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Prevalence of, and factors associated with, diabetes mellitus in people with severe mental illness attending a multidisciplinary, outpatient cardiometabolic health assessment service

Tim Lambert ,[1,2] Tim Middleton,[3] Roger Chen,[4,5] Premala Sureshkumar [1]

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For numbered affiliations see end of article.

Correspondence to
Professor Tim Lambert;
tim.lambert@sydney.edu.au

ABSTRACT

Introduction Evaluate the prevalence of, and factors associated with, diabetes in people with severe mental illness (SMI) attending the Collaborative Centre for Cardiometabolic Health in Psychosis (ccCHiP) tertiary referral clinics.

Research design and methods Adult patients attending an initial ccCHiP clinic consultation (2014–2019) were studied. Diabetes was defined by an hemoglobin A1c of ≥6.5%, fasting blood glucose of ≥7.0 mmol/L, or a self-reported diagnosis of diabetes and prescription of antihyperglycemic medication.

Results Over 5 years, 1402 individuals attended a baseline consultation. Mean age of 43.9±12.8 years, 63.1% male and 63.5% had a diagnosis of schizophrenia. Prevalence of diabetes was 23.0% (n=322); an additional 19.5% fulfilled criteria for pre-diabetes. Of those with diabetes, 15.8% were newly diagnosed. Of those with pre-existing diabetes, 84.5% were receiving treatment with antihyperglycemic medication. Over 94% of individuals with diabetes had dyslipidemia; half were current smokers; and 46.4% reported sedentary behavior. On multivariate analysis, diabetes was associated with older age, Aboriginal, Indian or Middle Eastern maternal ethnicity, elevated waist-to-height ratio, family history of diabetes and use of antipsychotic medication.

Conclusion Prevalence of diabetes mellitus in this multiethnic cohort with SMI is significantly higher than the Australian population. Targeted interventions via an assertive integrated approach are required to optimize cardiometabolic health in this population.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Internationally, the risk of diabetes in people with severe mental illness (SMI) has been reported to exceed threefold that of the general population. While diabetes is undoubtedly a common comorbidity for Australians living with SMI, an accurate estimate of the prevalence of diabetes in Australians with SMI is yet to be firmly established.

WHAT THIS STUDY ADDS

⇒ Prevalence of diabetes mellitus in this multiethnic cohort of people with SMI is significantly higher than the background Australian population, especially in younger people. New diabetes was detected in 15.8% of the cohort.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our finding of new diabetes in a multidisciplinary clinic setting provides support for more comprehensive screening in this high-risk population. Moreover, it raises the need for early intervention with a focus on younger people and in the subgroup of people with pre-diabetes as a preventative measure in reducing the risk of diabetes in this vulnerable population.

INTRODUCTION

Diabetes remains one of the most common chronic health conditions[1] and is associated with high levels of morbidity and premature mortality.[2 3] The Australian Bureau of Statistics 2017–2018 National Health Survey estimated the prevalence of self-reported diabetes in the general Australian population to be 4.9%[4 5]; a further 3.1% of the Australian population has been estimated to have pre-diabetes.[6]

People with severe mental illness (SMI) are known to be at increased risk of diabetes.[7 8] Those with SMI face significant medical and psychosocial challenges, and these undoubtedly contribute to an increased risk of diabetes. Chronic treatment with antipsychotic and other psychotropic medications is frequently associated with significant weight gain. Overweight and obesity are associated with increased insulin resistance and

increased risk of dysglycemia. People with SMI face financial constraints that significantly restrict dietary choices. In addition, many people with SMI struggle to maintain adequate levels of physical activity with a significant proportion of this cohort leading sedentary lives.

Research has shown that individuals with SMI have excess mortality compared with the general population due to the development of premature chronic physical and medical conditions.[8] There are reports that people with schizophrenia or bipolar disorder and diabetes have a higher mortality rate than those with no diabetes[9] and those with SMI only.[10] In a small Australian study, the combination of schizophrenia and diabetes increased the mortality rate by sixfold compared with that seen in people with neither condition.[11] A large Danish registry-based study reported that the cumulative risk of death was 15.0% at 7 years post diagnosis of diabetes for the cohort of people <50 years of age with both SMI and diabetes.[12] Similarly, in a British register-based study, Vinogradova *et al* found that 23.1% of people with SMI and diabetes died within 5 years of follow-up.[9]

Despite this knowledge, the screening and diagnosis of diabetes in this population remains poor due to limited access to care, fragmentation of care delivery and patient-related factors. It has been estimated that 70% of people prescribed second-generation antipsychotic pharmacotherapy remain unscreened for diabetes.[13] Those with schizophrenia have a greater risk of acquiring acute and macrovascular complications[14] of diabetes and an estimated 74% greater risk of requiring a hospital admission for hypoglycemia/hyperglycemia compared with those without schizophrenia.[15]

Internationally, the prevalence of diabetes in people with SMI has been reported to be two to three times higher than that in the general population without SMI.[16] However, rigorous studies examining prevalence of diabetes in the setting of SMI in Australia are scarce. The self-reported prevalence of diabetes in the 2010 Australian Survey of High Impact Psychosis was 20%.[17] Previous studies conducted within a number of Australian mental health services determined the combined prevalence of impaired fasting glucose and diabetes (diagnosed on the basis of elevated fasting glucose) in the SMI population to be >30%.[18 19]

A more comprehensive understanding of the diabetes burden in the Australian SMI population is clearly required. The primary aim of our study was to determine the prevalence of diabetes in this high-risk population using more comprehensive screening criteria for detecting diabetes and compare this to the general Australian population. The secondary aim was to investigate the factors associated with the diabetes status in these patients. This knowledge will help to facilitate more appropriate allocation of resources and thus provide an opportunity to improve early treatment and the holistic management of people with SMI.

METHODS

Study setting

The study population included adults (aged 18–65 years) with SMI who attended a baseline visit to the Collaborative Centre for Cardiometabolic Health in Psychosis (ccCHiP) clinics between May 2014 and December 2019. The ccCHiP clinics are located within the Sydney Local Health District New South Wales, Australia, which services a catchment area of approximately 700 000 residents. ccCHiP provides a multidisciplinary, consultative service for patients with SMI, and referrals are received from local community mental health centers and local general practitioners. The service runs on an integrative health model with input from a psychiatrist, endocrinologist, cardiologist, dietitian, exercise physiologist, sleep clinician, nurse and oral health team.[20] It is a one-stop shop where all clinicians are seen by the patient in a single session.

Diagnostic criteria used to classify diabetes mellitus and prediabetes in the ccCHiP clinic

For the purpose of this study, a hierarchical approach (table 1) was used to determine type 2 diabetes status (patients with type 1 diabetes are not seen in the clinic). If an individual presented with a hemoglobin A1c (HbA1c) level of ≥6.5%, this was deemed to be consistent

Table 1 Categories used to determine diabetes status in the ccCHiP cohort

Level	Diagnostic category	N	Per cent
1	HbA1c ≥6.5%	175	54.3
2	FPG ≥7 mmol/L and a previous diagnosis of diabetes or FPG ≥7 mmol/L and receiving antihyperglycemic medication	27	8.4
3	FPG ≥7 mmol/L and no previous diagnosis of diabetes	36	11.2
4	Receiving treatment with insulin therapy	2	0.6
5	Receiving metformin and a previous diagnosis of diabetes	66	20.5
6	Receiving antihyperglycemic medication other than metformin	16	5.0
Total		322	100

ccCHiP, Collaborative Centre for Cardiometabolic Health in Psychosis; FPG, fasting plasma glucose; HbA1c, hemoglobin A1c.

with diabetes and coded accordingly. In the event that an HbA1c was unavailable (or the HbA1c was <6.5% at the time of their visit), a self-report of a diagnosis of diabetes, treatment with insulin or other antihyperglycemic medications and/or elevated fasting blood glucose measurements were used to identify individuals with diabetes. We excluded people who did not have a pre-existing diagnosis of diabetes and were using metformin for an off-label indication. Overall prevalence of diabetes was determined by the addition of the six diagnostic subgroups incorporated in table 1. Within the cohort of clinic patients not identified as having diabetes, further review of HbA1c and fasting blood glucose results allowed for the identification of individuals with pre-diabetes. Individuals with an HbA1c of 6.0%–6.4% (Australian Diabetes Society criteria)[21] and/or a fasting blood glucose level between 5.6 mmol/L and 6.9 mmol/L (ADA criteria)[22] were classified as having pre-diabetes.

Data collection

Demographic data (age, gender, ethnicity and marital status) and clinical data (International Classification of Diseases, 10th Revision (ICD-10) psychiatric diagnosis, medication use, personal history of diabetes, family history of diabetes, smoking status, alcohol consumption, physical activity level, body mass index (BMI), waist:height ratio (WtoHt), blood pressure, fasting blood glucose, HbA1c, total cholesterol, triglyceride, high-density lipoprotein (HDL) cholesterol, low-density (LDL) lipoprotein cholesterol and estimated glomerular filtration rate (eGFR) are routinely collected for patients who attend the ccCHiP clinic.

Ethnicity was classified as low-risk category for diabetes when the father's or mother's country of birth was from a Mediterranean or Caucasian origin; high-risk category when African–American, Pacific Islander, Middle Eastern, Asian/Southeast Asian, Aboriginal/Torres Strait Islander, Indian subcontinent or other high-risk origin. BMI was defined as 'normal' if (18.0–<25.0 kg/m^2 and low-risk ethnicity or 16.0–<23.0 kg/m^2 and high-risk ethnicity), overweight (25.0–<30.0 kg/m^2 and low-risk ethnicity or 23.0–<27.5 kg/m^2 and high-risk ethnicity) and obese (≥30 kg/m^2 and low-risk ethnicity or ≥27.5 and high-risk ethnicity).

WtoHt was categorized as elevated if an individual's WtoHt was >0.52 and low-risk ethnicity, or >0.50 and high-risk ethnicity. Abdominal circumference was categorized as normal if an individual's waist was <94.0 cm for men and low-risk ethnicity, or <90.0 cm for men and high-risk ethnicity, or <80.0 cm for women; and 'abnormal' if ≥94.0 cm for men and low-risk ethnicity, or ≥90.0 cm for men and high-risk ethnicity or ≥80.0 cm for women. Dyslipidemia was defined by the presence of one or more of the following findings: (1) prescription of cholesterol-lowering medication, (2) total cholesterol of ≥4.2 mmol/L, (3) HDL cholesterol of <1.04 mmol/L (for men) and <1.29 mmol/L for women, (4) LDL cholesterol of ≥2.59 mmol/L and (5) triglycerides of ≥1.7 mmol/L. Consumption of alcohol was categorized as 'high risk' (≥7 standard drinks/week for men and ≥5 standard drinks/week for women) and 'low risk' (<7 standard drinks/week for men and <5 standard drinks/week for women). Treatment with antipsychotic medication was categorized as (1) clozapine (±another antipsychotic medication), (2) olanzapine (±another antipsychotic medication), (3) non-clozapine/non-olanzapine antipsychotic medication and (4) no antipsychotic medication.

Statistical analysis

Data were analyzed using SAS V.9.1.4 statistical software program.[23] Descriptive statistics are presented as count and percentage for discrete variables and as mean and SD for continuous variables. Prevalence of diabetes and the prevalence of pre-diabetes are both reported with their corresponding 95% CIs. The Pearson's χ^2 test was used to assess for differences in the distribution of categorical variables. Logistic regression analyses were carried out to explore the association between risk factors and diabetes status. In this approach, potential risk factors against diabetes status were analyzed in a backward selection procedure. Variables with p values of < 0.10 in the univariate association were entered into the multivariate model with a p value of <0.05 being the criterion for removal of variables. ORs (with 95% CIs) for each risk factor are reported. Statistical tests were two-tailed with the significance level set at 0.05.

RESULTS

Characteristics of ccCHiP clinic participants

Between May 2014 and December 2019, 1402 patients with SMI were seen for a baseline visit at a ccCHiP clinic. The mean age of the ccCHiP cohort was 43.9±12.8 years; 63.1% were male; 79.0% were overweight or obese; and 50.0% were current tobacco smokers (table 2). White/Caucasian (64.0%) and Asian/Southeast Asian (17.0%) were the most frequently cited ethnicities within the clinic population. The most common psychiatric diagnosis among ccCHiP clinic attendees was schizophrenia (63.5% of the clinic cohort). For those individuals not reporting a diagnosis of schizophrenia, the primary psychiatric diagnosis was attributed to schizoaffective disorder (in 9.6% of cases), bipolar disorder (12.2% of cases), depression (4.0% of cases) and other psychosis (7.4%). Of the clinic cohort, 3.3% had another ICD-10 diagnosis recorded as their primary psychiatric illness. Table 2 demonstrates that there is a difference across various psychiatric diagnosis with the diabetes and no diabetes groups (p<0.001).

Diabetes and pre-diabetes prevalence

Overall, the prevalence of diabetes within the ccCHiP clinic population was found to be 23.0% (95% CI 20.8% to 25.2%) (table 2). The prevalence of diabetes was similar for men (24.0%, 95% CI 21.2% to 26.8%) and women (21.2%, 95% CI 17.7% to 24.8%). A further 19.5% (95% CI 17.4% to 21.5%) of our cohort were classified as having

Table 2 Baseline characteristics of ccCHiP clinic population by diabetes status

Characteristic	ccCHiP clinic N=1402 n (%)	No diabetes N=1080 n (%)	Diabetes N=322 n (%)	P value*
Age group (years)				
18–24	125 (8.9)	117 (10.8)	8 (2.5)	<0.001
25–34	209 (14.9)	180 (16.7)	29 (9.0)	
35–44	343 (24.5)	267 (24.7)	76 (23.6)	
45–54	394 (28.1)	292 (27.1)	102 (31.7)	
55–64	271 (19.3)	185 (17.1)	86 (26.7)	
>64	60 (4.3)	39 (3.6)	21 (6.5)	
Gender				0.238
Male	884 (63.1)	672 (62.2)	212 (65.8)	
Female	518 (36.9)	408 (37.8)	110 (34.2)	
Psychiatric diagnosis†				<0.001
Schizophrenia	888 (63.5)	654 (60.7)	234 (72.9)	
Schizoaffective disorder	135 (9.6)	104 (9.7)	31 (9.7)	
Bipolar disorder	170 (12.2)	141 (13.0)	29 (9.0)	
Depression	56 (4.0)	43 (4.0)	13 (4.0)	
Other psychosis	104 (7.4)	96 (8.9)	8 (2.5)	
Other ICD-10 diagnosis	46 (3.3)	40 (3.7)	6 (1.9)	
Antipsychotic use				<0.001
Clozapine±other antipsychotic	369 (26.3)	256 (23.7)	113 (35.1)	
Olanzapine±other antipsychotic	254 (18.1)	218 (20.2)	36 (11.2)	
Other antipsychotic only	667 (47.6)	515 (47.7)	152 (47.2)	
No antipsychotic medication	112 (8.0)	91 (8.4)	21 (6.5)	
Fasting blood glucose level (mmol/L)†				<0.001
► <5.6.	810 (61.2)	762 (74.6)	48 (15.8)	
► ≥5.6 and <7.0.	318 (24.0)	259 (25.4)	59 (19.5)	
► ≥7.	196 (14.8)	0	196 (64.7)	
HbA1c (%)†				<0.001
► <6.0.	820 (76.1)	747 (94.8)	73 (25.3)	
► ≥6.0 and <6.5.	82 (7.6)	41 (5.2)	41 (14.2)	
► ≥6.5%.	175 (16.2)	0	175 (60.5)	
Hypertension				<0.001
Yes	450 (32.1)	281 (26.0)	169 (52.5)	
No	952 (67.9)	799 (74.0)	153 (47.5)	
Dyslipidemia				0.07
Yes	1295 (92.4)	990 (91.7)	305 (94.7)	
No	107 (7.6)	90 (8.3)	17 (5.3)	
Abdominal circumference†				
Normal	176 (14.2)	164 (17.1)	12 (4.3)	<0.001
Abnormal	1063 (85.8)	797 (82.9)	266 (95.7)	
Waist:height ratio†				
Normal	173 (13.8)	163 (16.8)	10 (3.5)	<0.001
Abnormal	1083 (86.2)	808 (83.2)	275 (96.5)	
BMI†				<0.001

Continued

Table 2 Continued

Characteristic	ccCHiP clinic N=1402 n (%)	No diabetes N=1080 n (%)	Diabetes N=322 n (%)	P value*
Normal	209 (16.5)	192 (19.7)	17 (5.9)	
Overweight	331 (26.2)	270 (27.7)	61 (21.1)	
Obese	724 (57.3)	513 (52.6)	211 (73.0)	
Smoking status†				0.527
Never	454 (33.2)	357 (33.8)	97 (31.4)	
Previous	226 (16.5)	169 (16.0)	57 (18.4)	
Current	686 (50.2)	531 (50.2)	155 (50.2)	
Alcohol consumption level†				0.001
Low risk	1206 (87.0)	910 (85.4)	296 (92.5)	
Risky	30 (2.2)	23 (2.2)	7 (2.2)	
High risk	150 (10.8)	133 (12.4)	17 (5.3)	
Father's ethnicity†				0.015
Mediterranean/Caucasian/white	856 (64.6)	674 (65.8)	182 (60.5)	
African–American	13 (1.0)	9 (0.9)	4 (1.3)	
Pacific Islander	51 (3.8)	37 (3.6)	14 (4.7)	
Middle Eastern	82 (6.2)	56 (5.4)	26 (8.6)	
Asian/Southeast Asian	230 (17.3)	184 (17.9)	46 (15.3)	
Aboriginal/Torres Strait Islander	29 (2.2)	20 (2.0)	9 (3.0)	
Indian subcontinent	37 (2.8)	21 (2.1)	16 (5.3)	
Other high-risk	28 (2.1)	24 (2.3)	4 (1.3)	
Mother's ethnicity†				<0.001
Mediterranean/Caucasian/white	839 (63.0)	665 (64.6)	174 (57.6)	
African–American	12 (0.9)	8 (0.8)	4 (1.3)	
Pacific Islander	57 (4.3)	42 (4.1)	15 (5.0)	
Middle Eastern	74 (5.6)	50 (4.8)	24 (7.9)	
Asian/Southeast Asian	242 (18.2)	192 (18.7)	50 (16.6)	
Aboriginal/Torres Strait Islander	38 (2.9)	20 (1.9)	18 (6.0)	
Indian subcontinent	37 (2.8)	23 (2.2)	14 (4.6)	
Other high-risk	32 (2.4)	29 (2.8)	3 (1.0)	
Marital status†				0.395
Single	936 (67.0)	732 (68.1)	204 (63.3)	
Defacto	48 (3.4)	39 (3.6)	9 (2.8)	
Married	87 (6.2)	62 (5.8)	25 (7.8)	
Separated/divorced	210 (15.0)	159 (14.8)	51 (15.8)	
Widowed	22 (1.6)	15 (1.4)	7 (2.2)	
Unknown	94 (6.7)	68 (6.3)	26 (8.1)	
Living arrangements†				0.056
Alone	438 (32.9)	323 (31.4)	115 (38.1)	
Spouse/de facto	128 (9.6)	98 (9.5)	30 (9.9)	
Parents or siblings	375 (28.2)	309 (30.1)	66 (21.9)	
Other family member	59 (4.4)	47 (4.6)	12 (4.0)	
Group of others	49 (3.7)	34 (3.3)	15 (5.0)	
One other (not family)	46 (3.5)	35 (3.4)	11 (3.6)	

Continued

Table 2 Continued

Characteristic	ccCHiP clinic N=1402 n (%)	No diabetes N=1080 n (%)	Diabetes N=322 n (%)	P value*
Long term hospital	11 (0.8)	10 (1.0)	1 (0.3)	
Supported accommodation	72 (5.4)	50 (4.8)	22 (7.3)	
Boarding house	152 (11.4)	122 (11.9)	30 (9.9)	
Educational level†				0.002
Primary	42 (3.2)	29 (2.8)	13 (4.4)	
Secondary	676 (51.3)	497 (48.7)	179 (60.1)	
Postsecondary	266 (20.2)	216 (21.2)	50 (16.7)	
Tertiary	289 (21.9)	242 (23.7)	47 (15.8)	
Unknown	46 (3.5)	37 (3.6)	9 (3.0)	
Exercise level†				<0.001
Sedentary	503 (38.0)	363 (35.6)	140 (46.4)	
Minimal exercise	270 (20.4)	210 (20.6)	60 (19.9)	
Lightly active	385 (29.1)	306 (30.0)	79 (26.2)	
Moderately active	150 (11.3)	127 (12.5)	23 (7.6)	
Very/extra active	14 (1.1)	14 (1.3)	0	

*P values are derived from the Pearson's χ^2 test comparing the distribution of 'diabetes' and 'no diabetes' groups.
†Number not equal to 1402.
BMI, body nass index; ccCHiP, Collaborative Centre for Cardiometabolic Health in Psychosis; HbA1c, hemoglobin A1c; ICD-10, International Classification of Diseases.

evidence of pre-diabetes (on the basis of an HbA1c in the 6.0%–6.4% range and/or a fasting blood glucose in the 5.6–6.9 mmol/L range). Pre-diabetes was identified in a slightly higher proportion in men than in women (21.0%, 95% CI 18.4% to 23.7% (male) vs 16.8%, 95% CI 13.6% to 20.0% (female)). Within the female cohort, 8.2% (95% CI 5.5% to 10.9%) of individuals reported a history of gestational diabetes. Of those with a history of gestational diabetes, one-third had developed diabetes mellitus by the time of their first visit to the ccCHiP clinic.

Figure 1 highlights the prevalence of diabetes mellitus (stratified by age group and sex) for the ccCHiP clinic population. These data are presented in comparison to the background, general Australian population.[4 5] As can be seen, the prevalence of diabetes within the ccCHiP clinic population is substantially higher than the Australian General population across each of the 18–44, 45–54 and 55–64 years of age categories.

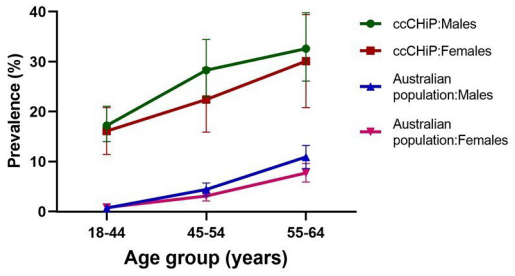

Figure 1 Prevalence of diabetes (stratified by age group and sex) for the ccCHiP population and the background, Australian general population. ccCHiP, Collaborative Centre for Cardiometabolic Health in Psychosis.

Diabetes treatment and level of glycaemic control

Of the 322 individuals classified as having diabetes according to our diagnostic criteria, 51 (15.8%) were newly diagnosed with diabetes at the time of their first ccCHiP clinic visit. Of the 271 individuals with pre-existing diabetes at the time of first ccCHiP clinic visit, 229 (84.5%) were receiving treatment with diabetic pharmacotherapy. Within the cohort of patients holding valid prescriptions for diabetic pharmacotherapy, the three most prescribed agents were metformin (216/229, 94.3%), gliclazide (or other sulfonylurea) (44/229, 19.2%) and insulin (36/229, 15.7%) (table 3). The most prescribed treatment regimen was metformin monotherapy (n=145, 63.3%). Of those with a pre-existing diagnosis of diabetes and on metformin monotherapy, 36.4% were not at the recommended HbA1c target (<7.0%) at the time of their ccCHiP visit. Approximately 37.0% were prescribed dual antihyperglycemic therapy. Sodium-glucose co-transporter-2 (SGLT2) inhibitors and glucagon-like peptide-1 (GLP-1) receptor agonists were the least frequently used pharmaceutical agents. Table 3 illustrates the distribution of diabetic pharmacotherapy use at the time of the initial ccCHiP clinic visit.

Ninety per cent of individuals (n=289 of the diabetes cohort) with a diagnosis of diabetes had a recent HbA1c

Table 3 Diabetic pharmacotherapy use among those individuals holding at least one valid prescription for an antihyperglycemic agent at the time of initial ccCHiP clinic visit (n=229)

Antihyperglycemic agent	n (%) holding a valid prescription
Metformin	216 (94.3)
Gliclazide (or other sulfonylurea)	44 (19.2)
DPP4 inhibitor	26 (11.4)
GLP-1 receptor agonist	1 (0.4)
SGLT2 inhibitor	17 (7.4)
Insulin	36 (15.7)

ccCHiP, Collaborative Centre for Cardiometabolic Health in Psychosis.

measurement available at the time of their first clinic visit. The median HbA1c for those with a diagnosis of diabetes was 6.8% (range 4.3%–16.2%). Forty-five per cent (n=131) had an HbA1c of ≥7.0%, and 28.0% (n=82) had an HbA1c of ≥8.0%.

Diabetes and antipsychotic therapy

Thirty-five per cent of people with diabetes were receiving treatment with clozapine±other antipsychotic medication, 11.0% olanzapine±other antipsychotic medication, 47.2% were receiving treatment with non-clozapine/non-olanzapine antipsychotic medication, and 6.5% were not prescribed any antipsychotic medication.

Factors associated with diabetes in the ccCHiP population

Univariate logistic analysis revealed that age, WtoHt, father's ethnicity, mother's ethnicity, family history of diabetes, psychiatric diagnosis, consumption of alcohol, physical activity and antipsychotic treatment with clozapine±other antipsychotic medication or olanzapine±other antipsychotic medication were statistically significantly associated with diabetes (table 4). We did not find a significant association between gender and diabetes or smoking status and diabetes.

Multivariate logistic analysis found that older age was significantly associated with diabetes. Those with an elevated WtoHt had significantly higher odds of diabetes (OR 4.5, 95% CI 2.2 to 9.2) relative to those with a normal WtoHt. People with a family history of diabetes had twofold higher odds of diabetes (OR 2.0, 95% CI 1.5 to 2.8). Those with Aboriginal/Torres Strait Islander and Indian subcontinent maternal ethnic backgrounds had greater than threefold increased odds of diabetes relative to the Caucasian/Mediterranean ethnic group. Finally, the odds of diabetes in those treated with clozapine±other antipsychotic medication (OR 1.7, 95% CI 1.2 to 2.4) were almost twofold higher than in those treated with non-clozapine/non-olanzapine antipsychotic therapy. Treatment with olanzapine±other antipsychotic medication was associated with half the odds (OR 0.5, 95% CI 0.3 to 0.8) of having diabetes than those treated with non-clozapine/non-olanzapine antipsychotic therapy.

DISCUSSION

Throughout the world, the prevalence of diabetes mellitus continues to increase with predictions that the 2045 worldwide prevalence will reach 783 million.[24] Within the cohort of people with SMI, most antipsychotic pharmacotherapy contributes to weight gain and insulin resistance. International studies have found that the prevalence of diabetes is two to three times higher in those with SMI than that observed in the general population.[16] In the Australian setting, we have confirmed a significantly higher prevalence of diabetes in the SMI population than that seen in the general Australian population. In the category aged 18–44 years, diabetes prevalence in the ccCHiP population is 16.7% (>10 times higher than the age-matched, general Australian population). In the 45–54 years of age category, diabetes prevalence in the ccCHiP population is 25.9% (>6 times higher than the age-matched, general Australian population) and in the 55–64 years of age category, diabetes prevalence in the ccCHiP population is 31.7% (>3 times higher than the age-matched, general Australian population).

Within the ccCHiP cohort alone, we found that diabetes was significantly associated with older age; elevated WtoHt; presence of a family history of diabetes; maternal ethnic background being Aboriginal/Torres Strait Islander, Indian or Middle Eastern compared with Caucasian/Mediterranean, and being on clozapine or olanzapine±other antipsychotic medication compared with not using any antipsychotic medication. Comparable risk factors are prevalent in high-risk psychosis groups globally, reinforcing the notion that the diabesity 'pandemic' is even more accentuated in those with SMI.

In this study, treatment with olanzapine±other antipsychotic medication was associated with lower odds of having diabetes than those on other antipsychotic medication only. This unexpected finding was in contrast to the increased odds of diabetes observed in those on treatment with clozapine±other antipsychotic medication. One possible explanation for the discordance between olanzapine and clozapine may be driven by prescriber behavior. We observe that many prescribers in our local area are acutely aware of the orexigenic and diabetogenic effects of olanzapine and are therefore more proactive in the metabolic management of patients commenced on treatment with olanzapine. This certainly needs to be explored in future research in similar cohorts.

A significant concern for the ccCHiP service is a relatively high prevalence of undiagnosed diabetes at the time of first clinic visit. From the literature, it is estimated that up to 70% of cases with diabetes in people with SMI are undiagnosed.[25] In our clinic population, over 15% of those with diabetes mellitus were newly diagnosed at the time of their first visit. Over 40% of those newly

Table 4 Logistic regression models of factors associated with diabetes in people with severe mental illness attending a multidisciplinary service

	Univariate	Multivariate
Variable	**OR (95% CI)**	**OR (95% CI)**
Age (per 5-year increase)	1.2 (1.1 to 1.3)*	1.3 (1.2 to 1.4)*
Gender		
Male	Reference	Reference
Female	0.9 (0.7 to 1.1)	0.8 (0.6 to 1.1)
BMI		–
Normal	Reference	
Overweight	2.6 (1.4 to 4.5)*	
Obese	4.6 (2.8 to 7.8)*	
Waist circumference		–
Normal	Reference	
Abnormal	4.6 (2.5 to 8.3)*	
Waist:height ratio		
Normal	Reference	Reference
Abnormal	5.5 (2.9 to 10.7)*	4.5 (2.2 to 9.2)*
Family history of diabetes		
No	Reference	Reference
Yes	2.0 (1.5 to 2.6)*	2.0 (1.5 to 2.8)*
Psychiatric diagnosis		–
Schizophrenia	Reference	
Schizoaffective	0.8 (0.5 to 1.3)	
Bipolar	0.6 (0.4 to 0.9)*	
Depression	0.9 (0.5 to 1.6)	
Other psychosis	0.2 (0.1 to 0.5)*	
All others	0.4 (0.2 to 1.0)	
Father's ethnicity		–
Low-risk group (Mediterranean/Caucasian)	Reference	
Aboriginal/Torres Strait Islander	1.7 (0.8 to 3.7)	
African–American	1.7 (0.5 to 5.4)	
Asian	0.9 (0.7 to 1.3)	
Indian	2.8 (1.4 to 5.5)*	
Middle Eastern	1.7 (1.0 to 2.8)	
Other high risk	0.6 (0.2 to 1.8)	
Pacific Islander	1.4 (0.7 to 2.7)	
Mother's ethnicity		
Low-risk group (Mediterranean/Caucasian)	Reference	Reference
Aboriginal/Torres Strait Islander	3.4 (1.8 to 6.6)*	4.0 (1.8 to 8.5)*
African–American	1.9 (0.6 to 6.4)	3.6 (0.9 to 14.7)
Asian	0.9 (0.7 to 1.4)	1.3 (0.9 to 2.0)
Indian	2.3 (1.2 to 4.6)*	3.5 (1.6 to 7.5)*
Middle Eastern	1.8 (1.1 to 3.1)*	1.9 (1.1 to 3.4)*
Other high risk	0.4 (0.1 to 1.3)	0.4 (0.09 to 1.8)
Pacific Islander	1.4 (0.7 to 2.5)	1.8 (0.9 to 3.7)
Dyslipidemia		–

Continued

Table 4 Continued

Variable	Univariate OR (95% CI)	Multivariate OR (95% CI)
No	Reference	
Yes	1.6 (1.0 to 2.8)	
Alcohol risk		–
Low risk	Reference	
Risky	0.9 (0.4 to 2.2)	
High risk	0.4 (0.2 to 0.7)*	
Smoking		–
Never	Reference	
Previous	1.4 (0.9 to 2.0)	
Current	1.0 (0.8 to 1.4)	
Vegetable intake ≥5 serves		–
Adequate	Reference	
Inadequate	1.7 (0.8 to 3.5)	
Exercise level		–
Sedentary	Reference	
Minimal active	0.7 (0.5 to 1.1)	
Lightly exercise	0.7 (0.5 to 0.9)*	
Moderately active	0.5 (0.3 to 0.8)*	
Extra/very active	Not estimable	
Antipsychotic use		
Clozapine±other antipsychotic	1.5 (1.1 to 2.0)*	1.7 (1.2 to 2.4)*
Olanzapine±other antipsychotic	0.6 (0.4 to 0.8)*	0.5 (0.3 to 0.8)*
Other antipsychotic only	Reference	Reference
No antipsychotic medication	0.8 (0.5 to 1.3)	1.2 (0.7 to 2.2)

*P<0.05.
BMI, body mass index.

diagnosed with diabetes at the time of their first visit were aged less than 45 years.

These data support a more proactive screening approach in the young adult SMI population. It is now well recognized that early detection and assertive treatment of diabetes can be very useful in achieving better long-term outcomes.[26] The high rate of undiagnosed diabetes provides a strong argument for more intensive screening for diabetes within the SMI population. It appears that screening for diabetes should start at least two decades earlier for those with SMI. Such screening also provides an opportunity to identify those who have impaired glucose tolerance or pre-diabetes. From a pragmatic point of view, screening with fasting glucose and an HbA1c level would appear to be a reasonable strategy to adopt.

Another concern for clinicians at the ccCHiP clinic is that of treatment inertia in the management of diabetes for the target cohort. For those with a pre-existing diagnosis of diabetes, >40% were not at the recommended HbA1c target (<7%) at the time of their ccCHiP visit. On review of pharmacotherapy use, it is apparent that metformin, gliclazide and insulin were the most commonly prescribed antihyperglycemic agents during the study period. In view of high levels of suboptimal glycemic control at the time of a patient's initial ccCHiP clinic appointment, diabetes treatment intensification appears currently inadequate within the local community who have SMI. In this context, a ccCHiP-like service is well placed to provide diabetes management support to primary care and local community mental healthcare teams. The relative underuse of newer, antihyperglycemic pharmacotherapies (namely, SGLT2 inhibitors and GLP-1 receptor agonists) is most likely explained by the national pharmaceutical benefit scheme prescribing restrictions that were in place for these agents during the study period (2014–2019). Moving forward, there is certainly a role for services like ccCHiP to support an increased uptake of these metabolically favorable treatments in partnership with local general practitioners.

Strengths and limitations

Our study is notable for a number of strengths. The ccCHiP clinic has provided clinical services to >1400 individuals with SMI over the past 5 years, and thus this study captured data from a substantial number of individuals with SMI who reside in the Sydney Local Health District.

This study provides the first systematically collected data on cases of schizophrenia in our catchment area. The question of representativeness arises. Given the currently accepted point prevalence rate for the schizophrenias (0.28%), the catchment population size serviced (700 000) and the known number and diagnoses of persons in public psychiatric care (2200; ~65% schizophrenia spectrum), and given public clinics are the predominant setting for the treatment of SMI, we estimate that about three-quarters of suitable patients are referred to ccCHiP. There is no significant difference (age and gender) between our cohort of people with SMI and the Australian SMI population not referred to the ccCHiP Clinical Service.[27] Further, referral criteria are not based on anthropometric or pathology criteria, but rather a mandate that all new patients with psychosis are assessed within a year and then between 12 and 24 months in periodic follow-up. This suggests that the ccCHiP cohort is representative of those that are managed in public psychiatric settings.

The use of a hierarchical approach to diabetes identification incorporating both HbA1c and fasting glucose data, in addition to self-report and review of pharmacotherapy, is another strength. Previous Australian studies have primarily relied on fasting glucose measurements to estimate diabetes/pre-diabetes prevalence, and in some studies, simply a self-report. Evidently, these previous studies may have resulted in a less accurate estimation than the more comprehensive approach employed in this study. It is also important to note that the ccCHiP service prospectively collects clinical data at each patient visit to the clinic, and thus missing data are kept to a minimum. In addition, the comprehensive data collected by the ccCHiP service has allowed insights into pharmacotherapy use within the cohort of patients with co-morbid SMI and diabetes. In turn this provided an opportunity to quantify the degree of diabetes treatment inertia currently faced by this high-risk population.

It is also important to recognize the study's limitations. Data presented are collected from a secondary referral service and thus may be subject to a referral bias. Nevertheless, our criteria used for referring individuals to ccCHiP clinics accommodated all people with a diagnosis of 'psychosis' which is reasonably representative of those in the Central Sydney public mental health population, as described previously. Referrals are accepted from all local healthcare providers; however, the majority of referrals are received from local community mental health services and a minority are received from within-area general practitioners. Individuals with SMI managed in the private health sector are relatively under-represented. We also acknowledge that the criteria used to identify individuals with diabetes within the ccCHiP clinic population, while more comprehensive than those used in previous Australian studies, are imperfect. Ideally, to confirm a new diagnosis of diabetes, one would normally request a second confirmatory fasting blood test. This is usually performed by the patient's GP, and the ccCHiP clinic does not have direct access to the results of confirmatory testing that may have been performed by general practitioners.

CONCLUSION

Overall, the prevalence of diabetes within the SMI population in metropolitan Sydney is significantly higher than that of the age-matched, general Australian population. Two areas of significant concern are the relatively high rates of undiagnosed diabetes in the clinic population (especially considering the elevated rates of early onset) and an apparent treatment inertia in those with an established diagnosis of diabetes. Implementation of targeted interventions via an integrated care approach may help these high-risk individuals improve their diabetes management and their cardiometabolic health.

Author affiliations
[1]Concord Medical School, The University of Sydney, Sydney, New South Wales, Australia
[2]Collaborative Centre for Cardiometabolic Health in Psychosis (ccCHiP), Concord Repatriation General Hospital, Concord, New South Wales, Australia
[3]Department of Endocrinology, Royal Prince Alfred Hospital, Camperdown, New South Wales, Australia
[4]Diabetes and Endocrinology, The University of Sydney, Sydney, New South Wales, Australia
[5]St Vincent's Clinical School, University of New South Wales, Sydney, New South Wales, Australia

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ORCID iDs
Tim Lambert http://orcid.org/0000-0003-2118-7081
Premala Sureshkumar http://orcid.org/0000-0003-3521-3391

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