Published in final edited form as:
Compr Psychiatry. 2012 October ; 53(7): 1028–1033. doi:10.1016/j.comppsych.2012.02.003.

The effect of dietary and physical activity pattern on metabolic profile in individuals with schizophrenia: A cross-sectional study

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Abstract

Objective—With the rate of obesity on the rise worldwide, individuals with schizophrenia represent a particularly vulnerable population. The aim of this study was to assess the metabolic profile of individuals with schizophrenia in relation to dietary and physical activity habits compared to normal controls.

Methods—Dietary and physical activity habits of 130 individuals with Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) diagnosis of schizophrenia or schizoaffective disorder were compared with 250 BMI, age, gender, and racially matched controls from the 2005-2008 National Health and Nutrition Examination Surveys (NHANES) using a 24-hour diet recall and a self report physical activity questionnaire.

Results—Individuals with schizophrenia had significantly higher levels of glycosylated hemoglobin (HbA1c) and insulin compared to matched controls. Additionally, these individuals had an increased waist circumference and diastolic blood pressure than the comparison group. Daily caloric intake was not different between groups; however, individuals with schizophrenia consumed significantly greater amounts of sugar and fat. Individuals with schizophrenia reported engaging in moderate physical activity less frequently than the NHANES group, but there was no difference in reported vigorous physical activity.

Conclusions—These findings suggest that the dietary and physical activity habits of individuals with schizophrenia contribute to an adverse metabolic profile. Increased opportunities for physical activity and access to healthy foods for individuals with schizophrenia may ease the burden of disease.

Keywords

obesity; schizophrenia; dietary intake; physical activity; metabolic syndrome

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1. Introduction

The increasing prevalence of obesity in the United States is linked to an elevated risk for cardiovascular disease (CVD) and type 2 diabetes (1) resulting in excess mortality. This alarming trend is even more pronounced among schizophrenia patients. Allison et al. (2) found that 42% of a group of individuals with schizophrenia had a BMI greater than 27, compared to 27% of the general population. Individuals with schizophrenia have a significantly elevated risk of dying from CVD (3, 4) and a 22.5 year reduction in life expectancy (5). Weight gain is a major side effect of second generation antipsychotic drugs (6), which exacerbates cardiometabolic risk in individuals with schizophrenia (7, 8).

In addition to pharmacological reasons for weight gain, individuals with schizophrenia seem to make poor dietary choices (9) and lack physical activity (10). The diet of individuals with schizophrenia has been characterized as deficient in fruit and vegetable intake; while consuming a surplus of fat and sugar (11, 12). These poor dietary choices are likely related to lower socioeconomic status and cognitive deficits, leading to a preference for cheap, highly palatable, pre-made meals. There are only two studies that have used dietary recalls to investigate dietary intake for individuals with schizophrenia, with both finding discordant results (13, 14). Several factors contribute to the sedentary lifestyle of individuals with schizophrenia including negative symptoms (10) and sedating effects of antipsychotic medications. The development of metabolic syndrome also plays a considerable role in reduced physical activity (15).

The purpose of this study was to assess the 24-hour dietary intake, physical activity, laboratory, and anthropometric measurements of individuals with schizophrenia in comparison to BMI, age, gender, and racially matched normal controls using data from the 2005-2008 National Health and Nutrition Examination Surveys (NHANES).

2. Subjects and Methods

2.1. Subjects

One hundred thirty adult patients with Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; (16)) diagnosis of schizophrenia or schizoaffective disorder followed in the outpatient clinics at the Connecticut Mental Health Center who were treated by antipsychotic medications were interviewed. The study protocol was approved by the Human Investigation Committee of Yale University School of Medicine and all subjects signed written informed consent.

2.2. Data Collection

Sociodemographic data and current medications were obtained through interviews and self-report questionnaires. A 24-hour diet recall using food models and measuring utensils were performed by trained personnel. This method has been employed in the NHANES (17). Since there were no patients currently prescribed a very-low calorie diet, dietary intakes of less than 800 calories per day were considered not typical and excluded from the analysis. Height and weight were measured without shoes while wearing light clothing and BMI was calculated. Waist circumference was measured around the trunk in a horizontal plane just above the uppermost lateral border of the right ilium. A calibrated wrist blood pressure monitor (Oregon Scientific, Portland, OR) was used to measure blood pressure after resting five minutes. Nutritional values were calculated using FoodWorks version 12 (The Nutrition Company, Long Valley, NJ).

2.3. NHANES

The NHANES is a program of studies designed to evaluate the health and nutritional status of individuals in the United States. The data from NHANES are used to assess the prevalence and risk factors for diseases. A complete description of NHANES guidelines can be found online at http://www.cdc.gov/nchs/nhanes. Two hundred fifty age, gender, BMI, and racially matched controls that provided a reliable 24-hour dietary recall were randomly selected from the 2005-2008 NHANES and compared to the study population.

2.4. Laboratory Analyses

2.5. Fasting plasma glucose, glycosylated hemoglobin, and insulin concentration

Plasma glucose concentration was analyzed by the glucose oxidase method (Yellow Springs Instruments, Ohio). Glycosylated hemoglobin (HbA1c) was measured using an Ames DCA 2000 analyzer (Miles, Inc., Elkhart, IN). Plasma immunoreactive insulin concentration was determined with a double antibody radioimmunoassay (Diagnostic, Webster, TX).

2.6. Lipid profile

Fasting blood was collected into vacutainers containing no additive. Lipid values were determined by standard enzymatic procedures (Sigma, St. Louis, MO).

2.7. Physical activity

Patients were asked how often they engaged in moderate (“makes you breathe somewhat harder than normal”) or vigorous (“makes you breathe much harder than normal”) physical activity for at least 15 minutes during the past week using a modified version of the Godin Leisure Time Questionnaire (GLTEQ; (18). Examples of possible moderate forms of exercise included; fast walking, dancing, tennis, baseball, volleyball, and other low impact sports. Examples of vigorous physical activity included; running, jogging, basketball, football, soccer, and swimming. For NHANES participants, this question was divided into work-related and recreational moderate and vigorous physical activity. Due to high unemployment among individuals with schizophrenia, we combined the responses so that each participant had one value for moderate and vigorous physical activity.

2.8. Statistical Analyses

All analyses were performed using SPSS, version 17.0 for Windows (SPSS Inc., Chicago, IL). Records within the NHANES 2005-2008 databases were randomly selected within demographic categories and the record was excluded if there was not a reliable 24-hour dietary recall. Independent sample t-tests were used to compare mean values in the schizophrenia group to NHANES and P values $< .05$ were considered significant. Relationships between variables were calculated using the Pearson correlation coefficient. Linear regression was used to assess the contribution of household income on dietary intake and physical activity.

3. Results

Data from 130 patients with a DSM-IV diagnosis of schizophrenia or schizoaffective disorder and 250 participants of the 2005-2008 NHANES were analyzed. There were no significant differences between the patients and controls with regard to BMI, age, gender, and race distribution since subjects were matched on these variables. Sixty-nine percent of patients ($n = 90$) were prescribed atypical antipsychotic medications and there were no significant differences between patients receiving typical or atypical antipsychotic medications. The demographic distribution of the participants is presented in Table 1.

Laboratory and anthropometric values for all participants are presented in Table 2. The waist circumference of the sample patients was significantly higher compared to the NHANES group ($t= -2.46$, $p<.05$). Accordingly, HbA1c ($t= -2.84$, $p<.01$) and plasma insulin concentration ($t= -2.37$, $p<.05$) were also increased in the sample patients. Additionally, diastolic blood pressure was significantly higher in the sample patients ($t= -4.18$, $p<.01$). As a group, schizophrenia patients had significantly reduced total and LDL cholesterol compared to the NHANES group ($p<.01$). Waist circumference was moderately correlated with insulin concentration ($r=.40$, $p<.01$) and negatively correlated with HDL cholesterol ($r= -.38$, $p<.01$), these associations remained significant when excluding participants with diabetes.

Laboratory and anthropometric values for participants not taking diabetes or lipid-lowering medications are presented in Table 3. Sample patients had significantly higher levels of systolic ($t= -3.26$, $p<.01$) and diastolic blood pressure ($t= -4.95$, $p<.01$) compared to the NHANES group. Mean fasting glucose levels ($t= 3.50$, $p<.01$) were significantly lower in sample patients compared to the NHANES group. There were no significant differences in means for any other laboratory or anthropometric variables.

Mean (±SD) nutrient intakes are presented in Table 4. There was no significant difference in total caloric intake between groups. Sample patients consumed significantly higher amounts of total sugar ($t= -3.80$, $p<.01$), saturated fat ($t= -2.55$, $p<.05$), total fat ($t= -1.99$, $p<.05$), and protein ($t= -2.46$, $p<.05$) compared to the NHANES group. Both groups exceeded the upper limit for sodium intake. After controlling for household income, sample patients still had significantly higher total sugar intakes ($t= -1.98$, $p<.05$).

The frequency of weekly moderate and vigorous physical activity is presented in Table 5. Less than half of the sample patients reported moderate physical activity, while few individuals reported any vigorous physical activity. The control group had a significantly higher frequency of moderate physical activity ($t= 4.01$, $p<.01$), but there was no difference in the frequency of vigorous physical activity. Household income was inversely correlated with moderate physical activity ($r = -.198$, $p<.01$), however, there was no association with vigorous physical activity.

4. Discussion

The dietary and physical activity pattern of individuals with schizophrenia likely contributed to the adverse metabolic profile in sample patients. Individuals with schizophrenia had significantly higher HbA1c, insulin concentration, and waist circumference compared to normal controls with a similar BMI. While schizophrenia itself may signify an increased risk of metabolic syndrome, pharmacological treatment of symptoms is also associated with impaired glucose regulation and metabolic risk (19-21). Total and LDL cholesterol levels were significantly higher in the reference population; however, this is likely attributed to the greater number of individuals with schizophrenia already receiving treatment for obesity related comorbidities. Schizophrenia patients in our clinics see physicians frequently to manage their psychiatric illness, so other comorbidities are possibly caught earlier than they are in the normal population. After removing individuals receiving treatment for diabetes, there were no longer significant differences in total and LDL cholesterol between groups. However, individuals with schizophrenia still had significantly greater blood pressure than the control group. Additionally, sample patients had significantly lower fasting glucose levels compared to the NHANES group after the removal of participants that were being treated with diabetes or lipid-lowering medications, demonstrating the importance of early intervention in the clinical setting. While the importance of waist circumference as an independent predictor of CVD is controversial (22, 23), the association with insulin

concentration and negative association with HDL cholesterol observed in this study in the absence of diabetes is worth noting.

There was no difference in caloric intake observed between the schizophrenia sample and the controls, which is opposed to previous research which found that individuals with schizophrenia consume either more (13) or less (14) than controls. The current study matched individuals with schizophrenia with controls that had similar BMIs, allowing for a more direct comparison of food intake. Individuals with schizophrenia consumed significantly greater amounts of total sugar and fat, especially saturated fat. Economic considerations play a sizeable role in food choice. Individuals with limited income have a propensity for readily available meals, which are loaded with excess fat and sugar. Individuals with schizophrenia are willing to consume more fruits and vegetables when the food is provided free of charge, but return to lower habitual consumption when the food subsidy ends (24). Antipsychotic medications exacerbate the problem, possibly by stimulating appetite. Making healthy foods more accessible could combat the obesity epidemic by reducing total fat and sugar intake.

Both groups consumed almost three times the daily recommended amount of sodium. Individuals with schizophrenia had a reliance on fast food and packaged meals at the expense of fruit and vegetables. Increased sodium consumption elevates the risk of hypertension, heart disease, and stroke. Accordingly, diastolic blood pressure was significantly higher in individuals with schizophrenia. Forty percent of the sample patients were already taking an antihypertensive medication, making a reduction in sodium intake imperative to an already at risk population.

Sample patients engaged in significantly less moderate physical activity than the control group. These results are in accordance with previous research (25), which found that 40% of individuals with schizophrenia report no moderate physical activity, and 75% report no vigorous physical activity. A recent systematic review has reported that physical activity participation is impaired in patients with lower socio-economic status (26). Household income was inversely correlated with moderate activity, but did not significantly explain any additional variation above and beyond a schizophrenia diagnosis. The metabolic syndrome has been associated with a lack of physical activity (15) and reduced quality of life (27) in individuals with schizophrenia. One possible reason may involve a reduction in peripheral circulation (28), which hinders physical activity (29), and creates a cycle of sedentary lifestyle and adverse metabolic profile (30). Increased physical activity can provide numerous metabolic benefits (10, 21). Physical activity interventions have been shown to reduce blood pressure (31) and insulin concentration (32) in individuals with schizophrenia. Interventions that combine education with physical activity may be most appropriate since people with serious mental illness have significantly lower knowledge of the beneficial effects of exercise on coronary heart disease risk (33).

As with any cross sectional analysis, the results of this study should be interpreted carefully. The sample patients were volunteers for a research study, so results may not be indicative of the population. Longitudinal studies would provide significant additional information about the contribution of lifestyle to the metabolic profile of individuals with schizophrenia. One limitation of the study is the use of one 24-hour diet recall to determine habitual caloric intake. A person may eat more on a weekend compared to a weekday or vice versa, however, the timing of the diet recalls were randomized with an approximately equal portion of weekends and weekdays accounted for in the analysis. Second, patients may make errors in reporting portion size or underreport foods consumed. To counteract this, study staff provided measuring utensils and food models to estimate portion size, while using probing questions to help patients recall foods from specific groups. While it is possible that patients

underreported caloric intake, a previous study found approximately one quarter of NHANES III respondents underreported caloric intake as well (34). Due to cognitive deficits in the sample population, the number of under reporters may be greater; therefore, this analysis may underestimate the magnitude of caloric difference between individuals with schizophrenia and the general population. Third, patients may not have fasted for their metabolic assessments, although the phlebotomist did receive verbal confirmation of fasting status from each participant. Finally, physical activity was self-reported, which may lead to under- or overestimation of actual physical activity. Although the GLTEQ has not yet been validated in this population, research assistants clarified participants' responses to ensure the frequency and intensity of physical activity was recorded as accurately as possible given the limitations inherent in the instrument.

These findings enhance the scarce literature on the dietary intake and physical activity patterns of individuals with schizophrenia and support the recently published international guidelines on physical activity for preventing and treating metabolic risks in schizophrenia (35). Compared to BMI, age, gender, and racially matched controls, individuals with schizophrenia consumed significantly greater amounts of total sugar and fat, while reporting significantly less moderate physical activity. The combination of low income, unhealthy lifestyle, and weight producing antipsychotic medications creates an obesogenic environment which promotes metabolic syndrome and increases risk of early mortality. A complete metabolic risk screening, including a fasting glucose measurement and lipid panel, is essential to limit metabolic risk (36). Health care providers should offer increased opportunities for physical activity and access to healthy foods for individuals with schizophrenia, which may improve treatment outcomes and ease the burden of disease.

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Table 1

Demographic characteristics[1]

	Patients with Schizophrenia or Schizoaffective Disorder	NHANES
Sample size	130	250
Gender	M=56; F=74	M=107; F=143
Ethnicity (Caucasian/African American/Hispanic)	C=51; AA=71; H=8	C=102; AA=132; H=16
Age (mean years)	45.3 ± 10.4	45.4 ± 10.3
BMI (kg/m^2)	38.2 ± 7.8	37.6 ± 7.1
Household Income (under $20,000/year)	123 (95%)	45 (18%)
Diabetes medication	57 (44%)	43 (17%)
Cholesterol medication	40 (31%)	48 (19%)
Blood Pressure medication	52 (40%)	88 (35%)

[1] Age is reported as mean ± SD. Values in parentheses are the percentage of the sample.

Table 2

Anthropometric and lab measurements[1]

	Patients with Schizophrenia or Schizoaffective Disorder	NHANES	Significance
HbA1C (%)	6.4 ± 1.3 (n=112)	6.0 ± 1.3 (n=238)	p≤ .01**
Waist circumference (cm)	119.2 ± 15.2 (n=119)	115.1 ± 14.8 (n=244)	p≤ .05*
Systolic pressure (mmHg)	126.0 ± 17.2 (n=121)	124.0 ± 14.9 (n=246)	NS
Diastolic pressure (mmHg)	80.0 ± 11.8 (n=121)	74.7 ± 10.8 (n=245)	p ≤ .01**
Glucose (mg/dl)	111.0 ± 38.7 (n=110)	114.8 ± 50.7 (n=118)	NS
Insulin (uU/L)	22.0 ± 19.2 (n=109)	16.9 ± 12.4 (n=117)	p≤ .05*
Triglycerides (mg/dl)	133.6 ± 60.6 (n=110)	159.0 ± 135.2 (n=116)	NS
LDL cholesterol (mg/dl)	106.8 ± 37.0 (n=110)	121.2 ± 38.5 (n=111)	p≤ .01**
HDL cholesterol (mg/dl)	47.9 ± 16.7 (n=110)	49.9 ± 14.4 (n=237)	NS
Total cholesterol (mg/dl)	181.2 ± 42.7 (n=110)	200.4 ± 45.0 (n=237)	p≤ .01**

[1] All values are means ± SDs. P values derived from independent t tests.

* p ≤ 0.05

** p ≤ 0.01

Table 3

Anthropometric and lab measurements for participants not taking diabetes or lipidlowering medications[1]

	Patients with Schizophrenia or Schizoaffective Disorder	NHANES	Significance
HbA1C (%)	5.8 ± 0.5 (n=46)	5.6 ± 0.7 (n=178)	NS
Waist circumference (cm)	115.4 ± 13.0 (n=48)	113.1 ± 13.7 (n=184)	NS
Systolic pressure (mmHg)	131.5 ± 19.6 (n=48)	123.3 ± 14.5 (n=246)	P ≤ .01**
Diastolic pressure (mmHg)	83.5 ± 12.0 (n=48)	74.7 ± 10.8 (n=186)	p ≤ .01**
Glucose (mg/dl)	92.2 ± 11.7 (n=43)	102.1 ± 16.6 (n=86)	p≤ .01**
Insulin (uU/L)	17.6 ± 15.9 (n=43)	15.9 ± 11.0 (n=86)	NS
Triglycerides (mg/dl)	123.7 ± 57.6 (n=43)	141.4 ± 108.8 (n=86)	NS
LDL cholesterol (mg/dl)	116.8 ± 39.4 (n=43)	122.7 ± 36.8 (n=83)	NS
HDL cholesterol (mg/dl)	52.5 ± 18.9 (n=43)	51.1 ± 14.8 (n=178)	NS
Total cholesterol (mg/dl)	194.1 ± 43.2 (n=43)	200.6 ± 42.3 (n=178)	NS

[1] All values are means ± SDs. P values derived from independent t tests.

* p ≤ 0.05

** p ≤ 0.01

Table 4

Nutrient intake comparison between patients with schizophrenia and NHANES controls using a 24-hour diet recall[1]

	Patients with Schizophrenia or Schizoaffective Disorder (n=105)	NHANES (n=250)	Significance
Energy (kcal)	2351 ± 1138	2171 ± 847	NS
Protein (g)	94.7 ± 67.0	81.4 ± 34.6	p≤ .05*
Carbohydrates (g)	280.0 ± 159.0	270.8 ± 114.3	NS
Total fat (g)	94.9 ± 57.8	83.9 ± 42.4	p≤ .05*
Saturated fat (g)	31.8 ± 20.9	26.7 ± 15.3	p≤ .05*
MUFA (g)	32.6 ± 19.8	31.6 ± 17.2	NS
PUFA (g)	19.8 ± 18.0	18.5 ± 10.9	NS
Sugar (g)	112.0 ± 91.2	72.6 ± 84.5	p≤ .01**
Cholesterol (mg)	348.3 ± 434.2	290.1 ± 214.1	NS
Sodium (mg)	3781 ± 2135	3531 ± 1561	NS
Caffeine (mg)	185.3 ± 304.6	165.4 ± 197.3	NS

MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids

[1] All values are means ± SDs. P values derived from independent t tests.

* p≤ 0.05

** p≤ 0.01

Table 5

Frequency of weekly moderate and vigorous physical activity

	Patients with schizophrenia or schizoaffective disorder (n=130)	NHANES (n=250)	Significance
Engaged in moderate physical activity in the past week (%)	47	61	NS
Frequency of moderate physical activity in the past week (# of times) [1]	2.2 ± 2.7	4.5 ± 6.2	p≤ .01**
Engaged in vigorous physical activity in the past week (%)	16	31	NS
Frequency of vigorous physical activity in the past week (# of times) [1]	.54 ± 1.5	.69 ± 1.8	NS

[1] Values are means ± SDs. P values derived from independent t tests.

* p≤ 0.05

** p≤0.01