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Complete List of Authors:	O'Neill, Braden; North York General Hospital, Family and Community Medicine; University of Toronto, Family and Community Medicine Kalia, Sumeet; University of Toronto, Department of Family and Community Medicine Aliarzadeh, Babak; University of Toronto, Department of Family and Community Medicine Sullivan, Frank; University of St. Andrews, ; North York General hospital, Moineddin, Rahim; University of Toronto, Family and Community Medicine Kelly, Martina; University of Calgary Faculty of Medicine, DEPARTMENT OF FAMILY MEDICINE Greiver, Michelle; University of Toronto, Family and Community Medicine
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Cardiovascular disease risk in patients with schizophrenia: retrospective cohort study of risk factor documentation and management in primary care electronic medical records

Braden O'Neill[1,2,3], Sumeet Kalia[2], Babak Aliarzadeh[2], Frank Sullivan[1,4], Rahim Moineddin[3], Martina Kelly[5], Michelle Greiver[1,2,3]

[1]Department of Family and Community Medicine, North York General Hospital, Toronto, Ontario, Canada

[2]University of Toronto Practice-Based Research Network, Toronto, Ontario, Canada

[3]Department of Family and Community Medicine, Faculty of Medicine, University of Toronto, Ontario, Canada

[4]School of Medicine, University of St. Andrews, Fife, Scotland

[5]Department of Family Medicine, University of Calgary, Alberta, Canada

Corresponding author:

Braden O'Neill

braden.oneill@nygh.on.ca

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There was no patient and public involvement in the design or conduct of this study.

Keywords: cardiovascular diseases; schizophrenia; primary health care; electronic health records; primary prevention

Word count: 2384

Abstract

Objectives: In order to address the substantial increased risk of cardiovascular disease among people with schizophrenia, it is necessary to identify the factors responsible for some of that increased risk. We analyzed the extent to which these risk factors were documented in primary care electronic medical records, and compared their documentation by patient and provider characteristics.

Design: Retrospective cohort study

Setting: Electronic medical record (EMR) database of the University of Toronto Practice Based Research Network (UTOPIAN) Data Safe Haven.

Participants: 197129 adults between 40-75 years of age; 4882 with schizophrenia and 192247 without.

Primary and secondary outcome measures: Documentation of cardiovascular disease risk factors (age, sex, smoking history, presence of diabetes, blood pressure, whether a patient is currently on medication to reduce blood pressure, total cholesterol, and high density lipoprotein cholesterol)

Results: Documentation of cardiovascular risk factors was more complete among people with schizophrenia (74.5% of whom had blood pressure documented at least once in the last two years versus 67.3% of those without, p >0.0001). Smoking status was not documented in 19.8% of those with schizophrenia and 20.8% of those without (p= 0.0843). Factors associated with improved documentation included older patients (OR for age 70-75 vs 45-49= 3.51, 95% CI 3.26-3.78), male patients (OR= 1.39, 95% CI 1.33-1.45), patients cared for by a female provider (OR= 1.52, 95% CI: 1.12-2.07), and increased number of encounters (OR for >=10 visits vs 3-5 visits= 1.53, 95% CI 1.46-1.60).

Conclusions: Documentation of cardiovascular risk factors was better among people with schizophrenia than without, although overall documentation was inadequate. Efforts to improve documentation of risk factors are warranted in order to facilitate improved management.

Article summary:

- This study analyzes data from the University of Toronto Practice-Based Research Network (UTOPIAN) Data Safe Haven, one of the world's largest primary care electronic medical record (EMR) databases
- It uses de-identified data from primary care charts to identify cardiovascular disease risk factors
- Strengths of the study include the sample size and the breadth of data included, from approximately 400 primary care clinics in Ontario, Canada
- Weaknesses include possible missing data resulting from the process of transferring data from primary care charts into a de-identified database, and the fact that the clinics included in the database are mainly urban and suburban academic clinics; these results may not necessarily be generalizable to all primary care settings

Introduction

High quality, comprehensive data are needed to understand health and how to improve it. Risk factors must be known and documented so that interventions can be planned and implemented.

One of the key challenges in primary care research has been the availability and quality of data. When Julian Tudor Hart conducted research on patients accessing care in his practice in Wales in the 1970s, it required laboriously searching through individual paper charts to collect necessary data.(1) Today, electronic medical records are widely used and can facilitate instant searches at the practice level as well as at local and national levels through databases that aggregate data from multiple practices. However, several studies have demonstrated that important data – for example, regarding cardiovascular risk factors such as smoking and whether someone has a diagnosis of hypertension – remain incomplete.(2,3)

People with serious mental illnesses, particularly those with schizophrenia, die 8 to 10 years earlier than those without these conditions.(4,5) This is primarily due to higher rates of cardiovascular disease.(5-7) Medications used to treat schizophrenia may worsen risk factors associated with cardiovascular disease, such as obesity or hyperglycemia; patients may face challenges with self-care or accessing appropriate medical care.(8) To date there is sparse evidence about how to improve physical health status in these patients; a recent review of 'collaborative care' where both physical and mental health are attended to for these patients did not find any evidence of reductions in cardiovascular disease risk.(9)

The primary prevention of cardiovascular disease includes addressing risk factors such as tobacco use and hypertension; these are commonly managed in primary care. This is particularly true for people with serious mental illness, who are seen more frequently by family physicians than by psychiatrists.(10) The prevalence of schizophrenia in the general adult population is 1-3%, making it a relatively common condition.(11,12) The prevalence and frequency of interaction strongly supports the important role played by family medicine in reducing the risk of cardiovascular disease for people with mental illness. To do this effectively it is necessary to understand what that risk is and what variables should be focused on.

As a first step in establishing patients' physical health status and identifying who to target for interventions to improve health, it is necessary to understand their health status . Whether data completeness concerns regarding cardiovascular disease risk are general to all patients or whether they are more pronounced amongst those with serious mental illness is unknown.

Our study objectives were: to describe documentation of cardiovascular disease risk factors (HDL, LDL, total cholesterol; blood pressure; smoking status) among patients with and without schizophrenia; and to explore patient and provider characteristics associated with sufficient documentation of these risk factors to calculate the Framingham risk score for patients with schizophrenia.

Methods

This is an observational retrospective cohort study design. We applied the STrengthening the Reporting of OBservational studies in Epidemiology checklist for reporting observational studies.(13) Ethics approval was obtained from the North York General Hospital Research Ethics Board, approval #18-0006.

Setting and data sources

We used data from the University of Toronto Practice-Based Research Network (UTOPIAN) Data Safe Haven, a primary care electronic medical record (EMR) database; data extracted as of April 1 2018 were used for this project.(14) The UTOPIAN Data Safe Haven contains EMR records from over 550 000 patients who access care in primary care practices in the Greater Toronto Area in Ontario, Canada. Physicians have consented to the provision of de-identified data, housed in a secure environment. These data are used for quality improvement and research purposes. The UTOPIAN database includes validated definitions for eight long-term conditions: osteoarthritis, diabetes, epilepsy, parkinsonism, dementia, hypertension, COPD, depression.(15,16) Neighbourhood level income quintiles are also available from patient residential postal codes using Statistics Canada's Postal Code Conversion Files.(17,18)

Study population

We included patients 40-75 years of age because Canadian guidelines recommend regular screening for cardiovascular disease (CVD) risk in this age range. There is no clear consensus on the recommended interval for screening, which varies between yearly to every 5 years.(19-21) Guidelines suggest yearly CVD risk assessment for patients with schizophrenia (22); however these are not routinely followed in primary care practice and this increased frequency is consensus-based and not necessarily supported by strong evidence. We therefore chose to look at a two year interval in which screening could have taken place, recognizing that there may be some patients for whom it may be appropriate to screen less often. The most commonly used CVD risk assessment tool in Canadian primary care practice is the Framingham risk calculator (23), which includes the following items: (i) age, (ii) sex, (iii) smoking history, (iv) presence of diabetes, (v) systolic blood pressure (SBP), (vi) whether a patient is currently on medication to reduce blood pressure, (vii) total cholesterol, and (viii) high density lipoprotein (HDL) cholesterol. This is a validated risk stratification tool that establishes a patient's risk of developing cardiovascular disease (CVD; including: coronary death, myocardial infarction, coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack, peripheral artery disease, heart failure) within the next 10 years. It is valid for patients 30 – 74 years of age.(23)

We identified patients that were 40-75 years of age as of March 31, 2018. We limited our cohort definition to those that had at least 3 primary care visits in the 2 year period between April 1, 2016 and March 31, 2018. To identify outcomes we looked at whether people had CVD risk factors as outlined above documented at least once in the above period. This definition ensured that we included patients likely to be routinely followed by the providers whose records are included in the database, and is consistent with our usual approach for studies using this database. We identified patients with schizophrenia using the same definition used in a previous study using the same database, using a combination of encounter diagnoses used for billing purposes as well as documentation of the condition in the electronic medical record.(24)

Statistical analysis

We compared the documentation of cardiovascular disease (CVD) risk factors included in the Framingham risk calculator between those with and without schizophrenia using a chi-square test. In particular, the CVD risk factors included: HDL cholesterol, SBP, total cholesterol measured in the last two years of study follow-up, and whether smoking status had ever been recorded. The relationship between the complete documentation of all Framingham elements was also assessed with respect to patient characteristics (age, sex, number of encounters in two years of study follow-up, diagnosis of schizophrenia, most recent body mass index in the last two years of study follow-up), provider characteristics (age, sex) and geographical characteristics (income quintiles, rurality). A mixed-effects multilevel logistic regression was used to estimate unadjusted and adjusted odds ratios for the complete documentation of all Framingham elements (i.e. calculable Framingham score). Providers were specified as a random effect in the regression model.

All statistical analyses were generated using SAS software, version 9.4 M4 (SAS Institute). A fixed nominal level of 0.05 was used to determine statistical significance in this study.

Results

Cohort generation

Data from 376 physicians practicing in 96 different clinic sites were included. In total, 197,309 patients were identified with age between 40-75 years old (as of March 31, 2018), recorded sex and had at least 3 visits in the two years of interest (Figure 1). Out of 197,309 patients, 83,064 patients (40.4%) had adequate data to calculate a Framingham risk score using the most recent data available for HDL, SBP, and total cholesterol in the last 2 years and smoking status ever recorded. Of these, 4880 patients met the definition of schizophrenia and 2130 (43.8%) of these patients with schizophrenia had complete documentation to calculate the Framingham risk score.

FIGURE 1 HERE

Individual Framingham Data Elements

We compared the presence of individual Framingham elements between 4882 patients with schizophrenia and 192247 patients without, over a two year look back window (April 1, 2016 – March 31, 2018) (Table 1). Framingham elements were documented more completely among those with schizophrenia: 25.5% of those with schizophrenia and 32.7% of those without had no documented blood pressure readings over the last two years ($p < 0.0001$). 39.2% of those with schizophrenia and 42.1% of those without did not have any cholesterol readings ($p < 0.0001$). There was no difference in documentation of smoking status between the two groups ($p = 0.084$), with documentation missing in approximately 20% of all charts.

TABLE 1 HERE

Patient, provider and geographical characteristics as predictors of calculable Framingham score

Overall, patients with schizophrenia appeared to have decreased adjusted odds for the complete documentation of Framingham score as compared to patients without schizophrenia, but this was not statistically significant (OR = 0.90, 95% CI 0.79 – 1.01, p-value=0.07) (Figure 2). Individual patient characteristics between those who had complete documentation of Framingham score factors and those who did not are in Table 2. The adjusted odds for the complete documentation of Framingham factors increased with respect to the patient's age (70-75 years vs 40-44 years OR = 3.51, 95% CI 3.26 – 3.78). Male patients had increased adjusted odds of calculable Framingham score as compared to female patients (male vs. female OR = 1.39, 95% CI 1.33 – 1.45). An increase in the BMI level was associated with an increase in adjusted odds for calculable Framingham score (Obese class III vs. Underweight, OR = 2.00, 95% CI 1.66 – 2.43) (Table 3). An increase in the total number of encounters also led to increased adjusted odds for the complete documentation of Framingham factors (more than 10 visits vs. 3-5 visits in last two years OR = 1.53, 95% CI 1.46 – 1.60).

TABLE 2 HERE

Patients residing in urban regions had higher adjusted odds for the complete documentation of Framingham factors as compared to patients residing in rural regions (OR=1.08, 95% CI: 1.02 – 1.16). However, no significant differences in adjusted odds ratios were detected across the five levels of income quintiles (1 vs 5, OR=0.97, 95% CI: 0.91-1.03, p-value=0.38). Female physicians had increased adjusted odds for the complete documentation of Framingham factors as compared to male physicians (OR=1.52, 95% CI: 1.12 – 2.07). However, provider age did not contribute to increased or decreased adjusted odds for calculable Framingham score (29-39 years vs. 60+ years, OR=1.49, 95% CI: 0.98 – 2.26, p-value=0.06).

TABLE 3 HERE

Discussion

In this study of primary care electronic medical records from the University of Toronto Practice-Based Research Network, we found better documentation of cardiovascular risk factors among people with schizophrenia as opposed to those without the condition. However, overall documentation was inadequate.

Other studies on preventive health for people with schizophrenia, such as those addressing cancer screening, have found lower rates of preventive care when compared with the general population.(25) We actually found more complete documentation of some risk factors among people with schizophrenia when compared to those without, such as blood pressure. There are various recommendations for frequency of cardiovascular disease risk screening in the general population; Allan et al suggested every 5 years for men over 40 and women over 50.(21) More complete documentation of risk factors would be expected based on guidelines suggesting more frequent cardiovascular disease risk assessment among people who are on antipsychotic medication.(12) To some extent the present study demonstrates a promising finding, suggesting that patients with schizophrenia are receiving at least as good care from this perspective as those without the condition. It is, however, quite concerning that there are substantial gaps in documentation of particular risk factors such as smoking cessation. Nearly 20% of patients did not have smoking status documented in the chart. We suggest that if it is not documented, then it

is extremely unlikely that smoking cessation has been addressed at a primary care visit. Smoking is highly prevalent among people with schizophrenia; Canadian estimates range from 47% (26) and 78% (27). There are many effective interventions to support patients with schizophrenia to stop smoking.(28) It is therefore essential to document smoking status for all patients with schizophrenia and to make smoking cessation a priority.

We found several factors associated with what we assessed to be 'appropriate' documentation of risk factors sufficient for cardiovascular risk assessment.

Limitations of this study include the use of EMR data, which is known to have deficiencies around data quality and completeness.(29,30) UTOPIAN, as part of the Canadian Primary Care Sentinel Surveillance Network, is disproportionally comprised of more providers in academic practices and has an older population than the Canadian average.(31) These findings therefore may not be generalizable to all Canadian primary care settings. UTOPIAN contains data from multiple EMR vendors and as a consequence there is the possibility that some data may be missing as a result of errors in database formation; these data are extracted with the best available approaches and regular data cleaning attempts to minimize these errors. Other studies have found some deficiencies, particularly related to documentation of health conditions, in EMR data in the Canadian setting.(3) There are no Canadian national standards for necessary elements of EMR documentation in primary care. In Ontario, laboratory results enter most physicians' EMRs through the Ontario Laboratory Information System (32) which is an automatic process, reducing the extent to which documentation is incomplete because of provider error. Our focus on 'documentation' in this study is as a result of the practical principle that if something is not documented, it cannot be acted on; therefore data documentation and completeness are being taken as a proxy for their consideration in clinical decision-making. It is not possible from the data considered in this study to ascertain whether a provider has attempted to intervene towards smoking cessation, or whether someone has addressed blood pressure management. There are other available risk stratification approaches available both for the general population [such as QRISK2 (33)] and specifically for people with serious mental illness [PRIMROSE (34)]. We chose to focus on the Framingham assessment because it is the most commonly used in Canadian primary care and therefore would be most relevant to the study context.

In summary, we found slightly more complete documentation of cardiovascular risk factors and their management among people with schizophrenia as opposed to those without this condition. However, overall documentation of these risk factors remains incomplete. Adequate cardiovascular disease risk assessment is essential to identifying and addressing risk factors, particularly among people with schizophrenia who have much higher mortality from cardiovascular disease (and other conditions) than the general public. Efforts should be undertaken in primary care to improve data completeness and CVD risk assessment and management.

Conflicts of interest: All authors report that they have no conflicts of interest to declare.

Data statement: Data from this study are held by the University of Toronto Practice-Based Research Network; ethics approval for this study does not allow unrestricted public access to the data. Please contact the corresponding author for information on how to access.

Author statement: BO, SK, BA, FS, RM, MK, MG contributed to the initial conception of the study. BO, SK, BA, RM made substantial contributions to the statistical methodology, analysis and data interpretation. BO and SK wrote the first draft of the manuscript. BO, SK, BA, FS, MK, MG provided substantial revisions to the manuscript.

References

1. Hart JT. The inverse care law. Lancet. 1971 Feb 27;297(7696):405-12.

2. Greiver M, Aliarzadeh B, Meaney C, Moineddin R, Southgate CA, Barber DT, White DG, Martin KB, Ikhtiar T, Williamson T. Are we asking patients if they smoke? Missing information on tobacco use in Canadian electronic medical records. Am J Prevent Med. 2015 Aug 31;49(2):264-8.

3. Singer A, Yakubovich S, Kroeker AL, Dufault B, Duarte R, Katz A. Data quality of electronic medical records in Manitoba: do problem lists accurately reflect chronic disease billing diagnoses? J Am Med Inform Assoc. 2016 Apr 23;23(6):1107-12.

4. Walker ER, McGee RE, Druss BG. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. JAMA Psych. 2015 Apr 1;72(4):334-41.

5. Gatov E, Rosella L, Chiu M, Kurdyak P. Trends in standardized mortality among individuals with schizophrenia, 1993–2012: a population-based, repeated cross-sectional study. CMAJ 2017;189:e1177-87.

6. Hennekens CH, Hennekens AR, Hollar D, Casey DE. Schizophrenia and increased risks of cardiovascular disease. Am Heart J. 2005 Dec 31;150(6):1115-21.

7. Goldstein BI, Fagiolini A, Houck P, Kupfer DJ. Cardiovascular disease and hypertension among adults with bipolar I disorder in the United States. Bipolar Disor. 2009 Sep 1;11(6):657-62.

8. De Hert M, Dekker JM, Wood D, Kahl KG, Holt RI, Möller HJ. Cardiovascular disease and diabetes in people with severe mental illness position statement from the European Psychiatric Association (EPA), supported by the European Association for the Study of Diabetes (EASD) and the European Society of Cardiology (ESC). European Psych. 2009 Sep 1;24(6):412-24.

9. Bullock HL, Waddell K, & Wilson MG. Rapid synthesis: Identifying and assessing core components of collaborative-care models for treating mental and physical health conditions. Hamilton, Canada: McMaster Health Forum, 31 March 2017.

10. Slomp M, Bland R, Patterson S, Whittaker L. Three-year physician treated prevalence rate of mental disorders in Alberta. Can J Psych. 2009 Mar;54(3):199-203.

11. Government of Canada [Internet]: Ottawa, ON. Chapter 3: Schizophrenia – A report on mental illnesses in Canada. 2012. [cited 31 January 2018] Available from: https://www.canada.ca/en/public-health/services/reports-publications/report-on-mental-illnesses-canada/schizophrenia.htm

12. Saha S, Chant D, Welham J, McGrath J. A systematic review of the prevalence of schizophrenia. PLoS medicine. 2005 May 31;2(5):e141.

13. von Elm E , Altman DG , Egger M , et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Surg 2014;12:1495–9.doi:10.1016/j.ijsu.2014.07.013

14. University of Toronto Department of Family and Community Medicine [Internet]. University of Toronto Practice Based Research Network (UTOPIAN). [cited 31 January 2018] Available from: https://www.dfcm.utoronto.ca/landing-page/utopian

15. CPCSSN Team, Case Definitions: Canadian Primary Care Sentinel Surveillance Network (CPCSSN), Version 2. July 16, 2019. URL: http://cpcssn.ca/research-resources/cpcssn-case-definitions-v2

16. Williamson T, Green ME, Birtwhistle R, Khan S, Garies S, Wong ST, Natarajan N, Manca D, Drummond N. Validating the 8 CPCSSN case definitions for chronic disease surveillance in a primary care database of electronic health records. Ann Fam Med. 2014 Jul 1;12(4):367-72.

17. Wilkins R. Use of postal codes and addresses in the analysis of health data. Health Reports. 1993;5(2):157–77. pmid:8292756

18. Pampalon R, Hamel D, Gamache P, Raymond G. A deprivation index for health planning in Canada. Chronic Dis Can. 2009 Jan 1;29(4):178–91. pmid:1980468

19. Genest J, McPherson R, Frohlich J, Anderson T, Campbell N, Carpentier A, Couture P, Dufour R, Fodor G, Francis GA, Grover S. 2009 Canadian Cardiovascular Society/Canadian guidelines for the diagnosis and treatment of dyslipidemia and prevention of cardiovascular disease in the adult–2009 recommendations. Canadian Journal of Cardiology. 2009 Oct 1;25(10):567-79.

20. Anderson TJ, Grégoire J, Hegele RA, Couture P, Mancini GJ, McPherson R, Francis GA, Poirier P, Lau DC, Grover S, Genest Jr J. 2012 update of the Canadian Cardiovascular Society guidelines for the diagnosis and treatment of dyslipidemia for the prevention of

cardiovascular disease in the adult. Canadian Journal of Cardiology. 2013 Feb 1;29(2):151-67.

21. Allan GM, Lindblad AJ, Comeau A, Coppola J, Hudson B, Mannarino M, McMinis C, Padwal R, Schelstraete C, Zarnke K, Garrison S. Simplified lipid guidelines: Prevention and management of cardiovascular disease in primary care. Canadian Family Physician. 2015 Oct 1;61(10):857-67.

22. Pringsheim T, Kelly M, Urness D, Teehan M, Ismail Z, Gardner D. Physical Health and Drug Safety in individuals with schizophrenia. Can J Psych. 2017 Sep;62(9):673-83.

23. D'Agostino RB, Vasan RS, Pencina MJ, Wolf PA, Cobain M, Massaro JM, Kannel WB. General cardiovascular risk profile for use in primary care. Circulation. 2008 Feb 12;117(6):743-53.

24. O'Neill B, Kalia S, Aliarzadeh B, Moineddin R, Fung WL, Sullivan F, Maloul A, Bernard S, Greiver M. Agreement between primary care and hospital diagnosis of schizophrenia and bipolar disorder: A cross-sectional, observational study using record linkage. PLOS One. 2019 Jan 7;14(1):e0210214.

25. Martens PJ, Chochinov HM, Prior HJ, Fransoo R, Burland E, Team TN. Are cervical cancer screening rates different for women with schizophrenia? A Manitoba population-based study. Schizophrenia research. 2009 Aug 1;113(1):101-6.

26. Johnson JL, Ratner PA, Malchy LA, Okoli CT, Procyshyn RM, Bottorff JL, Groening M, Schultz A, Osborne M. Gender-specific profiles of tobacco use among non-institutionalized people with serious mental illness. BMC psychiatry. 2010 Dec;10(1):101.

27. Gerber, G.J., Krupa, T., Eastabrook, S., Gargaro, J., 2003. Substance use among persons with serious mental illness in eastern Ontario. Can J Community Ment Health 22, 113 – 128.

28. Tsoi DT, Porwal M, Webster AC. Interventions for smoking cessation and reduction in individuals with schizophrenia. Cochrane Database Sys Rev. 2013(2).

29. Weiskopf NG, Weng C. Methods and dimensions of electronic health record data quality assessment: enabling reuse for clinical research. J Am Inform Assoc. 2013 Jan 1;20(1):144-51.

30. Birtwhistle R, Williamson T. Primary care electronic medical records: a new data source for research in Canada. CMAJ. 2015 Mar 3;187(4):239-40.

31. Queenan JA, Williamson T, Khan S, Drummond N, Garies S, Morkem R, Birtwhistle R. Representativeness of patients and providers in the Canadian Primary Care Sentinel Surveillance Network: a cross-sectional study. CMAJ Open. 2016 Jan;4(1):E28.

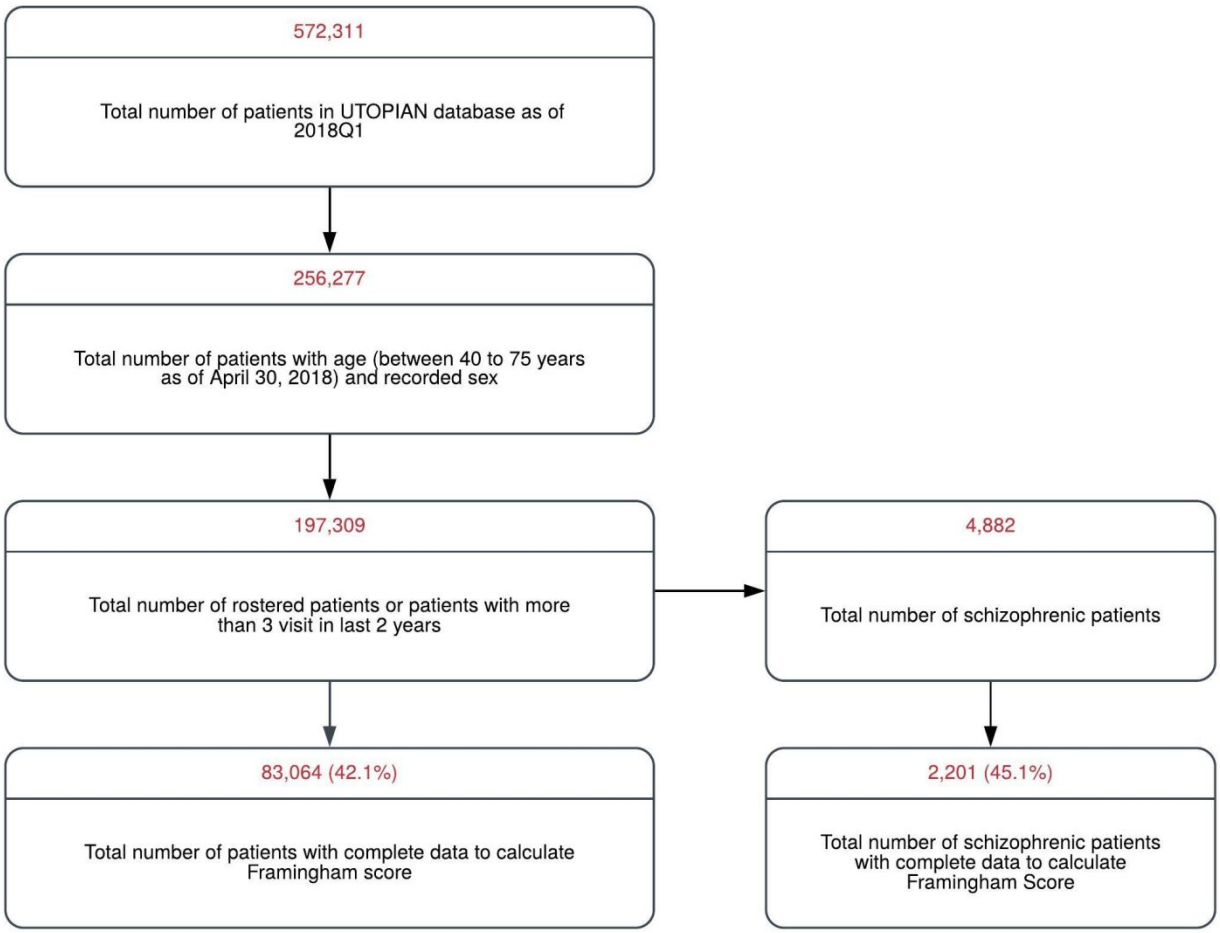
32. Ontario Laboratory Information System. eHealth Ontario. https://www.ehealthontario.on.ca/en/for-healthcare-professionals/ontario-laboratories-information-system-olis

33. Hippisley-Cox J, Coupland C, Vinogradova Y, Robson J, Brindle P. Performance of the QRISK cardiovascular risk prediction algorithm in an independent UK sample of patients from general practice: a validation study. Heart. 2008 Jan 1;94(1):34-9.

34. Zomer E, Osborn D, Nazareth I, Blackburn R, Burton A, Hardoon S, Holt RI, King M, Marston L, Morris S, Omar R. Effectiveness and cost-effectiveness of a cardiovascular risk prediction algorithm for people with severe mental illness (PRIMROSE). BMJ open. 2017 Sep 1;7(9):e018181.

Figures and tables

Figure 1. Cohort generation



513 Table 1. Distribution of Framingham factors among patients with and without schizophrenia

	Schizophrenia				
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	P-values*
Age range (years)					-
40-44 years	28574	14.8%	700	14.3%	
45-49 years	29137	15.1%	753	15.4%	
50-54 years	30939	16.1%	784	16.1%	
55-59 years	31790	16.5%	832	17.0%	
60-64 years	27061	14.1%	707	14.5%	
65-69 years	22430	11.7%	588	12.0%	
70-75 years	22496	11.7%	518	10.6%	
Sex (M/F)					-
Female	106841	55.5%	2539	52.0%	
Male	85586	44.5%	2343	48.0%	
HDL level (mmol/L)					<0.0001
Missing	79437	41.3%	1842	37.7%	
0-0.89 mmol/L	8565	4.5%	375	7.7%	
0.9-1.19 mmol/L	27925	14.5%	866	17.7%	
1.2-1.29 mmol/L	11006	5.7%	272	5.6%	
1.3-1.59 mmol/L	28313	14.7%	703	14.4%	
1.60+ mmol/L	37181	19.3%	824	16.9%	
Total cholesterol (mmol/L)					<0.0001
Missing	81073	42.1%	1916	39.2%	
0-4.09 mmol/L	25388	13.2%	865	17.7%	
4.1-5.19 mmol/L	39801	20.7%	1068	21.9%	
5.2-6.19 mmol/L	30009	15.6%	663	13.6%	
6.2-7.19 mmol/L	11225	5.8%	252	5.2%	
7.2+ mmol/L	4931	2.6%	118	2.4%	
Systolic blood pressure (mmHg)					<0.0001
Missing	62934	32.7%	1245	25.5%	
120 mmHg or less	42293	22.0%	1445	29.6%	
120-129 mmHg	36752	19.1%	940	19.3%	
130-139 mmHg	28764	14.9%	725	14.9%	
140-149 mmHg	14043	7.3%	350	7.2%	
150-159 mmHg	5752	3.0%	124	2.5%	
160 mmHg or more	1889	1.0%	53	1.1%	
Smoking Status					0.0843
Missing	40109	20.8%	968	19.8%	
Non-smoker	125796	65.4%	2633	53.9%	
Smoker	26522	13.8%	1281	26.2%	
Type II Diabetes Mellitus					-
No	168151	87.4%	3953	81.0%	
Yes	24276	12.6%	929	19.0%	
Anti-Hypertensive medication					-
No	140415	73.0%	3486	71.4%	

	Schizophrenia				
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	P-values*
Yes	52012	27.0%	1396	28.6%	
Total	192427	100.0%	4882	100.0%	-

*p-values compare the proportion of missing data and non-missing data with respect to schizophrenia (using chi-square test).

Table 2. Calculable Framingham score with respect to individual Framingham factors

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Age range (years)					
40-44 years	21922	74.9%	7352	25.1%	29274
45-49 years	20367	68.1%	9523	31.9%	29890
50-54 years	19024	60.0%	12699	40.0%	31723
55-59 years	18106	55.5%	14516	44.5%	32622
60-64 years	14143	50.9%	13625	49.1%	27768
65-69 years	10565	45.9%	12453	54.1%	23018
70-75 years	10118	44.0%	12896	56.0%	23014
Sex (M/F)					
Female	63352	57.9%	46028	42.1%	109380
Male	50893	57.9%	37036	42.1%	87929
HDL level (mmol/L)					
Missing	81279	100.0%	.	.	81279
0-0.89 mmol/L	2408	26.9%	6532	73.1%	8940
0.9-1.19 mmol/L	7973	27.7%	20818	72.3%	28791
1.2-1.29 mmol/L	3092	27.4%	8186	72.6%	11278
1.3-1.59 mmol/L	8069	27.8%	20947	72.2%	29016
1.60+ mmol/L	11424	30.1%	26581	69.9%	38005
Total cholesterol (mmol/L)					
Missing	82989	100.0%	.	.	82989
0-4.09 mmol/L	6336	24.1%	19917	75.9%	26253
4.1-5.19 mmol/L	11400	27.9%	29469	72.1%	40869
5.2-6.19 mmol/L	8686	28.3%	21986	71.7%	30672
6.2-7.19 mmol/L	3167	27.6%	8310	72.4%	11477
7.2+ mmol/L	1667	33.0%	3382	67.0%	5049
Systolic blood pressure (mmHg)					
Missing	62874	98.0%	1305	2.0%	64179
120 mmHg or less	18185	41.6%	25553	58.4%	43738
120-129 mmHg	14338	38.0%	23354	62.0%	37692
130-139 mmHg	10431	35.4%	19058	64.6%	29489
140-149 mmHg	5359	37.2%	9034	62.8%	14393
150-159 mmHg	2270	38.6%	3606	61.4%	5876
160 mmHg or more	788	40.6%	1154	59.4%	1942

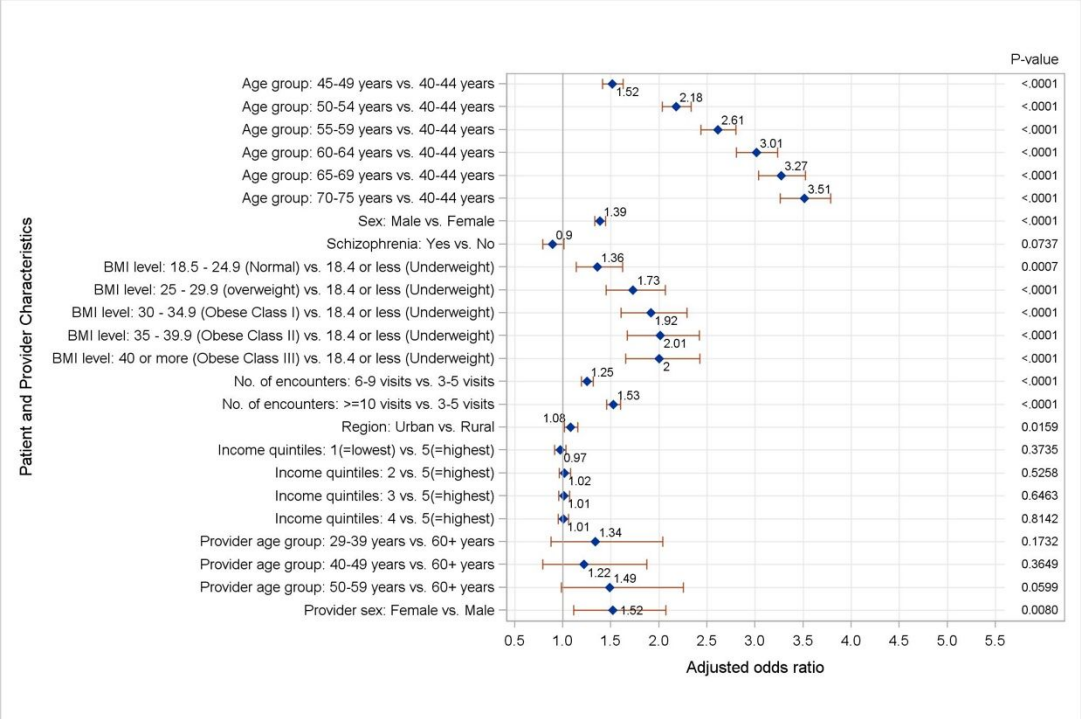
	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Smoking Status					
Missing	41077	100.0%	.	.	41077
Non-smoker	58342	45.4%	70087	54.6%	128429
Smoker	14826	53.3%	12977	46.7%	27803
Type II Diabetes Mellitus					
No	105354	61.2%	66750	38.8%	172104
Yes	8891	35.3%	16314	64.7%	25205
Anti-Hypertensive medication					
No	92342	64.2%	51559	35.8%	143901
Yes	21903	41.0%	31505	59.0%	53408
Total	114245	57.9%	83064	42.1%	197309

Table 3: Calculable Framingham score with respect to patient, provider and geographical characteristics

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Schizophrenia					
No	111564	58.0%	80863	42.0%	192427
Yes	2681	54.9%	2201	45.1%	4882
BMI level (Kg/m²)					
Missing	84398	77.7%	24206	22.3%	108604
18.4 or less (Underweight)	378	42.9%	503	57.1%	881
18.5 - 24.9 (Normal)	9191	38.6%	14619	61.4%	23810
25 - 29.9 (overweight)	10622	32.6%	21935	67.4%	32557
30 - 34.9 (Obese Class I)	5847	30.5%	13331	69.5%	19178
35 - 39.9 (Obese Class II)	2306	30.4%	5279	69.6%	7585
40 or more (Obese Class III)	1503	32.0%	3191	68.0%	4694
No. of encounters					
Missing	42673	86.0%	6952	14.0%	49625
3-5 visits	25915	58.6%	18311	41.4%	44226
6-9 visits	19861	48.8%	20830	51.2%	40691
>=10 visits	25796	41.1%	36971	58.9%	62767
Income Quintiles					
Missing	14795	58.9%	10326	41.1%	25121
1	15851	58.7%	11162	41.3%	27013
2	15883	58.3%	11348	41.7%	27231
3	17118	58.2%	12281	41.8%	29399
4	20810	57.8%	15221	42.2%	36031
5	29788	56.7%	22726	43.3%	52514

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Region					
Missing	2284	73.6%	819	26.4%	3103
Rural	11590	59.7%	7833	40.3%	19423
Urban	100371	57.4%	74412	42.6%	174783
Provider age					
Missing	5880	50.6%	5741	49.4%	11621
29-39 years	21926	54.1%	18618	45.9%	40544
40-49 years	23203	58.4%	16550	41.6%	39753
50-59 years	29127	55.9%	22943	44.1%	52070
60+ years	34109	64.0%	19212	36.0%	53321
Provider sex					
Female	52950	54.2%	44655	45.8%	97605
Male	61295	61.5%	38409	38.5%	99704
Total	114245	57.9%	83064	42.1%	197309

Figure 2: Adjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model



Supplementary tables

Table S1: Unadjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

Unadjusted odds ratio						
Characteristics	**Index group**	**Reference group**	**Odds Ratio**	**Lower limit**	**Upper limit**	**P-value**
Age	45-49 years	40-44 years	1.49	1.434	1.547	<.0001
Age	50-54 years	40-44 years	2.24	2.162	2.329	<.0001
Age	55-59 years	40-44 years	2.78	2.681	2.887	<.0001
Age	60-64 years	40-44 years	3.50	3.371	3.640	<.0001
Age	65-69 years	40-44 years	4.44	4.266	4.626	<.0001
Age	70-75 years	40-44 years	5.05	4.850	5.262	<.0001
Sex	Male	Female	1.07	1.048	1.092	<.0001
Schizophrenia	Yes	No	1.25	1.173	1.327	<.0001
BMI level	18.5 - 24.9 (Normal)	18.4 or less (Underweight)	1.25	1.077	1.450	0.0034
BMI level	25 - 29.9 (overweight)	18.4 or less (Underweight)	1.77	1.522	2.047	<.0001
BMI level	30 - 34.9 (Obese Class I)	18.4 or less (Underweight)	2.03	1.749	2.361	<.0001
BMI level	35 - 39.9 (Obese Class II)	18.4 or less (Underweight)	2.09	1.784	2.437	<.0001
BMI level	40 or more (Obese Class III)	18.4 or less (Underweight)	1.99	1.695	2.342	<.0001
No. of encounters	6-9 visits	3-5 visits	1.60	1.558	1.653	<.0001
No. of encounters	>=10 visits	3-5 visits	2.39	2.320	2.455	<.0001
Region	Urban	Rural	1.06	1.026	1.105	0.0008
Income quintiles	1(=lowest)	5(=highest)	1.04	1.004	1.075	0.0285
Income quintiles	2	5(=highest)	1.05	1.020	1.089	0.0017
Income quintiles	3	5(=highest)	1.04	1.005	1.071	0.0217
Income quintiles	4	5(=highest)	1.00	0.974	1.034	0.8188
Provider age	29-39 years	60+ years	1.69	1.225	2.334	0.0014
Provider age	40-49 years	60+ years	1.36	0.972	1.914	0.0725
Provider age	50-59 years	60+ years	1.38	0.986	1.944	0.0600
Provider sex	Female	Male	1.61	1.296	2.012	<.0001

Table S2: Adjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

Adjusted odds ratio						
Characteristics	**Index group**	**Reference group**	**Odds Ratio**	**Lower limit**	**Upper limit**	**P-value**
Age group	45-49 years	40-44 years	1.52	1.41	1.63	<.0001
Age group	50-54 years	40-44 years	2.18	2.03	2.33	<.0001
Age group	55-59 years	40-44 years	2.61	2.44	2.80	<.0001
Age group	60-64 years	40-44 years	3.01	2.81	3.24	<.0001
Age group	65-69 years	40-44 years	3.27	3.04	3.52	<.0001
Age group	70-75 years	40-44 years	3.51	3.26	3.78	<.0001
Sex	Male	Female	1.39	1.33	1.45	<.0001
Schizophrenia	Yes	No	0.90	0.79	1.01	0.0737
BMI level	18.5 - 24.9 (Normal)	18.4 or less (Underweight)	1.36	1.14	1.62	0.0007
BMI level	25 - 29.9 (overweight)	18.4 or less (Underweight)	1.73	1.45	2.07	<.0001
BMI level	30 - 34.9 (Obese Class I)	18.4 or less (Underweight)	1.92	1.60	2.29	<.0001
BMI level	35 - 39.9 (Obese Class II)	18.4 or less (Underweight)	2.01	1.67	2.42	<.0001
BMI level	40 or more (Obese Class III)	18.4 or less (Underweight)	2.00	1.66	2.43	<.0001
No. of encounters	6-9 visits	3-5 visits	1.25	1.19	1.31	<.0001
No. of encounters	>=10 visits	3-5 visits	1.53	1.46	1.60	<.0001
Region	Urban	Rural	1.08	1.02	1.16	0.0159
Income quintiles	1(=lowest)	5(=highest)	0.97	0.91	1.03	0.3735
Income quintiles	2	5(=highest)	1.02	0.96	1.08	0.5258
Income quintiles	3	5(=highest)	1.01	0.96	1.07	0.6463
Income quintiles	4	5(=highest)	1.01	0.96	1.06	0.8142
Provider age group	29-39 years	60+ years	1.34	0.88	2.04	0.1732
Provider age group	40-49 years	60+ years	1.22	0.79	1.88	0.3649
Provider age group	50-59 years	60+ years	1.49	0.98	2.26	0.0599
Provider sex	Female	Male	1.52	1.12	2.07	0.0080

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

Cardiovascular disease risk in patients with schizophrenia: retrospective cohort study of risk factor documentation and management in primary care electronic medical records

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7/8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	

Outcome data	15*	Report numbers of outcome events or summary measures over time	8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Cardiovascular risk factor documentation and management in primary care electronic medical records among people with schizophrenia: retrospective cohort study

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Cardiovascular risk factor documentation and management in primary care electronic medical records among people with schizophrenia: retrospective cohort study

Braden O'Neill[1,2,3], Sumeet Kalia[2], Babak Aliarzadeh[2], Frank Sullivan[1,4], Rahim Moineddin[3], Martina Kelly[5], Michelle Greiver[1,2,3]

[1]Department of Family and Community Medicine, North York General Hospital, Toronto, Ontario, Canada

[2]University of Toronto Practice-Based Research Network, Toronto, Ontario, Canada

[3]Department of Family and Community Medicine, Faculty of Medicine, University of Toronto, Ontario, Canada

[4]School of Medicine, University of St. Andrews, Fife, Scotland

[5]Department of Family Medicine, University of Calgary, Alberta, Canada

Corresponding author:

Braden O'Neill

braden.oneill@nygh.on.ca

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There was no patient and public involvement in the design or conduct of this study.

Keywords: cardiovascular diseases; schizophrenia; primary health care; electronic health records; primary prevention

Word count: 2384

Abstract

Objectives: In order to address the substantial increased risk of cardiovascular disease among people with schizophrenia, it is necessary to identify the factors responsible for some of that increased risk. We analyzed the extent to which these risk factors were documented in primary care electronic medical records, and compared their documentation by patient and provider characteristics.

Design: Retrospective cohort study

Setting: Electronic medical record (EMR) database of the University of Toronto Practice Based Research Network (UTOPIAN) Data Safe Haven.

Participants: 197129 adults between 40-75 years of age; 4882 with schizophrenia and 192247 without.

Primary and secondary outcome measures: Documentation of cardiovascular disease risk factors (age, sex, smoking history, presence of diabetes, blood pressure, whether a patient is currently on medication to reduce blood pressure, total cholesterol, and high density lipoprotein cholesterol)

Results: Documentation of cardiovascular risk factors was more complete among people with schizophrenia (74.5% of whom had blood pressure documented at least once in the last two years versus 67.3% of those without, p >0.0001). Smoking status was not documented in 19.8% of those with schizophrenia and 20.8% of those without (p= 0.0843). Factors associated with improved documentation included older patients (OR for age 70-75 vs 45-49= 3.51, 95% CI 3.26-3.78), male patients (OR= 1.39, 95% CI 1.33-1.45), patients cared for by a female provider (OR= 1.52, 95% CI: 1.12-2.07), and increased number of encounters (OR for >=10 visits vs 3-5 visits= 1.53, 95% CI 1.46-1.60).

Conclusions: Documentation of cardiovascular risk factors was better among people with schizophrenia than without, although overall documentation was inadequate. Efforts to improve documentation of risk factors are warranted in order to facilitate improved management.

Article summary:

- This study analyzes data from the University of Toronto Practice-Based Research Network (UTOPIAN) Data Safe Haven, one of the world's largest primary care electronic medical record (EMR) databases
- It uses de-identified data from primary care charts to identify cardiovascular disease risk factors
- Strengths of the study include the sample size and the breadth of data included, from approximately 400 primary care clinics in Ontario, Canada
- Weaknesses include possible missing data resulting from the process of transferring data from primary care charts into a de-identified database, and the fact that the clinics included in the database are mainly urban and suburban academic clinics; these results may not necessarily be generalizable to all primary care settings

Introduction

High quality, comprehensive data are needed to understand health and how to improve it. Risk factors must be known and documented so that interventions can be planned and implemented.

One of the key challenges in primary care research has been the availability and quality of data. When Julian Tudor Hart conducted research on patients accessing care in his practice in Wales in the 1970s, it required laboriously searching through individual paper charts to collect necessary data.(1) Today, electronic medical records are widely used and can facilitate instant searches at the practice level as well as at local and national levels through databases that aggregate data from multiple practices. However, several studies have demonstrated that important data – for example, regarding cardiovascular risk factors such as smoking and whether someone has a diagnosis of hypertension – remain incomplete.(2,3)

People with serious mental illnesses, particularly those with schizophrenia, die 8 to 10 years earlier than those without these conditions.(4,5) This is primarily due to higher rates of cardiovascular disease.(5-7) While the long-term metabolic effects of antipsychotic medications used to treat schizophrenia are unclear, their use is associated with increased weight and blood glucose.(8,9) Patients may also face challenges with self-care or accessing appropriate medical care.(10) To date there is sparse evidence about how to improve physical health status in these patients; a recent review of 'collaborative care' where both physical and mental health are attended to for these patients did not find any evidence of reductions in cardiovascular disease risk.(11)

The primary prevention of cardiovascular disease includes addressing risk factors such as tobacco use and hypertension; these are commonly managed in primary care. This is particularly true for people with serious mental illness, who are seen more frequently by family physicians than by psychiatrists.(12) The prevalence of schizophrenia in the general adult population is 1-3%, making it a relatively common condition.(13,14) The prevalence and frequency of interaction strongly supports the important role played by family medicine in reducing the risk of

cardiovascular disease for people with mental illness. To do this effectively it is necessary to understand what that risk is and what variables should be focused on.

As a first step in establishing patients' physical health status and identifying who to target for interventions to improve health, it is necessary to understand their health status. Whether data completeness concerns regarding cardiovascular disease risk are general to all patients or whether they are more pronounced amongst those with serious mental illness is unknown.

Our study objectives were: to describe documentation of cardiovascular disease risk factors (HDL, LDL, total cholesterol; blood pressure; smoking status) among patients with and without schizophrenia; and to explore patient and provider characteristics associated with sufficient documentation of these risk factors to calculate the Framingham risk score for patients with schizophrenia.

Methods

This is an observational retrospective cohort study design. We applied the STrengthening the Reporting of OBservational studies in Epidemiology checklist for reporting observational studies.(15) Ethics approval was obtained from the North York General Hospital Research Ethics Board, approval #18-0006.

Setting and data sources

We used data from the University of Toronto Practice-Based Research Network (UTOPIAN) Data Safe Haven, a primary care electronic medical record (EMR) database; data extracted as of April 1 2018 were used for this project.(16) The UTOPIAN Data Safe Haven contains EMR records from over 550 000 patients who access care in primary care practices in the Greater Toronto Area in Ontario, Canada. Physicians have consented to the provision of de-identified data, housed in a secure environment. These data are used for quality improvement and research purposes. The UTOPIAN database includes validated definitions for eight long-term conditions: osteoarthritis, diabetes, epilepsy, parkinsonism, dementia, hypertension, COPD,

depression.(17,18) Neighbourhood level income quintiles are also available from patient residential postal codes using Statistics Canada's Postal Code Conversion Files.(19,20)

Study population

We included patients 40-75 years of age because Canadian guidelines recommend regular screening for cardiovascular disease (CVD) risk in this age range. There is no clear consensus on the recommended interval for screening, which varies between yearly to every 5 years.(21-23) Guidelines suggest yearly CVD risk assessment for patients with schizophrenia (24); however these are not routinely followed in primary care practice and this increased frequency is consensus-based and not necessarily supported by strong evidence. We therefore chose to look at a two year interval in which screening could have taken place, recognizing that there may be some patients for whom it may be appropriate to screen less often. The most commonly used CVD risk assessment tool in Canadian primary care practice is the Framingham risk calculator (25), which includes the following items: (i) age, (ii) sex, (iii) smoking history, (iv) presence of diabetes, (v) systolic blood pressure (SBP), (vi) whether a patient is currently on medication to reduce blood pressure, (vii) total cholesterol, and (viii) high density lipoprotein (HDL) cholesterol. This is a validated risk stratification tool that establishes a patient's risk of developing cardiovascular disease (CVD; including: coronary death, myocardial infarction, coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack, peripheral artery disease, heart failure) within the next 10 years. It is valid for patients 30 – 74 years of age.(25)

We identified patients that were 40-75 years of age as of March 31, 2018. We limited our cohort definition to those that had at least 3 primary care visits in the 2 year period between April 1, 2016 and March 31, 2018. To identify outcomes we looked at whether people had CVD risk factors as outlined above documented at least once in the above period. This definition ensured that we included patients likely to be routinely followed by the providers whose records are included in the database, and is consistent with our usual approach for studies using this database. We identified patients with schizophrenia using the same definition used in a previous

study using the same database, using a combination of encounter diagnoses used for billing purposes as well as documentation of the condition in the electronic medical record.(26)

Statistical analysis

We compared the documentation of cardiovascular disease (CVD) risk factors included in the Framingham risk calculator between those with and without schizophrenia using a chi-square test. P-values derived from multiple hypothesis tests were adjusted using false discovery rates. In particular, the CVD risk factors included: HDL cholesterol, SBP, total cholesterol measured in the last two years of study follow-up, and whether smoking status had ever been recorded. The relationship between the complete documentation of all Framingham elements was also assessed with respect to patient characteristics (age, sex, number of encounters in two years of study follow-up, diagnosis of schizophrenia, most recent body mass index in the last two years of study follow-up), provider characteristics (age, sex) and geographical characteristics (income quintiles, rurality). A mixed-effects multilevel logistic regression was used to estimate unadjusted and adjusted odds ratios for the complete documentation of all Framingham elements (i.e. calculable Framingham score). Providers were specified as a random effect in the regression model.

All statistical analyses were generated using SAS software, version 9.4 M4 (SAS Institute). A fixed nominal level of 0.05 was used to determine statistical significance in this study.

Results

Cohort generation

Data from 376 physicians practicing in 96 different clinic sites were included. In total, 197,309 patients were identified with age between 40-75 years old (as of March 31, 2018), recorded sex and had at least 3 visits in the two years of interest (Figure 1). Out of 197,309 patients, 83,064 patients (40.4%) had adequate data to calculate a Framingham risk score using the most recent data available for HDL, SBP, and total cholesterol in the last 2 years and smoking status ever

recorded. Of these, 4880 patients met the definition of schizophrenia and 2130 (43.8%) of these patients with schizophrenia had complete documentation to calculate the Framingham risk score.

FIGURE 1 HERE

Individual Framingham Data Elements

We compared the presence of individual Framingham elements between 4882 patients with schizophrenia and 192247 patients without, over a two year look back window (April 1, 2016 – March 31, 2018) (Table 1). Framingham elements were documented more completely among those with schizophrenia: 25.5% of those with schizophrenia and 32.7% of those without had no documented blood pressure readings over the last two years ($p < 0.0001$). 39.2% of those with schizophrenia and 42.1% of those without did not have any cholesterol readings ($p < 0.0001$). There was no difference in documentation of smoking status between the two groups ($p = 0.084$), with documentation missing in approximately 20% of all charts.

TABLE 1 HERE

Patient, provider and geographical characteristics as predictors of calculable Framingham score

Individual patient characteristics between those who had complete documentation of Framingham score factors and those who did not are in Table 2 and Table 3. Unadjusted and adjusted odds ratios for the complete documentation of Framingham score are in supplementary Table S1 and Table S2.

Patients with schizophrenia did not have statistically significant decreased adjusted odds for the complete documentation of Framingham score as compared to patients without schizophrenia, (OR = 0.90, 95% CI 0.79 – 1.01, p-value=0.10) (Figure 2). The adjusted odds for the complete documentation of Framingham factors increased with respect to the patient's age (70-75 years vs 40-44 years OR = 3.51, 95% CI 3.26 – 3.78). Male patients had increased adjusted odds of

calculable Framingham score as compared to female patients (male vs. female OR = 1.39, 95% CI 1.33 – 1.45). An increase in the BMI level was associated with an increase in adjusted odds for calculable Framingham score (Obese class III vs. Underweight, OR = 2.00, 95% CI 1.66 – 2.43) (Table 3). An increase in the total number of encounters also led to increased adjusted odds for the complete documentation of Framingham factors (more than 10 visits vs. 3-5 visits in last two years OR = 1.53, 95% CI 1.46 – 1.60).

TABLE 2 HERE

Patients residing in urban regions had higher adjusted odds for the complete documentation of Framingham factors as compared to patients residing in rural regions (OR=1.08, 95% CI: 1.02 – 1.16). However, no significant differences in adjusted odds ratios were detected across the five levels of income quintiles (1 vs 5, OR=0.97, 95% CI: 0.91-1.03, p-value=0.43). Female physicians had increased adjusted odds for the complete documentation of Framingham factors as compared to male physicians (OR=1.52, 95% CI: 1.12 – 2.07). However, provider age did not contribute to increased or decreased adjusted odds for calculable Framingham score (29-39 years vs. 60+ years, OR=1.49, 95% CI: 0.98 – 2.26, p-value=0.08).

TABLE 3 HERE

Discussion

In this study of primary care electronic medical records from the University of Toronto Practice-Based Research Network, we found better documentation of cardiovascular risk factors among people with schizophrenia as opposed to those without the condition. However, overall documentation was inadequate.

Other studies on preventive health for people with schizophrenia, such as those addressing cancer screening, have found lower rates of preventive care when compared with the general population.(27) We actually found more complete documentation of some risk factors among people with schizophrenia when compared to those without, such as blood pressure. There are various recommendations for frequency of cardiovascular disease risk screening in the general

population; Allan et al suggested every 5 years for men over 40 and women over 50.(23) More complete documentation of risk factors would be expected based on guidelines suggesting more frequent cardiovascular disease risk assessment among people who are on antipsychotic medication.(14) To some extent the present study demonstrates a promising finding, suggesting that patients with schizophrenia are receiving at least as good care from this perspective as those without the condition. It is, however, quite concerning that there are substantial gaps in documentation of particular risk factors such as smoking cessation. Nearly 20% of patients did not have smoking status documented in the chart. We suggest that if it is not documented, then it is extremely unlikely that smoking cessation has been addressed at a primary care visit. Smoking is highly prevalent among people with schizophrenia; Canadian estimates range from 47% (28) and 78% (29). There are many effective interventions to support patients with schizophrenia to stop smoking.(30) It is therefore essential to document smoking status for all patients with schizophrenia and to make smoking cessation a priority.

We found several factors associated with what we assessed to be 'appropriate' documentation of risk factors sufficient for cardiovascular risk assessment.

Limitations of this study include the use of EMR data, which is known to have deficiencies around data quality and completeness.(31, 32) UTOPIAN, as part of the Canadian Primary Care Sentinel Surveillance Network, is disproportionally comprised of more providers in academic practices and has an older population than the Canadian average.(33) These findings therefore may not be generalizable to all Canadian primary care settings. UTOPIAN contains data from multiple EMR vendors and as a consequence there is the possibility that some data may be missing as a result of errors in database formation; these data are extracted with the best available approaches and regular data cleaning attempts to minimize these errors. Other studies have found some deficiencies, particularly related to documentation of health conditions, in EMR data in the Canadian setting.(3) There are no Canadian national standards for necessary elements of EMR documentation in primary care. In Ontario, laboratory results enter most physicians' EMRs through the Ontario Laboratory Information System (34) which is an automatic process, reducing the extent to which documentation is incomplete because of provider error. Our focus on 'documentation' in this study is as a result of the practical principle that if something is not documented, it cannot be acted on; therefore data documentation and

completeness are being taken as a proxy for their consideration in clinical decision-making. It is not possible from the data considered in this study to ascertain whether a provider has attempted to intervene towards smoking cessation, or whether someone has addressed blood pressure management. There are other available risk stratification approaches available both for the general population [such as QRISK2 (35)] and specifically for people with serious mental illness [PRIMROSE (36)]. We chose to focus on the Framingham assessment because it is the most commonly used in Canadian primary care and therefore would be most relevant to the study context.

In summary, we found slightly more complete documentation of cardiovascular risk factors and their management among people with schizophrenia as opposed to those without this condition. However, overall documentation of these risk factors remains incomplete. Adequate cardiovascular disease risk assessment is essential to identifying and addressing risk factors, particularly among people with schizophrenia who have much higher mortality from cardiovascular disease (and other conditions) than the general public. Efforts should be undertaken in primary care to improve data completeness and CVD risk assessment and management.

Conflicts of interest: All authors report that they have no conflicts of interest to declare.

Data statement: Data from this study are held by the University of Toronto Practice-Based Research Network; ethics approval for this study does not allow unrestricted public access to the data. Please contact the corresponding author for information on how to access.

Author statement: BO, SK, BA, FS, RM, MK, MG contributed to the initial conception of the study. BO, SK, BA, RM made substantial contributions to the statistical methodology, analysis and data interpretation. BO and SK wrote the first draft of the manuscript. BO, SK, BA, FS, MK, MG provided substantial revisions to the manuscript.

References

1. Hart JT. The inverse care law. Lancet. 1971 Feb 27;297(7696):405-12.

2. Greiver M, Aliarzadeh B, Meaney C, Moineddin R, Southgate CA, Barber DT, White DG, Martin KB, Ikhtiar T, Williamson T. Are we asking patients if they smoke? Missing information on tobacco use in Canadian electronic medical records. Am J Prevent Med. 2015 Aug 31;49(2):264-8.

3. Singer A, Yakubovich S, Kroeker AL, Dufault B, Duarte R, Katz A. Data quality of electronic medical records in Manitoba: do problem lists accurately reflect chronic disease billing diagnoses? J Am Med Inform Assoc. 2016 Apr 23;23(6):1107-12.

4. Walker ER, McGee RE, Druss BG. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. JAMA Psych. 2015 Apr 1;72(4):334-41.

5. Gatov E, Rosella L, Chiu M, Kurdyak P. Trends in standardized mortality among individuals with schizophrenia, 1993–2012: a population-based, repeated cross-sectional study. CMAJ 2017;189:e1177-87.

6. Hennekens CH, Hennekens AR, Hollar D, Casey DE. Schizophrenia and increased risks of cardiovascular disease. Am Heart J. 2005 Dec 31;150(6):1115-21.

7. Goldstein BI, Fagiolini A, Houck P, Kupfer DJ. Cardiovascular disease and hypertension among adults with bipolar I disorder in the United States. Bipolar Disor. 2009 Sep 1;11(6):657-62.

8. Hirsch L, Yang J, Bresee L, Jette N, Patten S, Pringsheim T. Second-generation antipsychotics and metabolic side effects: a systematic review of population-based studies. Drug safety. 2017 Sep 1;40(9):771-81.

9. Spertus J, Horvitz-Lennon M, Abing H, Normand SL. Risk of weight gain for specific antipsychotic drugs: a meta-analysis. NPJ schizophrenia. 2018 Jun 27;4(1):1-7.

10. De Hert M, Dekker JM, Wood D, Kahl KG, Holt RI, Möller HJ. Cardiovascular disease and diabetes in people with severe mental illness position statement from the European Psychiatric Association (EPA), supported by the European Association for the Study of Diabetes (EASD) and the European Society of Cardiology (ESC). European Psych. 2009 Sep 1;24(6):412-24.

11. Bullock HL, Waddell K, & Wilson MG. Rapid synthesis: Identifying and assessing core components of collaborative-care models for treating mental and physical health conditions. Hamilton, Canada: McMaster Health Forum, 31 March 2017.

12. Slomp M, Bland R, Patterson S, Whittaker L. Three-year physician treated prevalence rate of mental disorders in Alberta. Can J Psych. 2009 Mar;54(3):199-203.

13. Government of Canada [Internet]: Ottawa, ON. Chapter 3: Schizophrenia – A report on mental illnesses in Canada. 2012. [cited 31 January 2018] Available from: https://www.canada.ca/en/public-health/services/reports-publications/report-on-mental-illnesses-canada/schizophrenia.htm

14. Saha S, Chant D, Welham J, McGrath J. A systematic review of the prevalence of schizophrenia. PLoS medicine. 2005 May 31;2(5):e141.

15. von Elm E , Altman DG , Egger M , et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Surg 2014;12:1495–9.doi:10.1016/j.ijsu.2014.07.013

16. University of Toronto Department of Family and Community Medicine [Internet]. University of Toronto Practice Based Research Network (UTOPIAN). [cited 31 January 2018] Available from: https://www.dfcm.utoronto.ca/landing-page/utopian

17. CPCSSN Team, Case Definitions: Canadian Primary Care Sentinel Surveillance Network (CPCSSN), Version 2. July 16, 2019. URL: http://cpcssn.ca/research-resources/cpcssn-case-definitions-v2

18. Williamson T, Green ME, Birtwhistle R, Khan S, Garies S, Wong ST, Natarajan N, Manca D, Drummond N. Validating the 8 CPCSSN case definitions for chronic disease

surveillance in a primary care database of electronic health records. Ann Fam Med. 2014 Jul 1;12(4):367-72.

19. Wilkins R. Use of postal codes and addresses in the analysis of health data. Health Reports. 1993;5(2):157–77. pmid:8292756

20. Pampalon R, Hamel D, Gamache P, Raymond G. A deprivation index for health planning in Canada. Chronic Dis Can. 2009 Jan 1;29(4):178–91. pmid:1980468

21. Genest J, McPherson R, Frohlich J, Anderson T, Campbell N, Carpentier A, Couture P, Dufour R, Fodor G, Francis GA, Grover S. 2009 Canadian Cardiovascular Society/Canadian guidelines for the diagnosis and treatment of dyslipidemia and prevention of cardiovascular disease in the adult–2009 recommendations. Canadian Journal of Cardiology. 2009 Oct 1;25(10):567-79.

22. Anderson TJ, Grégoire J, Hegele RA, Couture P, Mancini GJ, McPherson R, Francis GA, Poirier P, Lau DC, Grover S, Genest Jr J. 2012 update of the Canadian Cardiovascular Society guidelines for the diagnosis and treatment of dyslipidemia for the prevention of cardiovascular disease in the adult. Canadian Journal of Cardiology. 2013 Feb 1;29(2):151-67.

23. Allan GM, Lindblad AJ, Comeau A, Coppola J, Hudson B, Mannarino M, McMinis C, Padwal R, Schelstraete C, Zarnke K, Garrison S. Simplified lipid guidelines: Prevention and management of cardiovascular disease in primary care. Canadian Family Physician. 2015 Oct 1;61(10):857-67.

24. Pringsheim T, Kelly M, Urness D, Teehan M, Ismail Z, Gardner D. Physical Health and Drug Safety in individuals with schizophrenia. Can J Psych. 2017 Sep;62(9):673-83.

25. D'Agostino RB, Vasan RS, Pencina MJ, Wolf PA, Cobain M, Massaro JM, Kannel WB. General cardiovascular risk profile for use in primary care. Circulation. 2008 Feb 12;117(6):743-53.

26. O'Neill B, Kalia S, Aliarzadeh B, Moineddin R, Fung WL, Sullivan F, Maloul A, Bernard S, Greiver M. Agreement between primary care and hospital diagnosis of schizophrenia and bipolar disorder: A cross-sectional, observational study using record linkage. PLOS One. 2019 Jan 7;14(1):e0210214.

27. Martens PJ, Chochinov HM, Prior HJ, Fransoo R, Burland E, Team TN. Are cervical cancer screening rates different for women with schizophrenia? A Manitoba population-based study. Schizophrenia research. 2009 Aug 1;113(1):101-6.

28. Johnson JL, Ratner PA, Malchy LA, Okoli CT, Procyshyn RM, Bottorff JL, Groening M, Schultz A, Osborne M. Gender-specific profiles of tobacco use among non-institutionalized people with serious mental illness. BMC psychiatry. 2010 Dec;10(1):101.

29. Gerber, G.J., Krupa, T., Eastabrook, S., Gargaro, J., 2003. Substance use among persons with serious mental illness in eastern Ontario. Can J Community Ment Health 22, 113 – 128.

30. Tsoi DT, Porwal M, Webster AC. Interventions for smoking cessation and reduction in individuals with schizophrenia. Cochrane Database Sys Rev. 2013(2).

31. Weiskopf NG, Weng C. Methods and dimensions of electronic health record data quality assessment: enabling reuse for clinical research. J Am Inform Assoc. 2013 Jan 1;20(1):144-51.

32. Birtwhistle R, Williamson T. Primary care electronic medical records: a new data source for research in Canada. CMAJ. 2015 Mar 3;187(4):239-40.

33. Queenan JA, Williamson T, Khan S, Drummond N, Garies S, Morkem R, Birtwhistle R. Representativeness of patients and providers in the Canadian Primary Care Sentinel Surveillance Network: a cross-sectional study. CMAJ Open. 2016 Jan;4(1):E28.

34. Ontario Laboratory Information System. eHealth Ontario. https://www.ehealthontario.on.ca/en/for-healthcare-professionals/ontario-laboratories-information-system-olis

35. Hippisley-Cox J, Coupland C, Vinogradova Y, Robson J, Brindle P. Performance of the QRISK cardiovascular risk prediction algorithm in an independent UK sample of patients from general practice: a validation study. Heart. 2008 Jan 1;94(1):34-9.

36. Zomer E, Osborn D, Nazareth I, Blackburn R, Burton A, Hardoon S, Holt RI, King M, Marston L, Morris S, Omar R. Effectiveness and cost-effectiveness of a cardiovascular risk prediction algorithm for people with severe mental illness (PRIMROSE). BMJ open. 2017 Sep 1;7(9):e018181.

Tables

Table 1. Distribution of Framingham factors among patients with and without schizophrenia

	Schizophrenia				
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	P-values*
Age range (years)					-
40-44 years	28574	14.8%	700	14.3%	
45-49 years	29137	15.1%	753	15.4%	
50-54 years	30939	16.1%	784	16.1%	
55-59 years	31790	16.5%	832	17.0%	
60-64 years	27061	14.1%	707	14.5%	
65-69 years	22430	11.7%	588	12.0%	
70-75 years	22496	11.7%	518	10.6%	
Sex (M/F)					-
Female	106841	55.5%	2539	52.0%	
Male	85586	44.5%	2343	48.0%	
HDL level (mmol/L)					<0.0001
Missing	79437	41.3%	1842	37.7%	
0-0.89 mmol/L	8565	4.5%	375	7.7%	
0.9-1.19 mmol/L	27925	14.5%	866	17.7%	
1.2-1.29 mmol/L	11006	5.7%	272	5.6%	
1.3-1.59 mmol/L	28313	14.7%	703	14.4%	
1.60+ mmol/L	37181	19.3%	824	16.9%	
Total cholesterol (mmol/L)					<0.0001
Missing	81073	42.1%	1916	39.2%	
0-4.09 mmol/L	25388	13.2%	865	17.7%	
4.1-5.19 mmol/L	39801	20.7%	1068	21.9%	
5.2-6.19 mmol/L	30009	15.6%	663	13.6%	
6.2-7.19 mmol/L	11225	5.8%	252	5.2%	
7.2+ mmol/L	4931	2.6%	118	2.4%	
Systolic blood pressure (mmHg)					<0.0001
Missing	62934	32.7%	1245	25.5%	
120 mmHg or less	42293	22.0%	1445	29.6%	
120-129 mmHg	36752	19.1%	940	19.3%	
130-139 mmHg	28764	14.9%	725	14.9%	
140-149 mmHg	14043	7.3%	350	7.2%	
150-159 mmHg	5752	3.0%	124	2.5%	

	Schizophrenia				
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	P-values*
160 mmHg or more	1889	1.0%	53	1.1%	
Smoking Status					0.0843
Missing	40109	20.8%	968	19.8%	
Non-smoker	125796	65.4%	2633	53.9%	
Smoker	26522	13.8%	1281	26.2%	
Type II Diabetes Mellitus					-
No	168151	87.4%	3953	81.0%	
Yes	24276	12.6%	929	19.0%	
Anti-Hypertensive medication					-
No	140415	73.0%	3486	71.4%	
Yes	52012	27.0%	1396	28.6%	
Total	192427	100.0%	4882	100.0%	-

*p-values compare the proportion of missing data and non-missing data with respect to schizophrenia (using chi-square test with false discovery rate).

Table 2. Calculable Framingham score with respect to individual Framingham factors

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Age range (years)					
40-44 years	21922	74.9%	7352	25.1%	29274
45-49 years	20367	68.1%	9523	31.9%	29890
50-54 years	19024	60.0%	12699	40.0%	31723
55-59 years	18106	55.5%	14516	44.5%	32622
60-64 years	14143	50.9%	13625	49.1%	27768
65-69 years	10565	45.9%	12453	54.1%	23018
70-75 years	10118	44.0%	12896	56.0%	23014
Sex (M/F)					
Female	63352	57.9%	46028	42.1%	109380
Male	50893	57.9%	37036	42.1%	87929
HDL level (mmol/L)					
Missing	81279	100.0%	.	.	81279
0-0.89 mmol/L	2408	26.9%	6532	73.1%	8940
0.9-1.19 mmol/L	7973	27.7%	20818	72.3%	28791
1.2-1.29 mmol/L	3092	27.4%	8186	72.6%	11278
1.3-1.59 mmol/L	8069	27.8%	20947	72.2%	29016
1.60+ mmol/L	11424	30.1%	26581	69.9%	38005
Total cholesterol (mmol/L)					
Missing	82989	100.0%	.	.	82989
0-4.09 mmol/L	6336	24.1%	19917	75.9%	26253
4.1-5.19 mmol/L	11400	27.9%	29469	72.1%	40869
5.2-6.19 mmol/L	8686	28.3%	21986	71.7%	30672

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
6.2-7.19 mmol/L	3167	27.6%	8310	72.4%	11477
7.2+ mmol/L	1667	33.0%	3382	67.0%	5049
Systolic blood pressure (mmHg)					
Missing	62874	98.0%	1305	2.0%	64179
120 mmHg or less	18185	41.6%	25553	58.4%	43738
120-129 mmHg	14338	38.0%	23354	62.0%	37692
130-139 mmHg	10431	35.4%	19058	64.6%	29489
140-149 mmHg	5359	37.2%	9034	62.8%	14393
150-159 mmHg	2270	38.6%	3606	61.4%	5876
160 mmHg or more	788	40.6%	1154	59.4%	1942
Smoking Status					
Missing	41077	100.0%	.	.	41077
Non-smoker	58342	45.4%	70087	54.6%	128429
Smoker	14826	53.3%	12977	46.7%	27803
Type II Diabetes Mellitus					
No	105354	61.2%	66750	38.8%	172104
Yes	8891	35.3%	16314	64.7%	25205
Anti-Hypertensive medication					
No	92342	64.2%	51559	35.8%	143901
Yes	21903	41.0%	31505	59.0%	53408
Total	114245	57.9%	83064	42.1%	197309

Table 3: Calculable Framingham score with respect to patient, provider and geographical characteristics

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Schizophrenia					
No	111564	58.0%	80863	42.0%	192427
Yes	2681	54.9%	2201	45.1%	4882
BMI level (Kg/m²)					
Missing	84398	77.7%	24206	22.3%	108604
18.4 or less (Underweight)	378	42.9%	503	57.1%	881
18.5 - 24.9 (Normal)	9191	38.6%	14619	61.4%	23810
25 - 29.9 (overweight)	10622	32.6%	21935	67.4%	32557
30 - 34.9 (Obese Class I)	5847	30.5%	13331	69.5%	19178
35 - 39.9 (Obese Class II)	2306	30.4%	5279	69.6%	7585
40 or more (Obese Class III)	1503	32.0%	3191	68.0%	4694
No. of encounters					
Missing	42673	86.0%	6952	14.0%	49625

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
3-5 visits	25915	58.6%	18311	41.4%	44226
6-9 visits	19861	48.8%	20830	51.2%	40691
>=10 visits	25796	41.1%	36971	58.9%	62767
Income Quintiles					
Missing	14795	58.9%	10326	41.1%	25121
1	15851	58.7%	11162	41.3%	27013
2	15883	58.3%	11348	41.7%	27231
3	17118	58.2%	12281	41.8%	29399
4	20810	57.8%	15221	42.2%	36031
5	29788	56.7%	22726	43.3%	52514
Region					
Missing	2284	73.6%	819	26.4%	3103
Rural	11590	59.7%	7833	40.3%	19423
Urban	100371	57.4%	74412	42.6%	174783
Provider age					
Missing	5880	50.6%	5741	49.4%	11621
29-39 years	21926	54.1%	18618	45.9%	40544
40-49 years	23203	58.4%	16550	41.6%	39753
50-59 years	29127	55.9%	22943	44.1%	52070
60+ years	34109	64.0%	19212	36.0%	53321
Provider sex					
Female	52950	54.2%	44655	45.8%	97605
Male	61295	61.5%	38409	38.5%	99704
Total	114245	57.9%	83064	42.1%	197309

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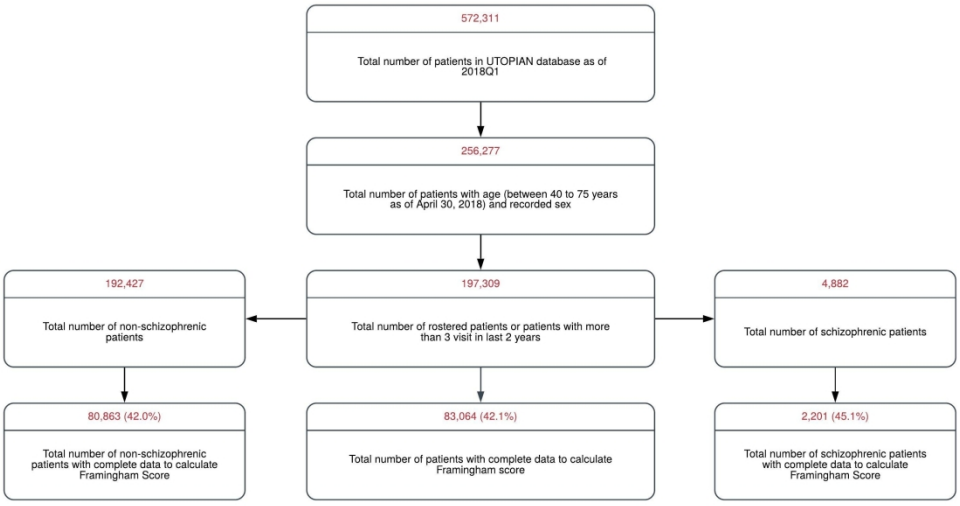

Distribution of Framingham risk factors among patients with and without schizophrenia

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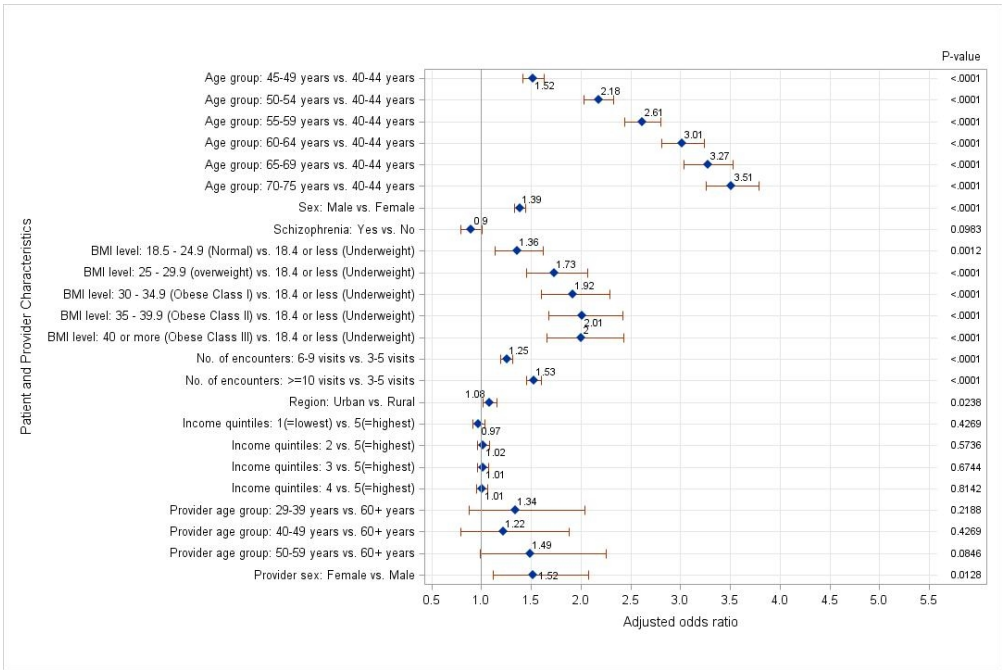

Adjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

285x190mm (96 x 96 DPI)

Supplementary tables

Table S1: Unadjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

Unadjusted odds ratio						
Characteristics	**Index group**	**Reference group**	**Odds Ratio**	**Lower limit**	**Upper limit**	**P-value**
Age	45-49 years	40-44 years	1.49	1.434	1.547	<.0001
Age	50-54 years	40-44 years	2.24	2.162	2.329	<.0001
Age	55-59 years	40-44 years	2.78	2.681	2.887	<.0001
Age	60-64 years	40-44 years	3.50	3.371	3.640	<.0001
Age	65-69 years	40-44 years	4.44	4.266	4.626	<.0001
Age	70-75 years	40-44 years	5.05	4.850	5.262	<.0001
Sex	Male	Female	1.07	1.048	1.092	<.0001
Schizophrenia	Yes	No	1.25	1.173	1.327	<.0001
BMI level	18.5 - 24.9 (Normal)	18.4 or less (Underweight)	1.25	1.077	1.450	0.0043
BMI level	25 - 29.9 (overweight)	18.4 or less (Underweight)	1.77	1.522	2.047	<.0001
BMI level	30 - 34.9 (Obese Class I)	18.4 or less (Underweight)	2.03	1.749	2.361	<.0001
BMI level	35 - 39.9 (Obese Class II)	18.4 or less (Underweight)	2.09	1.784	2.437	<.0001
BMI level	40 or more (Obese Class III)	18.4 or less (Underweight)	1.99	1.695	2.342	<.0001
No. of encounters	6-9 visits	3-5 visits	1.60	1.558	1.653	<.0001
No. of encounters	>=10 visits	3-5 visits	2.39	2.320	2.455	<.0001
Region	Urban	Rural	1.06	1.026	1.105	0.0012
Income quintiles	1(=lowest)	5(=highest)	1.04	1.004	1.075	0.0326
Income quintiles	2	5(=highest)	1.05	1.020	1.089	0.0023
Income quintiles	3	5(=highest)	1.04	1.005	1.071	0.0261
Income quintiles	4	5(=highest)	1.00	0.974	1.034	0.8188
Provider age	29-39 years	60+ years	1.69	1.225	2.334	0.0020
Provider age	40-49 years	60+ years	1.36	0.972	1.914	0.0757
Provider age	50-59 years	60+ years	1.38	0.986	1.944	0.0655
Provider sex	Female	Male	1.61	1.296	2.012	<.0001

Table S2: Adjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

Adjusted odds ratio						
Characteristics	**Index group**	**Reference group**	**Odds Ratio**	**Lower limit**	**Upper limit**	**P-value**
Age group	45-49 years	40-44 years	1.52	1.41	1.63	<.0001
Age group	50-54 years	40-44 years	2.18	2.03	2.33	<.0001
Age group	55-59 years	40-44 years	2.61	2.44	2.80	<.0001
Age group	65-69 years	40-44 years	3.27	3.04	3.52	<.0001
Age group	70-75 years	40-44 years	3.51	3.26	3.78	<.0001
Sex	Male	Female	1.39	1.33	1.45	<.0001
Schizophrenia	Yes	No	0.90	0.79	1.01	0.0983
BMI level	18.5 - 24.9 (Normal)	18.4 or less (Underweight)	1.36	1.14	1.62	0.0012
BMI level	25 - 29.9 (overweight)	18.4 or less (Underweight)	1.73	1.45	2.07	<.0001
BMI level	30 - 34.9 (Obese Class I)	18.4 or less (Underweight)	1.92	1.60	2.29	<.0001
BMI level	35 - 39.9 (Obese Class II)	18.4 or less (Underweight)	2.01	1.67	2.42	<.0001
BMI level	40 or more (Obese Class III)	18.4 or less (Underweight)	2.00	1.66	2.43	<.0001
No. of encounters	6-9 visits	3-5 visits	1.25	1.19	1.31	<.0001
No. of encounters	>=10 visits	3-5 visits	1.53	1.46	1.60	<.0001
Region	Urban	Rural	1.08	1.02	1.16	0.0238
Income quintiles	1(=lowest)	5(=highest)	0.97	0.91	1.03	0.4269
Income quintiles	2	5(=highest)	1.02	0.96	1.08	0.5736
Income quintiles	3	5(=highest)	1.01	0.96	1.07	0.6744
Income quintiles	4	5(=highest)	1.01	0.96	1.06	0.8142
Provider age group	29-39 years	60+ years	1.34	0.88	2.04	0.2188
Provider age group	40-49 years	60+ years	1.22	0.79	1.88	0.4269
Provider age group	50-59 years	60+ years	1.49	0.98	2.26	0.0846
Provider sex	Female	Male	1.52	1.12	2.07	0.0128

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

Cardiovascular disease risk in patients with schizophrenia: retrospective cohort study of risk factor documentation and management in primary care electronic medical records

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7/8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	

Outcome data	15*	Report numbers of outcome events or summary measures over time	8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Cardiovascular risk factor documentation and management in primary care electronic medical records among people with schizophrenia in Ontario, Canada: retrospective cohort study

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Cardiovascular risk factor documentation and management in primary care electronic medical records among people with schizophrenia in Ontario, Canada: retrospective cohort study

Braden O'Neill[1,2,3], Sumeet Kalia[2], Babak Aliarzadeh[2], Frank Sullivan[1,4], Rahim Moineddin[3], Martina Kelly[5], Michelle Greiver[1,2,3]

[1]Department of Family and Community Medicine, North York General Hospital, Toronto, Ontario, Canada

[2]University of Toronto Practice-Based Research Network, Toronto, Ontario, Canada

[3]Department of Family and Community Medicine, Faculty of Medicine, University of Toronto, Ontario, Canada

[4]School of Medicine, University of St. Andrews, Fife, Scotland

[5]Department of Family Medicine, University of Calgary, Alberta, Canada

Corresponding author:

Braden O'Neill

braden.oneill@nygh.on.ca

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Keywords: cardiovascular diseases; schizophrenia; primary health care; electronic health records; primary prevention

Word count: 2384

Abstract

Objectives: In order to address the substantial increased risk of cardiovascular disease among people with schizophrenia, it is necessary to identify the factors responsible for some of that increased risk. We analyzed the extent to which these risk factors were documented in primary care electronic medical records, and compared their documentation by patient and provider characteristics.

Design: Retrospective cohort study

Setting: Electronic medical record (EMR) database of the University of Toronto Practice Based Research Network (UTOPIAN) Data Safe Haven.

Participants: 197129 adults between 40-75 years of age; 4882 with schizophrenia and 192247 without.

Primary and secondary outcome measures: Documentation of cardiovascular disease risk factors (age, sex, smoking history, presence of diabetes, blood pressure, whether a patient is currently on medication to reduce blood pressure, total cholesterol, and high density lipoprotein cholesterol)

Results: Documentation of cardiovascular risk factors was more complete among people with schizophrenia (74.5% of whom had blood pressure documented at least once in the last two years versus 67.3% of those without, p >0.0001). Smoking status was not documented in 19.8% of those with schizophrenia and 20.8% of those without (p= 0.0843). Factors associated with improved documentation included older patients (OR for age 70-75 vs 45-49= 3.51, 95% CI 3.26-3.78), male patients (OR= 1.39, 95% CI 1.33-1.45), patients cared for by a female provider (OR= 1.52, 95% CI: 1.12-2.07), and increased number of encounters (OR for >=10 visits vs 3-5 visits= 1.53, 95% CI 1.46-1.60).

Conclusions: Documentation of cardiovascular risk factors was better among people with schizophrenia than without, although overall documentation was inadequate. Efforts to improve documentation of risk factors are warranted in order to facilitate improved management.

Strengths and limitations of the study

- This study analyzes data from the University of Toronto Practice-Based Research Network (UTOPIAN) Data Safe Haven, one of the world's largest primary care electronic medical record (EMR) databases
- It uses de-identified data from primary care charts to identify cardiovascular disease risk factors
- Strengths of the study include the sample size and the breadth of data included, from approximately 400 primary care clinics in Ontario, Canada
- Weaknesses include possible missing data resulting from the process of transferring data from primary care charts into a de-identified database, and the fact that the clinics included in the database are mainly urban and suburban academic clinics; these results may not necessarily be generalizable to all primary care settings

Introduction

High quality, comprehensive data are needed to understand health and how to improve it. Risk factors must be known and documented so that interventions can be planned and implemented.

One of the key challenges in primary care research has been the availability and quality of data. When Julian Tudor Hart conducted research on patients accessing care in his practice in Wales in the 1970s, it required laboriously searching through individual paper charts to collect necessary data.(1) Today, electronic medical records are widely used and can facilitate instant searches at the practice level as well as at local and national levels through databases that aggregate data from multiple practices. However, several studies have demonstrated that important data – for example, regarding cardiovascular risk factors such as smoking and whether someone has a diagnosis of hypertension – remain incomplete.(2,3)

People with serious mental illnesses, particularly those with schizophrenia, die 8 to 10 years earlier than those without these conditions.(4,5) This is primarily due to higher rates of cardiovascular disease.(5-7) While the long-term metabolic effects of antipsychotic medications used to treat schizophrenia are unclear, their use is associated with increased weight and blood glucose.(8,9) Patients may also face challenges with self-care or accessing appropriate medical care.(10) To date there is sparse evidence about how to improve physical health status in these patients; a recent review of 'collaborative care' where both physical and mental health are attended to for these patients did not find any evidence of reductions in cardiovascular disease risk.(11)

The primary prevention of cardiovascular disease includes addressing risk factors such as tobacco use and hypertension; these are commonly managed in primary care. This is particularly true for people with serious mental illness, who are seen more frequently by family physicians than by psychiatrists.(12) The prevalence of schizophrenia in the general adult population is 1-3%, making it a relatively common condition.(13,14) The prevalence and frequency of interaction strongly supports the important role played by family medicine in reducing the risk of

cardiovascular disease for people with mental illness. To do this effectively it is necessary to understand what that risk is and what variables should be focused on.

As a first step in establishing patients' physical health status and identifying who to target for interventions to improve health, it is necessary to understand their health status. Whether data completeness concerns regarding cardiovascular disease risk are general to all patients or whether they are more pronounced amongst those with serious mental illness is unknown.

Our study objectives were: to describe documentation of cardiovascular disease risk factors (HDL, LDL, total cholesterol; blood pressure; smoking status) among patients with and without schizophrenia; and to explore patient and provider characteristics associated with sufficient documentation of these risk factors to calculate the Framingham risk score for patients with schizophrenia.

Methods

This is an observational retrospective cohort study design. We applied the STrengthening the Reporting of OBservational studies in Epidemiology checklist for reporting observational studies.(15) Ethics approval was obtained from the North York General Hospital Research Ethics Board, approval #18-0006.

Setting and data sources

We used data from the University of Toronto Practice-Based Research Network (UTOPIAN) Data Safe Haven, a primary care electronic medical record (EMR) database; data extracted as of April 1 2018 were used for this project.(16) The UTOPIAN Data Safe Haven contains EMR records from over 550 000 patients who access care in primary care practices in the Greater Toronto Area in Ontario, Canada. Physicians have consented to the provision of de-identified data, housed in a secure environment. These data are used for quality improvement and research purposes. The UTOPIAN database includes validated definitions for eight long-term conditions: osteoarthritis, diabetes, epilepsy, parkinsonism, dementia, hypertension, COPD,

depression.(17,18) Neighbourhood level income quintiles are also available from patient residential postal codes using Statistics Canada's Postal Code Conversion Files.(19,20)

Study population

We included patients 40-75 years of age because Canadian guidelines recommend regular screening for cardiovascular disease (CVD) risk in this age range. There is no clear consensus on the recommended interval for screening, which varies between yearly to every 5 years.(21-23) Guidelines suggest yearly CVD risk assessment for patients with schizophrenia (24); however these are not routinely followed in primary care practice and this increased frequency is consensus-based and not necessarily supported by strong evidence. We therefore chose to look at a two year interval in which screening could have taken place, recognizing that there may be some patients for whom it may be appropriate to screen less often. The most commonly used CVD risk assessment tool in Canadian primary care practice is the Framingham risk calculator (25), which includes the following items: (i) age, (ii) sex, (iii) smoking history, (iv) presence of diabetes, (v) systolic blood pressure (SBP), (vi) whether a patient is currently on medication to reduce blood pressure, (vii) total cholesterol, and (viii) high density lipoprotein (HDL) cholesterol. This is a validated risk stratification tool that establishes a patient's risk of developing cardiovascular disease (CVD; including: coronary death, myocardial infarction, coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack, peripheral artery disease, heart failure) within the next 10 years. It is valid for patients 30 – 74 years of age.(25)

We identified patients that were 40-75 years of age as of March 31, 2018. We limited our cohort definition to those that had at least 3 primary care visits in the 2 year period between April 1, 2016 and March 31, 2018. To identify outcomes we looked at whether people had CVD risk factors as outlined above documented at least once in the above period. This definition ensured that we included patients likely to be routinely followed by the providers whose records are included in the database, and is consistent with our usual approach for studies using this database. We identified patients with schizophrenia using the same definition used in a previous

study using the same database, using a combination of encounter diagnoses used for billing purposes as well as documentation of the condition in the electronic medical record.(26)

Statistical analysis

We compared the documentation of cardiovascular disease (CVD) risk factors included in the Framingham risk calculator between those with and without schizophrenia using a chi-square test. P-values derived from multiple hypothesis tests were adjusted using false discovery rates. In particular, the CVD risk factors included: HDL cholesterol, SBP, total cholesterol measured in the last two years of study follow-up, and whether smoking status had ever been recorded. The relationship between the complete documentation of all Framingham elements was also assessed with respect to patient characteristics (age, sex, number of encounters in two years of study follow-up, diagnosis of schizophrenia, most recent body mass index in the last two years of study follow-up), provider characteristics (age, sex) and geographical characteristics (income quintiles, rurality). A mixed-effects multilevel logistic regression was used to estimate unadjusted and adjusted odds ratios for the complete documentation of all Framingham elements (i.e. calculable Framingham score). Providers were specified as a random effect in the regression model.

All statistical analyses were generated using SAS software, version 9.4 M4 (SAS Institute). A fixed nominal level of 0.05 was used to determine statistical significance in this study.

Patient and public involvement: There was no patient and public involvement in the design or conduct of this study.

Results

Cohort generation

Data from 376 physicians practicing in 96 different clinic sites were included. In total, 197,309 patients were identified with age between 40-75 years old (as of March 31, 2018), recorded sex

and had at least 3 visits in the two years of interest (Figure 1). Out of 197,309 patients, 83,064 patients (40.4%) had adequate data to calculate a Framingham risk score using the most recent data available for HDL, SBP, and total cholesterol in the last 2 years and smoking status ever recorded. Of these, 4880 patients met the definition of schizophrenia and 2130 (43.8%) of these patients with schizophrenia had complete documentation to calculate the Framingham risk score.

FIGURE 1 HERE

Individual Framingham Data Elements

We compared the presence of individual Framingham elements between 4882 patients with schizophrenia and 192247 patients without, over a two year look back window (April 1, 2016 – March 31, 2018) (Table 1). Framingham elements were documented more completely among those with schizophrenia: 25.5% of those with schizophrenia and 32.7% of those without had no documented blood pressure readings over the last two years ($p < 0.0001$). 39.2% of those with schizophrenia and 42.1% of those without did not have any cholesterol readings ($p < 0.0001$). There was no difference in documentation of smoking status between the two groups ($p = 0.084$), with documentation missing in approximately 20% of all charts.

TABLE 1 HERE

Patient, provider and geographical characteristics as predictors of calculable Framingham score

Individual patient characteristics between those who had complete documentation of Framingham score factors and those who did not are in Table 2 and Table 3. Unadjusted and adjusted odds ratios for the complete documentation of Framingham score are in supplementary Table S1 and Table S2.

Patients with schizophrenia did not have statistically significant decreased adjusted odds for the complete documentation of Framingham score as compared to patients without schizophrenia,

(OR = 0.90, 95% CI 0.79 – 1.01, p-value=0.10) (Figure 2). The adjusted odds for the complete documentation of Framingham factors increased with respect to the patient's age (70-75 years vs 40-44 years OR = 3.51, 95% CI 3.26 – 3.78). Male patients had increased adjusted odds of calculable Framingham score as compared to female patients (male vs. female OR = 1.39, 95% CI 1.33 – 1.45). An increase in the BMI level was associated with an increase in adjusted odds for calculable Framingham score (Obese class III vs. Underweight, OR = 2.00, 95% CI 1.66 – 2.43) (Table 3). An increase in the total number of encounters also led to increased adjusted odds for the complete documentation of Framingham factors (more than 10 visits vs. 3-5 visits in last two years OR = 1.53, 95% CI 1.46 – 1.60).

TABLE 2 HERE

Patients residing in urban regions had higher adjusted odds for the complete documentation of Framingham factors as compared to patients residing in rural regions (OR=1.08, 95% CI: 1.02 – 1.16). However, no significant differences in adjusted odds ratios were detected across the five levels of income quintiles (1 vs 5, OR=0.97, 95% CI: 0.91-1.03, p-value=0.43). Female physicians had increased adjusted odds for the complete documentation of Framingham factors as compared to male physicians (OR=1.52, 95% CI: 1.12 – 2.07). However, provider age did not contribute to increased or decreased adjusted odds for calculable Framingham score (29-39 years vs. 60+ years, OR=1.49, 95% CI: 0.98 – 2.26, p-value=0.08).

TABLE 3 HERE

Discussion

In this study of primary care electronic medical records from the University of Toronto Practice-Based Research Network, we found better documentation of cardiovascular risk factors among people with schizophrenia as opposed to those without the condition. However, overall documentation was inadequate.

Other studies on preventive health for people with schizophrenia, such as those addressing cancer screening, have found lower rates of preventive care when compared with the general

population.(27) We actually found more complete documentation of some risk factors among people with schizophrenia when compared to those without, such as blood pressure. There are various recommendations for frequency of cardiovascular disease risk screening in the general population; Allan et al suggested every 5 years for men over 40 and women over 50.(23) More complete documentation of risk factors would be expected based on guidelines suggesting more frequent cardiovascular disease risk assessment among people who are on antipsychotic medication.(14) To some extent the present study demonstrates a promising finding, suggesting that patients with schizophrenia are receiving at least as good care from this perspective as those without the condition. It is, however, quite concerning that there are substantial gaps in documentation of particular risk factors such as smoking cessation. Nearly 20% of patients did not have smoking status documented in the chart. We suggest that if it is not documented, then it is extremely unlikely that smoking cessation has been addressed at a primary care visit. Smoking is highly prevalent among people with schizophrenia; Canadian estimates range from 47% (28) and 78% (29). There are many effective interventions to support patients with schizophrenia to stop smoking.(30) It is therefore essential to document smoking status for all patients with schizophrenia and to make smoking cessation a priority.

We found several factors associated with what we assessed to be 'appropriate' documentation of risk factors sufficient for cardiovascular risk assessment.

Limitations of this study include the use of EMR data, which is known to have deficiencies around data quality and completeness.(31, 32) UTOPIAN, as part of the Canadian Primary Care Sentinel Surveillance Network, is disproportionally comprised of more providers in academic practices and has an older population than the Canadian average.(33) These findings therefore may not be generalizable to all Canadian primary care settings. UTOPIAN contains data from multiple EMR vendors and as a consequence there is the possibility that some data may be missing as a result of errors in database formation; these data are extracted with the best available approaches and regular data cleaning attempts to minimize these errors. Other studies have found some deficiencies, particularly related to documentation of health conditions, in EMR data in the Canadian setting.(3) There are no Canadian national standards for necessary elements of EMR documentation in primary care. In Ontario, laboratory results enter most physicians' EMRs through the Ontario Laboratory Information System (34) which is an

automatic process, reducing the extent to which documentation is incomplete because of provider error. Primary care providers therefore receive test results from all other providers involved in a patient's care, making primary care records an appropriate location to assess these parameters. Our focus on 'documentation' in this study is as a result of the practical principle that if something is not documented, it cannot be acted on; therefore data documentation and completeness are being taken as a proxy for their consideration in clinical decision-making. We acknowledge that this approach may result in 'overestimation' of the extent to which cardiovascular disease risk screening is occurring for patients with schizophrenia. It is possible to have all of the Framingham items documented in the medical record but not to have brought them together to estimate overall cardiovascular risk. However, given the primary conclusion that cardiovascular risk screening is inadequate in this sample, the study methods biasing towards 'overestimation', if anything, support this main finding. It is not possible from the data considered in this study to ascertain whether a provider has attempted to intervene towards smoking cessation, or whether someone has addressed blood pressure management. There are other available risk stratification approaches available both for the general population [such as QRISK2 (35)] and specifically for people with serious mental illness [PRIMROSE (36)]. We chose to focus on the Framingham assessment because it is the most commonly used in Canadian primary care and therefore would be most relevant to the study context.

In summary, we found slightly more complete documentation of cardiovascular risk factors and their management among people with schizophrenia as opposed to those without this condition. However, overall documentation of these risk factors remains incomplete. Adequate cardiovascular disease risk assessment is essential to identifying and addressing risk factors, particularly among people with schizophrenia who have much higher mortality from cardiovascular disease (and other conditions) than the general public. Efforts should be undertaken in primary care to improve data completeness and CVD risk assessment and management.

Conflicts of interest: All authors report that they have no conflicts of interest to declare.

Data statement: Data from this study are held by the University of Toronto Practice-Based Research Network; ethics approval for this study does not allow unrestricted public access to the data. Please contact the corresponding author for information on how to access.

Author statement: BO, SK, BA, FS, RM, MK, MG contributed to the initial conception of the study. BO, SK, BA, RM made substantial contributions to the statistical methodology, analysis and data interpretation. BO and SK wrote the first draft of the manuscript. BO, SK, BA, FS, MK, MG provided substantial revisions to the manuscript.

Figure legends:

Figure 1: Distribution of Framingham risk factors among patients with and without schizophrenia

Figure 2: Adjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

References

1. Hart JT. The inverse care law. Lancet. 1971 Feb 27;297(7696):405-12.

2. Greiver M, Aliarzadeh B, Meaney C, Moineddin R, Southgate CA, Barber DT, White DG, Martin KB, Ikhtiar T, Williamson T. Are we asking patients if they smoke? Missing information on tobacco use in Canadian electronic medical records. Am J Prevent Med. 2015 Aug 31;49(2):264-8.

3. Singer A, Yakubovich S, Kroeker AL, Dufault B, Duarte R, Katz A. Data quality of electronic medical records in Manitoba: do problem lists accurately reflect chronic disease billing diagnoses? J Am Med Inform Assoc. 2016 Apr 23;23(6):1107-12.

4. Walker ER, McGee RE, Druss BG. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. JAMA Psych. 2015 Apr 1;72(4):334-41.

5. Gatov E, Rosella L, Chiu M, Kurdyak P. Trends in standardized mortality among individuals with schizophrenia, 1993–2012: a population-based, repeated cross-sectional study. CMAJ 2017;189:e1177-87.

6. Hennekens CH, Hennekens AR, Hollar D, Casey DE. Schizophrenia and increased risks of cardiovascular disease. Am Heart J. 2005 Dec 31;150(6):1115-21.

7. Goldstein BI, Fagiolini A, Houck P, Kupfer DJ. Cardiovascular disease and hypertension among adults with bipolar I disorder in the United States. Bipolar Disor. 2009 Sep 1;11(6):657-62.

8. Hirsch L, Yang J, Bresee L, Jette N, Patten S, Pringsheim T. Second-generation antipsychotics and metabolic side effects: a systematic review of population-based studies. Drug safety. 2017 Sep 1;40(9):771-81.

9. Spertus J, Horvitz-Lennon M, Abing H, Normand SL. Risk of weight gain for specific antipsychotic drugs: a meta-analysis. NPJ schizophrenia. 2018 Jun 27;4(1):1-7.

10. De Hert M, Dekker JM, Wood D, Kahl KG, Holt RI, Möller HJ. Cardiovascular disease and diabetes in people with severe mental illness position statement from the European Psychiatric Association (EPA), supported by the European Association for the Study of Diabetes (EASD) and the European Society of Cardiology (ESC). European Psych. 2009 Sep 1;24(6):412-24.

11. Bullock HL, Waddell K, & Wilson MG. Rapid synthesis: Identifying and assessing core components of collaborative-care models for treating mental and physical health conditions. Hamilton, Canada: McMaster Health Forum, 31 March 2017.

12. Slomp M, Bland R, Patterson S, Whittaker L. Three-year physician treated prevalence rate of mental disorders in Alberta. Can J Psych. 2009 Mar;54(3):199-203.

13. Government of Canada [Internet]: Ottawa, ON. Chapter 3: Schizophrenia – A report on mental illnesses in Canada. 2012. [cited 31 January 2018] Available from: https://www.canada.ca/en/public-health/services/reports-publications/report-on-mental-illnesses-canada/schizophrenia.htm

14. Saha S, Chant D, Welham J, McGrath J. A systematic review of the prevalence of schizophrenia. PLoS medicine. 2005 May 31;2(5):e141.

15. von Elm E , Altman DG , Egger M , et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Surg 2014;12:1495–9.doi:10.1016/j.ijsu.2014.07.013

16. University of Toronto Department of Family and Community Medicine [Internet]. University of Toronto Practice Based Research Network (UTOPIAN). [cited 31 January 2018] Available from: https://www.dfcm.utoronto.ca/landing-page/utopian

17. CPCSSN Team, Case Definitions: Canadian Primary Care Sentinel Surveillance Network (CPCSSN), Version 2. July 16, 2019. URL: http://cpcssn.ca/research-resources/cpcssn-case-definitions-v2

18. Williamson T, Green ME, Birtwhistle R, Khan S, Garies S, Wong ST, Natarajan N, Manca D, Drummond N. Validating the 8 CPCSSN case definitions for chronic disease surveillance in a primary care database of electronic health records. Ann Fam Med. 2014 Jul 1;12(4):367-72.

19. Wilkins R. Use of postal codes and addresses in the analysis of health data. Health Reports. 1993;5(2):157–77. pmid:8292756

20. Pampalon R, Hamel D, Gamache P, Raymond G. A deprivation index for health planning in Canada. Chronic Dis Can. 2009 Jan 1;29(4):178–91. pmid:1980468

21. Genest J, McPherson R, Frohlich J, Anderson T, Campbell N, Carpentier A, Couture P, Dufour R, Fodor G, Francis GA, Grover S. 2009 Canadian Cardiovascular

Society/Canadian guidelines for the diagnosis and treatment of dyslipidemia and prevention of cardiovascular disease in the adult–2009 recommendations. Canadian Journal of Cardiology. 2009 Oct 1;25(10):567-79.

22. Anderson TJ, Grégoire J, Hegele RA, Couture P, Mancini GJ, McPherson R, Francis GA, Poirier P, Lau DC, Grover S, Genest Jr J. 2012 update of the Canadian Cardiovascular Society guidelines for the diagnosis and treatment of dyslipidemia for the prevention of cardiovascular disease in the adult. Canadian Journal of Cardiology. 2013 Feb 1;29(2):151-67.

23. Allan GM, Lindblad AJ, Comeau A, Coppola J, Hudson B, Mannarino M, McMinis C, Padwal R, Schelstraete C, Zarnke K, Garrison S. Simplified lipid guidelines: Prevention and management of cardiovascular disease in primary care. Canadian Family Physician. 2015 Oct 1;61(10):857-67.

24. Pringsheim T, Kelly M, Urness D, Teehan M, Ismail Z, Gardner D. Physical Health and Drug Safety in individuals with schizophrenia. Can J Psych. 2017 Sep;62(9):673-83.

25. D'Agostino RB, Vasan RS, Pencina MJ, Wolf PA, Cobain M, Massaro JM, Kannel WB. General cardiovascular risk profile for use in primary care. Circulation. 2008 Feb 12;117(6):743-53.

26. O'Neill B, Kalia S, Aliarzadeh B, Moineddin R, Fung WL, Sullivan F, Maloul A, Bernard S, Greiver M. Agreement between primary care and hospital diagnosis of schizophrenia and bipolar disorder: A cross-sectional, observational study using record linkage. PLOS One. 2019 Jan 7;14(1):e0210214.

27. Martens PJ, Chochinov HM, Prior HJ, Fransoo R, Burland E, Team TN. Are cervical cancer screening rates different for women with schizophrenia? A Manitoba population-based study. Schizophrenia research. 2009 Aug 1;113(1):101-6.

28. Johnson JL, Ratner PA, Malchy LA, Okoli CT, Procyshyn RM, Bottorff JL, Groening M, Schultz A, Osborne M. Gender-specific profiles of tobacco use among non-institutionalized people with serious mental illness. BMC psychiatry. 2010 Dec;10(1):101.

29. Gerber, G.J., Krupa, T., Eastabrook, S., Gargaro, J., 2003. Substance use among persons with serious mental illness in eastern Ontario. Can J Community Ment Health 22, 113 – 128.

30. Tsoi DT, Porwal M, Webster AC. Interventions for smoking cessation and reduction in individuals with schizophrenia. Cochrane Database Sys Rev. 2013(2).

31. Weiskopf NG, Weng C. Methods and dimensions of electronic health record data quality assessment: enabling reuse for clinical research. J Am Inform Assoc. 2013 Jan 1;20(1):144-51.

32. Birtwhistle R, Williamson T. Primary care electronic medical records: a new data source for research in Canada. CMAJ. 2015 Mar 3;187(4):239-40.

33. Queenan JA, Williamson T, Khan S, Drummond N, Garies S, Morkem R, Birtwhistle R. Representativeness of patients and providers in the Canadian Primary Care Sentinel Surveillance Network: a cross-sectional study. CMAJ Open. 2016 Jan;4(1):E28.

34. Ontario Laboratory Information System. eHealth Ontario. https://www.ehealthontario.on.ca/en/for-healthcare-professionals/ontario-laboratories-information-system-olis

35. Hippisley-Cox J, Coupland C, Vinogradova Y, Robson J, Brindle P. Performance of the QRISK cardiovascular risk prediction algorithm in an independent UK sample of patients from general practice: a validation study. Heart. 2008 Jan 1;94(1):34-9.

36. Zomer E, Osborn D, Nazareth I, Blackburn R, Burton A, Hardoon S, Holt RI, King M, Marston L, Morris S, Omar R. Effectiveness and cost-effectiveness of a cardiovascular risk prediction algorithm for people with severe mental illness (PRIMROSE). BMJ open. 2017 Sep 1;7(9):e018181.

Tables

Table 1. Distribution of Framingham factors among patients with and without schizophrenia

	Schizophrenia				
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	P-values*
Age range (years)					-
40-44 years	28574	14.8%	700	14.3%	
45-49 years	29137	15.1%	753	15.4%	
50-54 years	30939	16.1%	784	16.1%	
55-59 years	31790	16.5%	832	17.0%	
60-64 years	27061	14.1%	707	14.5%	
65-69 years	22430	11.7%	588	12.0%	
70-75 years	22496	11.7%	518	10.6%	
Sex (M/F)					-
Female	106841	55.5%	2539	52.0%	
Male	85586	44.5%	2343	48.0%	
HDL level (mmol/L)					<0.0001
Missing	79437	41.3%	1842	37.7%	
0-0.89 mmol/L	8565	4.5%	375	7.7%	
0.9-1.19 mmol/L	27925	14.5%	866	17.7%	
1.2-1.29 mmol/L	11006	5.7%	272	5.6%	
1.3-1.59 mmol/L	28313	14.7%	703	14.4%	
1.60+ mmol/L	37181	19.3%	824	16.9%	
Total cholesterol (mmol/L)					<0.0001
Missing	81073	42.1%	1916	39.2%	
0-4.09 mmol/L	25388	13.2%	865	17.7%	
4.1-5.19 mmol/L	39801	20.7%	1068	21.9%	
5.2-6.19 mmol/L	30009	15.6%	663	13.6%	
6.2-7.19 mmol/L	11225	5.8%	252	5.2%	
7.2+ mmol/L	4931	2.6%	118	2.4%	
Systolic blood pressure (mmHg)					<0.0001
Missing	62934	32.7%	1245	25.5%	
120 mmHg or less	42293	22.0%	1445	29.6%	
120-129 mmHg	36752	19.1%	940	19.3%	
130-139 mmHg	28764	14.9%	725	14.9%	
140-149 mmHg	14043	7.3%	350	7.2%	
150-159 mmHg	5752	3.0%	124	2.5%	
160 mmHg or more	1889	1.0%	53	1.1%	
Smoking Status					0.0843
Missing	40109	20.8%	968	19.8%	
Non-smoker	125796	65.4%	2633	53.9%	
Smoker	26522	13.8%	1281	26.2%	
Type II Diabetes Mellitus					-
No	168151	87.4%	3953	81.0%	
Yes	24276	12.6%	929	19.0%	
Anti-Hypertensive medication					-
No	140415	73.0%	3486	71.4%	
Yes	52012	27.0%	1396	28.6%	

	Schizophrenia				
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	P-values*
Total	192427	100.0%	4882	100.0%	-

*p-values compare the proportion of missing data and non-missing data with respect to schizophrenia (using chi-square test with false discovery rate).

Table 2. Calculable Framingham score with respect to individual Framingham factors

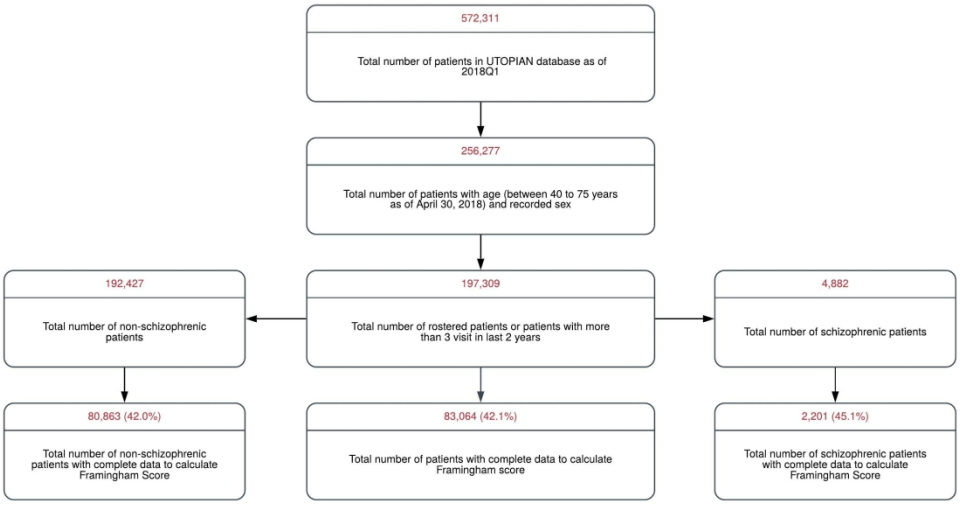
	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Age range (years)					
40-44 years	21922	74.9%	7352	25.1%	29274
45-49 years	20367	68.1%	9523	31.9%	29890
50-54 years	19024	60.0%	12699	40.0%	31723
55-59 years	18106	55.5%	14516	44.5%	32622
60-64 years	14143	50.9%	13625	49.1%	27768
65-69 years	10565	45.9%	12453	54.1%	23018
70-75 years	10118	44.0%	12896	56.0%	23014
Sex (M/F)					
Female	63352	57.9%	46028	42.1%	109380
Male	50893	57.9%	37036	42.1%	87929
HDL level (mmol/L)					
Missing	81279	100.0%	.	.	81279
0-0.89 mmol/L	2408	26.9%	6532	73.1%	8940
0.9-1.19 mmol/L	7973	27.7%	20818	72.3%	28791
1.2-1.29 mmol/L	3092	27.4%	8186	72.6%	11278
1.3-1.59 mmol/L	8069	27.8%	20947	72.2%	29016
1.60+ mmol/L	11424	30.1%	26581	69.9%	38005
Total cholesterol (mmol/L)					
Missing	82989	100.0%	.	.	82989
0-4.09 mmol/L	6336	24.1%	19917	75.9%	26253
4.1-5.19 mmol/L	11400	27.9%	29469	72.1%	40869
5.2-6.19 mmol/L	8686	28.3%	21986	71.7%	30672
6.2-7.19 mmol/L	3167	27.6%	8310	72.4%	11477
7.2+ mmol/L	1667	33.0%	3382	67.0%	5049
Systolic blood pressure (mmHg)					
Missing	62874	98.0%	1305	2.0%	64179
120 mmHg or less	18185	41.6%	25553	58.4%	43738
120-129 mmHg	14338	38.0%	23354	62.0%	37692
130-139 mmHg	10431	35.4%	19058	64.6%	29489
140-149 mmHg	5359	37.2%	9034	62.8%	14393
150-159 mmHg	2270	38.6%	3606	61.4%	5876
160 mmHg or more	788	40.6%	1154	59.4%	1942
Smoking Status	41077	100.0%	.	.	41077

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Missing					
Non-smoker	58342	45.4%	70087	54.6%	128429
Smoker	14826	53.3%	12977	46.7%	27803
Type II Diabetes Mellitus					
No	105354	61.2%	66750	38.8%	172104
Yes	8891	35.3%	16314	64.7%	25205
Anti-Hypertensive medication					
No	92342	64.2%	51559	35.8%	143901
Yes	21903	41.0%	31505	59.0%	53408
Total	114245	57.9%	83064	42.1%	197309

Table 3: Calculable Framingham score with respect to patient, provider and geographical characteristics

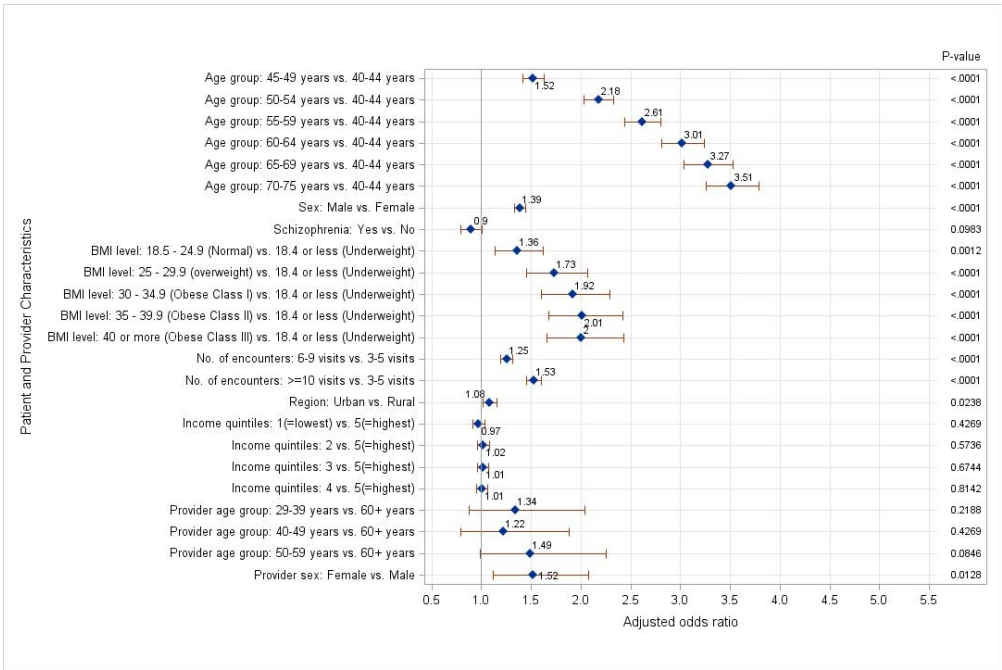
	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Schizophrenia					
No	111564	58.0%	80863	42.0%	192427
Yes	2681	54.9%	2201	45.1%	4882
BMI level (Kg/m^2)					
Missing	84398	77.7%	24206	22.3%	108604
18.4 or less (Underweight)	378	42.9%	503	57.1%	881
18.5 - 24.9 (Normal)	9191	38.6%	14619	61.4%	23810
25 - 29.9 (overweight)	10622	32.6%	21935	67.4%	32557
30 - 34.9 (Obese Class I)	5847	30.5%	13331	69.5%	19178
35 - 39.9 (Obese Class II)	2306	30.4%	5279	69.6%	7585
40 or more (Obese Class III)	1503	32.0%	3191	68.0%	4694
No. of encounters					
Missing	42673	86.0%	6952	14.0%	49625
3-5 visits	25915	58.6%	18311	41.4%	44226
6-9 visits	19861	48.8%	20830	51.2%	40691
>=10 visits	25796	41.1%	36971	58.9%	62767
Income Quintiles					
Missing	14795	58.9%	10326	41.1%	25121
1	15851	58.7%	11162	41.3%	27013
2	15883	58.3%	11348	41.7%	27231
3	17118	58.2%	12281	41.8%	29399
4	20810	57.8%	15221	42.2%	36031
5	29788	56.7%	22726	43.3%	52514
Region	2284	73.6%	819	26.4%	3103

	Calculable Framingham Score				Total
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	N
Missing					
Rural	11590	59.7%	7833	40.3%	19423
Urban	100371	57.4%	74412	42.6%	174783
Provider age					
Missing	5880	50.6%	5741	49.4%	11621
29-39 years	21926	54.1%	18618	45.9%	40544
40-49 years	23203	58.4%	16550	41.6%	39753
50-59 years	29127	55.9%	22943	44.1%	52070
60+ years	34109	64.0%	19212	36.0%	53321
Provider sex					
Female	52950	54.2%	44655	45.8%	97605
Male	61295	61.5%	38409	38.5%	99704
Total	114245	57.9%	83064	42.1%	197309



Distribution of Framingham risk factors among patients with and without schizophrenia

263x142mm (300 x 300 DPI)



Adjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

285x190mm (96 x 96 DPI)

Supplementary tables

Table S1: Unadjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

Unadjusted odds ratio						
Characteristics	**Index group**	**Reference group**	**Odds Ratio**	**Lower limit**	**Upper limit**	**P-value**
Age	45-49 years	40-44 years	1.49	1.434	1.547	<.0001
Age	50-54 years	40-44 years	2.24	2.162	2.329	<.0001
Age	55-59 years	40-44 years	2.78	2.681	2.887	<.0001
Age	60-64 years	40-44 years	3.50	3.371	3.640	<.0001
Age	65-69 years	40-44 years	4.44	4.266	4.626	<.0001
Age	70-75 years	40-44 years	5.05	4.850	5.262	<.0001
Sex	Male	Female	1.07	1.048	1.092	<.0001
Schizophrenia	Yes	No	1.25	1.173	1.327	<.0001
BMI level	18.5 - 24.9 (Normal)	18.4 or less (Underweight)	1.25	1.077	1.450	0.0043
BMI level	25 - 29.9 (overweight)	18.4 or less (Underweight)	1.77	1.522	2.047	<.0001
BMI level	30 - 34.9 (Obese Class I)	18.4 or less (Underweight)	2.03	1.749	2.361	<.0001
BMI level	35 - 39.9 (Obese Class II)	18.4 or less (Underweight)	2.09	1.784	2.437	<.0001
BMI level	40 or more (Obese Class III)	18.4 or less (Underweight)	1.99	1.695	2.342	<.0001
No. of encounters	6-9 visits	3-5 visits	1.60	1.558	1.653	<.0001
No. of encounters	>=10 visits	3-5 visits	2.39	2.320	2.455	<.0001
Region	Urban	Rural	1.06	1.026	1.105	0.0012
Income quintiles	1(=lowest)	5(=highest)	1.04	1.004	1.075	0.0326
Income quintiles	2	5(=highest)	1.05	1.020	1.089	0.0023
Income quintiles	3	5(=highest)	1.04	1.005	1.071	0.0261
Income quintiles	4	5(=highest)	1.00	0.974	1.034	0.8188
Provider age	29-39 years	60+ years	1.69	1.225	2.334	0.0020
Provider age	40-49 years	60+ years	1.36	0.972	1.914	0.0757
Provider age	50-59 years	60+ years	1.38	0.986	1.944	0.0655
Provider sex	Female	Male	1.61	1.296	2.012	<.0001

Table S2: Adjusted odds ratios for calculable Framingham score using random-effects multilevel logistic regression model

Adjusted odds ratio						
Characteristics	**Index group**	**Reference group**	**Odds Ratio**	**Lower limit**	**Upper limit**	**P-value**
Age group	45-49 years	40-44 years	1.52	1.41	1.63	<.0001
Age group	50-54 years	40-44 years	2.18	2.03	2.33	<.0001
Age group	55-59 years	40-44 years	2.61	2.44	2.80	<.0001
Age group	65-69 years	40-44 years	3.27	3.04	3.52	<.0001
Age group	70-75 years	40-44 years	3.51	3.26	3.78	<.0001
Sex	Male	Female	1.39	1.33	1.45	<.0001
Schizophrenia	Yes	No	0.90	0.79	1.01	0.0983
BMI level	18.5 - 24.9 (Normal)	18.4 or less (Underweight)	1.36	1.14	1.62	0.0012
BMI level	25 - 29.9 (overweight)	18.4 or less (Underweight)	1.73	1.45	2.07	<.0001
BMI level	30 - 34.9 (Obese Class I)	18.4 or less (Underweight)	1.92	1.60	2.29	<.0001
BMI level	35 - 39.9 (Obese Class II)	18.4 or less (Underweight)	2.01	1.67	2.42	<.0001
BMI level	40 or more (Obese Class III)	18.4 or less (Underweight)	2.00	1.66	2.43	<.0001
No. of encounters	6-9 visits	3-5 visits	1.25	1.19	1.31	<.0001
No. of encounters	>=10 visits	3-5 visits	1.53	1.46	1.60	<.0001
Region	Urban	Rural	1.08	1.02	1.16	0.0238
Income quintiles	1(=lowest)	5(=highest)	0.97	0.91	1.03	0.4269
Income quintiles	2	5(=highest)	1.02	0.96	1.08	0.5736
Income quintiles	3	5(=highest)	1.01	0.96	1.07	0.6744
Income quintiles	4	5(=highest)	1.01	0.96	1.06	0.8142
Provider age group	29-39 years	60+ years	1.34	0.88	2.04	0.2188
Provider age group	40-49 years	60+ years	1.22	0.79	1.88	0.4269
Provider age group	50-59 years	60+ years	1.49	0.98	2.26	0.0846
Provider sex	Female	Male	1.52	1.12	2.07	0.0128

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

Cardiovascular disease risk in patients with schizophrenia: retrospective cohort study of risk factor documentation and management in primary care electronic medical records

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7/8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	

Outcome data	15*	Report numbers of outcome events or summary measures over time	8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.