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Prevalence of Metabolic Syndrome and Metabolic Abnormalities in Schizophrenia and Related Disorders—A Systematic Review and Meta-Analysis

Alex J. Mitchell[*,1], Davy Vancampfort[2], Kim Sweers[3], Ruud van Winkel[3], Weiping Yu[3], and Marc De Hert[3]

[1]Department of Cancer Studies and Molecular Medicine, Leicester Royal Infirmary, University of Leicester, Leicester, UK; [2]Department of Rehabilitation Sciences, Faculty of Kinesiology and Rehabilitation Sciences, Catholic University Leuven, Heverlee, Belgium; [3]University Psychiatric Centre Katholieke Universiteit Leuven campus Kortenberg, Leuvensesteenweg 517, Kortenberg, Belgium

*To whom correspondence should be addressed; tel: +44-116-246-3470, fax: +44-116-2256673, e-mail: ajm80@le.ac.uk

Individuals with schizophrenia have high levels of medical comorbidity and cardiovascular risk factors. The presence of 3 or more specific factors is indicative of metabolic syndrome, which is a significant influence upon future morbidity and mortality. We aimed to clarify the prevalence and predictors of metabolic syndrome (MetS) in adults with schizophrenia and related disorders, accounting for subgroup differences. A PRISMA systematic search, appraisal, and meta-analysis were conducted of 126 analyses in 77 publications ($n = 25\ 692$). The overall rate of MetS was 32.5% (95% CI = 30.1%–35.0%), and there were only minor differences according to the different definitions of MetS, treatment setting (inpatient vs outpatient), by country of origin and no appreciable difference between males and females. Older age had a modest influence on the rate of MetS (adjusted $R^2 = .20$; $P < .0001$), but the strongest influence was of illness duration (adjusted $R^2 = .35$; $P < .0001$). At a study level, waist size was most useful in predicting high rate of MetS with a sensitivity of 79.4% and a specificity of 78.8%. Sensitivity and specificity of high blood pressure, high triglycerides, high glucose and low high-density lipoprotein, and age (>38 y) are shown in supplementary appendix 2 online. Regarding prescribed antipsychotic medication, highest rates were seen in those prescribed clozapine (51.9%) and lowest rates of MetS in those who were unmedicated (20.2%). Present findings strongly support the notion that patients with schizophrenia should be considered a high-risk group. Patients with schizophrenia should receive regular monitoring and adequate treatment of cardio-metabolic risk factors.

Key words: metabolic syndrome/cardiovascular risk/diabetes/lipids/glucose/schizophrenia/waist/obesity/smoking

Introduction

Increased rates of cardiovascular disease (CVD)[1–5] and associated premature mortality[6,7] have become a major concern in patients with schizophrenia. In order to help psychiatric clinicians to focus more on these CVD risks in patients with schizophrenia, the concept of MetS has found its way into the psychiatric literature. The metabolic syndrome (MetS) brings together a collection of abnormal clinical and metabolic findings that are predictive for CVD.[8,9] These abnormal findings include visceral adiposity, insulin resistance, increased blood pressure, elevated triglyceride levels, and low high-density lipoprotein (HDL) cholesterol levels. The most common definitions for the MetS are the Adult Treatment Panel III (ATP III) of the National Cholesterol Education Program,[10] and the adapted Adult Treatment Panel (ATP III-A) proposed by the American Heart Association[11] which allows for a lower threshold for impaired fasting glucose of 100 mg/dl (table 1). The International Diabetes Federation (IDF) stresses the importance of waist circumference as a mandatory feature.[12] Recently, more stringent and ethnic/race specific criteria were defined with, eg, slightly modified criteria of waist circumference for Asians (90 cm for male and 80 cm for female).[13]

In the general population, MetS is associated with a 4 times relative risk of developing diabetes[14] and approximately a 2-fold risk of coronary heart disease, stroke, and premature mortality.[8] As a result, MetS has been proposed as an alternative or an augmentation to the Framingham[15] or systematic coronary risk evaluation[16] calculations to assess the risk of CVD and death. Similar results for the MetS as a predictor of the risk of coronary heart disease have been found previously in schizophrenia.[17]

In part, the development of the MetS is attributable to genetic risk,[18,19] limited access to general somatic health care,[20] and unhealthy lifestyle choices including physical inactivity,[21,22] poor diet,[23] and high rates of cigarette smoking.[24] In the general population, genetic and geographical environmental differences might partially be responsible for the observation that estimated rates of MetS alter to

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Table 1. Common Definitions of Metabolic Syndrome

	ATP III Definition (3 of 5 Required)	ATP III-A Definition (3 of 5 Required)	IDF Consensus Definition (Waist Plus 2 Required)
Waist circumference	Men > 102 cm (>40 in) Women > 88 cm (>35 in)	Men > 102 cm (>40 in) Women > 88 cm (>35 in)	Male ≥ 94 cm (>37 in) Female ≥ 80 cm (>31.5 in)
Blood pressure	≥130/≥85 mmHg	≥130/≥85 mmHg	≥130/≥85 mmHg
HDL cholesterol	Men < 40 mg/dl (1.04 mmol/l) Women < 50 mg/dl (1.29 mmol/l)	Men < 40 mg/dl (1.04 mmol/l) Women < 50 mg/dl (1.29 mmol/l)	Men < 40 mg/dl (1.04 mmol/l) Women < 50 mg/dl (1.29 mmol/l)
Triglycerides	≥150 mg/dl (1.7 mmol/l)	≥150 mg/dl (1.7 mmol/l)	≥150 mg/dl (1.7 mmol/l)
Fasting glucose	≥110 mg/dl (6.1 mmol/l)	≥100 mg/dl (5.6 mmol/l)	≥100 mg/dl (5.6 mmol/l)

Note: IDF, International Diabetes Federation; ATP, Adult Treatment Panel; HDL, high-density lipoprotein.

different countries of origin. For example, adopting the ATP III definition, the age-adjusted rates are 18.4% for men and 14.4% for women in Europeans, 28.8% for men and 31.8% for women in South Asians, 15.5% for men and 23.4% for women in African-Caribbeans,[25] while the rate was 15.7% in Taiwan[26] and 23.7% in the United States,[27,28] respectively. Although previous narrative reviews[29–32] reported on differences in MetS rates between different countries, to the best of our knowledge, meta-analytic data comparing MetS rates across different countries in patients with schizophrenia are lacking. In the same way, it remains to be explored if MetS rates differ between different treatment settings, ie, in order to identify patients at risk psychiatric clinicians should know if patients in particular treatment settings are at higher risk or not.

In recent years, it has become apparent that in patients with schizophrenia particular antipsychotic agents (AP) can have a negative impact on some of the modifiable MetS risk factors.[4,5] The differential effects of various AP on weight are well described, with clozapine and olanzapine associated with the highest weight gain.[5] Previous systematic reviews on metabolic side effects of AP were of AP have only focussed upon metabolic changes after exposure following convenience testing.[33,34] A recent meta-analysis suggested a typical weight gain of 3.8 kg in drug-naïve patients after starting antipsychotic treatment in the first 3 months of treatment.[35] No data on differences in MetS rates between patients taking different APs are available.

In the same way, no systematic data on differences in MetS rates between patients with and without AP and between first-episode and chronic patients are available. Knowledge of all these differences would guide psychiatric clinicians in identifying patients at risk for CVD. Given this uncertainty, we conducted a systematic review and meta-analysis with an objective to clarify prevalence rate of MetS in schizophrenia and related disorders taking into account variations in country, setting, stage of illness, AP treatment, and illness duration. Our secondary aim was to clarify the prevalence rates of every individual MetS risk factor in those systematically monitored. A tertiary aim was to examine which individual MetS risk factors would be useful markers of the full MetS at the study level.

Methods

Inclusion and Exclusion Criteria

The systematic review was written up according to the PRISMA standard (a protocol used to evaluate systematic reviews).[36] Our focus was on patients with defined schizophrenia (with or without related psychosis). We excluded all studies without subjects with schizophrenia. Studies were included that examined MetS using ATP III,[10] ATP III-A,[11] or IDF[12] criteria. We excluded studies using nonstandardized definitions of metabolic syndrome. We included only studies on adults (excluding studies in those under 18 y and over 65 y) as variations in MetS in older and younger patients may warrant separate analysis. However, to further account for the effect of age in adults, we analyzed the effect of mean age across studies. We were particularly interested in the prevalence rate of MetS in each clinical setting (inpatient, outpatient, or mixed settings), according to disease stage, country of origin, and prescribed medication. Finally, we excluded studies with inadequate data for extraction.

Search Criteria and Critical Appraisal

A systematic literature search, critical appraisal of the collected studies, and meta-analysis were conducted. The following abstract databases were searched from inception to July 2011—Medline, PsycINFO, and Embase. Four full text collections namely Science Direct, Ingenta Select, Ovid Full text, Blackwell/Wiley Interscience were searched. The abstract database Web of Knowledge (4.0, Insitute of Scientific Information) was searched, using the above terms as a text word search and using key papers in a reverse citation search. The search terms "metabolic or diabetes or cardiovascular or blood pressure or glucose or lipid" and "psychosis or psychotic or schizophrenia or schizoaffective" yield 1092 hits, of which 933 were not relevant. We

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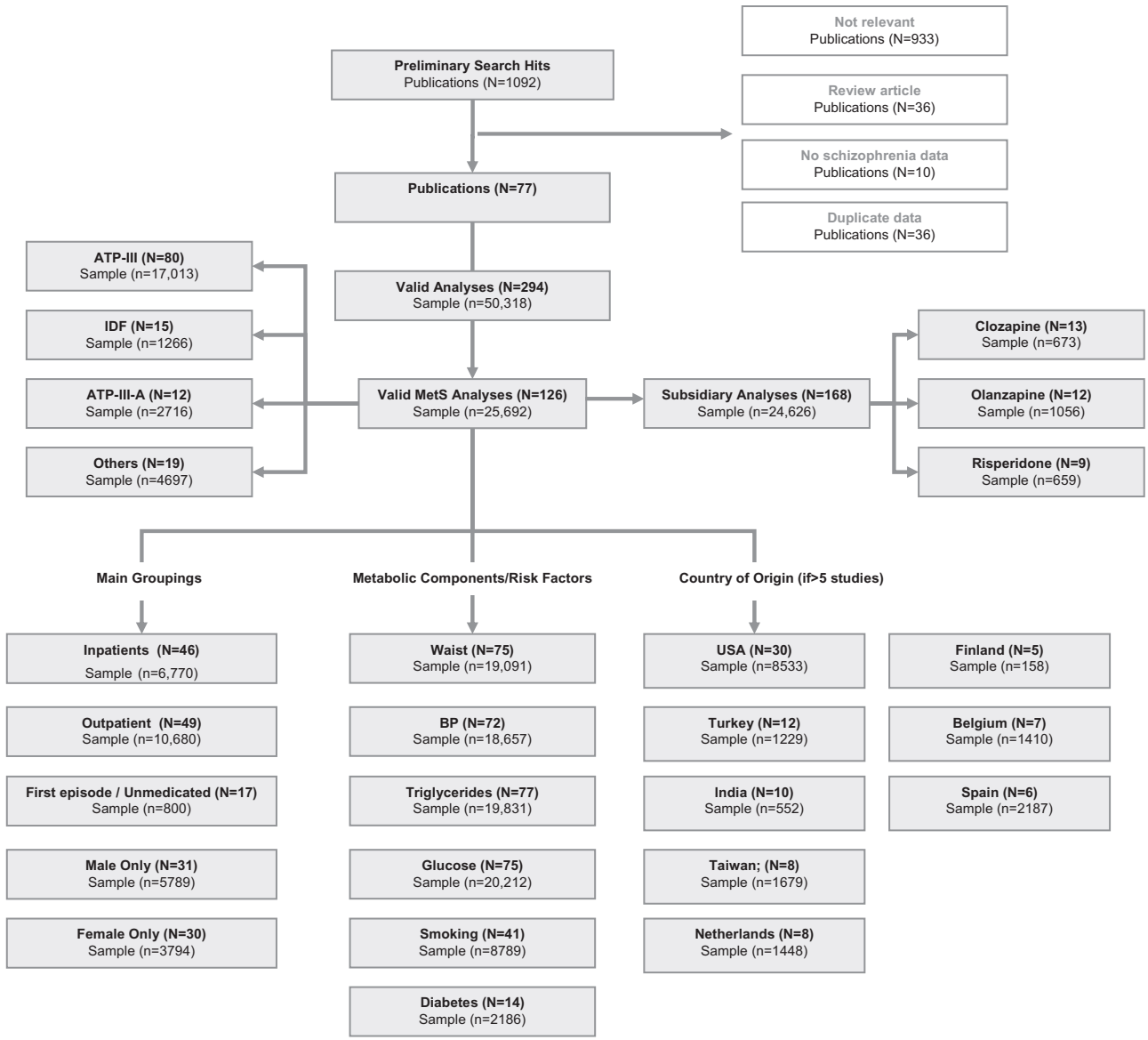

Fig. 1. Quality of reporting of meta-analyses (Quorom) search results.

also contacted many experts in the field for papers in preparation and additional data and received data from 20 groups (see Acknowledgments). Methodological appraisal of each study was conducted according to PRISMA standard including evaluation of bias (confounding, overlapping data, and publication bias).[30]

Statistical Analysis

We pooled individual study data using DerSimonian-Laird proportion meta-analysis.[37] Heterogeneity was invariably moderate to high therefore a random effects meta-analysis was performed using StatsDirect 2.6.2. For comparative analyses (eg, by country of origin, rate per prescribed medication), we required a minimum of 3 independent studies to justify analysis according to convention. In order to elucidate subgroup effects, we stratified data by disorder, MetS definition, clinical setting, and gender, where appropriate. We analyzed several predictors of MetS including age, publication year, and duration of illness using regression analysis, and examined components of MetS were most predictive of the full syndrome at a study level using Receiver Operator Characteristic curve analysis. We excluded 36 publications containing 71 analyses with data, which were either duplicates from the same group as well as 10 publications that did not include any patients with schizophrenia.

Results

Search Results

From 160 candidate publications following exclusions, our search generated 77 publications containing 294

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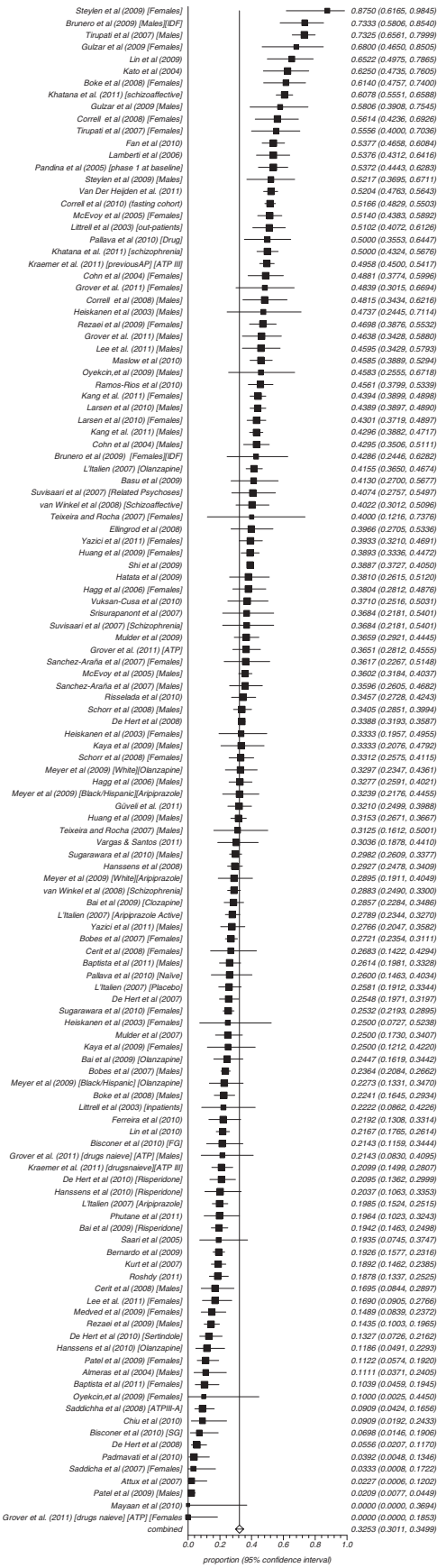

Fig. 2. Summary rate of metabolic.

analyses (126 main group analyses and 168 subgroup analyses). Subgroup analyses were generally those containing analyses of patients on individual antipsychotic drugs (supplementary appendix 3). The dataset comprised 25 692 unique patients from 27 countries or regions (figure 1). Of 126 main analyses, 84 (66.7%) used *Diagnostic and Statistical Manual of Mental Disorders* criteria to define schizophrenia and related psychosis, and 18 of 126 (14.3%) used ICD10 criteria but 24 used clinical expert judgment or miscellaneous criteria. A subset of 66 analyses examined only those with pure schizophrenia and no related psychoses.

Of 126 main analyses, 46 were conducted among inpatients ($n = 6770$), 49 were conducted in outpatient settings ($n = 10\ 680$), and 29 were conducted in mixed samples ($n = 8186$). Seventeen studies examined individuals who were either in their first-episode drug naïve or both ($n = 800$). The remainder examined patients in mixed stages, taking antipsychotic medication although sample sizes for those taking individual AP were modest. Only 31 analyses reported data on males and females separately, and only 33 analyses reported data on ethnicity.

Prevalence of Metabolic Syndrome in Schizophrenia

Across all 126 analyses involving 25 692 patients with schizophrenia, 64.0% of patients were male and their the mean length of illness was 10.4 years. There was no publication bias (supplementary appendix 1). The overall rate of MetS was 32.5% (95% CI = 30.1%–35.0%) (figure 2, table 2) using any standardized MetS criteria. The rates using the ATP III, adapted ATP III, or IDF definitions were 32.8% ($N = 80$, $n = 17005$, 95% CI = 30.0%–35.7%); 28.6% ($N = 12$, $n = 2716$, 95% CI = 19.8%–38.3%); and 35.3% ($N = 15$, $n = 1266$, 95% CI = 23.1%–48.6%), respectively.

We examined whether rates varied in several potentially important subgroups. There were only minor differences in MetS according to country of study origin. For example, the rate of ATPIII MetS was 32.5% ($N = 26$, $n = 7037$, 95% CI = 26.6%–38.7%) in the United States; 34.5% ($N = 5$, $n = 158$, 95% CI = 25.4%–44.2%) in Finland; 30.1% ($N = 9$, $n = 702$, 95% CI = 24.7%–35.8%) in Turkey; and 30.2% ($N = 6$, $n = 2187$, 95% CI = 23.6%–37.2%) in Spain. Among inpatients, the rate of MetS was 30.4% ($N = 46$, $n = 6770$, 95% CI = 26.7%–34.2%), and in outpatients, it was 31.8% ($N = 49$; $n = 10\ 680$, 95% CI = 27.5%–36.2%). In males, MetS was present in 34.8% ($N = 31$, $n = 5789$, 95% CI = 29.2%–40.6%), and in females, it was diagnosed in 34.8% ($N = 30$, $n = 3794$, 95% CI = 29.5%–40.3%). In those studies of patients who were drug naïve or in their first episode, the rate was 11.3% ($N = 14$, $n = 800$, 95% CI = 7.3%–16.1%). After including all subgroups with first-episode patients, the rate in pure first-episode patients was 13.0% ($N = 7$, $n = 490$, 95% CI = 7.2%–20.1%). In those who were neither drug naïve

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nor in their first episode, it was 35.3% ($N = 112$, $n = 24\,892$, 95% CI = 32.8%–37.8%). In studies recruiting older patients with a mean age of 50 years or higher, MetS was present in 39.2% ($N = 14$, $n = 6396$, 95% CI = 32.6%–46.1%).

Individual Metabolic Abnormalities in Schizophrenia

Fifty-three studies reported on the rate of obesity defined as a waist (cm) more than 102 in males and 88 cm in females (ATP) and 8 reported those with more than 94 cm in males and 80 cm in females (IDF) (figures 3–8). The proportion overweight by ATP definition was 49.4% ($N = 53$; $n = 14\,305$, 95% CI = 44.8%–53.3%) and 44.4% according to IDF ($N = 8$, $n = 263$, 95% CI = 32.3%–56.8%). Of studies reporting the rate of hyperglycaemia (>110 mg/dl; ATP), the rate was 19.5% ($N = 47$, $n = 13784$, 95% CI = 16.9%–22.2%), and it was 18.8% ($N = 28$, $n = 6499$, 95% CI = 15.5%–22.4%) for those with more than 100 mg/dl. The rate of hypertriglyceridemia was 39.3% ($N = 77$, $n = 19\,831$, 95% CI = 35.0%–43.6%), and the proportion of those with low HDL was 42.6% ($N = 76$, $n = 19\,280$, 95% CI = 39.3%–46.0%). Additionally, 38.7% ($N = 72$; $n = 18\,657$, 95% CI = 35.6%–41.9%) of those with schizophrenia had high blood pressure and 54.2% ($N = 41$, $n = 8789$, 95% CI = 50.9%–57.5%) were smokers (table 2) and 10.9% ($N = 14$, $n = 2186$, 95% CI = 7.0%–15.5%) had diabetes. Of note, in studies from United States rates of high waist size, blood pressure, smoking, and low HDL were all above 50% (see online supplementary table 3).

Predictors of Metabolic Syndrome in Schizophrenia

On regression analysis, there was a modest association of high rates of MetS in studies with older participants (adjusted $R^2 = .20$; $t = 5.5$; $P < .0001$) and a trend associated with older year of publication (adjusted $R^2 = .7$; $t = -1.8$; $P = .08$). When studies from USA alone were considered only the effect of age remained significant. In the whole sample, there was a strong effect of illness duration (adjusted $R^2 = .35$; $t = 4.9$; $P < .0001$). Using the median value of >32.8% to define a high rate of MetS, we examined which metabolic components were most predictive of the full syndrome. At a study level, waist size was most useful in predicting high rate of MetS with an area under curve (AUC) of 0.848 (sensitivity =79.4%; specificity 78.8%). Illness duration (>7.8 y) was also a useful predictor. Sensitivity and specificity of high blood pressure, high triglycerides, high glucose and low HDL, and age (>38 y) are shown in supplementary appendix 2 online.

Metabolic Syndrome in Schizophrenia According to Current Antipsychotic

Given the limitations in the sample, only 4 comparisons were possible: unmedicated, those taking clozapine, olanzapine, or risperidone alone. Using the same criteria (ATP

Table 2. Summary of Main Results of Meta-Analytic Rates of Metabolic Abnormalities in Schizophrenia and Related Psychoses

	MetS by ATP III (%)	Waist (ATP) (M > 102, F > 88)	Blood pressure, >130/85	Triglycerides (>150 mg/dl)	Glucose (ATP III) (>110 mg/dl)	Glucose (>100 mg/dl)	HDL (M < 40 mg/dl, F < 50 mg/dl)	Smoking	Diabetes
Number of studies (*n*)	80	53	72	77	47	28	76	41	14
Sample size (*n*)	17 005	14 305	18 657	19 831	13 784	6499	19 280	8789	2186
Pooled proportion (%)	32.8	49.4	38.7	39.3	19.5	18.8	42.6	54.3	10.9
95% CI	30.0% –35.7%	44.8% - 53.3%	35.6%–41.9%	35.0%–43.6%	16.9%–22.2%	15.5%–22.4%	39.3%–46.0%	50.9% –57.5%	7.1% –15.5%

Note: M, male; F, female.

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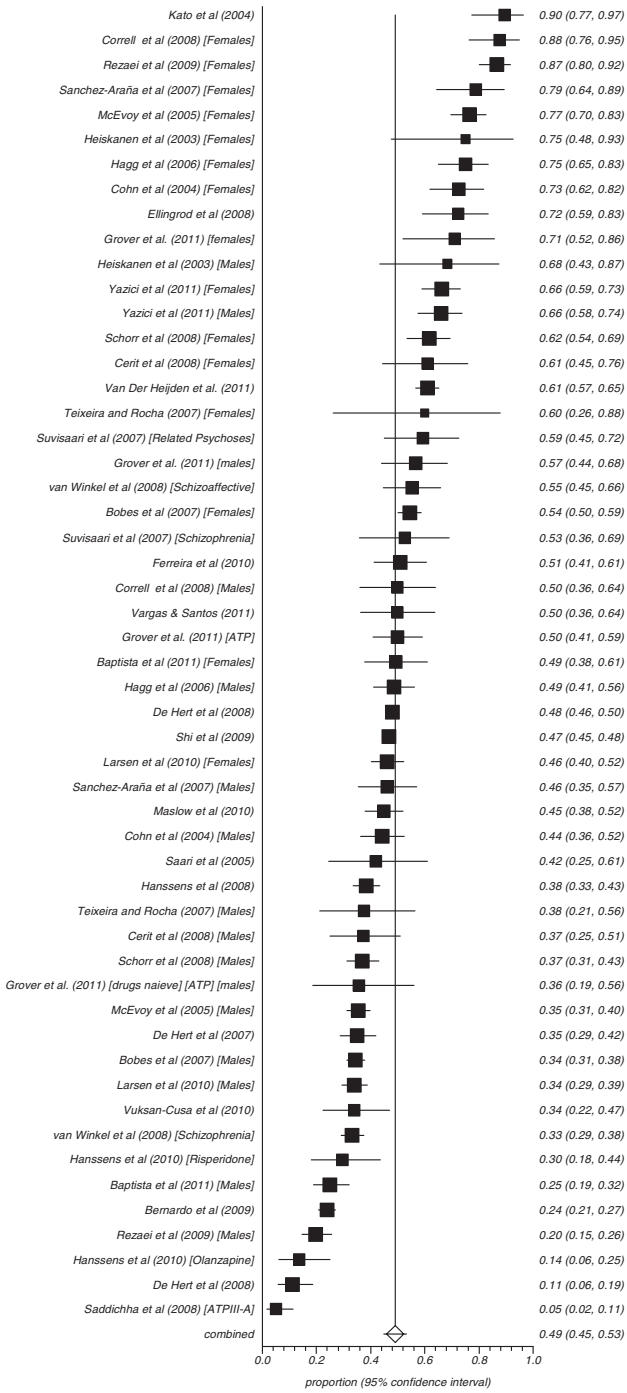

Fig. 3. Summary rate of obesity by waist size.

III), the rate of MetS was 51.9% ($N = 13$, $n = 673$, 95% CI = 45.8%–57.9%) for clozapine; 28.2% ($N = 12$, $n = 1056$, 95% CI = 19.1%–38.4%) for olanzapine; and 27.9% ($N = 9$, $n = 659$, 95% CI = 12.6%–46.5%) for risperidone. In unmedicated patients, the rate of MetS was 20.2% ($N = 7$, $n = 297$, 95% CI = 15.9%–24.9%) using ATPIII criteria. However, we cannot exclude that certain prescriptions such as clozapine were likely to be linked with covariates of age and illness duration.

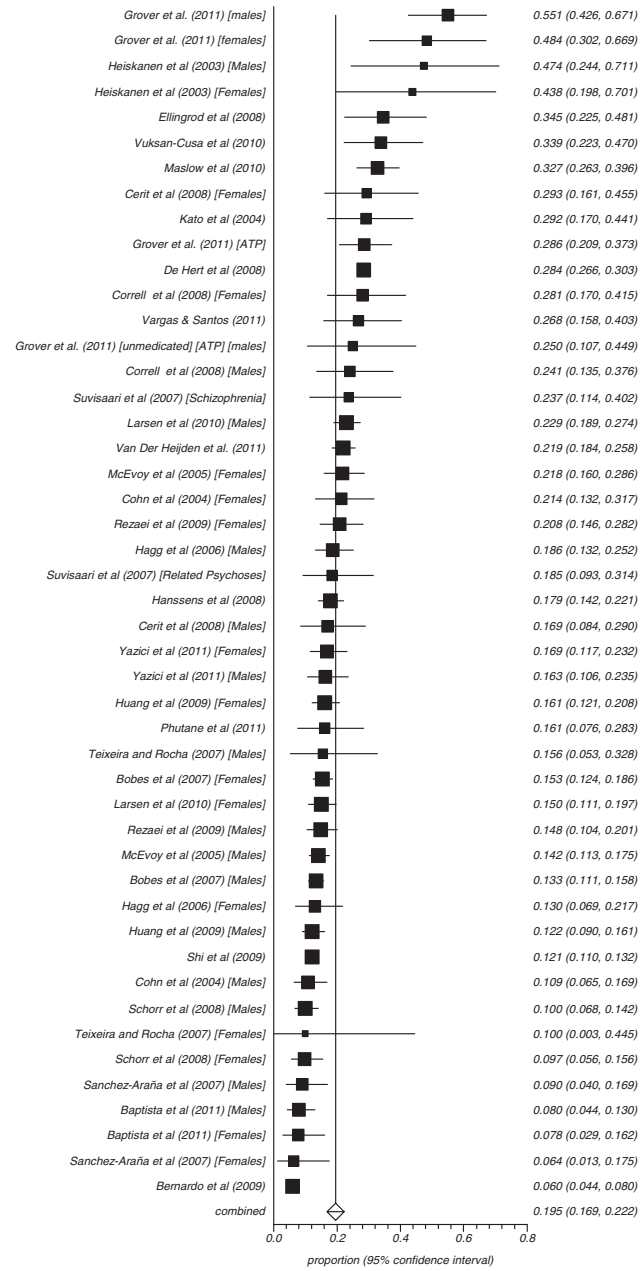

Fig. 4. Summary rate of hyperglycaemia.

Discussion

General Findings

To the authors' knowledge, the present large-scale meta-analysis is the first to demonstrate that almost 1 in 3 of unselected patients with schizophrenia suffer from MetS. We found 126 valid analyses in 77 publications within the period 2003 to July 2011 (see figure 1). This indicates that the cardio-metabolic risk in patients with schizophrenia is clearly becoming recognized as a key consideration in the long-term health of these patients. Examining individual cardio-metabolic risk abnormalities, 1 in 2 patients with schizophrenia are overweight, 1 in 5 appear to have significant hyperglycaemia, and at least 2 in 5 have lipid

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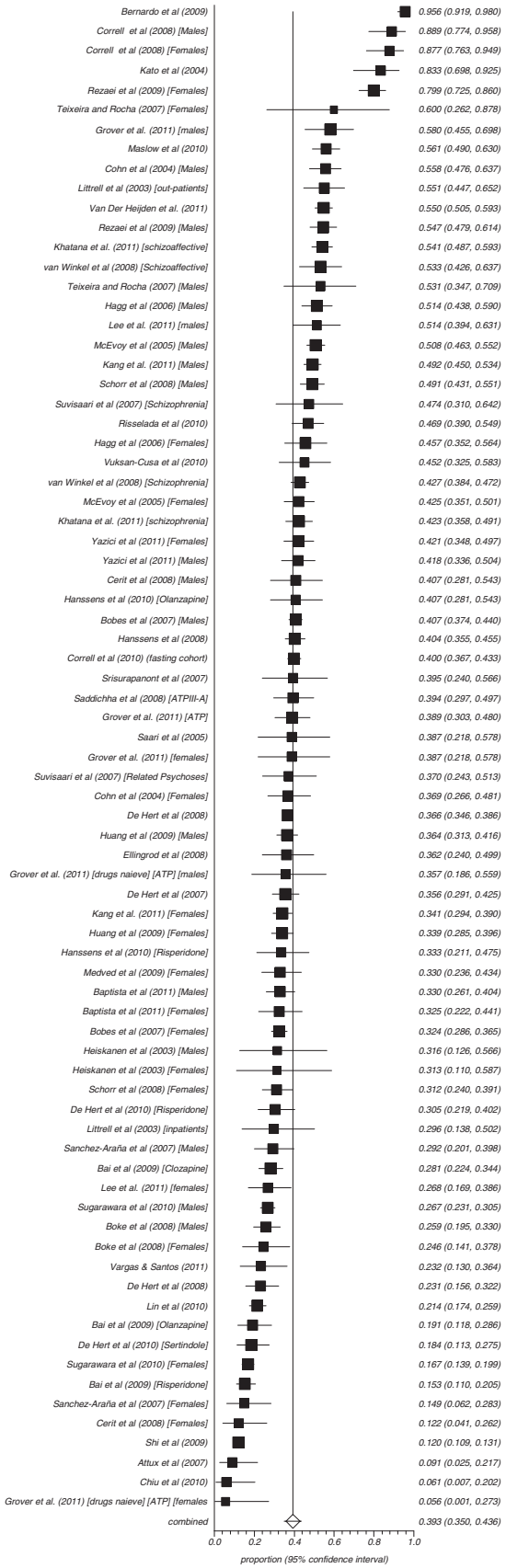

Fig. 5. Summary rate of hypertriglyceridemia in schizophrenia (random effects).

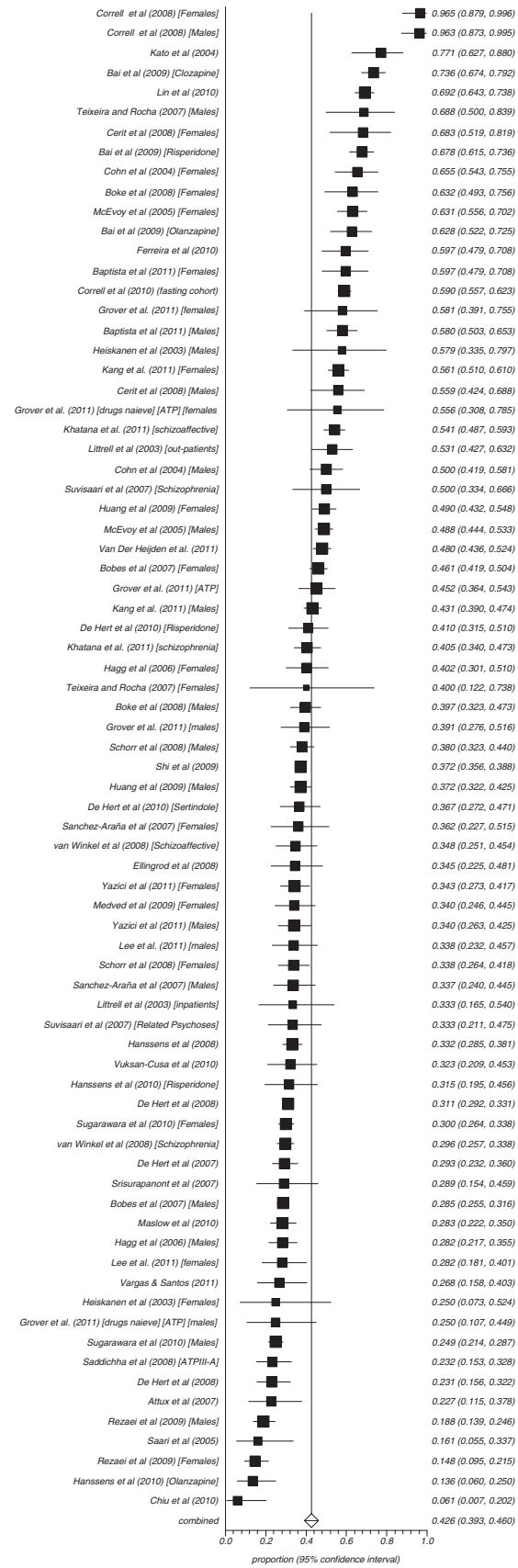

Fig. 6. Summary rate of high-density lipoprotein (random effects).

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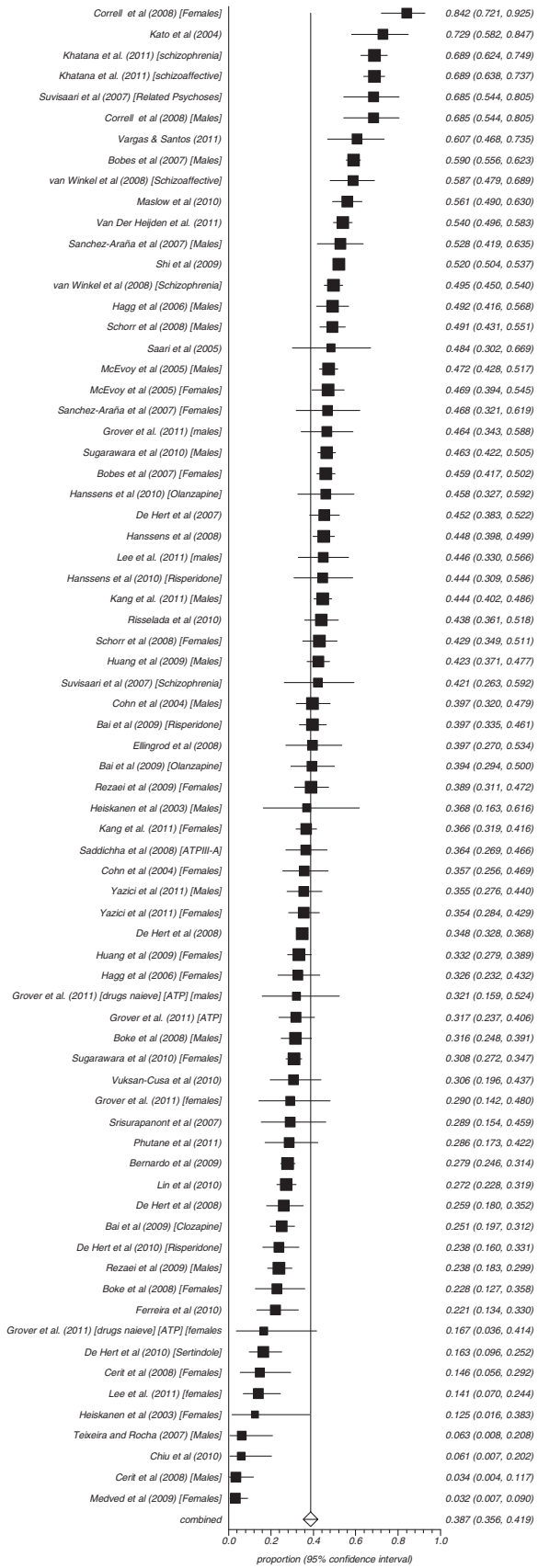

Fig. 7. Summary rate of hypertension in schizophrenia (random effects).

abnormalities when systematically tested (see table 2). The MetS rates appear consistently high regardless of definition of MetS (rates were nonsignificantly lower in ATP III-A) and population norms although the magnitude of the latter effect are not entirely clear. When looking at the overall rate of MetS, only minor differences were apparent between United States, Finland, Turkey, and Spain, and there was considerable heterogeneity in data from other countries. A subanalysis of studies from the United States (see online supplementary table 3) suggests significantly higher rates of obesity (by waist size), hypertension, and abnormal HDL cholesterol (all $P < .0001$) compared with other countries.

When considering the MetS, identifying patients who currently have or are at high risk for metabolic disorders is a first step. Knowledge on which factors are associated with the highest MetS rates helps to identify these patients at greater risk. Consistent with population studies,[25–28] there was no appreciable difference in men and women indicating that both sexes need the same care. Despite the large sample size (n = 25 692), there was modest data on ethnic minority nonwhite populations. Consequently, no meta-analytic conclusions can be drawn on the differences in MetS between different ethnic populations. In contrast, prevalence of MetS was higher in those receiving antipsychotic drugs compared with those who were unmedicated. We also attempted to examine differences by prescribed antipsychotic drug for MetS, but our findings were limited by small sample size for each drug. High rates were most notably seen on clozapine (51.9%), although this could be influenced by subject age and duration of illness or indeed previous antipsychotic exposure. The present meta-analytic findings demonstrate that MetS rates are increasing with older age. Lowest MetS rates were seen in first-episode patients. However, one of the major determinants for higher MetS risk was longer illness duration (see supplementary appendix 2 online). The cumulative long-term effect of poor health behaviors and long-term exposure to antipsychotic drug places a patient with longer illness duration at a greater risk of cardio-metabolic disorders.

The lower rates of MetS observed in first-episode patients is of great interest. No study has compared these low rates with the general population, but it is quite plausible that the risk is not increased in these patients early in the course of their illness, prior to exposure to AP. Several groups have however proposed a liability for people with schizophrenia to develop metabolic abnormalities in the absence of antipsychotic medication. [38–40] In support of this, there are indications of an increased risk for diabetes in first-degree relatives.[41] There is also some evidence for the underlying genetic risk for the development of metabolic abnormalities after antipsychotic treatment initiation.[18,19] In studies that have assessed metabolic abnormalities in drug-naïve first-episode patients, several have found impaired glucose tolerance or insulin

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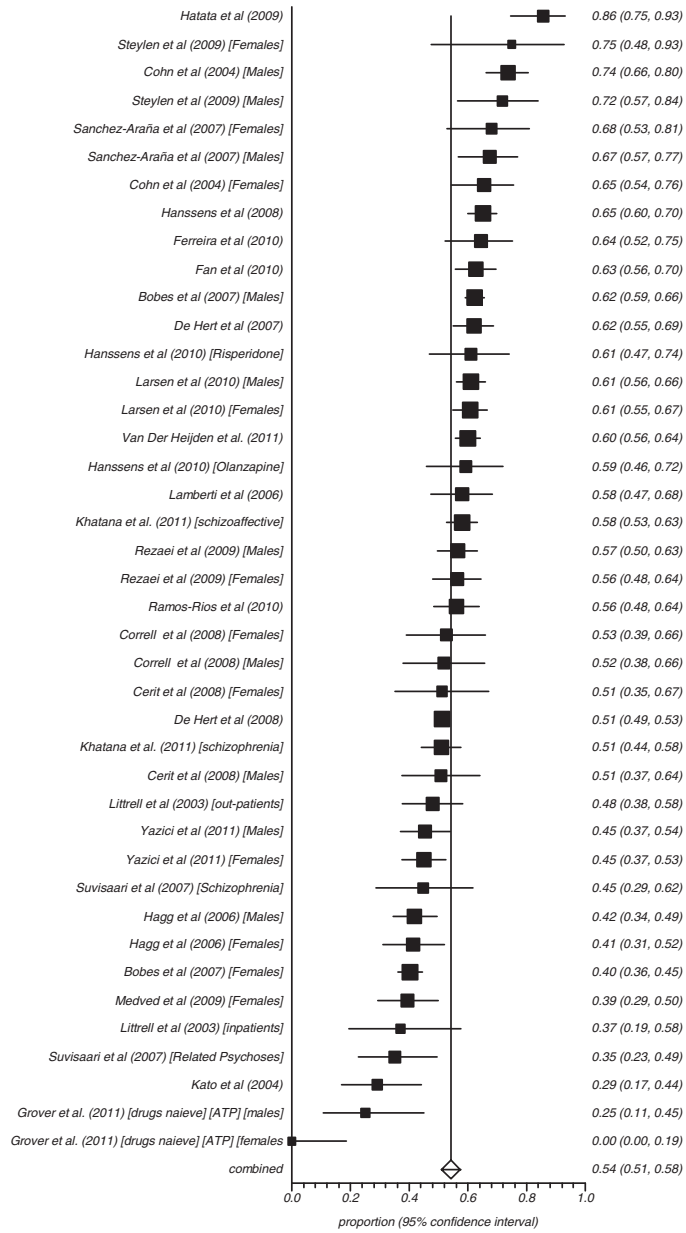

Fig. 8. Summary rate of smoking in schizophrenia (random effects).

resistance,[38–40,42–45] while others have found no appreciable effect.[46–49] Raised cholesterol and/or triglyceride levels have been reported by some groups[43,44] but not by others.[44] Green et al[50] described a significant increase in weight and total cholesterol levels but not in fasting glucose in a cohort of 263 first-episode patients treated with haloperidol or olanzapine for 2 years. In the European First-Episode Study, Kahn et al[51] evaluated first-episode cases of schizophrenia during first year of exposure to antipsychotic treatment and found an increase in the number of overweight patients from 17% at baseline to 54% at 12 months and people with high cholesterol from 23% to 46.3%. Perez-Ingesias et al[52] found limited abnormalities at baseline, but weight gain was positively correlated with changes in insulin levels, insulin resistance index, and triglyceride levels. Oriot et al[53] found that after 9 months of first exposure, there were significant increases in body mass index (BMI), fasting glucose, and waist circumference but no effect on blood pressure or lipids.

Limitations

We wish to acknowledge several limitations in the primary data and this meta-analysis. First, there was considerable heterogeneity, which can only be partly controlled by stratification for MetS definition and setting. Second, there were limited data on nonschizophrenia psychosis, and hence, analysis of this subgroup was not possible on its own. Third, there were often missing data on duration of illness. Indeed, it is important to note that

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duration of illness is often a proxy of duration of medication exposure and is related to patient age, both of which may influence MetS. Fourth, there were inadequate data on individuals prescribed specific AP, particularly first-generation antipsychotic drugs. Fifth, there was inadequate measurement of population rates of MetS in each study, and as such, relative risk estimates of MetS could only be extrapolated. Finally, there was marked variation in the quality of studies, particularly sample size.

Clinical Implications

Although with limitations, our findings demonstrate that patients with schizophrenia are a high-risk group for MetS. They should therefore be routinely screened for MetS risk factors at key stages.[54,55] This can be achieved by establishing a risk profile based on consideration of medical factors (eg, obesity, dyslipidaemia, hypertension, hyperglycaemia, and established diabetes) but also behavioral factors (eg, poor diet, smoking, and physical inactivity). This risk profile can then be used as a basis for ongoing monitoring, treatment selection, and management. Of the individual components of MetS, increased waist size (or abdominal obesity) was most predictive of MetS status (see supplementary appendix 2 online). At a study level, waist size predicted MetS with an AUC of 0.848. Visceral (intra-abdominal) adiposity is known to be closely associated with hyperinsulinaemia, dyslipidaemia, and impaired glucose tolerance. Several groups have proposed that waist size or BMI could be used as a simple screening test for MetS in schizophrenia.[56–58] Straker et al[56] found that abdominal obesity alone has 92% sensitivity and 55.6% specificity for full MetS De Hert et al[59] developed a schizophrenia specific conversion method to calculate waist size from BMI Waist circumference can predicted according to the following formula: waist = 33.0 + (2.4 × BMI) for men and waist = 27.9 + (2.4 × BMI) for women.

Although measuring waist circumference and/or BMI is simple, easy to perform, and inexpensive, 50% of patients in routine care have no recorded BMI measure,[60] and about 60% of inpatients receive no comprehensive physical examination.[61] The American Diabetes Association[62] recommends that patients receiving atypical antipsychotics should have waist circumference measured at baseline and annually and BMI at baseline, at 4, 8, and 12 weeks and then quarterly. Guidelines from the European Psychiatric Association[4] recommend that monitoring should be taken at the initial presentation and before the first prescription of antipsychotic medication and (for patients with normal baseline tests) repeated at 6 and 12 weeks after initiation of treatment and at least annually thereafter. In light of the high rates of MetS observed in all settings, we propose that minimum monitoring should include BMI and waist circumference, and optimal monitoring should also include fasting glucose, lipids, and cholesterol. Additionally, psychiatrists, physicians, nurses, and other members of the multidisciplinary team can help educate and motivate patients with schizophrenia to improve their lifestyle through the use of effective behavioral interventions, including smoking cessation, dietary measures, and exercise.[55,63,64] However, if lifestyle interventions do not succeed (or are unlikely to succeed) then preferential use of or switching to a lower risk medication or addition of a medication known to reduce weight and/or metabolic abnormalities should be considered.[4,20,55,64–66]

Future Research

Future studies should evaluate interventions that target the individual components of the metabolic syndrome especially abdominal obesity. Future research should also undertake a comprehensive assessment of MetS risk factors following, at the very least, recommended monitoring guidelines. Long-term follow-up will be required here in order to accurately document the emergence of some outcomes, such as diabetes. Thirdly, examining whether cardio-metabolic outcomes are moderated by clinical characteristics and genetic factors should become a clinical research priority.

Conclusions

Our meta-analysis clearly demonstrates that MetS risk factors are highly prevalent in patients with schizophrenia. Psychiatrists need to be aware of the potential metabolic side effects of antipsychotic medication and to include them in the risk/benefit assessment when choosing a specific antipsychotic. The treating psychiatrists should also be responsible for the implementation of the necessary screening assessments and referral for treatment. Multidisciplinary assessment of medical and behavioral conditions is needed. Psychiatric treatment facilities should offer and promote healthy lifestyle intervention early in the course of disease aiming to prevent serious metabolic adverse effects. Future research should focus on evaluating interventions that target MetS and examine if cardio-metabolic outcomes are moderated by clinical characteristics and genetic factors.

Supplementary Material

Supplementary material is available at http://schizophreniabulletin.oxfordjournals.org.

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