schizophrenia, schizoaffective disorders, bipolar disorders, and major depression) would be expected to have lower physical activity levels than less severe mental illnesses such as anxiety or obsessive compulsive disorder. Likewise within severe mental illnesses, adults with schizophrenia would be expected to have lower physical activity than adults with schizoaffective disorders, bipolar disorders, or major depression. Adults experiencing depression (bipolar or major depression)

would be expected to have lower activity levels than adults with bipolar disorder experiencing hypomania, mania or a mixed mood state. These differences in physical activity levels and patterns may not only be associated with the severity of the disorder but also the symptoms of the disorders and the anti-psychotic medications prescribed for treatment of the disorder. Understanding these differences may shed light on possible mechanisms and treatments for improving the mental and physical health of adults with severe mental illnesses.

Additional research is also warranted on the role of physical activity on mental and physical health for specific mental health conditions and symptoms. A considerable body of research literature exists for the beneficial effects of physical activity on depression. However, the effects of physical activity on the other severe mental illnesses (schizophrenia, schizoaffective, and bipolar disorders) is sparse. Hypothetically, physical activity may be beneficial for the physical health for adults with schizophrenia and schizoaffective disorders but have little influence on the course of the mental health disorder. In contrast, physical activity may be beneficial for the mental and physical health of adults with bipolar disorder.

It is unknown whether national guidelines for physical activity that were developed for the general population are sufficient or appropriate for adults with severe mental illness especially those diagnosed with schizophrenia, schizoaffective, or bipolar disorders. McLeod and associates have hypothesized that adults with schizophrenia or schizoaffective disorder may need to more physically active than the general population to counteract the known negative side effects of poor diet and psychiatric medications on weight (50). The same hypothesis would be valid among adults with bipolar disorder. Thus, additional research is warranted to determine the optimal frequency, dose, duration, and type of physical activity to promote the mental and physical health of adults with specific mental health disorders.

As previously mentioned, additional research on physical activity in adults with schizophrenia and schizoaffective disorders is also warranted. The WAIST Study reported the association between physical activity and overall psychiatric symptoms as measured by the total PANSS score and CGI-S. Investigating the association of physical activity with the various subscales for PANSS (negative, positive, and general symptoms) may be informative especially for a better understanding of the observed association between smoking and physical activity in the WAIST Study. Determining if physical activity levels or patterns differ by specific diagnosis (schizophrenia versus schizoaffective disorders) may also be informative.

Future studies may want to characterize physical activity levels and patterns of adults with schizophrenia and schizoaffective disorders experiencing moderate to severe psychiatric symptoms since the WAIST Study was restricted to adults experiencing mild to low moderate psychiatric symptoms. The current literature suggests cultural differences between Australia, France and North American countries in the amount and type of physical activities among adults with schizophrenia and schizoaffective disorders. Understanding these cultural differences (lifestyle, medical care, residency, family and/or community support) may be informative and potentially guide improvements in clinical as well as public health practices.

Another interesting line of investigation would be the effect of physical activity on function and quality of life for adults with schizophrenia and schizoaffective disorders. Although limited, encouraging findings have been reported by two studies. First, McLeod and associates found that physically active adults with schizophrenia and schizoaffective disorder had fewer psychiatric hospitalizations over a three year period (50). Second, the WAIST Study found that less functional impairments were observed among the more active participants. Hence, physical activity may be one avenue to improve the poor functional outcomes primarily associated with the "negative symptoms (loss of will, anhedonia, poverty of thought) and cognitive deficits (reduced working memory, poor cognitive control)"(109) of schizophrenia and schizoaffective disorders. In addition, physical activity should positively impact the common medical comorbidities of schizophrenia, such as obesity, diabetes, and poor cardiovascular health that often leads to chronic disability and premature death.

Even though the number of studies are limited, the WAIST Study and previously published reports have consistently found that adults with schizophrenia or schizoaffective disorders are sedentary regardless how physical activity is measured. By describing and quantifying the physical activity levels of overweight and obese adults with schizophrenia and schizoaffective disorders, the WAIST Study provides a solid foundation for further studying the effects of physical activity on the psychiatric and physical health of adults with schizophrenia and schizoaffective disorders. Physical activity may be one avenue to address the severe medical complications, functional impairments, and premature morbidity and mortality observed among adults with schizophrenia and schizoaffective disorders.

APPENDIX A: STUDY MEASUREMENTS

A.1 Modified Modifiable Activity Questionnaire (MAQ)(33)

Interviewer: Read through the list of activities in each section (work, gardening/yardwork, caretaking, and leisure). For each activity, ask the participant to indicate whether he/she did that activity for *10 minutes or longer* during the **past week**. For all activities the individual responded "yes" to ask how much time (minutes per week) they spent doing this activity during the **past week**. If needed, use the worksheet provided.

Housework

Activity	**Yes or No**	**Time (mins/wk)**
Shopping (grocery, clothes)	□ Yes □ No	
Laundry (time loading, unloading, hanging, folding only)	□ Yes □ No	
Light Housework (tidying, dusting, sweeping, collecting trash in home, polishing, indoor gardening, ironing)	□ Yes □ No	
Heavy Housework (vacuuming, mopping, scrubbing floors or walls, moving furniture, boxes, or garbage bags)	□ Yes □ No	
Food Preparation (chopping, stirring, moving about to get food items or pans)	□ Yes □ No	
Food Service (setting table, washing/drying dishes, putting dishes away)	□ Yes □ No	
Dish Washing (clearing table, washing/drying dishes, putting dishes away)	□ Yes □ No	
Light Home Repair (small appliance repair, light home maintenance/repair)	□ Yes □ No	
Heavy Home Repair (painting, carpentry, washing/polishing car)	□ Yes □ No	
Other	□ Yes □ No	

Gardening/Yardwork

Activity	**Yes or No**	**Time (mins/wk)**
Gardening (planting, weeding, digging, hoeing)	□ Yes □ No	
Lawn Mowing (walking only)	□ Yes □ No	
Cleaning Walks/Driveway (sweeping, shoveling, raking)	□ Yes □ No	
Other	□ Yes □ No	

Caretaking

Activity	**Yes or No**	**Time (mins/wk)**
Older or disabled person (lifting, pushing wheelchair)	□ Yes □ No	
Childcare (lifting, carrying, pushing stroller)	□ Yes □ No	
Other	□ Yes □ No	

Transportation

Activity	Yes or No	Time (mins/wk)
Walking (to a store, church, friend's house, volunteer work, paid work, etc.) * *Do not include walking for exercise*	□ Yes □ No	
Bicycling (to a store, church, friend's house, volunteer work, paid work, etc.) * *Only include pedal bicycling. Do not include bicycling for exercise*	□ Yes □ No	
Other	□ Yes □ No	

Leisure

Activity	Yes or No	Time (mins/wk)
Jogging (outdoor, treadmill)	□ Yes □ No	
Swimming (laps, snorkeling)	□ Yes □ No	
Bicycling (indoor, outdoor) **Only include pedal bicycling. Do not include bicycling for transportation*	□ Yes □ No	
Softball/Baseball	□ Yes □ No	
Bowling	□ Yes □ No	
Basketball	□ Yes □ No	
Calisthenics/Toning Exercises	□ Yes □ No	
Wood Chopping	□ Yes □ No	
Aerobic Dance/Step Aerobics	□ Yes □ No	
Strength/Weight Training	□ Yes □ No	
Jumping Rope	□ Yes □ No	
Yoga	□ Yes □ No	
Pilates	□ Yes □ No	
Walking for Exercise * *Do not include walking for transportation*	□ Yes □ No	
Other	□ Yes □ No	

Please answer the following questions pertaining to the **past week**.

	Hours	Minutes
On average, how many hours of sleep did you get each night?		
On average, how many hours do you nap per day?		
3. On average, how many hours do you usually spend watching television, videos,/DVDs, or playing video games?		

4. Do you have difficulty doing any of the following activities?	Yes	No
a. Getting in or out of bed?	□	□
b. Walking across a small room without resting?	□	□
c. Walking for 10 minutes without resting?	□	□

List all JOBS that the individual held over the past week. If unemployed, disabled, retired, homemaker, student during all or part of the past week, list as such and probe for job activities of a normal 8 hour day, 5 day week.

PAST WEEK JOB SCHEDULE			Out of the total # of "Hrs/Day" the individual reported working at this "job", how much of this time was usually spent sitting? Enter this # in "Hrs Sitting" column, then place a check "✓" in the category which best describes their job activities when they were not sitting.			
			Hrs spent sitting at work	Check the category that best describes job activities when not sitting		
Job Name	Day/Wk	Hrs/Day	Hrs Sitting	A	B	C

Category A (includes all sitting activities)	**Category B** (includes most indoor activities)	**Category C** (heavy industrial work, outdoor construction, farming)
Sitting	Carrying light loads	Carrying moderate to heavy loads
Standing still w/o heavy lifting	Continuous walking	Heavy construction
Light cleaning (ironing, cooking, washing, dusting)	Heavy cleaning (mopping, sweeping, scrubbing, vacuuming)	Farming (hoeing, digging, mowing, raking)
Driving a bus, taxi, tractor	Gardening (planting, weeding)	Digging ditches, shoveling
Jewelry making/weaving	Painting/Plastering	Chopping (ax), sawing wood
General office work	Plumbing/Welding	Tree/pole climbing
Occasional/short distance walking	Electrical work	Water/coal/wood hauling
	Sheep herding	

For Interviewer

In general, during the past week, were there any days that were not conducive to outdoor activity?

Yes □ No □

a. If yes, how many days during the past week were not conductive to outdoor activity?

_____ days

MET Values assigned to MAQ items

Housework

ACTIVITY	METS Value
Shopping (grocery, clothes)	2.3
Laundry (time loading, unloading, hanging, folding only)	2.3
Light Housework (tidying, dusting, sweeping, collecting trash in home, polishing, indoor gardening, ironing)	2.5
Heavy Housework (vacuuming, mopping, scrubbing floors or walls, moving furniture, boxes, or garbage bags)	3.5
Food Preparation (chopping, stirring, moving about to get food items or pans)	2.0
Food Service (setting table, washing/drying dishes, putting dishes away)	2.5
Dish Washing (clearing table, washing/drying dishes, putting dishes away)	2.3
Light Home Repair (small appliance repair, light home maintenance/repair)	3.0
Heavy Home Repair (painting, carpentry, washing/polishing car)	4.5

Gardening/Yardwork

ACTIVITY	METS Value
Gardening (planting, weeding, digging, hoeing)	3.5
Lawn Mowing (walking only)	5.5
Cleaning Walks/Driveway (sweeping, shoveling, raking)	4.5

Caretaking

ACTIVITY	METS Value
Older or disabled person (lifting, pushing wheelchair)	4.0
Childcare (lifting, carrying, pushing stroller)	4.0

Transportation

ACTIVITY	METS Value
Walking (to a store, church, friend's house, volunteer work, paid work, etc.) * *Do not include walking for exercise*	3.5
Bicycling (to a store, church, friend's house, volunteer work, paid work, etc.) * *Only include pedal bicycling. Do not include bicycling for exercise*	4.5

Leisure

ACTIVITY	METS Value
Jogging (outdoor, treadmill)	7.0
Swimming (laps, snorkeling)	7.0
Bicycling (indoor, outdoor) **Only include pedal bicycling. Do not include bicycling for transportation*	4.5
Softball/Baseball	4.0
Bowling	2.5
Basketball	7.0
Calisthenics/Toning Exercises	4.0
Wood Chopping	6.0
Aerobic Dance/Step Aerobics	6.0
Strength/Weight Training	4.5
Jumping Rope	9.0
Yoga	3.0
Pilates	4.5
Walking for Exercise* *Do not include walking for transportation*	3.5

JOB

ACTIVITY	METS Value
Category A	0.0
Category B	4.0
Category C	7.0

A.2 PSYCHIATRIC ASSESSMENTS

A.2.1 Positive and Negative Syndrome Scale (PANSS)(71)

POSITIVE AND NEGATIVE SYNDROME SCALE FOR SCHIZOPHRENIA (PANSS)
Enter the appropriate score for each item, refer to the Rating Manual for item definitions, description of anchoring points and scoring procedures

Positive Subscale	Absent 1	Minimal 2	Mild 3	Moderate 4	Moderate Severe 5	Severe 6	Extreme 7
P1 Delusions	□	□	□	□	□	□	□
P2 Conceptual Disorganization	□	□	□	□	□	□	□
P3 Hallucinatory Behavior	□	□	□	□	□	□	□
P4 Excitement	□	□	□	□	□	□	□
P5 Grandiosity	□	□	□	□	□	□	□
P6 Suspiciousness/ persecution	□	□	□	□	□	□	□
P7 Hostility	□	□	□	□	□	□	□
							Subtotal □□

Negative Subscales	Absent 1	Minimal 2	Mild 3	Moderate 4	Moderate Severe 5	Severe 6	Extreme 7
N1 Blunted affect	□	□	□	□	□	□	□
N2 Emotional withdrawal	□	□	□	□	□	□	□
N3 Poor rapport	□	□	□	□	□	□	□
N4 Passive/apathetic social withdrawal	□	□	□	□	□	□	□
N5 Difficulty in abstract thinking	□	□	□	□	□	□	□
N6 Lack of spontaneity and flow of conversation	□	□	□	□	□	□	□
N7 Stereotyped thinking	□	□	□	□	□	□	□
							Subtotal □□

General Psychopathology Subscales	Absent 1	Minimal 2	Mild 3	Moderate 4	Moderate Severe 5	Severe 6	Extreme 7
G1 Somatic Concern	□	□	□	□	□	□	□
G2 Anxiety	□	□	□	□	□	□	□
G3 Guilt feelings	□	□	□	□	□	□	□
G4 Tensions	□	□	□	□	□	□	□
G5 Mannerisms and posturing	□	□	□	□	□	□	□
G6 Depression	□	□	□	□	□	□	□
G7 Motor retardation	□	□	□	□	□	□	□
G8 Uncooperativeness	□	□	□	□	□	□	□
G9 Unusual thought content	□	□	□	□	□	□	□
G10 Disorientation	□	□	□	□	□	□	□
G11 Poor attention	□	□	□	□	□	□	□
G12 Lack of judgment and insight	□	□	□	□	□	□	□
G13 Disturbance of volition	□	□	□	□	□	□	□
G14 Poor impulse control	□	□	□	□	□	□	□
G15 Preoccupation	□	□	□	□	□	□	□
G16 Active social avoidance	□	□	□	□	□	□	□
							Subtotal □□
Raters Initials ___ ___ ____							Total □□□

A.2.2 Clinical Global Impression of Severity (CGIS)(72, 73)

Severity of Illness

Considering your total clinical experience with this particular population, how mentally ill is the patient at this time?

□0 = Not Assessed
□1 = Not Ill
□2 = Very Mild
□3 = Mild
□4 = Moderate
□5 = Severe
□7 = Extremely Severe

A.3 FUNCTION AND HEALTH STATUS ASSESSMENTS

A.3.1 Global Assessment of Functioning (GAF) Scale (3)

Instructions: Consider psychological, social, and occupational functioning on a hypothetical continuum of mental health-illness. Do not include impairment in functioning due to physical (or environmental) limitations. Code. (Note: Use intermediate codes when appropriate eg 45, 68, 72)

Rater _____

GAF Rating: _____

91 - 100 Superior functioning in a wide range of activities, life's problems never seem to get out of hand, is sought out by others because of his or her many positive qualities. No symptoms.
81 - 90 Absent or minimal symptoms (e.g., mild anxiety before an exam), good functioning in all areas, interested and involved in a wide range of activities, socially effective, generally satisfied with life, no more than everyday problems or concerns (e.g., an occasional argument with family members).
71 - 80 If symptoms are present, they are transient and expectable reactions to psychosocial stressors (e.g., difficulty concentrating after family argument); no more than slight impairment in social, occupational, or school functioning (e.g., temporarily falling behind in schoolwork).
61 - 70 Some mild symptoms (e.g., depressed mood and mild insomnia) OR some difficulty in social, occupational, or school functioning (e.g., occasional truancy, or theft within the household), but generally functioning pretty well, has some meaningful interpersonal relationships.
51 - 60 Moderate symptoms (e.g., flat affect and circumstantial speech, occasional panic attacks) OR moderate difficulty in social, occupational, or school functioning (e.g., few friends, conflicts with peers or co-workers).
41 - 50 Serious symptoms (e.g., suicidal ideation, severe obsessional rituals, frequent shoplifting) OR any serious impairment in social, occupational, or school functioning (e.g., no friends, unable to keep a job).
31 - 40 Some impairment in reality testing or communication (e.g., speech is at times illogical, obscure, or irrelevant) OR major impairment in several areas, such as work or school, family relations, judgment, thinking, or mood (e.g., depressed man avoids friends, neglects family, and is unable to work; child frequently beats up younger children, is defiant at home, and is failing at school).
21 - 30 Behavior is considerably influenced by delusions or hallucinations OR serious impairment, in communication or judgment (e.g., sometimes incoherent, acts grossly inappropriately, suicidal preoccupation) OR inability to function in almost all areas (e.g., stays in bed all day, no job, home, or friends)
11 - 20 Some danger of hurting self or others (e.g., suicide attempts without clear expectation of death; frequently violent; manic excitement) OR occasionally fails to maintain minimal personal hygiene (e.g., smears feces) OR gross impairment in communication (e.g., largely incoherent or mute).
1 - 10 Persistent danger of severely hurting self or others (e.g., recurrent violence) OR persistent inability to maintain minimal personal hygiene OR serious suicidal act with clear expectation of death.
0 Inadequate Information

A.3.2 General Health Status Question from Medical Outcomes Study Short Form Health Survey (SF-12) (74)

Instructions: This questionnaire asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities.

Please answer every question by marking one box. If you are unsure about how to answer: please give the best answer you can

1. In general, would you say your health is:

□	□	□	□	□
Excellent	Very Good	Good	Fair	Poor

A.3.3 Living Situation from the Quality of Life Interview (Brief Version) (77)

1. LIVING SITUATION

"What is your current living situation?"
(Interviewer: IF RESPONDENT IS CURRENTLY IN THE HOSPITAL AND THIS HOSPITALIZATION HAS LASTED LESS THAN 3 MONTHS, USE LIVING SITUATION JUST PRIOR TO HOSPITALIZATION. IF THE HOSPITALIZATION HAS BEEN FOR 3 MONTHS OR MORE, CODE "HOSPITAL"). IF HOMELESS (CODE 13 OR 15)

	(Circle #)
Hospital	1
Skilled nursing facility – 24 hour nursing service	2
Intermediate care facility – less than 24 hour nursing care facility	3
Supervised group living (generally long term)	4
Transitional group home (halfway or quarterway house)	5
Family foster care	6
Cooperative apartment, supervised (staff on premise)	7
Cooperative apartment, unsupervised (staff not on premise)	8
Board and care home (private proprietary home for adults, with program and supervision)	9
Boarding house (includes meals, no program or supervision)	10
Rooming or boarding house or hotel (includes single room occupancy, no meals are provided, cooking facilities may be available)	11
Private house or apartment	12
Shelter	13
Jail	14
No current residence (including the streets, bus stations, missions, etc)	15
Other	16
No information	99

B. Supplemental Tables

Table A-1 Continuous demographic and health information for overweight and obese adults with schizophrenia or schizoaffective disorder by MAQ Administration (WAIST Study) (n=258).

Variable	Waist Study (n=258)	MAQ Cohort (n=252)	MAQ not administered (n=6)
Age (yrs)			
Mean ± STD	45.0 ± 10.5	44.7 ± 10.3	57.7 ± 8.4
Median	47.0	47.0	60.0
Range	18.0, 65.0	18.0, 63.0	45.0, 65.0
95% CI	37.0, 53.0	36.5, 53.0	51.0, 65.0
N (missing)	258 (0)	252 (0)	6 (0)
BMI (kg/m^2)			
Mean ± STD	38.0 ± 8.0	38.0 ± 7.9	37.3 ± 11.0
Median	37.0	37.0	37.3
Range	27.0, 83.4	27.0, 83.4	27.2, 57.5
95% CI	32.0, 41.6	32.3, 41.5	28.2, 49.7
N (missing)	258 (0)	252 (0)	6 (0)
Positive and Negative Syndrome Scale (PANSS) [a]			
Mean ± STD	55.7 ± 11.8	55.7 ± 11.8	56.2 ± 13.1
Median	56.0	60.0	57.0
Range	30.0, 89.0	30, 89	43, 66
95% CI	48.0, 63.0	48.0, 63.0	48.0, 63.0
N (missing)	258 (0)	252 (0)	6 (0)
Global Assessment of Functioning Scale (GAF) [a]			
Mean ± STD	59.4 ± 7.5	59.4 ± 7.6	59.2 ± 5.2
Median	60.0	60.0	61.0
Range	35.0, 88.0	35.0, 88.0	50.0, 62.0
95% CI	54.0, 65.0	54.0, 65.0	61.0, 62.0
N (missing)	231 (27)	226 (16)	5 (1)

Table A-2 Categorical demographic and health information for overweight and obese adults with schizophrenia or schizoaffective disorder by MAQ administration (WAIST Study) (n=258)

.

Variable N (%)	Waist Study (n=258)	MAQ Cohort (n=252)	MAQ not administered (n=6)
Gender			
Men	92 (35.7)	90 (35.7)	2 (33.3)
Women	166 (64.3)	162 (64.3)	4 (66.7)
Age Category			
18-39 yrs	70 (27.1)	70 (27.8)	0 (0)
40-49 yrs	86 (33.3)	85 (33.7)	1 (16.7)
50-65 yrs	102 (39.5)	97 (38.5)	5 (83.3)
BMI categories			
Overweight (27.0-29.9 kg/m^2)	33 (12.8)	30 (11.9)	3 (50.0)
Obese (30.0-39.9 kg/m^2)	146 (56.6)	145 (57.5)	1 (16.7)
Extreme Obese (40.0 $^+$ kg/m^2)	79 (30.6)	77 (30.6)	2 (33.3)
Race			
White/Caucasian	128 (49.6)	124 (49.2)	4 (66.7)
Black/ African American	124 (48.1)	122 (48.4)	2 (33.3)
Other	6 (2.3)	6 (2.4)	0 (0)
Marital Status			
Never Married	160 (62.0)	158 (62.7)	2 (33.3)
Married	20 (7.8)	20 (7.9)	0 (0)
Separated/Divorced	43 (16.7)	40 (15.8)	3 (50.0)
Widowed	0 (0)	0 (0)	0 (0)
Don't Know/Refused	35 (13.6)	34 (13.5)	1 (16.7)
Education			
< High School	29 (11.2)	27 (10.7)	2 (33.3)
High School Graduate	90 (34.9)	89 (35.3)	1 (16.7)
College Educated	91 (35.3)	89 (35.3)	2 (33.3)
Don't Know/Refused	48 (18.6)	47 (18.7)	1 (16.7)
Employment			
Unemployed	179 (69.4)	176 (69.8)	3 (50.0)
Employed	44 (17.1)	42 (16.7)	2 (33.3)
Occupational/Vocational Therapy	3 (1.2)	3 (1.2)	0 (0)
Precision Production Crafts or Repairs	1 (0.4)	1 (0.4)	0 (0)
Volunteer	4 (1.6)	3 (1.2)	1 (16.7)
Professional Specialty	4 (1.6)	4 (1.6)	0 (0)
Other Services	14 (5.4)	14 (5.6)	0 (0)
Administrative or clerical support	5 (1.9)	5 (2.0)	0 (0)
Transportation or material moving	2 (0.8)	2 (0.8)	0 (0)
Technician and related support	2 (0.8)	2 (0.8)	0 (0)
Handlers, equipment cleaners, helpers	4 (1.6)	3 (1.2)	1 (16.7)
Sales	5 (1.9)	5 (2.0)	0 (0)
Don't Know/Refused	35 (13.6)	34 (13.5)	1 (16.7)
Current Smoker			
No	144 (55.8)	141 (56.0)	3 (50.0)
Yes	114 (44.2)	111 (44.1)	3 (50.0)

Table A-2 (continued) Categorical demographic and health information for overweight and obese adults with schizophrenia or schizoaffective disorder by MAQ administration (WAIST Study) (n=258).

Variable N (%)	Waist Study (n=258)	MAQ Cohort (n=252)	MAQ not administered (n=6)
Medications			
Aripiprazole	36 (14.0)	35 (13.9)	1 (16.7)
Clozapine	47 (18.2)	46 (18.3)	1 (16.7)
Haloperidol	1 (0.4)	1 (0.4)	0 (0)
Olanzapine	25 (9.7)	25 (9.9)	0 (0)
Polypharmacy	45 (17.4)	43 (17.1)	2 (33.3)
Quetiapine	29 (11.2)	29 (11.5)	0 (0)
Risperidone	61 (23.6)	59 (23.4)	2 (33.3)
Ziprasidone	14 (5.4)	14 (5.6)	0 (0)
Antipsychotic Medication			
Single	213 (82.6)	209 (82.9)	4 (66.7)
Polypharmacy	45 (17.4)	43 (17.1)	2 (33.3)
Weight Gaining Properties of single anti-psychotic medications (n=213)			
High	72 (33.8)	71 (34.0)	1 (25.0)
Low/Moderate	91 (42.7)	89 (42.6)	2 (50.0)
No	50 (23.5)	49 (23.4)	1 (25.0)
Clinical Global Impression of Severity (CGI-S)[a]			
Normal, not mentally ill	6 (2.3)	6 (2.4)	0 (0)
Very mild mental illness	13 (5.0)	13 (5.2)	0 (0)
Mild mental illness	83 (32.2)	81 (32.1)	2 (33.3)
Moderate mental illness	123 (47.7)	120 (47.6)	3 (50.0)
Severe mental illness	4 (1.6)	4 (1.6)	0 (0)
Extremely severe mental illness	0 (0)	0 (0)	0 (0)
Not Assessed	29 (11.2)	0 (0)	1 (16.7)
Positive and Negative Syndrome Scale PANSS)[a]			
Mild illness (<60)	170 (65.9)	166 (65.9)	4 (66.7)
Moderate illness (60-129)	88 (34.1)	86 (34.1)	2 (33.3)
Severe illness (≥130)	0 (0)	0 (0)	0 (0)
Global Assessment of Functioning Scale (GAF) Categories[a]			
Impairment (31-40)	2 (0.8)	2 (0.8)	0 (0)
Serious symptoms (41-50)	14 (5.4)	13 (5.2)	1 (16.7)
Moderate symptoms (51-60)	111 (43.0)	111 (44.1)	0 (0)
Mild symptoms (61-70)	91 (35.3)	87 (34.5)	4 (66.7)
Transient symptoms (71-80)	11 (4.3)	11 (4.4)	0 (0)
Symptoms absent or minimal (81-90)	2 (0.8)	2 (0.8)	0 (0)
Superior functioning (91-100)	0 (0)	0 (0)	0 (0)
Inadequate Information to assess	27 (10.5)	26 (10.3)	1 (16.7)

Table A-2 (continued) Categorical demographic and health information for overweight and obese adults with schizophrenia or schizoaffective disorder by MAQ administration (WAIST Study) (n=258)

Variable N (%)	Waist Study (n=258)	MAQ Cohort (n=252)	MAQ not administered (n=6)
Global Assessment of Functioning Scale (GAF) Categories [a]			
Impairments and serious symptoms	16 (6.2)	15 (6.0)	1 (16.7)
Moderate symptoms	111 (43.0)	111 (44.1)	0 (0)
Mild or absent symptoms	104 (40.3)	100 (39.7)	4 (66.7)
Inadequate information to assess	27 (10.5)	26 (10.3)	1 (16.7)
General Health Status [b]			
Excellent	13 (5.0)	13 (5.2)	0 (0)
Very good	32 (12.4)	29 (11.5)	3 (50.0)
Good	84 (32.6)	84 (33.3)	0 (0)
Fair	83 (32.2)	83 (32.9)	0 (0)
Poor	35 (13.6)	33 (13.1)	2 (33.3)
Missing	11 (4.3)	10 (4.0)	1 (16.7)
General Health Status[b] [N (%)]			
Excellent, Very good, or Good	129 (50.0)	126 (50.0)	3 (50.0)
Fair or Poor	118 (45.7)	116 (46.0)	2 (33.3)
Missing	11 (4.3)	10 (4.0)	1 (16.7)
Living Situation[b] [N (%)]			
Hospital	5 (1.9)	5 (2.0)	0 (0)
Skilled nursing facility	23 (8.9)	23 (9.1)	0 (0)
Intermediate care facility	18 (7.0)	17 (6.8)	1 (16.7)
Supervised group living	46 (17.8)	46 (18.3)	0 (0)
Transitional group home	51 (19.8)	48 (19.1)	3 (50.0)
Family foster care	68 (26.4)	68 (27.0)	0 (0)
Supervised cooperative apartment	40 (15.5)	38 (15.1)	2 (33.3)
Board and care home	1 (0.4)	1 (0.4)	0 (0)
Not assessed	6 (2.3)	6 (2.4)	0 (0)

Table A-3 Subjective physical activity [Modified MAQ (METS per week)] for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) by gender (n=252).

Modified MAQ (METS/wk)	MAQ Cohort (n=252)	Female (n=162)	Male (n=90)	p-value for Kruskal-Wallis Test
Occupational				0.09
Mean ± STD	214.0 ± 987.7	156.7 ± 905.8	316.4 ± 1117.2	
Median	0	0	0	
Range	0, 7200.0	0, 7200.0	0, 6000.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	245 (7)	157 (5)	88 (2)	
Housework				0.0008
Mean ± STD	999.5 ± 1266.1	1152.9 ± 1375.8	723.5 ± 988.2	
Median	576.5	714.3	384.3	
Range	0, 7830.0	0, 7830.0	0, 6639.0	
25th, 75th percentile	258.5, 1281.3	356.1, 1429.0	195.5, 789.0	
N (missing)	252 (0)	162 (0)	90 (0)	
Gardening/Yardwork				0.09
Mean ± STD	39.6 ± 220.3	32.1 ± 239.7	53.1 ± 180.7	
Median	0	0	0	
Range	0, 2940.0	0, 2940.0	0, 1080.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	252 (0)	162 (0)	90 (0)	
Caretaking				0.30
Mean + STD	86.4 ± 499.0	91.5 ± 524.6	77.3 ± 452.0	
Median	0	0	0	
Range	0, 5040.0	0, 5040.0	0, 3360.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	252 (0)	162 (0)	90 (0)	
Transportation				0.13
Mean ± STD	152.0 ± 295.3	148.6 ± 317.7	158.1 ± 251.5	
Median	0	0	70.0	
Range	0, 2940	0, 2940.0	0, 1260.0	
25th, 75th percentile	0, 210.0	0, 210.0	0, 210.0	
N (missing)	252 (0)	162 (0)	90 (0)	
Leisure				0.89
Mean ± STD	338.5 ± 639.1	375.0 ± 691.5	273.5 ± 530.9	
Median	60.0	37.5	80.0	
Range	0, 4530	0, 4530.0	0, 3240.0	
25th, 75th percentile	0, 405.0	0, 450.0	0, 315.0	
N (missing)	250 (2)	160 (2)	90 (0)	
Total				0.32
Mean ± STD	1803.0 ± 2097.6	1934.1 ± 2303.2	1572.2 ± 1662.6	
Median	1027.5	1168.5	897.3	
Range	0, 11715.0	0, 11715.0	0, 7231.5	
25th, 75th percentile	35.0, 2332.0	427.0, 2314.5	416.9, 2446.0	
N (missing)	243 (9)	155 (7)	88 (2)	

Table A-3 (continued) Subjective physical activity [Modified MAQ (METS per week)] for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) by gender (n=252).

Modified MAQ (METS/wk)	MAQ Cohort (n=252)	Female (n=162)	Male (n=90)	p-value for Kruskal-Wallis Test
Total w/o occupational activities				0.05
Mean ± STD	1608.4 ± 1849.7	1790.1 ± 2042.2	1285.5 ± 1398.72	
Median	993.5	1107.5	727.3	
Range	0, 11190.0	0, 11190.0	0, 7231.5	
25th, 75th percentile	413.0, 2181.5	472.0, 2296.5	382.0, 1581.5	
N (missing)	250 (2)	160 (2)	90 (0)	
Total w/o household activities				0.41
Mean ± STD	695.5 ± 1212.0	670.9 ± 1211.5	738.7 ± 1218.4	
Median	280.0	270.0	302.5	
Range	0, 8715.0	0, 8715.0	0, 6070.0	
25th, 75th percentile	35.0, 780.0	0, 807.5	87.5, 682.5	
N (missing)	243 (9)	155 (7)	88 (2)	

Table A-4 Subjective physical activity [Modified MAQ (METS per week)] for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) by race (n=246)[a].

Modified MAQ (METS/wk)	White (n=124)	Black (n=122)	p-value for Kruskal-Wallis Test
Occupational			0.10
Mean ± STD	287.8 ± 1080.8	152.7 ± 912.8	
Median	0	0	
Range	0, 7200.0	0, 7200.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	118 (6)	121 (1)	
Housework			0.48
Mean ± STD	934.9 ± 1233.0	1060.4 ± 1318.3	
Median	577.5	566.8	
Range	0, 7830.0	0, 6804.0	
25th, 75th percentile	245.2, 1079.8	279.0, 1429.0	
N (missing)	124 (0)	122 (0)	
Gardening/Yardwork			0.51
Mean + STD	58.8 ± 300.3	16.3 ± 66.1	
Median	0	0	
Range	0, 2940.0	0, 420.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	124 (0)	122 (0)	
Caretaking			0.75
Mean + STD	72.1 ± 419.3	105.2 ± 580.5	
Median	0	0	
Range	0, 3360.0	0, 5040.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	124 (0)	122 (0)	
Transportation			0.94
Mean ± STD	173.4 ± 356.3	127.3 ± 199.0	
Median	0	17.5	
Range	0, 2940.0	0, 1260.0	
25th, 75th percentile	0, 210.0	0, 210.0	
N (missing)	124 (0)	122 (2)	
Leisure			0.95
Mean ± STD	303.1 ± 544.4	380.5 ± 735.4	
Median	68.8	17.5	
Range	0, 3240.0	0, 4530.0	
25th, 75th percentile	0, 367.5	0, 446.3	
N (missing)	124 (0)	120 (2)	

[a] n=1 for other race; size of other race category considered insufficient to include in analyses or summary tables

Table A-4 (continued) Subjective physical activity [Modified MAQ (METS per week)] for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) by race (n=246)[a].

Modified MAQ (METS/wk)	White (n=124)	Black (n=122)	p-value for Kruskal-Wallis Test
Total			0.72
Mean ± STD	1774.1 ± 1954.4	1839.2 ± 2265.2	
Median	1061.0	1014.0	
Range	0, 11190.0	0, 11715.0	
25th, 75th percentile	467.0, 2370.0	408.0, 2314.5	
N (missing)	118 (6)	119 (3)	
Total w/o occupational activities			0.90
Mean ± STD	1542.3 ± 1718.4	1674.5 ± 1999.2	
Median	1000.8	954.5	
Range	0, 11190.0	0, 10872.5	
25th, 75th percentile	466.5, 2052.3	398.0, 2293.5	
N (missing)	124 (0)	120 (2)	
Total w/o household activities			0.34
Mean ± STD	734.6 ± 1181.6	669.5 ± 1269.8	
Median	303.8	270.0	
Range	0, 7200.0	0, 8715.0	
25th, 75th percentile	70.0, 840.0	0, 690.0	
N (missing)	118 (6)	119 (3)	

[a] n=1 for other race; size of other race category considered insufficient to include in analyses or summary tables

Table A-5 Subjective physical activity [Modified MAQ (METS per week)] by age groups for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) (n=252).

Modified MAQ Physical Activity (METS/wk)	**18-39 yrs (n=70)**	**40-49 yrs (n=85)**	**50-65 yrs (n=97)**	**p-value for Kruskal-Wallis Test**
Occupational				0.29
Mean ± STD	271.8 ± 1110.3	115.7 ± 763.9	259.1 ± 1069.5	
Median	0	0	0	
Range	0, 7200.0	0, 6000	0, 7200.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	68 (2)	83 (2)	94 (3)	
Housework				0.29
Mean ± STD	851.2 ± 1103.8	997.0 ± 1280.5	1108.8 ± 1361.0	
Median	477.3	586.5	590.0	
Range	0, 6804.0	0, 7830.0	0, 7422.0	
25th, 75th percentile	196.5, 1171.5	213.0, 1429.0	308.0, 1260.5	
N (missing)	70 (0)	85 (0)	97 (0)	
Gardening/Yardwork				0.69
Mean ± STD	31.8 ± 133.2	53.4 ± 328.5	33.2 ± 139.6	
Median	0	0	0	
Range	0, 975.0	0, 2940.0	0, 1080.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	70 (0)	85 (0)	97 (0)	
Caretaking				0.96
Mean + STD	136.0 ± 736.3	70.9 ± 394.6	64.3 ± 350.3	
Median	0	0	0	
Range	0, 5040.0	0, 3360.0	0, 2640.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	70 (0)	85 (0)	97 (0)	
Transportation				0.37
Mean ± STD	150.7 ± 242.5	158.8 ± 391.9	146.9 ± 226.3	
Median	17.5	0	35.0	
Range	0, 1260.0	0, 2940.0	0, 1050.0	
25th, 75th percentile	0, 210.0	0, 210.0	0, 210.0	
N (missing)	70 (0)	85 (0)	97 (0)	
Leisure				0.87
Mean + STD	352.4 ± 676.6	317.1 ± 586.0	347.4 ± 662.3	
Median	70.0	0	60.0	
Range	0, 4530.0	0, 3240.0	0, 3937.5	
25th, 75th percentile	0, 420.0	0, 367.5	0, 412.5	
N (missing)	69 (1)	85 (0)	96 (1)	

Table A-5 (continued) Subjective physical activity [Modified MAQ (METS per week)] by age groups for overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) (n=252).

Modified MAQ Physical Activity (METS/wk)	**18-39 yrs (n=70)**	**40-49 yrs (n=85)**	**50-65 yrs (n=97)**	**p-value for Kruskal-Wallis Test**
Total				0.59
Mean ± STD	1789.7 ± 2280.5	1654.8 ± 1875.9	1944.9 ± 2160.0	
Median	1021.0	908.5	1069.5	
Range	0, 10872.5	0, 11190.0	0, 11715.0	
25th, 75th percentile	382.0, 2302.5	368.0, 2428.5	589.0, 2314.5	
N (missing)	67 (3)	83 (2)	93 (4)	
Total w/o occupational activities				0.52
Mean ± STD	1507.3 ± 2032.0	1597.2 ± 1819.8	1691.1 ± 1751.9	
Median	944.0	862.0	1024.3	
Range	0, 10872.5	0, 11190.0	0, 8667.0	
25th, 75th percentile	382.0, 2016.0	368.0, 2332.0	520.0, 2181.0	
N (missing)	69 (1)	85 (0)	96 (1)	
Total w/o household activities				0.23
Mean ± STD	796.2 ± 1247.6	549.9 ± 938.4	752.8 ± 1390.1	
Median	380.0	210.0	292.5	
Range	0, 7200.0	0, 6070.0	0, 8715.0	
25th, 75th percentile	70.0, 900.0	0, 690.0	70.0, 735.0	
N (missing)	67 (3)	83 (2)	93 (4)	

Table A-6 Means (standard deviation) for baseline demographics in overweight and obese adults with schizophrenia or schizoaffective disorder who participated in actigraphy monitoring in the WAIST study (n=54).

	Valid actigraphy monitoring days	
Varoable	**At least 3 days (n=46)**	**0-2 days (n=9)**
Age (yrs)	45.6 (9.8)	45.2 (8.9)
BMI (kg/m^2)	37.9 (8.1)	40.1 (6.4)
Male [N (%)]	17 (37.0)	4 (44.4)
Current Smoker [N (%)]	16 (34.8)	4 (44.4)
Race [N (%)]		
White	19 (41.3)	3 (33.3)
Black	26 (56.5)	6 (66.7)
Other	1 (2.2)	0 (0)
Positive and Negative Syndrome Scale (PANSS)	58.8 (15.9)	58.2 (10.2)
Global Assessment of Functioning Scale (GAF) Score	58.5 (8.2)	58.7 (6.7)
Clinical Global Impression of Severity (CGI-S) [N (%)]		
Normal, not mentally ill, very mild or mild mental illness	20 (43.5)	3 (33.3)
Moderate or severe mental illness	24 (52.2)	6 (66.7)
Not assessed	2 (4.4)	0 (0)
General Health Status [N (%)]		
Excellent, Very good, or Good	23 (50.0)	5 (55.6)
Fair or Poor	21 (45.7)	4 (44.4)
Missing	2 (4.4)	0 (0)

Table A-7 Mean (standard deviation) for demographics and objective physical activity monitoring at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by gender (n=46).

Variable	Men (n=17)	Women (n=29)	p-value for Kruskal-Wallis Test
Age (yrs)	45.9 (12.0)	45.4 (8.5)	0.58
BMI (kg/m^2)	35.5 (5.0)	39.4 (9.3)	0.17
Current Smoker [N (%)]	5 (29.4)	11 (37.9)	0.56[a]
Race [N (%)]			0.01[b]
White	11 (64.7)	8 (27.6)	
Black	5 (29.4)	21 (72.4)	
Other	1 (5.9)	0 (0)	
Positive and Negative Syndrome Scale (PANSS)	58.2 (16.5)	59.2 (15.9)	1.00
Global Assessment of Functioning Scale (GAF) Scores	60.1 (9.1)	57.7 (7.7)	0.34
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.15[b]
Normal, not mentally ill, very mild, or mild mental illness	8 (47.1)	12 (41.4)	
Moderate or severe mental illness	7 (41.2)	17 (58.6)	
Not assessed	2 (11.8)	0 (0)	
General Health Status [N (%)]			0.94[b]
Excellent, Very good, or Good	9 (52.9)	14 (48.3)	
Fair or Poor	8 (47.1)	13 (44.8)	
Missing	0 (0)	2 (6.9)	
Monitoring Period			
Days	7.2 (2.9)	7.4 (2.8)	0.77
Mins/day	925 + 140	937 (156)	0.79
Sedentary			
Mins/day	758 (136)	756 (144)	0.95
% of wear time	82 (6)	81 (6)	0.56
Light Activity			
Mins/day	146 (41)	164 (51)	0.39
% of wear time	16 (4)	18 (5)	0.45
Moderate/Vigorous Activity			
Mins/day	21 (15)	17 (9)	0.60
% of wear time	2 (2)	2 (1)	0.67
Total Activity			
Mins/day	167 + 52	181 (56)	0.49
% of wear time	18 (6)	19 (6)	0.56
Activity			
Counts/day	157202 (73296)	147421 (53603)	0.83
Counts/min	171 (78)	159 (55)	0.67

[a] Chi-square test
[b] Fischer's Exact Test

Table A-8 Mean (standard deviation) for demographics and objective physical activity monitoring at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by race (n=45[a]).

Variable	White (n=19)	Black (n=26)	p-value for Kruskal-Wallis Test
Age (yrs)	48.2 (9.5)	43.0 (9.1)	0.05
BMI (kg/m^2)	34.7 (4.7)	40.6 (9.2)	0.007
Male [N (%)]	11 (57.9)	5 (19.2)	<0.01[b]
Current Smoker [N (%)]	3 (15.8)	13 (50.0)	0.02 [b]
Positive and Negative Syndrome Scale PANSS)	60.7 (15.0)	56.7 (16.5)	0.26
Global Assessment of Functioning Scale (GAF) Scores	56.7 (8.4)	59.5 (8.0)	0.26
Clinical Global Impression of Severity (CGI-S) [N (%)]			0.14 [c]
Normal, not mentally ill; very mild; mild mental illness	5 (26.3)	10 (38.5)	
Moderate or severe mental illness	13 (68.4)	15 (57.7)	
Not assessed	1 (5.3)	1 (3.9)	
General Health Status [N (%)]			0.08 [b]
Excellent, Very good, or Good	12 (63.2)	10 (38.5)	
Fair or Poor	6 (31.6)	15 (57.7)	
Missing	1 (5.3)	1 (3.9)	
Monitoring period			
Days	7.9 (2.9)	7.1 (2.8)	0.37
Mins/day	987 (150)	896 (140)	0.02
Sedentary			
Mins/day	803 (148)	724 (129)	0.07
% of wear time	81 (5)	81 (6)	0.96
Light Activity			
Mins/day	164 (42)	155 (52)	0.29
% of wear time	17 (4)	17 (5)	0.93
Moderate/Vigorous Activity			
Mins/day	20 (13)	18 (11)	0.32
% of wear time	2 (1)	2 (1)	0.84
Total Activity			
Mins/day	184 (50)	173 (57)	0.43
% of wear time	19 (5)	19 (6)	0.81
Activity			
Counts/day	161197 (60318)	147426 (59936)	0.43
Counts/min	165 (60)	165 (66)	0.70

[a] n=1 for other race; size of other race category considered insufficient to include in analyses

[b] Chi-square test

[c] Fischer's Exact Test

Table A-9 Mean (standard deviation) for demographics and objective physical activity monitoring at baseline in overweight and obese adults with schizophrenia or schizoaffective disorder in the actigraphy cohort by age groups (n=46).

Variable	18-39 yrs (n=11)	40-49 yrs (n=15)	50-65 yrs (n=20)	p-value Kruskal-Wallis Test
Age (yrs)	30.8 (2.8)	45.1 (3.2)	54.1 (3.6)	< 0.0001
BMI (kg/m^2)	44.5 (12.2)	37.6 (5.1)	34.6 (4.7)	< 0.01
Male [N (%)]	5 (45.5)	3 (20.0)	9 (45.0)	0.25 [a]
Current Smoker [N (%)]	4 (36.4)	7 (46.7)	5 (25.0)	0.41 [a]
Race [N (%)]				0.05 [a,b]
White	3 (27.3)	4 (26.7)	12 (60.0)	
Black	8 (72.7)	11 (73.3)	7 (35.0)	
Other	0 (0)	0 (0)	1 (5.0)	
Positive and Negative Syndrome Scale (PANSS)	54.5 (12.5)	63.1 (17.1)	58.0 (16.7)	0.48
Global Assessment of Functioning Scale (GAF) Scores	60.1 (8.4)	57.8 (9.0)	58.4 (7.8)	0.74
Clinical Global Impression of Severity (CGI-S) [N (%)]				0.62 [c]
Normal, not mentally ill; very mild; mild mental illness	6 (54.6)	8 (53.3)	6 (30.0)	
Moderate or severe mental illness	3 (27.3)	7 (46.7)	14 (70.0)	
Not assessed	2 (18.2)	0 (0)	0 (0)	
General Health Status [N (%)]				0.62 [c]
Excellent, Very good, or Good	4 (36.4)	9 (60.0)	10 (50.0)	
Fair or Poor	6 (54.6)	6 (40.0)	9 (45.0)	
Missing	1 (9.1)	0 (0)	1 (5.0)	
Monitoring period				
Days	7.5 (3.4)	7.0 (2.4)	7.6 (2.8)	0.88
Mins/day	897 (119)	897 (125)	979 (172)	0.23
Sedentary				
Mins/day	725 (112)	731 (119)	792 (164)	0.32
% of wear time	81 (5)	82 (5)	81 (6)	0.96
Light Activity				
Mins/day	151 (46)	150 (43)	166 (52.9)	0.58
% of wear time	17 (5)	17 (4)	17 (6)	0.99
Moderate/Vigorous Activity				
Mins/day	20 (13)	15 (9)	21 (13)	0.30
% of wear time	2 (2)	2 (0.9)	2 (1)	0.46
Total Activity				
Mins/day	171 (53)	165 (48)	187 (60)	0.49
% of wear time	19 (5)	18 (5)	19 (6)	0.96
Activity				
Counts/day	157672 (60292)	130507 (52731)	162783 (65930)	0.19
Counts/min	170 (213)	147 (58)	168 (68)	0.49

[a] Chi-square test

[b] Excluded other race category from the analysis due to insufficient numbers for analyses

[c] Fischer's Exact Test

Table A-10 Subjective physical activity [Modified MAQ (METS per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by gender (n=46).

Modified MAQ (MET/ wk)	Actigraphy Cohort (n=46)	Female (n=29)	Male (n=17)	p-value for Kruskal-Wallis Test
Occupational				0.44
Mean ± STD	40.0 ± 268.3	64.3 ± 340.2	0 ± 0	
Median	0	0	0	
Range	0, 1800.0	0, 1800.0	0, 0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	45 (1)	28 (1)	17 (0)	
Housework				0.56
Mean ± STD	1011.7 ± 1093.2	1108.0 ±	847.3 ± 904.2	
Median	536.8	1194.8	471.0	
Range	0, 4459.5	557.5	0, 2886.0	
25th, 75th percentile	229.5, 1429.0	0, 4459.5	229.5, 1064.0	
N (missing)	46 (0)	305.0, 1759.5	17 (0)	
		29 (0)		
Gardening/Yardwork				0.11
Mean ± STD	47.1 ± 168.2	22.2 ± 101.5	89.6 ± 241.8	
Median	0	0	0	
Range	0, 975.0	0, 540.0	0, 975.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	46 (0)	29 (0)	17 (0)	
Caretaking				0.44
Mean ± STD	18.3 ± 123.9	29.0 ± 156.0	0 ± 0	
Median	0	0	0	
Range	0, 840.0	0, 840.0	0, 0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	46 (0)	29 (0)	17 (0)	
Transportation				0.39
Mean ± STD	106.4 ± 217.7	92.4 ± 225.1	130.1 ± 208.8	
Median	0	0	0	
Range	0, 1050.0	0, 1050.0	0, 700.0	
25th, 75th percentile	0, 105.0	0, 90.0	0, 210.0	
N (missing)	46 (0)	29 (0)	17 (0)	
Leisure				0.62
Mean ± STD	474.1 ± 704.1	475.3 ± 717.4	472.1 ± 703.6	
Median	70.0	0	157.5	
Range	0, 2940.0	0, 2940.0	0, 2535.0	
25th, 75th percentile	0, 780.0	0, 997.5	0, 517.5	
N (missing)	45 (1)	28 (1)	17 (0)	

Table A-10 (continued) Subjective physical activity [Modified MAQ (ETS per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by gender (n=46).

Modified MAQ (MET/ wk)	**Actigraphy Cohort (n=46)**	**Female (n=29)**	**Male (n=17)**	**p-value for Kruskal-Wallis Test**
Total				0.98
Mean ± STD	1698.8 ± 1623.5	1799.3 ± 1792.9	1539.2 ± 1347.6	
Median	1007.3	1429.0	974.5	
Range	0, 6600.0	0, 6600.0	0, 4173.0	
25th, 75th percentile	696.3, 2621.5	693.0, 2809.5	719.5, 2434.0	
N (missing)	44 (2)	27 (2)	17 (0)	
Total w/o occupational activities				0.88
Mean ± STD	1633.4 ± 1528.1	1690.7 ± 1649.2	1539.2 ± 1347.6	
Median	974.5	1112.8	974.5	
Range	0, 6600.0	0, 6600.0	0, 4173.0	
25th, 75th percentile	693.0, 2543.0	625.3, 2676.3	719.5, 2434.0	
N (missing)	45 (1)	28 (1)	17 (0)	
Total w/o household activities				0.70
Mean ± STD	637.0 ± 815.5	658.8 ± 864.0	602.3 ± 765.5	
Median	363.8	210.0	405.0	
Range	0, 2940.0	0, 2940.0	0, 2745.0	
25th, 75th percentile	0, 1062.5	0, 1102.5	70.0, 577.5	
N (missing)	44 (2)	27 (2)	17 (0)	

Table A-11 Subjective physical activity [Modified MAQ (minutes per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by race (n=45[a]).

Modified MAQ (mins/wk)	White (n=19)	Black (n=26)	p-value for Kruskal-Wallis Test
Occupational			0.25
Mean ± STD	23.7 ± 103.2	0 ± 0	
Median	0	0	
Range	0, 450.0	0, 0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	19 (0)	25 (1)	
Housework			0.84
Mean ± STD	421.4 ± 478.6	400.5 ± 425.2	
Median	202.0	230.0	
Range	0, 1350.0	0, 1725.0	
25th, 75th percentile	99.0, 1020.0	90.0, 580.0	
N (missing)	19 (0)	26 (0)	
Gardening/Yardwork			0.18
Mean ± STD	21.3 ± 54.6	3.5 ± 12.9	
Median	0	0	
Range	0, 210.0	0, 60.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	19 (0)	26 (0)	
Occupational			0.25
Mean ± STD	23.7 ± 103.2	0 ± 0	
Median	0	0	
Range	0, 450.0	0, 0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	19 (0)	25 (1)	
Housework			0.84
Mean ± STD	421.4 ± 478.6	400.5 ± 425.2	
Median	202.0	230.0	
Range	0, 1350.0	0, 1725.0	
25th, 75th percentile	99.0, 1020.0	90.0, 580.0	
N (missing)	19 (0)	26 (0)	

[a] n=1 for other race; size of other race category considered insufficient to include in analyses

Table A-11 (continued) Subjective physical activity [Modified MAQ (minutes per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by race (n=45[a]).

Modified MAQ (mins/wk)	White (n=19)	Black (n=26)	p-value for Kruskal-Wallis Test
Caretaking			0.39
Mean ± STD	0 ± 0	8.1 ± 41.2	
Median	0	0	
Range	0,0	0, 210.0	
25th, 75th percentile	0,0	0, 0	
N (missing)	19 (0)	26 (0)	
Transportation			0.89
Mean ± STD	39.7 ± 82.0	23.8 ± 43.9	
Median	0	0	
Range	0, 300.0	0, 180.0	
25th, 75th percentile	0, 45.0	0, 30.0	
N (missing)	19 (0)	26 (0)	
Leisure			0.78
Mean ± STD	139.3 ± 215.6	101.2 ± 135.2	
Median	20.0	15.0	
Range	0, 840.0	0, 450.0	
25th, 75th percentile	0, 210.0	0, 135.0	
N (missing)	19 (0)	25 (1)	
Total			0.73
Mean ± STD	645.4 ± 655.0	529.2 ± 482.1	
Median	328.0	372.5	
Range	0, 2160.0	0, 1830.0	
25th, 75th percentile	239.0, 1020.0	210.0, 861.0	
N (missing)	19 (0)	24 (2)	
Total w/o occupational activities			0.68
Mean ± STD	621.7 ± 610.7	517.8 ± 475.4	
Median	328.0	345.0	
Range	0, 2160.0	0, 1830.0	
25th, 75th percentile	239.0, 1020.0	210.0, 775.0	
N (missing)	19 (0)	25 (1)	
Total w/o household activities			0.62
Mean ± STD	202.7 ± 255.8	131.3 ± 154.7	
Median	120.0	75.0	
Range	0, 840.0	0, 510.0	
25th, 75th percentile	0, 360.0	5.0, 217.5	
N (missing)	19 (0)	24 (2)	

[a] n=1 for other race; size of other race category considered insufficient to include in analyses.

Table A-12 Subjective physical activity [Modified MAQ (METS per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by race (n=45[a]).

Modified MAQ (METS/wk)	White (n=19)	Black (n=28)	p-value for Kruskal-Wallis Test
Occupational			0.25
Mean ± STD	94.7 ± 412.9	0 ± 0	
Median	0	0	
Range	0, 0	0, 0	
25th, 75th percentile	0, 1800.0	0, 0	
N (missing)	19 (0)	25 (1)	
Housework			0.93
Mean ± STD	1057.7 ± 1189.7	979.7 ± 1062.7	
Median	485.5	554.3	
Range	0, 3120.0	0, 4459.5	
25th, 75th percentile	229.5, 2700.0	213.0, 1429.0	
N (missing)	19 (0)	26 (0)	
Gardening/Yardwork			0.19
Mean ± STD	94.3 ± 249.6	14.4 ± 56.0	
Median	0	0	
Range	0, 0	0, 0	
25th, 75th percentile	0, 975.0	0, 0	
N (missing)	19 (0)	26 (0)	
Caretaking			0.39
Mean ± STD	0 ± 0	32.3 ± 164.7	
Median	0	0	
Range	0, 0	0, 840.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	19 (0)	26 (0)	
Transportation			0.94
Mean ± STD	142.2 ± 288.0	84.2 ± 153.7	
Median	0	0	
Range	0, 1050.0	0, 630.0	
25th, 75th percentile	0, 157.5	0, 105.0	
N (missing)	19 (0)	26 (0)	
Leisure			0.85
Mean ± STD	545.8 ± 807.3	435.7 ± 638.5	
Median	70.0	52.5	
Range	0, 2940.0	0, 2535.0	
25th, 75th percentile	0, 945.0	0, 540.0	
N (missing))	19 (0)	25 (1)	

[a] n=1 for other race; size of other race category considered insufficient to include in analyses or summary table.

Table A-12 (continued) Subjective physical activity [Modified MAQ (METS per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by race (n=45[a]).

Modified MAQ (METS/wk)	White (n=19)	Black (n=28)	p-value for Kruskal-Wallis Test
Total			0.70
Mean ± STD	1934.8 ± 1935.1	1539.4 ± 1380.6	
Median	951.0	1201.8	
Range	0, 6600.0	0, 4827.0	
25th, 75th percentile	714.5, 3453.0	598.5, 2488.5	
N (missing)	19 (0)	24 (2)	
Total w/o occupational activities			0.64
Mean ± STD	1840.1 ± 1769.6	1500.1 ± 1365.7	
Median	951.0	974.5	
Range	0, 6600.0	0, 4827.0	
25th, 75th percentile	714.5, 3453.0	557.5, 2434.0	
N (missing)	19 (0)	25 (1)	
Total w/o household activities			0.66
Mean ± STD	782.8 ± 950.9	545.1 ± 703.9	
Median	420.0	285.0	
Range	0, 2940.0	0, 2745.0	
25th, 75th percentile	0, 1680.0	17.5, 826.3	
N (missing)	19 (0)	24 (2)	

[a] n=1 for other race; size of other race category considered insufficient to include in analyses or summary table.

Table A-13 Subjective physical activity [Modified MAQ (minutes per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by age groups (n=46).

Modified MAQ (mins/wk)	**18-39 yrs (n=11)**	**40-49 yrs (n=15)**	**50-65 yrs (n=20)**	**p-value for Kruskal-Wallis Test**
Occupational				0.54
Mean ± STD	0 ± 0	0 ± 0	22.5 ± 100.6	
Median	0	0	0	
Range	0, 0	0, 0	0, 450.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	10 (1)	15 (0)	20 (0)	
Housework				0.31
Mean ± STD	234.3 ± 286.3	510.5 ± 498.4	428.2 ± 450.4	
Median	195.0	310.0	207.5	
Range	0, 1050.0	0, 1725.0	0, 1350.0	
25th, 75th percentile	55.0, 245.0	90.0, 857.0	114.5, 695.0	
N (missing)	11 (0)	15 (0)	20 (0)	
Gardening/Yardwork				0.20
Mean ± STD	21.8 ± 63.1	0 ± 0	12.8 ± 31.3	
Median	0	0	0	
Range	0, 210.0	0, 0	0, 120.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	11 (0)	15 (0)	20 (0)	
Caretaking				0.36
Mean ± STD	0 ± 0	14.0 ± 54.2	0 ± 0	
Median	0	0	0	
Range	0, 0	0, 210.0	0, 0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	11 (0)	15 (0)	20 (0)	
Transportation				0.67
Mean ± STD	17.7 ± 36.7	22.0 ± 48.7	42.5 ± 79.6	
Median	0	0	0	
Range	0, 120.0	0, 180.0	0, 300.0	
25th, 75th percentile	0, 20.0	0, 30.0	0, 60.0	
N (missing)	11 (0)	15 (0)	20 (0)	
Leisure				0.86
Mean ± STD	113.3 ± 14.5	95.0 ± 125.1	132.9 ± 219.4	
Median	45.0	0	20.0	
Range	0, 420.0	0, 315.0	0, 840.0	
25th, 75th percentile	0, 250.0	0, 180.0	0, 210.0	
N (missing)	11 (0)	15 (0)	19 (1)	

Table A-13 (continued) Subjective physical activity [Modified MAQ (minutes per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by age groups (n=46).

Modified MAQ (mins/wk)	18-39 yrs (n=11)	40-49 yrs (n=15)	50-65 yrs (n=20)	p-value for Kruskal-Wallis Test
Total				0.61
Mean ± STD	401.3 ± 388.8	641.5 ± 545.7	617.2 ± 637.4	
Median	316.5	400.0	400.0	
Range	0, 1200.0	0, 1830.0	0, 2160.0	
25th, 75th percentile	100.0, 485.0	271.0, 1005.0	239.0, 990.0	
N (missing)	10 (1)	15 (0)	19 (1)	
Total w/o occupational activities				0.49
Mean ± STD	387.1 ± 371.8	641.5 ± 545.7	593.5 ± 590.6	
Median	305.0	400.0	400.0	
Range	0, 1200.0	0, 1830.0	0, 2160.0	
25th, 75th percentile	100.0, 485.0	271.0, 1005.0	239.0, 990.0	
N (missing)	11 (0)	15 (0)	19 (1)	
Total w/o household activities				0.59
Mean ± STD	144.1 ± 139.2	117.0 ± 151.4	201.3 ± 262.9	
Median	123.0	60.0	90.0	
Range	0, 420.0	0, 495.0	0, 840.0	
25th, 75th percentile	15.0, 270.0	0, 180.0	0, 360.0	
N (missing)	10 (1)	15 (0)	19 (1)	

Table A-14 Subjective physical activity [Modified MAQ (METS per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by age groups (n=46).

Modified MAQ (METS/ wk)	18-39 yrs (n=11)	40-49 yrs (n=15)	50-65 yrs (n=20)	p-value for Kruskal-Wallis Test
Occupational				0.54
Mean ± STD	0 ± 0	0 ± 0	90.0 ± 402.5	
Median	0	0	0	
Range	0, 0	0, 0	0, 1800.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	10 (1)	15 (0)	20 (0)	
Housework				0.37
Mean ± STD	585.0 ± 686.6	1262.6 ± 1275.7	1058.1 ± 1107.2	
Median	451.5	727.5	518.3	
Range	0, 2487.0	0, 4459.5	0, 3120.0	
25th, 75th percentile	129.5, 451.5	213.0, 2074.0	267.3, 1711.5	
N (missing)	11 (0)	15 (0)	20 (0)	
Gardening/Yardwork				0.20
Mean ± STD	98.2 ± 292.5	0 ± 0	54.4 ± 136.5	
Median	0	0	0	
Range	0, 975.0	0, 0	0, 540.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	11 (0)	15 (0)	20 (0)	
Caretaking				0.36
Mean ± STD	0 ± 0	56.0 ± 216.9	0 ± 0	
Median	0	0	0	
Range	0, 0	0, 840.0	0, 0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	11 (0)	15 (0)	20 (0)	
Transportation				0.66
Mean ± STD	63.9 ± 128.7	77.0 ± 170.5	151.8 ± 279.6	
Median	0	0	0	
Range	0, 420.0	0, 630.0	0, 630.0	
25th, 75th percentile	0, 90.0	0, 87.5	0, 105.0	
N (missing)	11 (0)	15 (0)	20 (0)	
Leisure				0.83
Mean ± STD	456.9 ± 583.0	383.0 ± 511.9	555.9 ± 897.3	
Median	157.5	0	70.0	
Range	0, 1710.0	0, 1440.0	0, 2940.0	
25th, 75th percentile	0, 1050.0	0, 780.0	0, 945.0	
N (missing)	11 (0)	15 (0)	19 (1)	

Table A-14 (continued) Subjective physical activity [Modified MAQ (METS per week)] at baseline in overweight and obese men and women with schizophrenia or schizoaffective disorder in the actigraphy cohort by age groups (n=46).

Modified MAQ (METS/ wk)	**18-39 yrs (n=11)**	**40-49 yrs (n=15)**	**50-65 yrs (n=20)**	**p-value for Kruskal-Wallis Test**
Total				0.72
Mean ± STD	1268.6 ± 1251.9	1778.6 ± 1479.4	1862.2 ± 1916.9	
Median	959.3	1429.0	1040.0	
Range	0, 3646.0	0, 4827.0	0, 6600.0	
25th, 75th percentile	287.0, 1662.5	699.5, 2809.5	719.5, 2700.0	
N (missing)	10 (1)	15 (0)	19 (1)	
Total w/o occupational activities				0.58
Mean ± STD	1203.9 ± 1206.9	1778.6 ± 1479.4	1767.5 ± 1745.6	
Median	944.0	1429.0	1040.0	
Range	0, 3646.0	0, 4827.0	0, 6600.0	
25th, 75th percentile	287.0, 162.5	699.5, 2809.5	719.5, 2700.0	
N (missing)	11 (0)	15 (0)	19 (1)	
Total w/o household activities				0.54
Mean ± STD	572.9 ± 572.1	460.0 ± 599.1	810.4 ± 1042.1	
Median	490.5	210.0	405.0	
Range	0, 1710.0	0, 1845.0	0, 2940.0	
25th, 75th percentile	52.5, 1075.0	0, 780.0	0, 1680.0	
N (missing)	10 (1)	15 (0)	19 (1)	

Table A-15 Subjective physical activity [Modified MAQ (minutes or METS per week)] for overweight and obese adults with schizophrenia or schizoaffective disorder by GXT testing (WAIST Study) (n=248)[a].

Modified MAQ [Mean ± std]	GXT Cohort (n=109[b])	Non-volunteers for GXT testing (n=139)	p-value for Kruskal-Wallis Test
Mins/wk			
Occupational	82.0 ± 300.4[e]	30.9 ± 191.7[c]	0.14
Housework	399.3 ± 425.4[f]	420.9 ± 563.5	0.68
Gardening/Yardwork	5.6 ± 27.2[f]	13.6 ± 76.2	0.70
Caretaking	28.6 ± 132.9[f]	17.2 ± 121.1	0.82
Transportation	41.6 ± 68.2[f]	45.4 ± 96.4	0.94
Leisure	97.4 ± 185.6[e]	69.0 ± 105.5	0.92
Total	654.4 ± 647.9[g]	581.1 ± 713.4[c]	0.26
Total w/o occupational activities	563.6 ± 554.0[e]	566.1 ± 692.5	0.69
Total w/o household activities	225.0 ± 370.3[g]	138.5 ± 218.4[c]	0.54
METS/wk	346.7 ± 1227.7[e]	123.6 ± 766.7[c]	0.14
Housework	971.1 ± 1041.8[f]	1045.7 ± 1436.3	0.69
Gardening/Yardwork	24.1 ± 121.3[f]	53.2 ± 276.6	0.70
Caretaking	114.4 ± 531.6[f]	68.7 ± 484.4	0.82
Transportation	146.3 ± 238.7[f]	159.6 ± 337.7	0.94
Leisure	413.4 ± 827.9[e]	281.7 ± 455.1	0.93
Total	2021.1 ± 2173.0[g]	1677.8 ± 2068.6[c]	0.24
Total w/o occupational activities	1650.8 ± 1731.9[e]	1608.9 ± 1968.6	0.69
Total w/o household activities	918.1 ± 1544.8[g]	536.6 ± 876.7[c]	0.52

[a] 6 participants had incomplete GXT data
[b] 2 participants completed the exercise stress testing but were not administered the MAQ
[c] n=134
[e] n=105
[f] n=107
[g] n=103

Table A-16 Objective physical activity monitoring by actigraphy for overweight and obese adults with schizophrenia or schizoaffective disorder by GXT testing (WAIST Study) (n=46).

Actigraphy Variables [Mean ± std]	**GXT (n=29)**	**No GXT Testing (n=17)**	**p-value for Kruskal-Wallis Test**
Monitoring			
Days	7.3 ± 2.7	7.5 ± 3.1	0.94
Mins/day	889.1 ± 131.7	1006.8 ± 151.0	0.01
Sedentary			0.06
Mins/day	726.4 ± 115.5	807.9 ±164.4	0.49
% of wear time	81.7±4.8	79.7±6.7	
Light Activity			0.01
Mins/day	144.4 ± 43.4	179.7 ±48.3	0.41
% of wear time	16.3±4.1	18.3±6.0	
Moderate/Vigorous			0.93
Activity	18.3 ± 11.5	19.2±12.5	0.58
Mins/day	2.0±1.1	2.0±1.5	
% of wear time			
Total Activity			0.02
Mins/day	162.7±52.3	198.9±51.7	0.49
% of wear time	18.3±4.8	20.3±6.7	
Activity counts/day	140433 ± 61770	169124 ±56888	0.08
Activity counts/min	156.6±59.2	174.3±72.4	0.50

Table A-17 Summary of graded exercise test results for overweight and obese male adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by race (n=44).

Variable	White (n=31)	Black (n=13)	p-value for Kruskal-Wallis Test
VO_2 Max (mL/kg/min)			0.43
Mean ± STD	19.2 ± 7.1	17.2 ± 5.1	
Median	17.5	17.9	
Range	4.5, 38.4	10.3, 29.4	
25th, 75th percentile	15.2, 21.8	14.2, 19.5	
Minutes on Treadmill			0.45
Mean ± STD	9.3 ± 3.9	8.3 ± 4.7	
Median	8.0	8.0	
Range	4.0, 18.0	2.0, 19.0	
25th, 75th percentile	6.0, 12.0	4.0, 10.0	
Resting GXT Heart Rate (bpm)			0.91
Mean ± STD	89.2 ± 15.7	88.6 ± 9.3	
Median	87.0	90.0	
Range	60.0, 120.0	70.0, 106.0	
25th, 75th percentile	78.0, 99.0	85.0, 94.0	
Peak GXT Heart Rate (bpm)			0.84
Mean ± STD	143.0 ± 19.4	145.2 ± 19.7	
Median	141.0	144.0	
Range	112.0, 190.0	115.0, 172.0	
25th, 75th percentile	129.0, 155.0	131.0, 169.0	
Ratings of Perceived Exertion (RPE) N (%)			0.20[a]
9	0 (0)	1 (7.7)	
10	0 (0)	0 (0)	
11	0 (0)	0 (0)	
12	0 (0)	0 (0)	
13	8 (25.8)	2 (15.4)	
14	1 (3.2)	0 (0)	
15	10 (32.3)	2 (15.4)	
16	4 (12.9)	2 (15.4)	
17	6 (19.4)	4 (30.8)	
18	2 (6.5)	0 (0)	
19	0 (0)	2 (15.4)	
20	0 (0)	0 (0)	
Ratings of Perceived Exertion (RPE) Categories N (%)			0.30[a]
6-12	0 (0)	1 (7.7)	
13-20	31 (100.0)	12 (92.3)	
GXT Categories			1.00 [a]
Fit	2 (6.5)	0 (0)	
Unfit	29 (93.6)	13 (0)	

[a] Fischer's Exact Test

Table A-18 Summary of graded exercise test results for overweight and obese female adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by race (n=64).

Variable	White (n=19)	Black (n=45)	p-value for Kruskal-Wallis Test
VO_2 Max (mL/kg/min)			0.11
Mean ± STD	14.4 ± 5.1	12.2 ± 3.5	
Median	13.4	11.9	
Range	7.5, 27.2	4.5, 20.3	
25th, 75th percentile	11.3, 17.7	9.9, 14.1	
Minutes on Treadmill			0.45
Mean ± STD	7.1 ± 2.4	6.4 ± 2.4	
Median	6.0	6.0	
Range	4.0, 12.0	2.0, 12.0	
25th, 75th percentile	6.0, 8.0	4.0, 8.0	
Resting GXT Heart Rate (bpm)			0.95
Mean ± STD	87.5 ± 12.7	87.5 ± 12.7	
Median	91.0	91.0	
Range	62.0, 108.0	62.0, 108.0	
25th, 75th percentile	77.0, 98.0	77.0, 98.0	
Peak GXT Heart Rate (bpm)			0.89
Mean ± STD	139.7 ± 20.4	139.7 ± 20.4	
Median	142.0	142.0	
Range	72.0, 186.0	72.0, 186.0	
25th, 75th percentile	123.0, 152.0	123.0, 152.0	
Ratings of Perceived Exertion (RPE) N (%)			0.78[a]
9	0 (0)	1 (2.4)	
10	0 (0)	0 (0)	
11	0 (0)	3 (7.1)	
12	0 (0)	1 (2.4)	
13	4 (22.2)	14 (33.3)	
14	2 (11.1)	4 (9.5)	
15	6 (33.3)	11 (26.2)	
16	1 (5.6)	2 (4.8)	
17	4 (22.2)	5 (11.9)	
18	1 (5.6)	0 (0)	
19	0 (0)	0 (0)	
20	0 (0)	1 (2.4)	
Ratings of Perceived Exertion (RPE) Categories N (%)			0.31[a]
6-12	0 (0)	4 (9.5)	
13-20	18 (100.0)	38 (90.5)	
GXT Categories			------
Fit	0 (0)	0 (0)	
Unfit	19 (90.5)	45 (95.7)	

[a] Fischer's Exact Test

Table A-19 Summary of graded exercise test results for overweight and obese male adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by age groups (n=45).

Variable	18-39 yrs (n=6)	40-49 yrs (n=16)	50-65 yrs (n=23)	p-value for Kruskal-Wallis Test
VO_2 Max (mL/kg/min)				0.60
Mean ± STD	19.3 ± 4.6	19.4 ± 7.2	17.6 ± 6.7	
Median	18.0	17.7	16.7	
Range	15.8, 27.8	11.2, 38.4	4.5, 36.4	
25th, 75th percentile	15.9, 20.4	13.9, 21.9	14.2, 19.5	
Minutes on Treadmill				0.17
Mean ± STD	10.5 ± 4.1	10.3 ± 4.7	7.6 ± 3.4	
Median	9.0	8.0	8.0	
Range	7.0, 18.0	6.0, 19.0	2.0, 16.0	
25th, 75th percentile	8.0, 12.0	6.0, 13.5	4.0, 10.0	
Resting GXT Heart Rate (bpm)				0.001
Mean ± STD	109.8 ± 8.7	88.4 ± 12.8	84.0 ± 10.6	
Median	110.0	87.5	85.0	
Range	97.0, 120.0	70.0, 114.0	60.0, 99.0	
25th, 75th percentile	105.0, 117.0	77.0, 95.0	79.0, 93.0	
Peak GXT Heart Rate (bpm)				0.18
Mean ± STD	180.7 ± 22.7	141.6 ± 19.5	142.7 ± 19.3	
Median	159.5	142.5	139.0	
Range	129.0, 190.0	112.0, 183.0	112.0, 192.0	
25th, 75th percentile	147.0, 179.0	129.5, 150.5	129.0, 159.0	
Ratings of Perceived Exertion (RPE) N (%)				0.12[a]
9	0 (0)	1 (6.3)	0 (0)	
10	0 (0)	0 (0)	0 (0)	
11	0 (0)	0 (0)	0 (0)	
12	0 (0)	0 (0)	0 (0)	
13	3 (50.0)	4 (25.0)	3 (13.0)	
14	0 (0)	1 (6.3)	0 (0)	
15	2 (33.3)	6 (37.5)	5 (21.7)	
16	0 (0)	1 (6.3)	5 (21.7)	
17	1 (16.7)	1 (6.3)	8 (34.8)	
18	0 (0)	0 (0)	2 (8.7)	
19	0 (0)	2 (12.5)	0 (0)	
20	0 (0)	0 (0)	0 (0)	
Ratings of Perceived Exertion (RPE) Categories N (%)				0.49[a]
6-12	0 (0)	1 (6.3)	0 (0)	
13-20	6 (100.0)	15 (93.8)	23 (100.0)	
GXT Categories				1.00
Fit	0 (0)	1 (6.3)	1 (4.4)	
Unfit	6 (100.0)	15 (93.8)	22 (95.7)	

[a] Fischer's Exact Test

Table A-20 Summary of graded exercise test results for overweight and obese female adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by age groups (n=64).

Variable	18-39 yrs (n=17)	40-49 yrs (n=26)	50-65 yrs (n=21)	p-value for Kruskal-Wallis Test
VO_2 Max (mL/kg/mins)				0.11
Mean ± STD	15.1 ± 5.3	12.4 ± 3.3	11.5 ± 3.4	
Median	15.1	12.2	11.4	
Range	7.6, 27.2	4.5, 20.2	5.4, 20.7	
25th, 75th percentile	11.5, 18.1	10.5, 13.8	9.1, 13.6	
Minutes on Treadmill				0.007
Mean ± STD	8.3 ± 2.7	6.5 ± 2.0	5.5 ± 2.1	
Median	8.0	6.0	6.0	
Range	4.0, 12.0	4.0, 12.0	2.0, 8.0	
25th, 75th percentile	6.0, 11.0	6.0, 8.0	4.0, 8.0	
Resting GXT Heart Rate (bpm)				0.24
Mean ± STD	86.0 ± 16.7	91.2 ± 11.2	85.2 ± 14.2	
Median	82.0	91.5	84.0	
Range	62.0, 126.0	66.0, 114.0	61.0, 105.0	
25th, 75th percentile	76.0, 95.0	83.0, 99.0	73.0, 98.0	
Peak GXT Heart Rate (bpm)				0.10
Mean ± STD	150.1 ± 18.1	136.8 ± 21.3	136.6 ± 22.3	
Median	150.0	142.0	139.0	
Range	118.0, 186.0	72.0, 169.0	97.0, 187.0	
25th, 75th percentile	136.0, 159.0	123.0, 152.0	120.0, 151.0	
Ratings of Perceived Exertion (RPE) N (%)				0.37[a]
9	0 (0)	1 (4.4)	0 (0)	
10	0 (0)	0 (0)	0 (0)	
11	1 (5.9)	1 (4.4)	1 (5.0)	
12	0 (0)	0 (0)	1 (5.0)	
13	4 (23.5)	5 (21.7)	9 (45.0)	
14	0 (0)	4 (17.4)	2 (10.0)	
15	6 (35.3)	7 (30.4)	4 (20.0)	
16	2 (11.8)	1 (4.4)	0 (0)	
17	4 (23.5)	4 (17.4)	1 (5.0)	
18	0 (0)	0 (0)	1 (5.0)	
19	0 (0)	0 (0)	0 (0)	
20	0 (0)	0 (0)	1 (4.6)	
Ratings of Perceived Exertion (RPE) Categories N (%)				1.00
6-12	1 (5.9)	2 (8.7)	1 (5.0)	
13-20	16 (94.1)	21 (91.3)	19 (95.0)	
GXT Categories				-----
Fit	0 (0)	0 (0.0)	0 (0.0)	
Unfit	17 (100.0)	26 (100.0)	21 (100.0)	

[a] Fischer's Exact Test

Table A-21 Subjective physical activity [MAQ (METS per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by gender (n=109).

Variable	GXT Cohort (n=109)	Male (n=45)	Female (n=64)	p-value for Kruskal-Wallis Test
Occupational				0.76
Mean ± STD	341. 7 ± 1227.7	429.8 ± 1389.2	280.6 ± 1110.0	
Median	0	0	0	
Range	0, 5847.0	0, 6000.0	0, 7200.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	105 (4)	43 (2)	62 (2)	
Housework				0.005
Mean ± STD	971.1 ± 1041.8	661.5 ± 723.7	1187.4 ± 1173.4	
Median	580.5	387.3	842.0	
Range	0, 5847.0	0, 3132.0	0, 5847.0	
25th, 75th percentile	292.0, 1368.0	238.2, 709.5	357.0, 1706.0	
N (missing))	107 (2)	44 (1)	63 (1)	
Gardening/Yardwork				0.29
Mean ± STD	24.1 ± 121.3	41.6 ± 169.7	11.9 ± 69.3	
Median	0	0	0	
Range	0, 1080.0	0, 0	0, 540.0	
25th, 75th percentile	0, 0	0, 1780.0	0, 0	
N (missing)	107 (2)	44 (1)	63 (1)	
Caretaking				0.10
Mean ± STD	114.4 ± 531.6	76.4 ± 506.5	141.0 ± 550.9	
Median	0	0	0	
Range	0, 3600.0	0, 3360.0	0, 3600.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing))	107 (2)	44 (1)	63 (1)	
Transportation				0.70
Mean ± STD	146.3 ± 238.7	146.9 ± 266.7	145.9 ± 219.3	
Median	0	0	0	
Range	0, 1225.0	0, 1225.0	0, 1050.0	
25th, 75th percentile	0, 210.0	0, 157.5	0, 210.0	
N (missing)	107(2)	44 (1)	63 (1)	
Leisure				0.23
Mean ± STD	413.4 ± 827.9	223.2 ± 546.0	550.5 ± 963.8	
Median	0	35.0	0	
Range	0, 4530.0	0, 3240.0	0, 4530.0	
25th, 75th percentile	0, 360.0	0, 210.0	0, 735.0	
N (missing))	105 (4)	44 (1)	61 (4)	

Table A-21 (continued) Subjective physical activity [MAQ (METS per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by gender (n=109).

Variable	GXT Cohort (n=109)	Male (n=45)	Female (n=64)	p-value for Kruskal-Wallis Test
Total				0.13
Mean ± STD	2021.1 ± 2173.0	1596.8 ± 1705.2	2325.2 ± 2422.5	
Median	1067.5	902.5	1839.8	
Range	0, 11715.0	0, 6211.0	0, 11715.0	
25th, 75th percentile	490.5, 2700.0	446.0, 2181.5	618.6, 3279.8	
N (missing)	103 (6)	43 (2)	60 (5)	
Total w/o occupational activities				0.02
Mean ± STD	1650.8 ± 1731.9	1150.0 ± 1189.0	2012.4 ± 1966.9	
Median	951.0	723.5	1603.5	
Range	0, 9836.0	0, 5278.0	0, 9836.0	
25th, 75th percentile	477.0, 2300.5	408.9, 1494.5	641.5, 2611.5	
N (missing)	105 (4)	44 (1)	61 (4)	
Total w/o household activities				0.37
Mean ± STD	918.1 ± 1544.8	806.0 ± 1485.2	998.4 ± 1593.7	
Median	315.0	215.0	435.0	
Range	0, 8715.0	0, 6070.0	0, 8715.0	
25th, 75th percentile	0, 1140.0	0, 560.0	0, 1233.8	
N (missing)	103 (6)	43 (2)	60 (5)	

Table A-22 Subjective physical activity [Modified MAQ (minutes per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by race (n=108)[a]

.

Variable	White (n=50)	Black (n=58)	p-value for Kruskal-Wallis Test
Occupational (mins/wk)			0.58
Mean ± STD	92.6 ± 284.9	74.7 ± 317.1	
Median	0	0	
Range	0, 1200.0	0, 1800.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	0 (0)	0 (0)	
Housework			0.13
Mean ± STD	320.7 ± 343.6	467.3 ± 480.8	
Median	195.0	310.0	
Range	0, 1320.0	0, 2490.0	
25th, 75th percentile	110.0, 345.0	135.0, 735.0	
N (missing)	49 (1)	57 (1)	
Gardening/Yardwork			0.07
Mean ± STD	11.2 ± 39.4	0.9 ± 4.3	
Median	0	0	
Range	0, 240.0	0, 30.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	49 (1)	57 (1)	
Caretaking			0.57
Mean ± STD	27.3 ± 136.9	30.2 ± 131.7	
Median	0	0	
Range	0, 840.0	0, 900.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	49 (1)	57 (1)	
Transportation			0.88
Mean ± STD	53.9 ± 86.7	31.8 ± 45.7	
Median	0	0	
Range	0, 350.0	0, 180.0	
25th, 75th percentile	0, 60.0	0, 60.0	
N (missing)	49 (1)	57 (1)	
Leisure			0.07
Mean ± STD	60.7 ± 153.2	131.5 ± 207.3	
Median	0	35.0	
Range	0, 840.0	0, 875.0	
25th, 75th percentile	0, 50.0	0, 210.0	
N (missing)	49 (1)	55 (3)	

[a] Other race (n=1) excluded from analyses and summary due to insufficient numbers

Table A-22 (continued) Subjective physical activity [Modified MAQ (minutes per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by race (n=108)[a]

.

Variable	White (n=50)	Black (n=58)	p-value for Kruskal-Wallis Test
Total			0.41
Mean ± STD	578.2 ± 553.3	724.1 ± 721.7	
Median	350.0	540.0	
Range	0, 2160.0	0, 3390.0	
25th, 75th percentile	190.0, 745.0	170.0, 998.0	
N (missing)	47 (3)	55 (3)	
Total w/o occupational activities			0.23
Mean ± STD	473.8 ± 474.5	646.6 ± 613.3	
Median	315.0	465.0	
Range	0, 2160.0	0, 2630.0	
25th, 75th percentile	185.0, 625.0	150.0, 975.0	
N (missing)	49 (1)	55 (3)	
Total w/o household activities			0.56
Mean ± STD	209.8 ± 328.7	241.8 ± 407.1	
Median	60.0	105.0	
Range	0, 1320.0	0, 2130.0	
25th, 75th percentile	0, 210.0	0, 315.0	
N (missing)	47 (3)	55 (3)	

[a] Other race (n=1) excluded from analyses and summary due to insufficient numbers

Table A-23 Subjective physical activity [Modified MAQ (METS per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by race (n=108)[a].

Subjective Physical Activity (METS/wk)	White (n=50)	Black (n=58)	p-value for Kruskal-Wallis Test
Occupational (mins/wk)			0.59
Mean ± STD	370.2 ± 1139.8	324.2 ± 1314.9	
Median	0	0	
Range	0, 4800.0	0, 7200.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	47 (3)	57 (1)	
Housework			0.15
Mean ± STD	789.6 ± 859.3	1127.1 ± 1169.6	
Median	490.5	749.0	
Range	0, 3229.0	0, 5847.0	
25th, 75th percentile	283.0, 842.0	306.0, 1706.0	
N (missing)	49 (1)	57 (1)	
Gardening/Yardwork			0.06
Mean ± STD	49.1 ± 176.2	3.1 ± 15.2	
Median	0	0	
Range	0, 1080.0	0, 105.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	49 (1)	57 (1)	
Caretaking			0.57
Mean ± STD	109.4 ± 547.6	120.7 ± 526.9	
Median	0	0	
Range	0, 3360.0	0, 3600.0	
25th, 75th percentile	0, 0	0, 0	
N (missing)	49 (1)	57 (1)	
Transportation			0.86
Mean ± STD	189.8 ± 303.7	111.5 ± 159.8	
Median	0	0	
Range	0, 1225.0	0, 630.0	
25th, 75th percentile	0, 245.0	0, 210.0	
N (missing)	49 (1)	57 (1)	
Leisure			0.07
Mean ± STD	250.1 ± 646.8	565.0 ± 947.9	
Median	0	140.0	
Range	0, 3240.0	0, 4530.0	
25th, 75th percentile	0, 210.0	0, 975.0	
N (missing)	49 (1)	55 (3)	

[a] Other race (n=1) excluded from analyses and summary due to insufficient numbers.

Table A-23 (continued) Subjective physical activity [Modified MAQ (METS per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by race (n=108)[a].

Subjective Physical Activity (METS/wk)	White (n=50)	Black (n=58)	p-value for Kruskal-Wallis Test
Total			0.47
Mean ± STD	1795.2 ± 1808.2	2232.1 ± 2454.9	
Median	951.0	1662.5	
Range	0, 6600.0	0, 11715.0	
25th, 75th percentile	490.5, 2700.0	446.0, 2809.5	
N (missing)	47 (3)	55 (3)	
Total w/o occupational activities			0.27
Mean ± STD	1388.0 ± 1438.8	1896.1 ± 1950.8	
Median	902.5	1530.0	
Range	0, 6600.0	0, 9836.0	
25th, 75th percentile	490.5, 1879.0	345.0, 2543.0	
N (missing)	49 (1)	55 (3)	
Total w/o household activities			0.51
Mean ± STD	820.9 ± 1316.0	1016.6 ± 1732.4	
Median	245.0	380.0	
Range	0, 5160.0	0, 8715.0	
25th, 75th percentile	0, 735.0	0, 1207.5	
N (missing)	47 (3)	55 (3)	

[a] Other race (n=1) excluded from analyses and summary due to insufficient numbers.

Table A-24 Subjective physical activity [Modified MAQ (minutes per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by age groups (n=109).

Subjective Physical Activity (mins/wk)	**18-39 yrs (n=23)**	**40-49 yrs (n=42)**	**50-65 yrs (n=44)**	**p-value for Kruskal-Wallis Test**
Occupational (mins/wk)				0.17
Mean ± STD	31.3 ± 150.1	57.1 ± 267.0	137.3 ± 384.2	
Median	0	0	0	
Range	0, 720.0	0, 1500.0	0, 1800.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	23 (0)	42 (0)	40 (4)	
Housework				0.70
Mean ± STD	332.9 ± 312.0	397.6 ± 402.4	437.4 ± 499.7	
Median	215.0	297.5	207.5	
Range	0, 1050.0	0, 1725.0	0, 2490.0	
25th, 75th percentile	90.0, 570.0	135.0, 600.0	130.0, 540.0	
N (missing)	23 (0)	42 (0)	42 (2)	
Gardening/Yardwork				0.93
Mean ± STD	2.2 ± 6.7	2.7 ± 10.7	10.4 ± 41.7	
Median	0	0	0	
Range	0, 30.0	0, 60.0	0, 240.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	23 (0)	42 (0)	42 (2)	
Caretaking				0.74
Mean ± STD	40.0 ± 187.5	32.4 ± 138.4	18.6 ± 86.4	
Median	0	0	0	
Range	0, 900.0	0, 840.0	0, 480.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	23 (0)	42 (0)	42 (2)	
Transportation				0.69
Mean ± STD	27.0 ± 43.1	41.2 ± 73.0	50.0 ± 74.1	
Median	0	0	0	
Range	0, 180.0	0, 350.0	0, 300.0	
25th, 75th percentile	0, 40.0	0, 60.0	0, 60.0	
N (missing)	23 (0)	42 (0)	42 (2)	
Leisure				0.99
Mean ± STD	104.5 ± 190.8	91.0 ± 169.7	100.1 ± 202.1	
Median	20.0	0	15.0	
Range	0, 780.0	0, 840.0	0, 875.0	
25th, 75th percentile	0, 120.0	0, 90.0	0, 90.0	
N (missing)	22 (1)	42 (0)	41 (1)	

Table A-24 (continued) Subjective physical activity [Modified MAQ (minutes per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by age groups (n=109).

Subjective Physical Activity (mins/wk)	**18-39 yrs (n=23)**	**40-49 yrs (n=42)**	**50-65 yrs (n=44)**	**p-value for Kruskal-Wallis Test**
Total				0.39
Mean ± STD	513.7 ± 547.3	622.0 ± 529.0	768.6 ± 795.7	
Median	340.0	452.5	465.0	
Range	0, 2320.0	0, 1830.0	0, 3390.0	
25th, 75th percentile	100.0, 735.0	205.0, 975.0	190.0, 1050.0	
N (missing)	22 (1)	42 (0)	39 (5)	
Total w/o occupational activities				0.55
Mean ± STD	481.0 ± 531.3	564.9 ± 504.8	606.7 ± 618.8	
Median	340.0	347.5	340.0	
Range	0, 2320.0	0, 1830.0	0, 2630.0	
25th, 75th percentile	100.0, 735.0	95.0, 815.0	185.0, 905.0	
N (missing)	22 (1)	42 (0)	41 (3)	
Total w/o household activities				0.75
Mean ± STD	165.5 ± 229.2	189.3 ± 304.4	297.2 ± 479.8	
Median	60.0	60.0	110.0	
Range	0, 780.0	0, 1520.0	0, 2130.0	
25th, 75th percentile	10.0, 230.0	0, 210.0	0, 315.0	
N (missing)	22 (1)	42 (0)	39 (5)	

Table A-25 Subjective physical activity [Modified MAQ (METS per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by age groups (n=109).

Subjective Physical Activity (mins/wk)	**18-39 yrs (n=23)**	**40-49 yrs (n=42)**	**50-65 yrs (n=44)**	**p-value for Kruskal-Wallis Test**
Occupational				0.16
Mean ± STD	125.2 ± 600.5	228.6 ± 1068.0	585.0 ± 1585.8	
Median	0	0	0	
Range	0, 2280.0	0, 6000.0	0, 7200.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	23 (0)	42 (0)	40 (4)	
Housework				0.78
Mean ± STD	821.7 ± 743.7	969.4 ± 1018.1	1054.6 ± 1205.4	
Median	580.5	694.8	481.3	
Range	0, 2487.0	0, 4459.5	0, 5847.0	
25th, 75th percentile	240.0, 1381.5	328.5, 1431.0	305.0, 1260.5	
N (missing)	23 (0)	42 (0)	42 (2)	
Gardening/Yardwork				0.93
Mean ± STD	8.0 ± 24.1	11.8 ± 47.9	45.2 ± 186.2	
Median	0	0	0	
Range	0, 105.0	0, 270.0	0, 1080.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	23 (0)	42 (0)	42 (2)	
Caretaking				0.74
Mean ± STD	160.0 ± 750.1	129.5 ± 553.5	74.3 ± 345.5	
Median	0	0	0	
Range	0, 3600.0	0, 3360.0	0, 1920.0	
25th, 75th percentile	0, 0	0, 0	0, 0	
N (missing)	23 (0)	42 (0)	42 (2)	
Transportation				0.68
Mean ± STD	95.2 ± 150.9	144.2 ± 255.5	176.4 ± 259.7	
Median	0	0	0	
Range	0, 630.0	0, 1225.0	0, 1050.0	
25th, 75th percentile	0, 140.0	0, 210.0	0, 270.0	
N (missing)	23 (0)	42 (0)	42 (2)	
Leisure				0.94
Mean ± STD	503.3 ± 1013.4	381.3 ± 740.3	398.0 ± 821.9	
Median	80.0	0	60.0	
Range	0, 4530.0	0, 3240.0	0, 3937.5	
25th, 75th percentile	0, 540.0	0, 360.0	0, 315.0	
N (missing)	22 (1)	42 (0)	41 (3)	

Table A-25 (continued) Subjective physical activity [Modified MAQ (METS per week)] of overweight and obese adults with schizophrenia or schizoaffective disorder (WAIST Study) in GXT cohort by age groups (n=109).

Subjective Physical Activity (mins/wk)	**18-39 yrs (n=23)**	**40-49 yrs (n=42)**	**50-65 yrs (n=44)**	**p-value for Kruskal-Wallis Test**
Total				0.44
Mean ± STD	1669.2 ± 2147.0	1864.8 ± 1700.0	2388.1 ± 2602.4	
Median	897.5	1439.8	1040.0	
Range	0, 9836.0	0, 6211.0	0, 11715.0	
25th, 75th percentile	287.0, 2225.0	492.5, 2543.0	589.0, 3904.5	
N (missing)	22 (1)	42 (0)	39 (5)	
Total w/o occupational activities				0.65
Mean ± STD	1538.3 ± 2086.3	1636.2 ± 1523.7	1726.2 ± 1766.5	
Median	897.5	947.8	951.0	
Range	0, 9836.0	0, 5596.0	0, 6600.0	
25th, 75th percentile	287.0, 2170.5	490.5, 2428.5	528.0, 2300.5	
N (missing)	22 (1)	42 (0)	41 (3)	
Total w/o household activities				0.72
Mean ± STD	733.8 ± 1129.6	754.0 ± 1241.9	1198.8 ± 1976.4	
Median	212.5	212.5	405.0	
Range	0, 4530.0	0, 6070.0	0, 8715.0	
25th, 75th percentile	35.0, 1140.0	0, 735.0	0, 1470.0	
N (missing)	22 (1)	42 (0)	39 (5)	

Table A-26 Mean (standard deviation) for valid actigraphy monitoring at baseline in overweight and obese adults with schizophrenia or schizoaffective disorder by age groups in the GXT cohort (n=27).

Variable	18-39 yrs (n=5)	40-49 yrs (n=10)	50-65 yrs (n=12)	p-value for Kruskal-Wallis Test
Monitoring days	5.2 (2.5)	7.6 (2.5)	7.7 (2.7)	0.21
Mins/day	853 (127)	844 (74)	944 (164)	0.23
Sedentary				
Mins/day	705.2 (117.0)	687.0 (58.8)	776.2 (145.6)	0.48
% of wear time	82.7 (4.3)	81.6 (5.0)	82.2 (5.1)	0.93
Light Activity				
Mins/day	129.8 (34.8)	139.4 (44.2)	146.9 (43.8)	0.60
% of wear time	15.3 (3.6)	16.4 (4.3)	15.7 (4.0)	0.98
Moderate/Vigorous Activity				
Mins/day	17.7 (8.3)	17.1 (9.4)	20.6(14.9)	0.94
% of wear time	17.3 (4.3)	2.0 (1.1)	2.1 (1.3)	0.95
Total Activity				
Mins/day	147.4 (42.2)	156.5 (51.0)	167.4 (57.4)	0.59
% of wear time	17.3 (4.3)	18.4 (5.0)	17.8 (5.1)	0.93
Activity				
Counts/day	12904 (4939)	134181 (61075)	149599 (74737)	0.83
Counts/min	151.6 (42.8)	157.5 (62.8)	157.3 (70.0)	0.99

[a] Fisher's Exact Test

Table A-27 Comparison of adults who used mental health services in NHANES 2003-2004 with overweight and obese adults with schizophrenia or schizoaffective disorder in WAIST study. Age restricted to 18-70 yrs.

Variable	NHANES Users of mental health services (n=230)	WAIST Study Adults with schizophrenia or schizoaffective disorder (n=46)	p-value for t-distribution
Age (yrs) [Mean ± STD]	42.2 ± 0.7	45.6 ± 9.8	0.07
BMI (kg/m^2) [Mean ± STD]	28.6 ± 0.6	37.9 ± 8.1	<0.0001
Men [N (%)]	99 (43.0%)	17 (37.0)	0.45
Current Smoker [N (%)]	87 (37.8%)	16 (34.8)	0.55
Race [N (%)]			0.28
White	139 (60.4)	19 (41.3)	
Black	48 (20.9)	26 (56.5)	
Other	43 (28.7)	1 (2.2)	
General Health Status [N (%)]			0.007
Excellent, Very Good/ Good	156 (67.8)	23 (50.0)	
Fair or Poor	58 (25.2)	21 (45.7)	
Missing	16 (7.0)	2 (4.4)	
Monitoring [Mean ± STD]			
Days	6.1 ± 0.1	7.4 ± 2.8	0.006
Mins/day	941 ± 10	933 ± 149	0.81
Sedentary [Mean ± STD]			
Mins/day	608 ± 11	756 ± 140	<0.0001
% of wear time	64 ± 0.7	81 ± 6	<0.0001
Light Activity [Mean ± STD]			
Mins/day	308 ± 6	157 ± 48	<0.0001
% of wear time	33 ± 7	17 ± 5	<0.0001
Moderate/Vigorous Activity [Mean ± STD]			
Mins/day	25 ± 2	19 ± 12	0.39
% of wear time	3 ± 0.2	2 ± 1	0.45
Total Activity [Mean ± STD]			
Mins/day	333 ± 6	176 ± 54	<0.0001
% of wear time	36 ± 0.7	19 ± 6	<0.0001
Activity [Mean ± STD]			
Counts/day	253332 ± 7069	151036 ± 60998	<0.0001
Counts/min	271 ± 8	163 ± 64	<0.0001

Table 4-28 Univariate models for subjective physical activity (METS/week) in overweight and obese adults with schizophrenia and schizoaffective disorders in the WAIST Study

	Subjective Physical Activity (Modified MAQ)		
Independent Variable	Total Activity (METS/day)	Total w/o occupational activities (METS/day)	Total w/o household physical activities (METS/day)
Age (yrs)			
β ± SE	0.51 ± 13.1	5.3 ± 11.4	-7.6 ± 7.6
F-statistics	0.00	0.22	1.01
p-value	0.97	0.64	0.32
n	243	250	243
BMI (kg/m^2)			
β ± SE	-15.8 ± 17.2	-7.3 ± 14.9	-19.4 ± 9.9
F-statistics	0.84	0.24	3.84
p-value	0.36	0.63	0.05
n	243	250	243
Gender (0=male, 1=female)			
β ± SE	362.0 ± 279.6	504.6 ± 242.1	-67.8 ± 162.0
F-statistics	1.68	4.34	0.18
p-value	0.20	0.04	0.68
n	243	250	243
Race (0=White, 1= Black)			
β ± SE	65.1 ± 274.9	132.2 ± 238.4	-65.1 ± 159.4
F-statistics	0.06	0.31	0.17
p-value	0.81	0.58	0.68
n	237	244	237
Smoking status (0=no, 1=current)			
β ± SE	-80.1 ± 271.6	-93.6 ± 103.4	-109.3 ± 156.8
F-statistics	0.09	0.82	0.49
p-value	0.77	0.49	0.49
n	243	250	243
Psychiatric Medications (0=no, 1=yes)			
Polypharmacy			
β ± SE	-189.5 ± 119.4	-93.6 ± 103.4	117.4 ± 68.9
F-statistics	2.52	0.82	2.90
p-value	0.11	0.37	0.09
n	243	250	243
Weight gaining properties of single anti-psychotic medications (0=no, 1=yes)			
β ± SE	-623.5 ± 354.9	-348.4 ± 308.3	-497.3 ± 211.1
F-statistics	3.09	1.28	5.55
p-value	0.08	0.26	0.02
n	202	207	202
Fitness (0=unfit, 1=fit)			
β ± SE	731.6 ± 1557.7	1108.8 ± 1237.6	1572.5 ± 1097.5
F-statistics	0.22	0.80	2.05
p-value	0.64	0.37	0.16
n	103	105	103

Table 4-28 (continued) Univariate models for subjective physical activity (METS/week) in overweight and obese adults with schizophrenia and schizoaffective disorders in the WAIST Study

	Subjective Physical Activity (Modified MAQ)		
Independent Variable	Total Activity (METS/day)	Total w/o occupational activities (METS/day)	Total w/o household physical activities (METS/day)
Maximal Oxygen Consumption (units)			
β ± SE	15.8 ± 37.0	-8.8 ± 28.9	44.4 ± 26.0
F-statistics	0.18	0.09	2.92
p-value	0.67	0.76	0.09
n	103	105	103
Objective Physical Activity			
Activity(counts/day/100)			
β ± SE	1.94 ± 4.18	-1.75 ± 3.63	5.1 ± 2.6
F-statistics	0.22	0.23	3.77
p-value	0.64	0.63	0.06
n	46	47	46
Activity (counts/min)			
β ± SE	1.12 ± 3.97	-2.0 ± 3.4	3.9 ± 2.5
F-statistics	0.08	0.34	2.37
p-value	0.78	0.56	0.13
n	46	47	46
Total activity (light, moderate and vigorous) (mins/day)			
β ± SE	-0.08 ± 4.76	-2.9 ± 4.1	3.6 ± 3.1
F-statistics	0.00	0.51	1.37
p-value	0.99	0.48	0.25
n	46	47	46
Total activity (light, moderate and vigorous) (% of monitoring time)			
β ± SE	-1584.8 ± 4585.0	-3786.5 ± 3915.4	1907.2 ± 2993.9
F-statistics	0.12	0.94	0.41
p-value	0.73	0.34	0.53
n	46	47	46
Sedentary (mins/day)			
β ± SE	1.15 ± 1.89	1.25 ±1.65	0.76 ± 1.24
F-statistics	0.37	0.58	0.38
p-value	0.55	0.45	0.54
n	46	47	46
Sedentary (% of monitoring time)			
β ± SE	1143.8 ± 1488.9	1650.2 ± 1342.9	-330.3 ± 752.4
F-statistics	0.59	1.51	0.19
p-value	0.45	0.23	0.66
n	46	47	46

APPENDIX C. PUBLICATIONS FOR FULFILLMENT OF DOCTORAL REQUIREMENTS IN THE DEPARTMENT OF EPIDEMIOLOGY, SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF PITTSBURGH, PITTSBURGH, PA.

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Gender, mental health service use and objectively measured physical activity: Data from the National Health and Nutrition Examination Survey (NHANES 2003–2004)

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ABSTRACT

Objective: To examine the relationship between physical activity levels measured objectively by accelerometry and the use of mental health services (MHS) in a representative sample of males and females.

Method: NHANES 2003–2004 is a cross-sectional study of the civilian, non-institutionalized US adult population. Participants reported whether or not they had seen a mental health professional during the past 12 months. Three measures of daily physical activity (light minutes, moderate-vigorous minutes, and total activity counts) and sedentary minutes were determined by accelerometry. The relationship between physical activity and use of MHS was modeled with and without adjustments for potential socioeconomic and health confounders.

Results: Of the 1846 males and 1963 females included in this analysis, 7 and 8% reported seeing mental health professionals during the past 12 months, respectively. Men who used MHS were significantly less active than men who did not use MHS (227,700 versus 276,900 total activity counts, respectively, $p < 0.05$). Men who did not use MHS engaged in 38 min (95% CI 16.3, 59.0) more of light or moderate-vigorous physical activity per day than men who used MHS. Physical activity levels of women, regardless of MHS use, were significantly lower than men who did not use MHS. Differences in total physical activity between women who did and did not use MHS were small (1.3, 95% CI −14.0, 11.4).

Conclusion: Men and women who used MHS were relatively sedentary. Additional research is warranted to determine if increasing physical activity levels results in improved mental health in individuals who use MHS.

1. Introduction

Population-based studies have shown an inverse relationship between physical activity and depression or depressive symptoms; individuals with high activity levels report less depression or depressive symptoms than individuals with low activity levels (Abu-Omar, Rutten, & Lehtinen, 2004; Farmer et al., 1988; Goodwin, 2003; Kritz-Silverstein, Barrett-Connor, & Corbeau, 2001; Stephens, 1988). In addition, persons with severe mental illness (schizophrenia, major depression, or bipolar disorder) were less physically active than the general population (Daumit et al., 2005). With respect to physical activity, individuals who use mental health services have not been studied. Individuals using mental health services represent a population with a broad spectrum of mental health disorders and symptoms that may respond positively to physical activity (Biddle, Fox, & Boutcher, 2000; Broocks et al., 1998; Cattan, White, Bond, & Learmouth, 2005; Fox, Stathi, McKenna, & Davis, 2007; Meyer & Broocks, 2000; Morgan, 1997; Taylor, Sallis, & Needle, 1985).

Physical activity may be an effective alternative or additive treatment for individuals who use mental health services. As a therapeutic intervention, physical activity has several advantages including fewer side effects than pharmaceutical options and the

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improvement of emotional as well as physical well-being (Biddle et al., 2000). Also, physical activity may be a viable alternative for individuals who refuse medications or other treatments, and may improve adherence to medications by reducing antipsychotic-induced weight gain. Beyond its impact on mental health, physical activity reduces the risk of chronic comorbidities such as heart disease, diabetes, and obesity (Davidson et al., 2001; Prince et al., 2007) that are frequently observed in individuals with mental health disorders. Finally, annual direct medical expenditures have been shown to be $2785 lower for active versus sedentary individuals with mental disorders (Brown, Wang, & Safran, 2005).

Previous population studies have relied on self-reported measures of physical activity that are prone to recall errors, over-reporting of duration and/or intensity of physical activities, and social desirability bias (Freedson & Miller, 2000; Kriska & Casperson, 1997; Montoye, Kemper, Saris, & Washburn, 1996; Sallis & Saelens, 2000). The limitations of self-reported physical activity are avoided with objective monitoring of physical activity. Objective monitoring of physical activity allows measurement of (1) low-intensity and nonstructured physical activities such as walking that are difficult for participants to self-report (Department of Health and Human Services Center for Disease Control and Prevention, 2004), (2) physical activities related to transportation, occupation, and household activities as well as leisure-time physical activities, and (3) physical activity over extended time periods (days or weeks) (Freedson & Miller, 2000). Objective monitoring has been shown to be reliable and valid (Freedson, Melanson, & Sirard, 1998; McClain, Sisson, & Tudor-Locke, 2007; Welk, Blair, Wood, Jones, & Thompson, 2000), and is often used as the validity criterion for self-reported measures of physical activity (Kriska & Casperson, 1997; Sallis & Saelens, 2000).

Walking is an unstructured and low-intensity physical activity that is under-reported with self-reports (Bassett, Cureton, & Ainsworth, 2000). An objective measurement of walking is essential for studies investigating physical activity and mental health since walking is the primary mode of physical activity among individuals with mental illness and a greater percentage of persons with severe mental illness report walking as their only form of physical activity compared to the general population (29% versus 10%, respectively) (Daumit et al., 2005). Since under-reporting of walking may have occurred more frequently in the mentally ill than the general population, previous findings based on self-reported measures of physical activity may have been biased away from the null hypothesis. This study avoids this potential bias by objectively measuring physical activity.

The National Health and Nutrition Examination Survey (NHANES) 2003–2004 data provide the unique opportunity to examine the relationship between physical activities measured objectively by accelerometer and self-reported use of mental health services in a representative sample of the US adult population. While there is no gold standard for measuring use of mental health services, self-reported use and administrative records have been shown to provide equivalent estimates of mental health service use (Golding, Gongla, & Brownell, 1988; Rhodes, Lin, & Mustard, 2002). The association between use of mental health services and physical activity was examined separately for men and women since significant gender differences have been observed with respect to physical activity (Centers for Disease Control and Prevention, 2003; Hagstromer, Oja, & Sjostrom, 2007; Trost, Owen, Bauman, Sallis, & Brown, 2002). Our primary hypotheses were that men and women who use mental health services would be less physically active than men and women who do not use mental health services. By measuring physical activity objectively, these hypotheses will be investigated not only for total activity, but also by intensity of physical activity and may yield a different perspective on the relationship between mental health and physical activity than previously reported in studies that used self-reported measures of physical activity.

2. Method

The National Center for Health Statistics of the Centers for Disease Control conducted NHANES as a cross-sectional observational study using a stratified, multistage probability design to obtain a nationally representative sample of the civilian, non-institutionalized US population (Department of Health and Human services Center for Disease Control and Prevention, 2005b). From January 2003 through December 2004, NHANES participants who agreed to a medical examination were recruited for physical activity monitoring (Department of Health and Human Services Center for Disease Control and Prevention, 2006). Only 16% ($n = 880$) of the adult population ($n = 5620$) did not participate in the physical activity monitoring. Reasons for nonparticipation included: declining the medical examination, declining physical activity monitoring, or having physical impairments limiting walking or wearing the ActiGraph thus not being eligible to receive one (Department of Health and Human Services Center for Disease Control and Prevention, 2006). Only adults aged 18–85 years ($n = 4740$) were included in this present analysis.

Physical activity was measured by accelerometry using the ActiGraph AM-7164 monitoring device (ActiGraph, Ft. Walton Beach, FL) (Department of Health and Human Services Center for Disease Control and Prevention, 2006). The ActiGraph is considered the gold standard of accelerometer measurement and it has been used in 196 published studies to date (http://www.theactigraph.com/oldsite/studysearch2.asp). The ActiGraph has been validated with indirect calorimetry, and as expected, higher correlations were observed for laboratory ($r = 0.76$–0.85) than lifestyle activities ($r = 0.48$)(Welk et al., 2000). High interinstrument reliability was observed in free-living adults (intraclass correlations >0.97). The ActiGraphs were set to measure the duration and intensity of uniaxial movement within 1-min epochs. Participants wore the accelerometer on an elasticized belt over the right hip for seven consecutive days (Department of Health and Human Services Center for Disease Control and Prevention, 2006). 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 respondents with valid and reliable accelerometery data according to standard NHANES protocol and who wore the accelerometers for at least 10 h a day for four or more days. Each minute epoch was assigned an activity level based on the number of counts per minute; sedentary (<260 counts), light (260–1951 counts), or moderate/vigorous (≥1952 counts). For the most part, strenuous physical activities such as running, cycling, brisk walking and other aerobic activities were included in this definition of moderate/vigorous activity. As part of secondary analyses, we also defined moderate/vigorous activities with a lower cutpoint (≥760 counts) that encompassed activities of daily living with lower intensities (Bassett, Ainsworth, et al., 2000). This alternative definition would classify washing dishes, laundry and light cleaning as light activities; and vacuuming, sweeping, mopping, walking for errands and exercising as moderate/vigorous activities (Bassett, Ainsworth, et al., 2000). Daily totals of sedentary, light, and moderate-vigorous minutes as well as total activity counts were averaged and modeled as the outcome variables.

During the household interview, the use of mental health services was assessed by asking: "During the past 12 months, that is since (*date*), have you seen or talked to a mental health professional such as a psychologist, psychiatrist, psychiatric nurse, or clinical social worker about your health?" Participants responded yes or no, and the reference group was individuals who did not report using mental health services.

Half of the individuals aged 20–39 years were administered the Composite International Diagnostic Interview (CIDI, version 2.1) for major depression, generalized anxiety disorder (GAD), and generalized panic disorder during the past 12 months. The CIDI is administered by lay interviewers and does not rely on medical records or outside informants. Respondents were coded as a positive or negative diagnosis for each disorder.

3. Data analysis

Descriptive summaries and statistical analyses are presented separately for men and women. All analyses were performed using Stata (release 9, StataCorp, College Station, TX). The three estimates of physical activity (light minutes, moderate-vigorous minutes, and total activity counts) and sedentary minutes were the dependent variables in the separate linear regression models. Use of mental health services was modeled as the independent variable. Initially, the association between each outcome and use of mental health services was modeled. Next, age, race, education, body mass index (kg/m^2) (BMI), smoking status (current smoker if $\geq$10 ng/dl of cotinine), and health status (poor, fair versus good, very good, excellent) were added as potential confounders. Subsequent models added chronic health conditions (cardiovascular disease, chronic lung disease, diabetes, cancer, dialysis, liver disease, musculoskeletal disease, stroke, congestive heart failure, angina, emphysema, chronic bronchitis, and/or dialysis) and excluded participants with potentially mobility limiting chronic health conditions (stroke, congestive heart failure, angina, emphysema, chronic bronchitis, and/or dialysis). Finally, interactions between using mental health services and age, race, education, and chronic health conditions were added separately to the multivariate models (data not shown). Interactions were only retained in the multivariate models if the p-value was $\leq$0.05.

In the linear regression models, age was modeled as a quadratic term based on lowess splines (Vittinghoff, Glidden, Shiboski, & McCulloch, 2005). Lowess splines are smoothing functions used to depict the linear or non-linear relationship between two variables. This nonparametric function indicates the appropriate functional form of the independent variable. Each model was adjusted for the weighting and clustering of the complex sampling design to obtain results representative of the US adult population (Department of Health and Human Services Center for Disease Control and Prevention, 2005a).

Additional analyses were performed to determine the representativeness of the subsample with accelerometry data compared to the subsample without accelerometry data. The subsample without accelerometry data included adults who participated in the physical activity monitoring but did not provide valid and reliable accelerometry data ($n = 931$), and adults who did not participate in the physical activity monitoring ($n = 880$). Demographic, health, and use of mental health services variables were analyzed using Pearson Chi-Square statistics for categorical variables and linear regression for continuous variables.

4. Results

Overall, 2696 adult men and 2924 adult women participated in the household interview. Only one man and two women did not answer the question on mental health service utilization. Approximately 15% of these respondents ($n = 414$ for men and $n = 466$ for women) did not participate in the physical activity monitoring. Among those who participated in the physical activity monitoring ($n = 2282$ for men and $n = 2458$ for women), 80% of the sample ($n = 1846$ for men and $n = 1963$ for women) provided reliable and valid accelerometry data. Neither men nor women exhibited significant differences for those with and without accelerometry data in the use of mental health services ($p > 0.45$), diagnoses of at least one of three mental health disorders ($p > 0.19$), chronic health conditions ($p > 0.22$), mobility limiting chronic health conditions ($p > 0.14$) or BMI ($p > 0.58$). However, statistically significant ($p < 0.05$) differences between those with and without accelerometry data were observed for race, age, health status (in women only), education, and smoking status. In both men and women, individuals with accelerometry data were approximately 6 years older, and a greater percentage were college-educated, nonsmokers, Hispanics or Caucasians.

Descriptive characteristics of the participants with accelerometry and use of mental health service data are provided in Table 1. Of the 1846 males and 1963 females included in this analysis, 7 and 8% reported seeing mental health professionals during the previous 12 months, respectively. For both men and women, a greater percentage of individuals who used mental health services smoked (Table 1). Among men, chronic health conditions were reported more frequently for those who used mental health services (58%) compared to nonusers (40%).

On average, men engaged in more minutes of moderate to vigorous activities than women (men: 31 ± 23, women: 17 ± 15 min/day) regardless of mental health service use. Among men, sedentary minutes were greater and activity (light, moderate/vigorous, and total activity) was lower in those who used mental health services compared to those who did not use mental health services (Fig. 1). Based on the univariate and multivariate models, men who used mental health services averaged at least 30 min less of light physical activity, 5 min less of moderate physical activity, and 42,000 fewer total activity counts per day than men who did not use mental health services (Table 2). Conversely, men who used mental health services were sedentary approximately 40 min more per day than men who did not use mental health services (Table 2).

Overall, there was no significant difference in the activity patterns for women who did and did not see a mental health professional during the previous year. The differences in total physical activity were smaller (<10 min) between those women who did and did not use mental health services compared to the men who did and did not use mental health services (approximately 40 min). In the univariate models, total activity (approximately 15,000 counts, $p = 0.08$) and minutes in moderate/vigorous activities (approximately 5 min, $p = 0.05$) were higher in those women who used mental health services compared to those who did not (Fig. 1 and Table 2). These differences were not statistically significant in the multivariate models. The gender differences persisted in subsequent models after controlling for confounders and excluding participants with possible physical limitations (Table 2). Similar results were obtained if the lower cutpoint was used for the moderate/vigorous activity level (data not shown).

CIDI diagnoses of major depressive disorder, GAD, and panic disorder were available in 319 men and 372 women between the ages of 20 and 39 years. Overall, 27 men and 38 women were diagnosed with at least one of three mental health disorders. Major depressive disorder was diagnosed in 18 men and 32 women; GAD was diagnosed in 4 men and 8 women; and panic disorders in 7 men and 9 women. Approximately 25% of individuals with a diagnosed mental health disorder used mental health services ($n = 7$, 1, and 2 for men and 6,1, and 3 for women diagnosed with depression, GAD, and panic disorders, respectively). Accelerometry data were available in too few of the diagnosed cases ($n = 15$ for men and $n = 20$ for women) for statistical analysis.

5. Discussion

Physical activity levels were lower in men who used mental health services compared to men who did not use mental health services. Average activity levels for women regardless of whether

Table 1
Demographic and health information for men and women by whether or not they reported using mental health services (MHS) during the past 12 months, NHANES 2003–2004

Variable	Men (n = 1846)		Women (n = 1963)	
	Used MHS (n = 115)	Did not use MHS (n = 1731)	Used MHS (n = 138)	Did not use MHS (n = 1825)
Age (years)[a]	47 (36, 54)	45 (33, 58)	43 (32, 52)	47 (34, 61)
BMI (kg/m^2)[a]	27.4 (23.8, 29.8)	27.5 (24.5, 31.0)	26.0 (22.9, 34.7)	26.9 (23.2, 31.6)
Race (%)				
White	75.8	74.0	82.5	72.9
Hispanic	9.1	11.5	7.9	11.3
Black	11.6	9.1	4.9	10.7
Other	3.5	5.4	4.7	5.1
Education (%)				
<High school	15.5	17.5	7.9	18.3
High school graduate	28.2	26.5	24.7	26.1
College-educated	55.3	56.0	67.4	55.6
Smoker (%)	47.7	33.1	27.7	19.1
Health status (%)				
Poor	5.6	2.2	5.4	3.5
Fair	12.7	12.1	18.1	14.0
Good	40.1	35.7	34.6	34.3
Very good	33.7	36.2	30.8	35.6
Excellent	8.0	13.8	11.1	12.7
Chronic health conditions[b] (%)	58.3	40.2	51.5	48.7
Potentially mobility limiting chronic health conditions[c] (%)	18.8	11.5	14.4	14.6
Accelerometry measurements[a]				
Sedentary (min/day)	1233 (1164, 1282)	1190 (1122, 1256)	1219 (1167, 1292)	1218 (1163, 1271)
Light (min/day)	182 (143, 228)	218 (165, 285)	196 (163, 252)	205 (156, 255)
Moderate/vigorous (min/day)	24 (10, 40)	25 (11, 44)	15 (7, 34)	12 (5, 24)
Total activity (counts/day)	227,700 (165,300, 342,200)	276,900 (193,300, 376,500)	232,300 (168,000, 301,300)	212,800 (153,700, 278,800)

[a] Median (25th and 75th percentile).
[b] Self-reported cardiovascular disease, chronic lung disease, diabetes, cancer, dialysis, liver disease, musculoskeletal disease, stroke, congestive heart failure, angina, emphysema, chronic bronchitis, or dialysis.
[c] Self-reported stroke, congestive heart failure, angina, emphysema, chronic bronchitis, or dialysis.

or not they use mental health services were less than the low activity levels of men who use mental health services. Consistently, population studies have shown that adults diagnosed with depression, severe mental illness (schizophrenia, major depression, or bipolar disorder), or experiencing depressive symptoms have lower physical activity levels than the general population (Abu-Omar et al., 2004; Daumit et al., 2005; Farmer et al., 1988; Kritz-Silverstein et al., 2001; Stephens, 1988). Our results extend these

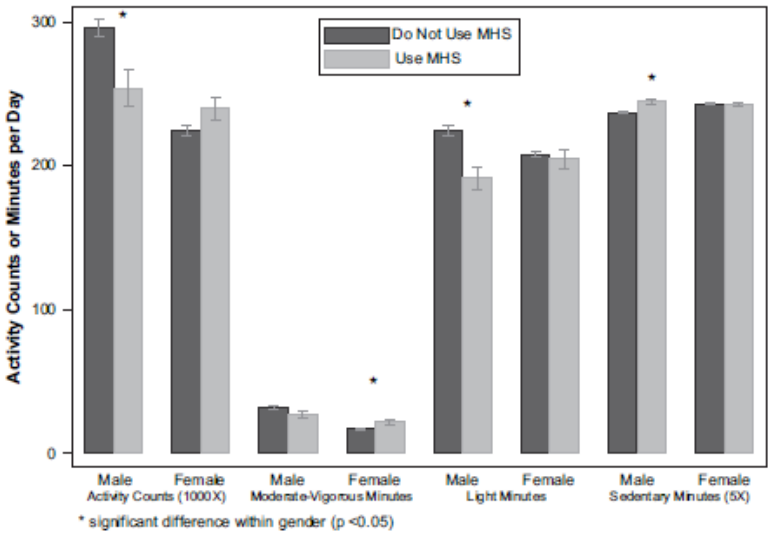

Fig. 1. Average daily physical activity (light minutes, moderate/vigorous minutes, or total activity counts) or sedentary minutes by use of mental health services (MHS) during the past 12 months for men and women, NHANES 2003–2004.

Table 2
Prediction of physical activity (light, moderate/vigorous, or total activity) or sedentary minutes by use of mental health services during the past 12 months for men and women in NHANES 2003–2004 using linear regression

Independent Variable	Dependent variable			
Use of mental health services (0 = no, 1 = yes)	Sedentary (min/day)	Light (min/day)	Moderate/vigorous (min/day) [a]	Total activity (counts/day)
Men	β[b] ± SE *p*-Value R^2 (%)	β[b] ± SE *p*-Value R^2 (%)	β[b] ± SE *p*-Value R^2 (%)	β[b] ± SE *p*-Value R^2 (%)
Univariate model (n = 1846)	37.6 ± 10.0 0.002 0.9	−32.9 ± 9.0 0.002 1.0	−4.7 ± 2.3 0.06 0.2	−42052 ± 12,984 0.006 0.5
Multivariate model 1[c] (n = 1690)	42.7 ± 8.4 <0.001 26	−37.4 ± 7.6 <0.001 21	−5.2 ± 2.5 0.05 25	−47216 ± 12,057 0.001 29
Multivariate Model 2[d] (n = 1441)	32.9 ± 8.6 0.002 21	−29.9 ± 8.5 0.003 16	−3.0 ± 2.5 0.03 22	−31875 ± 11,225 0.01 25
Women				
Univariate model (n = 1963)	−1.3 ± 6.0 0.83 0.0	−3.5 ± 6.5 0.60 0.0	4.8 ± 2.2 0.05 0.6	15158 ± 8067 0.08 0.2
Multivariate model 1[c] (n = 1741)	5.7 ± 6.2 0.37 19	−9.6 ± 6.6 0.17 16	4.0 ± 2.3 0.10 20	6827 ± 8491 0.43 24
Multivariate model 2[d] (n = 1478)	2.7 ± 7.0 0.70 15	−6.3 ± 7.2 0.40 12	3.6 ± 2.6 0.20 17	8539 ± 1086 0.41 19

[a] Defined as ≥1952 counts.
[b] β represents the difference in minutes or counts between those who use mental health services and those who did not. For example, males who use mental health services were sedentary 38 min/day longer than those who did not use mental health services in the univariate model.
[c] Adjusted for age, race, education, BMI, smoking status, and health status.
[d] Adjusted for age, race, education, BMI, smoking status, health status, and chronic health conditions in the model and excluded participants who self-reported potentially mobility limiting chronic health conditions (stroke, congestive heart failure, angina, emphysema, chronic bronchitis, or dialysis).

findings by studying individuals who use mental health services, a population that is defined by their behavior of seeking mental health treatment rather than their diagnosis and/or symptoms. By studying this population, we establish that individuals who use mental services are sedentary and may not fully derive the mental and physical benefits associated with physical activity. In addition, it clearly defines a population that is readily accessible via mental health professionals to target for physical activity interventions.

Richardson et al. (2005) have proposed that physical activity interventions should be integrated into mental health services for those with serious mental illness. Our findings suggest expanding the proposal to include all individuals using mental health services, not just those with serious mental illness. Advantages of implementing or integrating physical activity interventions at mental health settings include tailoring the program to the specific needs and concerns of individuals who use mental health services, and the opportunity for ongoing reinforcement for adopting and maintaining regular physical activity due to the frequent contacts with mental health care providers (Richardson et al., 2005). Although limited, existing literature suggests that individuals who use mental health services are receptive to physical activity interventions. Individuals with serious and persistent mental illness perceived physical activity positively and as benefiting both mental and physical health (McDevitt, Snyder, Miller, & Wilbur, 2006; Ussher, Stanbury, Cheeseman, & Faulkner, 2007). Furthermore, the majority of participants with severe mental illness in a smoking cessation program were interested in assistance in becoming more physically active (Faulkner et al., 2007).

To the best of our knowledge, this is the first population study to use an objective measure of physical activity to investigate the relationship between use of mental health services and physical activity. In contrast to self-reported measures of physical activity, objective monitoring provides a reliable and valid estimate of light physical activities. This is relevant in the present study since light but not moderate-vigorous physical activity primarily accounted for the differences in physical activity levels in men who do and do not use mental health services.

Previous population studies using self-reported measures of physical activity have reported differences in moderate-vigorous physical activities between individuals with depression or depressive symptoms and the general population (Abu-Omar et al., 2004; Farmer et al., 1988; Goodwin, 2003; Kritz-Silverstein et al., 2001; Stephens, 1988). The discrepancies between these studies and the present study may be due to differences in the measurement of physical activity. With self-reported measures, respondents tend to overestimate the intensity of their physical activities. In both psychiatric and adult general populations, physical activity levels are consistently lower for objective than self-reported measures of physical activity (Hagstromer et al., 2007). Hence, the differences in moderate-vigorous intensity physical activity based on self-reported measures may actually reflect differences in light physical activities that have been misclassified as moderate-vigorous physical activities.

A limitation of accelerometry is that it monitors the intensity and duration but not the type of physical activity performed. Additional research is necessary to determine what type of light physical activities accounts for the observed differences in men who do and do not use mental health services. Although speculative, nonstructured and low-intensity walking and not brisk walking may explain the observed differences in light physical activities between men who do and do not use mental health services. These differences in light physical activities may be attributed to employment, household activities, transportation and/or leisure activities. Identifying the type and reason for the differences in light physical activity may guide physical activity recommendations and interventions for men who use mental health services.

As suggested in a recent commentary by Troiano (2007), objective monitoring may redefine the duration and intensity of physical activities recommended to promote and maintain health. Only moderate and vigorous intensity physical activities are currently recommended in the national guidelines by the American College of Sports Medicine and the American Health Association (Haskell et al., 2007). However, these recommendations are based on studies using self-reported measures of physical activity (Haskell et al., 2007). If the self-reported measures misclassify light as moderate-vigorous intensity then light physical activity as defined by objective monitoring may confer mental and physical health benefits. If future studies using objectively measured physical activity substantiate a relationship between light physical activity and mental health then modifications to the national guidelines may include separate recommendations for light physical activities or combining recommendations for light and moderate physical activities. Individuals who use mental health services may be more likely to increase their physical activity levels and perceive fewer barriers to initiating and maintaining physical activity if mental and physical heath benefits were derived from light physical activities.

Previous studies based on self-reported physical activity have consistently shown that men are more active than women (Goodwin, 2003; Trost et al., 2002). The present study extends this gender difference in physical activity to individuals who use mental health services, and compares favorably to the finding that men (69%) report a higher prevalence of walking than women among adults with

severe mental illness (49%) (Daumit et al., 2005). Unfortunately, comparisons with other population studies are not possible since physical activity levels of men and women with depression were not reported (Abu-Omar et al., 2004; Farmer et al., 1988; Goodwin, 2003; Kritz-Silverstein et al., 2001; Stephens, 1988). Hence, the present findings are novel and establish the physical activity levels of men and women who used mental health services by objective monitoring.

Few population-based studies have measured physical activity objectively. Other than NHANES 2003–2004, only Hagstromer et al. (2007) have reported objectively measured physical activity in an adult Swedish population. The US and Swedish populations differed in total activity counts and minutes of moderate-vigorous activity. Overall, the Swedish population was more active than the US population (difference was approximately 45,000 counts/day for men and 92,000 counts per day for women). In both populations, total activity counts were higher in men than women but the gender difference was smaller in the Swedish (approximately 17,000 counts per day) than US (approximately 64,000 counts per day) population. On average, the Swedish population engaged in 8–13 min per day more of moderate-vigorous activity (Hagstromer et al., 2007). While the daily difference may seem modest, this difference in moderate-vigorous physical activity is substantial over a week, approximately 60–90 min. In both populations, daily minutes of moderate-vigorous activity was greater in men than women. Again, the gender difference was smaller in the Swedish than the US population (approximately 4 versus 13 min, respectively). Direct comparisons for average minutes in sedentary and inactivity are not possible since the studies used different definitions (inactivity defined as <100 counts/min in the Swedish study and sedentary defined as <260 counts/min in NHANES study). Although not provided, minutes in light physical activity can be estimated from the tables for the Swedish population. On average, light physical activity was higher in men than women in the US population and lower in men than women in the Swedish population. Interestingly, the magnitude of the gender difference for light physical activity (10–13 min/day) was similar for the Swedish and US population even though the definitions of light physical activity differed. In general, the proportion of time spent in sedentary, light and moderate-vigorous activities were comparable for the Swedish and US population. The actual time differences in the activity patterns and activity counts of the populations seemed plausible and may be attributed to true activity differences in Swedish and US populations and/or an artifact of the different cutpoints used to define inactivity and sedentary.

Although there was no validation of mental health utilization among the respondents in NHANES 2003–2004, self-reported use and administrative records have been shown to provide equivalent estimates of mental health service use (Golding et al., 1988; Rhodes et al., 2002). Seven to eight percent of the NHANES participants reported using mental health services from mental health professionals which is comparable to estimates (5–11%) from previous studies that have used self-reports (Barker et al., 2004; Bland, Newman, & Orn, 1997; Elhai & Ford, 2007; Kessler et al., 1999; Regier et al., 1993; Wang et al., 2006) or administrative records (Diehr, Price, Williams, & Martin, 1986; Simon, Grothaus, Durham, VonKorff, & Pabiniak, 1996). Higher estimates of mental health utilization (8–20%) have been reported in studies that used a broader definition of mental health services that included general practitioners or family physicians, religious or spiritual advisors, or any other healers (chiropractor, herbalist, or spiritualist) as well as psychiatrists, psychologists, social workers, counselors, or mental health professionals (Barker et al., 2004; Bland et al., 1997; Kessler et al., 2005; Lin, Goering, Offord, Campbell, & Boyle, 1996; Regier et al., 1993; Rhodes et al., 2002; Uebelacker, Wang, Berglund, & Kessler, 2006; Wang et al., 2005). Our results as well as the majority of population studies suggest no gender differences in the use of specialty mental health services (Albizu-Garcia, Alegria, Freeman, & Vera, 2001; Kessler et al., 2005; Leaf & Bruce, 1987; Mojtabai, 2005; Uebelacker et al., 2006). Taken together, these findings suggest that the measurement of mental health utilization in NHANES 2003–2004 was valid, comparable to other national surveys, and reflective of national trends in use of mental health services.

A limitation of this investigation is that homeless individuals were not included in the sampling frame. Folsom et al. (2005) estimate that 15% of patients treated for serious mental illness were homeless during a one year period in San Diego County, CA, USA. Estimates of homelessness are not available for individuals with no or less severe psychiatric diagnoses who use mental health services (Folsom et al., 2005). It should be noted that the present study does not represent homeless or institutionalized individuals who use mental health services. The NHANES survey only asked respondents if they used mental health services during the past 12 months (yes or no) thus preventing examination of (1) the dose–response relationship between physical activity and number of mental health visits or period of treatment, (2) physical activity levels of current versus past users of mental health services, (3) the relationship between type of mental health care provider and physical activity levels, and (4) the relationship between diagnosis and physical activity levels.

A strength of this study is that it is a large sample, representative of the adult US population. Utilization of mental health services was assessed in all participants except three. A majority of the participants (68%, or 3809 out of 5620) provided reliable and valid accelerometry data. No differences in use of mental health services were noted between those who did and did not provide valid and reliable accelerometry data suggesting that the subsample was representative of the entire sample with respect to utilization of mental health services.

Collectively, the population studies suggest that physical activity levels are low not only in individuals with depression and depressive symptoms, but also in individuals using mental health services. Due to the cross-sectional designs of these studies, causality cannot be determined; low physical activity may contribute to the mental disorder or symptoms, low physical activity may be a side effect or symptom of the mental disorder or symptoms, or physical activity may not have a temporal relationship with mental health. Randomized control trials are necessary to determine the following: (1) does physical activity at low-intensity confer mental and physical health benefits? (2) What are the optimal frequency, intensity and duration of physical activities to confer mental health benefits? Do these physical activity recommendations apply regardless of diagnoses or severity of symptoms? (3) Are physical activity interventions that are integrated or implemented at mental health services efficacious and effective? (4) Does adoption and maintenance of a physical activity program reduce the frequency of mental health visits, the need for mental health services, or the medical costs of individuals who use mental health services?

In summary, men who used mental health services were less physically active than men who did not use mental health services. There was no difference in activity levels between women who use mental health services and those who do not, but physical activity levels in both groups of women were low and justify physical activity interventions. This study establishes that individuals who use mental health services are relatively sedentary. Physical activity interventions may improve mental and physical health outcomes among individuals who use mental health services. Additional research is warranted to determine if increasing physical activity levels results in improved mental health in individuals who use mental health services.

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Corrigendum to "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. 1 (2008) 9–16]

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On p. 2 the statement:

"As part of secondary analyses, we also defined moderate/vigorous activities with a lower cutpoint (>760) that encompassed activities of living with lower intensities (Bassett, Ainsworth, et al., 2000)."

should have read:

"As part of secondary analyses, we also defined moderate/vigorous activities with a lower cutpoint (>760) that encompassed activities of living with lower intensities (Matthews, 2005)."

Reference

Matthews, C. E. (2005). Calibration of accelerometer output for adults. *Medicine & Science in Sports & Exercise, 37*(Suppl. 11), S512–S522.

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BRIEF REPORTS

Longitudinal Physical Activity Changes in Older Men in the Osteoporotic Fractures in Men Study

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OBJECTIVES: To describe the change in physical activity (total, leisure, household, occupational) in men over a mean 5-year follow-up period and to identify sociodemographic and health factors associated with change in physical activity.

DESIGN: Prospective cohort study; Osteoporotic Fractures in Men Study; data collected March 2000 through May 2006.

SETTING: Six U.S. clinical centers.

PARTICIPANTS: Volunteer sample of ambulatory community-dwelling men aged 65 and older (N = 5,161).

MEASUREMENTS: Self-reported physical activity assessed at baseline and Visit 2 (V2) (5 years apart) according to the Physical Activity Scale for the Elderly (PASE) (unitless, relative measure of physical activity).

RESULTS: At baseline, PASE scores averaged 16.8 ± 35.5 for occupational, 37.0 ± 34.0 for leisure, 95.9 ± 43.2 for household, and 149.7 ± 67.6 for total physical activity. Occupational (− 6.2 ± 33.9), leisure (− 3.2 ± 37.3), household (− 9.9 ± 44.3), and total (− 19.3 ± 67.7) physical activity change scores declined, on average, from baseline to V2. On average, change in total PASE scores declined more with age: − 15.6 ± 71.6 for men younger than 70, − 16.4 ± 67.0 for men aged 70 to 74, − 21.4 ± 66.9 for men aged 75 to 79, and − 29.5 ± 60.7 for men aged 80 and older. Living alone, smoking cigarettes, poor health, and higher blood pressure were associated with greater declines in physical activity over time. Although average scores declined, some older men (1,335, 26%) reported increasing physical activity levels. Better physical and mental health, living with others, and being younger were associated with the probability of increasing physical activity over time.

CONCLUSION: Over the 5-year period, the majority of men reported declines in total physical activity. Older men in poor health who live alone have a high risk of physical activity declines and may be an important group to target for exercise interventions. J Am Geriatr Soc 2010.

Key words: exercise; PASE; longitudinal; cohort; physical activity

Physical activity has been shown to be related to health status and quality of life in older adults.[1,2] The American College of Sports Medicine and the American Heart Association recommend that older adults engage in adequate physical activity levels and provide general physical activity guidelines for this age group.[1] Unfortunately, despite the benefits of physical activity, the majority of older U.S. adults (aged ≥75) are inactive (40%) or irregularly active (25%) as estimated according to the Behavioral Risk Factor Surveillance System[3] and spend a majority of their day (~ 60%) in sedentary behaviors.[4]

Cross-sectionally, physical activity levels declined with age in many investigations,[5–11] although longitudinal data on physical activity changes over time are limited, particularly for older adults.[12] In elderly men living in Zutphen, the Netherlands, total time spent in physical activity levels decreased 33% over a 10-year period.[12] However, although time spent gardening and bicycling declined, time spent walking (~ 18 min/day) remained stable over the 10-year period.[12]

The Osteoporotic Fractures in Men Study (MrOS)[13] provided the opportunity to examine change in self-reported physical activity longitudinally in a large cohort of older men. The MrOS population represents community-dwelling ambulatory men aged 65 and older and provides one of the largest samples in which physical activity was measured with a questionnaire designed specifically for older adults. The aims of the present analyses were to describe change in physical activity levels (total, leisure, household, occupational) in men aged 65 and older over a mean follow-up of 5 years and to identify sociodemographic

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and health factors that are associated with changes in physical activity levels in older men. A better understanding of changes in physical activity levels over time may facilitate effective interventions that promote and maintain health and quality of life in this population and to identify populations at high risk for decline.

METHODS

Participants

From March 2000 through April 2002, 5,995 men aged 65 and older were recruited from six U.S. centers (Birmingham, AL; Minneapolis, MN; the Monongahela Valley near Pittsburgh, PA; Palo Alto, CA; Portland, OR; and San Diego, CA) for participation in the MrOS.[13,14] Men were excluded if they had a bilateral hip replacement or were unable to walk without the assistance of another person. The second visit (V2) was conducted between March 2005 and May 2006, an average of 4.6 ± 0.4 years after baseline. This report is restricted to 5,161 men (95% of the surviving men) who provided data for Physical Activity Scale for the Elderly (PASE) scores at baseline and V2. Overall, PASE scores were missing for 834 participants for the following reasons; 571 died before V2, 174 were living but did not complete the PASE questionnaire at V2 (109 refused V2, and 65 did not answer all PASE V2 questions), 86 terminated participation in MrOS before V2, and three did not answer all PASE baseline questions. The institutional review board at each center approved the study protocol, and written informed consent was obtained from all participants.

Physical Activity Measurements

PASE[15] was self-administered at baseline and V2 and measured total, occupational, household, and leisure physical activities. Participants were asked about the intensity, frequency, and duration of a variety of activities, including walking; strenuous, moderate and light sports; muscle strength and endurance; occupational activities that included standing or walking; lawn work and gardening; caring for another person; home repairs; and heavy and light housework over the previous 7 days. The frequency and duration of each activity was multiplied by an empirically derived item weight and summed to compute the total PASE score activity.[15] PASE scores have no units and provide a relative rather than absolute measure of physical activity levels. Along with total PASE score, PASE subscales were computed for occupational, household, and leisure physical activities. Total PASE scores at baseline and V2 were categorized as limited (≤50.0), low (50.1–200.0), and high (>200.0) physical activity to allow comparisons with previously reported PASE results based on cross-sectional studies.[15–18] The PASE has been validated with objective measures of physical activity, including the doubly labeled water method,[19] accelerometry,[15,16,20] and pedometers.[18] In addition, the PASE has high test–retest reliability.[15,20]

In this report, change in physical activity was investigated as a continuous and categorical outcome because this is the first investigation to report longitudinal changes in physical activity using the PASE. The continuous outcome, total PASE change score, was computed by subtracting baseline total PASE scores from V2 PASE scores for each participant. PASE subscale change scores were computed similarly to the total PASE change score. Symmetrized percentage change [(V2 − baseline score) × 100/(V2+baseline score)] was calculated for total PASE scores because the maximum response is defined and bounded (±100).[21] The categorical outcome was defined as 20 or greater versus less than 20 PASE change score because it may represent a clinically relevant change in physical activity in older adults (unpublished data); a 20-point change in PASE score equates to a 13% change in physical activity for an older man with a baseline PASE score of 150 or a shift from never to some leisure physical activity (1–2 days for >4 hours, 3–4 days for 2–4 hours, or 5–7 days for 1–2 hours), an approximately 1-hour change in occupational activity, or indicating one additional or one less household activity. A 20-point change in PASE score also represented the top quartile of the distribution of change in PASE scores from baseline to V2 in MrOS.

Sociodemographic and Health Measurements

At baseline, data regarding demographics, medical history, and lifestyle information were collected. Race was self-declared and dichotomized from seven race categories into Caucasian or non-Caucasian. Caucasians who identified themselves as multiracial were coded as non-Caucasians. Categorical variables were created for education (high school or less, some or completed college, or some graduate school or more), age at baseline (65–69, 70–74, 75–79, and ≥80), living arrangement (alone or with others), and smoking status (never, former, current). Participants completed the Medical Outcomes Study 12-item Short Form Health Survey (SF-12), and summary scores for physical and mental health were derived from this questionnaire.[22] SF-12 physical and mental health scores were analyzed as binary variables, with the median value of all men at baseline defining the categories. Body mass index was calculated using weight (kg)/height (m^2) and analyzed as a categorical variable (<25.0, 25.0–29.9, ≥30.0 kg/m^2). During assessment of the ankle brachial index, a trained technician measured systolic blood pressure, which was analyzed as a categorical variable (≤140 mmHg, >140 mmHg) defined according to the median of all men at baseline.

Statistical Methods

Comparisons of PASE total and subscale scores at baseline and V2 according to baseline age groups were performed using analysis of variance for normally distributed scores and the Kruskal-Wallis test for skewed scores. The least squares means procedure was used to examine change in total PASE score (continuous variable) and baseline demographics, health history, health habits and status, and quality-of-life measures modeled as categorical variables. Based on these results, main effect candidates were identified for the model-building phase if significance was ≤.10. SF12 mental and physical health were selected to represent the various clinical and self-reported health conditions associated with the PASE change scores. All main effect candidates were added simultaneously to the main effects model. Sequential backward elimination of the main effect candidates with $P > .10$ was used to obtain the final main effects

multivariate model. Interaction terms considered biologically plausible based on the final main effects were added individually to the final main effects model and were considered candidates for the final model building phase if $P < .05$. Finally, all significant interaction candidates were added simultaneously to the main effects model, and backward elimination of main effects and interactions were used to obtain the final linear regression model ($P < .05$). Logistic regression was used to compare men who increased their physical activity over time (≥20 PASE change score) with those who maintained or decreased their physical activity over time (<20 PASE change score). All analyses were performed using SAS 9.1 (SAS Institute, Inc., Cary, NC) or Stata version 9.2 (StataCorp, College Station, TX).

RESULTS

The study population included 5,161 older men, with the majority being Caucasian (90%), living with others (87%), and having education beyond high school (41% some college or college degree and 36% graduate school). The mean age ± SD of the study population was 73.1 ± 5.5. Participants had a median number of three out of 20 possible clinical or self-reported health conditions at baseline.

PASE total and subscale scores at baseline and V2 are summarized in Table 1. At baseline, PASE scores averaged 16.8 ± 35.5 for occupational, 37.0 ± 34.0 for leisure, 95.9 ± 43.2 for household, and 149.7 ± 67.6 for total physical activity. On average, occupational (−6.2 ± 33.9), leisure (−3.2 ± 37.3), household (−9.9 ± 44.3), and total (−19.3 ± 67.7) physical activity scores declined from baseline to V2 ($P \leq .001$). The corresponding symmetrized percentage changes were −7.7 ± 52.3% for occupational, −6.9 ± 49.7% for leisure, −7.4 ± 34.8% for household, and −9.0 ± 29.0% for total physical activity. The distribution of change in PASE scores from baseline to V2 approximated a normal distribution. Using the limited, low, and high definitions for physical activity, the majority of the men (3,553, 69%) remained in the same physical activity category at V2 and baseline. Ten percent (n = 519) increased and 21% (n = 1,089) decreased their physical activity category from baseline to V2. The percentage of men categorized as engaging in limited physical activity (total PASE score ≤50) doubled over the 5-year period (6% at baseline to 12% at V2).

Of the subsample of men (1,335, 26%) who increased their physical activity (PASE score ≥20) from baseline to V2, median change scores (interquartile range) were 0 (0–9) for occupational, 14 (0–38) for leisure, 30 (0–50) for household, and 51 (33–78) for total physical activity scores. The corresponding median symmetrized percentage changes (interquartile range) were 0% (0–33%) for occupational, 25% (0–52%) for leisure, 14% (0–29%) for household, and 19% (12–29%) for total physical activity.

On average, younger men had higher total and subscale PASE scores at baseline and V2 than older men (Table 1).

Table 1. Physical Activity Scale for the Elderly (PASE) Change, Total, and Subscale Scores According to Baseline Age Groups in Older Men in the Osteoporotic Fractures in Men Study

Baseline Age	Visit	Mean ± Standard Deviation			
		Occupational	Leisure	Household	Total
<70 (n = 1,624)	Baseline	24.6 ± 44.2	38.0 ± 35.3	100.1 ± 42.4	162.8 ± 71.1
	V2	15.4 ± 32.8	36.3 ± 36.8	95.4 ± 43.5	147.2 ± 69.4
	Change	−9.2 ± 41.9	−1.7 ± 39.3	−4.7 ± 44.1	−15.6 ± 71.6
70–74 (n = 1,548)	Baseline	17.2 ± 34.5	38.5 ± 35.3	97.7 ± 42.2	153.4 ± 66.3
	V2	11.2 ± 26.8	36.5 ± 37.1	89.3 ± 43.8	137.0 ± 68.6
	Change	−6.0 ± 34.6	−2.0 ± 37.6	−8.3 ± 43.0	−16.4 ± 67.0
75–79 (n = 1,231)	Baseline	12.3 ± 28.4	35.1 ± 31.5	94.8 ± 43.0	142.1 ± 63.4
	V2	7.3 ± 21.9	31.1 ± 33.2	82.2 ± 46.4	120.7 ± 67.8
	Change	−5.0 ± 26.6	−3.9 ± 35.5	−12.5 ± 44.6	−21.4 ± 66.9
≥80 (n = 758)	Baseline	6.5 ± 19.6	34.8 ± 31.9	85.3 ± 45.5	126.5 ± 61.0
	V2	4.5 ± 17.8	27.0 ± 30.1	65.5 ± 46.3	97.1 ± 64.0
	Change	−1.9 ± 20.5	−7.8 ± 34.6	−19.8 ± 45.1	−29.5 ± 60.7
P-value testing for differences between age groups	Baseline	<.001†	.06†	<.001*	<.001*
	V2	<.001†	<.001†	<.001*	<.001*
	Change	<.001*	.001*	<.001*	<.001*
All ages (N = 5,161)	Baseline	16.8 ± 35.5	37.0 ± 34.0	95.9 ± 43.2	149.7 ± 67.6
	V2	10.6 ± 27.0	33.8 ± 35.3	86.1 ± 45.8	130.5 ± 70.1
	Change	−6.2 ± 33.9	−3.2 ± 37.3	−9.9 ± 44.3	−19.3 ± 67.7
	P-value	<.001‡	<.001‡	<.001‡	<.001‡

Possible PASE occupational, leisure, household, and total scores range from 0 to 300, 0 to 516, 0 to 171, and 0 to 987, respectively. In this sample, PASE occupational, leisure, household, and total scores ranged from 0 to 297, 0 to 343, 0 to 171, and 0 to 514.

* Analysis of variance.

† Based on Kruskal-Wallis test due to skewed data.

‡ Paired *t*-test.

V2 = Visit 2.

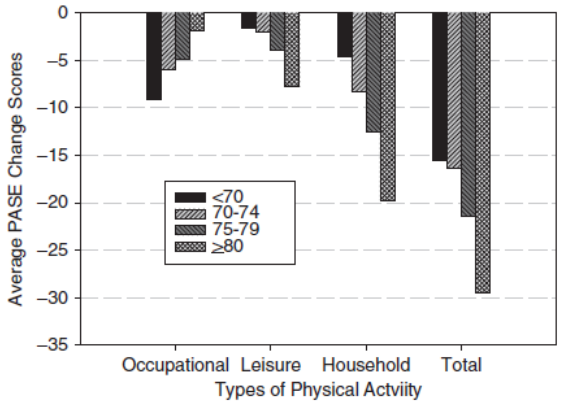

Figure 1. Mean change in total and subscale Physical Activity Scale for the Elderly (PASE) scores over a mean 5-year follow-up period according to baseline age groups in men (N = 5,161). Possible PASE occupational, leisure, household, and total scores range from 0 to 300, 0 to 516, 0 to 171, and 0 to 987, respectively. In this sample, PASE occupational, leisure, household, and total scores ranged from 0 to 297, 0 to 343, 0 to 171, and 0 to 514, respectively.

On average, total PASE scores declined with increasing age: −15.6 ± 71.6 for men younger than 70, −16.4 ± 67.0 for men aged 70 to 74, −21.4 ± 66.9 for men aged 75 to 79, and −29.5 ± 60.7 for men aged 80 and older (Figure 1). The corresponding symmetrized percentage changes were −5.6 ± 26.4% for men younger than 70, −7.3 ± 27.7% for men aged 70 to 74, −10.5 ± 30.0% for men aged 75 to 79, and −17.4 ± 33.0% for men aged 80 and older. Change in PASE subscales also varied according to age; declines in total physical activity were primarily attributed to occupational changes in men aged 65 to 70 and household changes in those aged 70 and older.

The majority of baseline demographics, health history, health habits and status, and quality-of-life measures were statistically associated with the change in total PASE scores in the univariate models (data not shown; available upon request from corresponding author). Except for SF12 mental health, all of the candidates (living arrangement, age, smoking status, BMI, systolic blood pressure, and SF12 physical and mental health) for the main effects multivariate model were significantly associated with change in PASE scores and were included in the final multivariate model (Table 2). None of the interaction terms were significantly associated with change in PASE scores ($P > .05$).

On average, the men exhibited a greater decline in physical activity if they lived alone or smoked cigarettes (Table 2). Higher systolic blood pressure was associated with greater decline in PASE change scores (Table 2). Men with better physical but not mental health as assessed according to the SF-12 had smaller declines in physical activity from baseline (Table 2). Declines in leisure (−7 vs −3), household (−15 vs −9), and occupational (−8 vs −6) physical activities contributed to the overall greater decline in total physical activity in men who lived alone than in those who lived with others (data not shown). Odds of increasing compared with maintaining or decreasing physical activity over time were greater for men who lived with others (odds ratio (OR) = 1.53, 95% confidence interval (CI) = 1.24–1.89) than for those who lived alone (OR = 1.00, reference group), with better SF-12 physical (OR = 1.23, 95% CI = 1.09–1.40 for men above the median vs OR = 1.00 (reference) for men below the median) and SF-12 mental (OR = 1.14, 95% CI = 1.00–1.29 for men above the median vs OR = 1.00 (reference) for men below the median) health, and younger age (OR = 1.74, 95% CI = 1.40–2.16 for age <70; OR = 1.58, 95% CI = 1.27–1.96 for age 70–74; OR = 1.47, 95% CI = 1.17–1.85 for age 75–79; and OR = 1.00 for age ≥80 (reference group)) based on the logistic regression model.

DISCUSSION

This study provides longitudinal evidence that self-reported physical activity declined, on average, over a 5-year period in community-dwelling older men aged 65 and older. On average, every component of physical activity (occupational, leisure, and household) declined with age, but the patterns of the physical activity declines varied according to age. Specifically, occupational activities primarily declined for men aged 65 to 69, and household activities primarily declined for men aged 70 and older. As expected, physical activity decreased, on average, with declining overall health.

These longitudinal findings provide the first evidence that average declines in physical activity are greater in older men who live alone than in those who live with others. Declines in leisure, household and occupational physical activities contributed to the overall greater decline in total physical activity in older men who lived alone. Living alone may encompass a constellation of sociodemographic and health risk factors that place older adults at high risk of inactivity. Physical activity interventions that target older adults who live alone may be an effective and efficient method to improve the health, functional, and emotional status of these high-risk older individuals.

These longitudinal results support previous cross-sectional findings[5,6,11,23–25] that physical activity tends to decline with age. On average, the decline in physical activity varied according to age group. Smaller declines in physical activity were noted in men aged 65 to 75, whereas men aged 80 and older had substantial declines in physical activity. The PASE subscales also suggest that the average decline in physical activity with age may be sequential, with occupational physical activity initially declining, followed by household physical activities and eventually leisure physical activities.

These declines in physical activity were observed even in relatively healthy community-dwelling older men. The findings suggest that poor health may be a primary factor in this decline of physical activity. It is a paradox that health conditions that benefit from physical activity may also limit or restrict physical activity. For instance, physical activity has been shown to have a therapeutic role in type 2 diabetes mellitus, osteoarthritis, the prevention of falls,[1] and Parkinson's disease,[26,27] yet these health conditions were significantly associated with the decline in physical activity in older men in the present study and were the primary reason

Table 2. Descriptive Statistics and Final Multivariate Model for Change in Total Physical Activity Scale for the Elderly (PASE) Scores over a Mean 5-Year Follow-Up Period in Older Men in the Osteoporotic Fractures in Men Study

	Descriptive Statistics (n = 5,161)		Multivariate Model (n = 5,063)	
Independent Variable	n (%)	Baseline Median PASE Score (Interquartile Range)	Least Squares Mean (95% Confidence Interval)	*P*-Value
Living arrangements				<.001
With others	4,492 (87)	146 (106–190)	−23 (−19 to −28)	
Alone	669 (13)	138 (95–184)	−34 (−28 to −41)	
Age				<.001
<70	1,624 (31)	156 (115–206)	−25 (−20 to −30)	
70–74	1,548 (30)	149 (110–193)	−25 (−20 to −30)	
75–79	1,231 (24)	140 (100–180)	−30 (−24 to −36)	
≥80	758 (15)	121 (83–163)	−36 (−30 to −43)	
Smoking status				.02
Never	1,982 (38)	143 (105–187)	−23 (−20 to −27)	
Former	3,019 (59)	146 (105–191)	−28 (−25 to −31)	
Current	159 (3)	149 (91–198)	−35 (−24 to −46)	
Medical Outcomes Study 12-item Short Form Survey physical health score				<.001
≤53	2,480 (48)	138 (96–182)	−26 (−21 to −30)	
>53	2,680 (52)	151 (112–196)	−32 (−27 to −37)	
Systolic blood pressure, mmHg				.01
≤140	2,956 (57)	147 (106–191)	−26 (−22 to −31)	
>140	2,110 (41)	144 (104–188)	−31 (−26 to −36)	
Body mass index, kg/m^2				.04
<25.0	1,370 (27)	148 (108–193)	−30 (−25 to −35)	
25.0–29.9	2,673 (52)	146 (105–187)	−26 (−21 to −30)	
≥30.0	1,116 (22)	138 (100–187)	−31 (−25 to −37)	

that older men in a community-based sample in Sonoma, California, gave for the limitation or avoidance of physical activity.[28] Designing physical activity interventions to address the specific needs and concerns of older adults with health conditions may be necessary. Maintaining or increasing the physical activity levels of older adults with health conditions may prevent or delay not only the progression of the disease or condition, but also the associated disability and functional impairments.[29,30]

Approximately 90% of the total study population was white non-Hispanic, with Asian and Hispanic men constituting only 5% of the study population. Further research is warranted in ethnic minorities and older women to determine whether similar associations and patterns are observed for physical activity levels over time. On average, the MrOS volunteer sample was more active than a representative sample of community-dwelling older men in western Massachusetts;[15] baseline PASE scores were approximately 11% higher in men aged 65 to 69 and 27% higher in those aged 70 and older.

One strength of this study is that physical activity levels were measured longitudinally in a large cohort of community-dwelling, ambulatory older men. These longitudinal findings extend previous cross-sectional studies by estimating changes not only in total physical activity levels, but also in the components of physical activity (leisure, occupational, and household physical activities) over a 5-year period in older men. In addition, physical activity levels were measured in a validated instrument developed specifically for older adults.

Over the 5-year period, the majority of men reported declines in total physical activity that were attributed to declines in occupational, leisure, and household physical activities. In contrast, approximately one-quarter of the men reported significant increases in total physical activity scores, primarily attributed to increases in leisure and household physical activities. Age, physical health, and living arrangements were predictors of change in total PASE scores and of the probability of increasing physical activity over the 5-year period. Specifically, greater declines in physical activity were observed in older men with poor physical health who lived alone. The probability of increasing physical activity over time was greater in younger men with better physical health who lived with others. Greater declines in physical activity levels were also observed in men whom smoked cigarettes and had higher blood pressure. In contrast, better mental health was associated with the probability of increasing physical activity levels over time. This report not only provides a description of change in physical activity patterns over time in older men, but also identifies characteristics of older men at risk for physical activity declines. These novel longitudinal findings may aid efforts to target, design, and implement effective physical activity interventions for older men.

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Author Contributions: Ms. Janney and Dr. Cauley developed the study concept and design. Dr. Cauley was responsible for the acquisition of data. Ms Janney performed the statistical analysis and wrote the manuscript. Drs. Cauley, Cawthon, and Kriska provided critical review of the manuscript.

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