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# BMJ Open

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

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7 3 **Cardiovascular disease risk in patients with schizophrenia: retrospective cohort study of**  
8 4 **risk factor documentation and management in primary care electronic medical records**  
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47 25 Canada.

48 26 There was no patient and public involvement in the design or conduct of this study.

49 27 Keywords: cardiovascular diseases; schizophrenia; primary health care; electronic health  
50 28 records; primary prevention

51 29 Word count: 2384  
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## 32 Abstract

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

38 **Design:** Retrospective cohort study

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

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

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

47 **Results:** Documentation of cardiovascular risk factors was more complete among people with  
48 schizophrenia (74.5% of whom had blood pressure documented at least once in the last two years  
49 versus 67.3% of those without,  $p > 0.0001$ ). Smoking status was not documented in 19.8% of  
50 those with schizophrenia and 20.8% of those without ( $p = 0.0843$ ). Factors associated with  
51 improved documentation included older patients (OR for age 70-75 vs 45-49 = 3.51, 95% CI  
52 3.26-3.78), male patients (OR = 1.39, 95% CI 1.33-1.45), patients cared for by a female provider  
53 (OR = 1.52, 95% CI: 1.12-2.07), and increased number of encounters (OR for  $\geq 10$  visits vs 3-5  
54 visits = 1.53, 95% CI 1.46-1.60).

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

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3 63 **Article summary:**  
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7 65 • This study analyzes data from the University of Toronto Practice-Based Research  
8 66 Network (UTOPIAN) Data Safe Haven, one of the world's largest primary care  
9 67 electronic medical record (EMR) databases  
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12 68 • It uses de-identified data from primary care charts to identify cardiovascular disease risk  
13 69 factors  
14  
15 70 • Strengths of the study include the sample size and the breadth of data included, from  
16 71 approximately 400 primary care clinics in Ontario, Canada  
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18  
19 72 • Weaknesses include possible missing data resulting from the process of transferring data  
20 73 from primary care charts into a de-identified database, and the fact that the clinics  
21 74 included in the database are mainly urban and suburban academic clinics; these results  
22 75 may not necessarily be generalizable to all primary care settings  
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## 93 Introduction

94  
95 High quality, comprehensive data are needed to understand health and how to improve it. Risk  
96 factors must be known and documented so that interventions can be planned and implemented.

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

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

113 The primary prevention of cardiovascular disease includes addressing risk factors such as  
114 tobacco use and hypertension; these are commonly managed in primary care. This is particularly  
115 true for people with serious mental illness, who are seen more frequently by family physicians  
116 than by psychiatrists.(10) The prevalence of schizophrenia in the general adult population is 1-  
117 3%, making it a relatively common condition.(11,12) The prevalence and frequency of  
118 interaction strongly supports the important role played by family medicine in reducing the risk of  
119 cardiovascular disease for people with mental illness. To do this effectively it is necessary to  
120 understand what that risk is and what variables should be focused on.

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3 121 As a first step in establishing patients' physical health status and identifying who to target for  
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5 122 interventions to improve health, it is necessary to understand their health status . Whether data  
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7 123 completeness concerns regarding cardiovascular disease risk are general to all patients or  
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9 124 whether they are more pronounced amongst those with serious mental illness is unknown.

10  
11 125 Our study objectives were: to describe documentation of cardiovascular disease risk factors  
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13 126 (HDL, LDL, total cholesterol; blood pressure; smoking status) among patients with and without  
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15 127 schizophrenia; and to explore patient and provider characteristics associated with sufficient  
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17 128 documentation of these risk factors to calculate the Framingham risk score for patients with  
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19 129 schizophrenia.

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## 21 131 **Methods**

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25 133 This is an observational retrospective cohort study design. We applied the STrengthening the  
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27 134 Reporting of OBservational studies in Epidemiology checklist for reporting observational  
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29 135 studies.(13) Ethics approval was obtained from the North York General Hospital Research Ethics  
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31 136 Board, approval #18-0006.

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### 33 138 *Setting and data sources*

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37 140 We used data from the University of Toronto Practice-Based Research Network (UTOPIAN)  
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39 141 Data Safe Haven, a primary care electronic medical record (EMR) database; data extracted as of  
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41 142 April 1 2018 were used for this project.(14) The UTOPIAN Data Safe Haven contains EMR  
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43 143 records from over 550 000 patients who access care in primary care practices in the Greater  
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45 144 Toronto Area in Ontario, Canada. Physicians have consented to the provision of de-identified  
46  
47 145 data, housed in a secure environment. These data are used for quality improvement and research  
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49 146 purposes. The UTOPIAN database includes validated definitions for eight long-term conditions:  
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51 147 osteoarthritis, diabetes, epilepsy, parkinsonism, dementia, hypertension, COPD,  
52  
53 148 depression.(15,16) Neighbourhood level income quintiles are also available from patient  
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55 149 residential postal codes using Statistics Canada's Postal Code Conversion Files.(17,18)

56 150



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*Study population*

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

171

172 We identified patients that were 40-75 years of age as of March 31, 2018. We limited our cohort  
173 definition to those that had at least 3 primary care visits in the 2 year period between April 1,  
174 2016 and March 31, 2018. To identify outcomes we looked at whether people had CVD risk  
175 factors as outlined above documented at least once in the above period. This definition ensured  
176 that we included patients likely to be routinely followed by the providers whose records are  
177 included in the database, and is consistent with our usual approach for studies using this  
178 database. We identified patients with schizophrenia using the same definition used in a previous  
179 study using the same database, using a combination of encounter diagnoses used for billing  
180 purposes as well as documentation of the condition in the electronic medical record.(24)

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5 183 *Statistical analysis*6  
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8 185 We compared the documentation of cardiovascular disease (CVD) risk factors included in the  
9 186 Framingham risk calculator between those with and without schizophrenia using a chi-square  
10 187 test. In particular, the CVD risk factors included: HDL cholesterol, SBP, total cholesterol  
11 188 measured in the last two years of study follow-up, and whether smoking status had ever been  
12 189 recorded. The relationship between the complete documentation of all Framingham elements  
13 190 was also assessed with respect to patient characteristics (age, sex, number of encounters in two  
14 191 years of study follow-up, diagnosis of schizophrenia, most recent body mass index in the last two  
15 192 years of study follow-up), provider characteristics (age, sex) and geographical characteristics  
16 193 (income quintiles, rurality). A mixed-effects multilevel logistic regression was used to estimate  
17 194 unadjusted and adjusted odds ratios for the complete documentation of all Framingham elements  
18 195 (i.e. calculable Framingham score). Providers were specified as a random effect in the regression  
19 196 model.

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22 198 All statistical analyses were generated using SAS software, version 9.4 M4 (SAS Institute). A  
23 199 fixed nominal level of 0.05 was used to determine statistical significance in this study.

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25 200

## 26 201 **Results**

### 27 202 *Cohort generation*

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30 204 Data from 376 physicians practicing in 96 different clinic sites were included. In total, 197,309  
31 205 patients were identified with age between 40-75 years old (as of March 31, 2018), recorded sex  
32 206 and had at least 3 visits in the two years of interest (Figure 1). Out of 197,309 patients, 83,064  
33 207 patients (40.4%) had adequate data to calculate a Framingham risk score using the most recent  
34 208 data available for HDL, SBP, and total cholesterol in the last 2 years and smoking status ever  
35 209 recorded. Of these, 4880 patients met the definition of schizophrenia and 2130 (43.8%) of these  
36 210 patients with schizophrenia had complete documentation to calculate the Framingham risk score.

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39 212 FIGURE 1 HERE

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3 2134  
5 214 *Individual Framingham Data Elements*6  
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8 216 We compared the presence of individual Framingham elements between 4882 patients with  
9 217 schizophrenia and 192247 patients without, over a two year look back window (April 1, 2016 –  
10 218 March 31, 2018) (Table 1). Framingham elements were documented more completely among  
11 219 those with schizophrenia: 25.5% of those with schizophrenia and 32.7% of those without had no  
12 220 documented blood pressure readings over the last two years ( $p < 0.0001$ ). 39.2% of those with  
13 221 schizophrenia and 42.1% of those without did not have any cholesterol readings ( $p < 0.0001$ ).  
14 222 There was no difference in documentation of smoking status between the two groups ( $p = 0.084$ ),  
15 223 with documentation missing in approximately 20% of all charts.  
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22 22523  
24 226 TABLE 1 HERE25  
26 22727 228 *Patient, provider and geographical characteristics as predictors of calculable Framingham*  
28 229 *score*29  
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31 230

32 231 Overall, patients with schizophrenia appeared to have decreased adjusted odds for the complete  
33 232 documentation of Framingham score as compared to patients without schizophrenia, but this was  
34 233 not statistically significant (OR = 0.90, 95% CI 0.79 – 1.01,  $p$ -value=0.07) (Figure 2). Individual  
35 234 patient characteristics between those who had complete documentation of Framingham score  
36 235 factors and those who did not are in Table 2. The adjusted odds for the complete documentation  
37 236 of Framingham factors increased with respect to the patient's age (70-75 years vs 40-44 years  
38 237 OR = 3.51, 95% CI 3.26 – 3.78). Male patients had increased adjusted odds of calculable  
39 238 Framingham score as compared to female patients (male vs. female OR = 1.39, 95% CI 1.33 –  
40 239 1.45). An increase in the BMI level was associated with an increase in adjusted odds for  
41 240 calculable Framingham score (Obese class III vs. Underweight, OR = 2.00, 95% CI 1.66 – 2.43)  
42 241 (Table 3). An increase in the total number of encounters also led to increased adjusted odds for  
43 242 the complete documentation of Framingham factors (more than 10 visits vs. 3-5 visits in last two  
44 243 years OR = 1.53, 95% CI 1.46 – 1.60).

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3 244 TABLE 2 HERE  
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5 245 Patients residing in urban regions had higher adjusted odds for the complete documentation of  
6 246 Framingham factors as compared to patients residing in rural regions (OR=1.08, 95% CI: 1.02 –  
7 247 1.16). However, no significant differences in adjusted odds ratios were detected across the five  
8  
9 248 levels of income quintiles (1 vs 5, OR=0.97, 95% CI: 0.91-1.03, p-value=0.38). Female  
10 249 physicians had increased adjusted odds for the complete documentation of Framingham factors  
11  
12 250 as compared to male physicians (OR=1.52, 95% CI: 1.12 – 2.07). However, provider age did not  
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14 251 contribute to increased or decreased adjusted odds for calculable Framingham score (29-39 years  
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16 252 vs. 60+ years, OR=1.49, 95% CI: 0.98 – 2.26, p-value=0.06).  
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19 253 TABLE 3 HERE  
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## 23 255 **Discussion** 24

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27 257 In this study of primary care electronic medical records from the University of Toronto Practice-  
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29 258 Based Research Network, we found better documentation of cardiovascular risk factors among  
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31 259 people with schizophrenia as opposed to those without the condition. However, overall  
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33 260 documentation was inadequate.  
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35 261 Other studies on preventive health for people with schizophrenia, such as those addressing  
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37 262 cancer screening, have found lower rates of preventive care when compared with the general  
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39 263 population.(25) We actually found more complete documentation of some risk factors among  
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41 264 people with schizophrenia when compared to those without, such as blood pressure. There are  
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43 265 various recommendations for frequency of cardiovascular disease risk screening in the general  
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45 266 population; Allan et al suggested every 5 years for men over 40 and women over 50.(21) More  
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47 267 complete documentation of risk factors would be expected based on guidelines suggesting more  
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49 268 frequent cardiovascular disease risk assessment among people who are on antipsychotic  
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51 269 medication.(12) To some extent the present study demonstrates a promising finding, suggesting  
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53 270 that patients with schizophrenia are receiving at least as good care from this perspective as those  
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55 271 without the condition. It is, however, quite concerning that there are substantial gaps in  
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57 272 documentation of particular risk factors such as smoking cessation. Nearly 20% of patients did  
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59 273 not have smoking status documented in the chart. We suggest that if it is not documented, then it  
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3 274 is extremely unlikely that smoking cessation has been addressed at a primary care visit. Smoking  
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5 275 is highly prevalent among people with schizophrenia; Canadian estimates range from 47% (26)  
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7 276 and 78% (27). There are many effective interventions to support patients with schizophrenia to  
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9 277 stop smoking.(28) It is therefore essential to document smoking status for all patients with  
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11 278 schizophrenia and to make smoking cessation a priority.

12  
13 279 We found several factors associated with what we assessed to be ‘appropriate’ documentation of  
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15 280 risk factors sufficient for cardiovascular risk assessment.

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17 281 Limitations of this study include the use of EMR data, which is known to have deficiencies  
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19 282 around data quality and completeness.(29,30) UTOPIAN, as part of the Canadian Primary Care  
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21 283 Sentinel Surveillance Network, is disproportionately comprised of more providers in academic  
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23 284 practices and has an older population than the Canadian average.(31) These findings therefore  
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25 285 may not be generalizable to all Canadian primary care settings. UTOPIAN contains data from  
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27 286 multiple EMR vendors and as a consequence there is the possibility that some data may be  
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29 287 missing as a result of errors in database formation; these data are extracted with the best  
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31 288 available approaches and regular data cleaning attempts to minimize these errors. Other studies  
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33 289 have found some deficiencies, particularly related to documentation of health conditions, in  
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35 290 EMR data in the Canadian setting.(3) There are no Canadian national standards for necessary  
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37 291 elements of EMR documentation in primary care. In Ontario, laboratory results enter most  
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39 292 physicians’ EMRs through the Ontario Laboratory Information System (32) which is an  
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41 293 automatic process, reducing the extent to which documentation is incomplete because of  
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43 294 provider error. Our focus on ‘documentation’ in this study is as a result of the practical principle  
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45 295 that if something is not documented, it cannot be acted on; therefore data documentation and  
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47 296 completeness are being taken as a proxy for their consideration in clinical decision-making. It is  
48  
49 297 not possible from the data considered in this study to ascertain whether a provider has attempted  
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51 298 to intervene towards smoking cessation, or whether someone has addressed blood pressure  
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53 299 management. There are other available risk stratification approaches available both for the  
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55 300 general population [such as QRISK2 (33)] and specifically for people with serious mental illness  
56  
57 301 [PRIMROSE (34)]. We chose to focus on the Framingham assessment because it is the most  
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59 302 commonly used in Canadian primary care and therefore would be most relevant to the study  
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303 context.

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3 304 In summary, we found slightly more complete documentation of cardiovascular risk factors and  
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5 305 their management among people with schizophrenia as opposed to those without this condition.  
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7 306 However, overall documentation of these risk factors remains incomplete. Adequate  
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9 307 cardiovascular disease risk assessment is essential to identifying and addressing risk factors,  
10  
11 308 particularly among people with schizophrenia who have much higher mortality from  
12  
13 309 cardiovascular disease (and other conditions) than the general public. Efforts should be  
14  
15 310 undertaken in primary care to improve data completeness and CVD risk assessment and  
16  
17 311 management.

18 312  
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20 313 **Conflicts of interest:** All authors report that they have no conflicts of interest to declare.

21  
22  
23 314 **Data statement:** Data from this study are held by the University of Toronto Practice-Based  
24  
25 315 Research Network; ethics approval for this study does not allow unrestricted public access to the  
26  
27 316 data. Please contact the corresponding author for information on how to access.

28  
29 317 **Author statement:** BO, SK, BA, FS, RM, MK, MG contributed to the initial conception of the  
30  
31 318 study. BO, SK, BA, RM made substantial contributions to the statistical methodology, analysis  
32  
33 319 and data interpretation. BO and SK wrote the first draft of the manuscript. BO, SK, BA, FS, MK,  
34  
35 320 MG provided substantial revisions to the manuscript.

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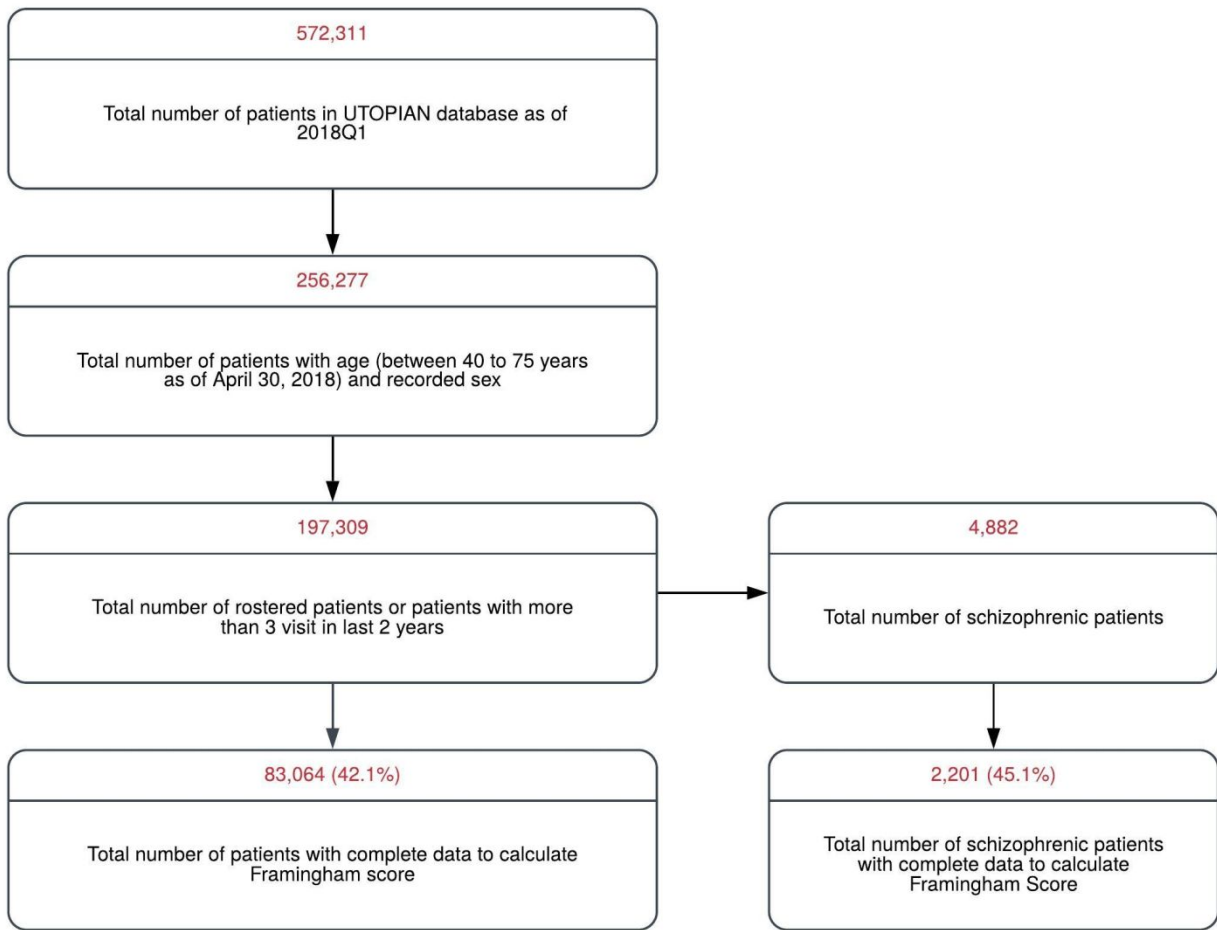
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495 **Figures and tables**

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Figure 1. Cohort generation



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

	Schizophrenia				P-values*
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	
<b>Age range (years)</b>					-
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%	
<b>Sex (M/F)</b>					-
Female	106841	55.5%	2539	52.0%	
Male	85586	44.5%	2343	48.0%	
<b>HDL level (mmol/L)</b>					<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%	
<b>Total cholesterol (mmol/L)</b>					<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%	
<b>Systolic blood pressure (mmHg)</b>					<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%	
<b>Smoking Status</b>					0.0843
Missing	40109	20.8%	968	19.8%	
Non-smoker	125796	65.4%	2633	53.9%	
Smoker	26522	13.8%	1281	26.2%	
<b>Type II Diabetes Mellitus</b>					-
No	168151	87.4%	3953	81.0%	
Yes	24276	12.6%	929	19.0%	
<b>Anti-Hypertensive medication</b>					-
No	140415	73.0%	3486	71.4%	

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

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

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

	Calculable Framingham Score				Total N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
<b>Age range (years)</b>					
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
<b>Sex (M/F)</b>					
Female	63352	57.9%	46028	42.1%	109380
Male	50893	57.9%	37036	42.1%	87929
<b>HDL level (mmol/L)</b>					
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
<b>Total cholesterol (mmol/L)</b>					
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
<b>Systolic blood pressure (mmHg)</b>					
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 N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
<b>Smoking Status</b>					
Missing	41077	100.0%	.	.	41077
Non-smoker	58342	45.4%	70087	54.6%	128429
Smoker	14826	53.3%	12977	46.7%	27803
<b>Type II Diabetes Mellitus</b>					
No	105354	61.2%	66750	38.8%	172104
Yes	8891	35.3%	16314	64.7%	25205
<b>Anti-Hypertensive medication</b>					
No	92342	64.2%	51559	35.8%	143901
Yes	21903	41.0%	31505	59.0%	53408
<b>Total</b>	114245	57.9%	83064	42.1%	197309

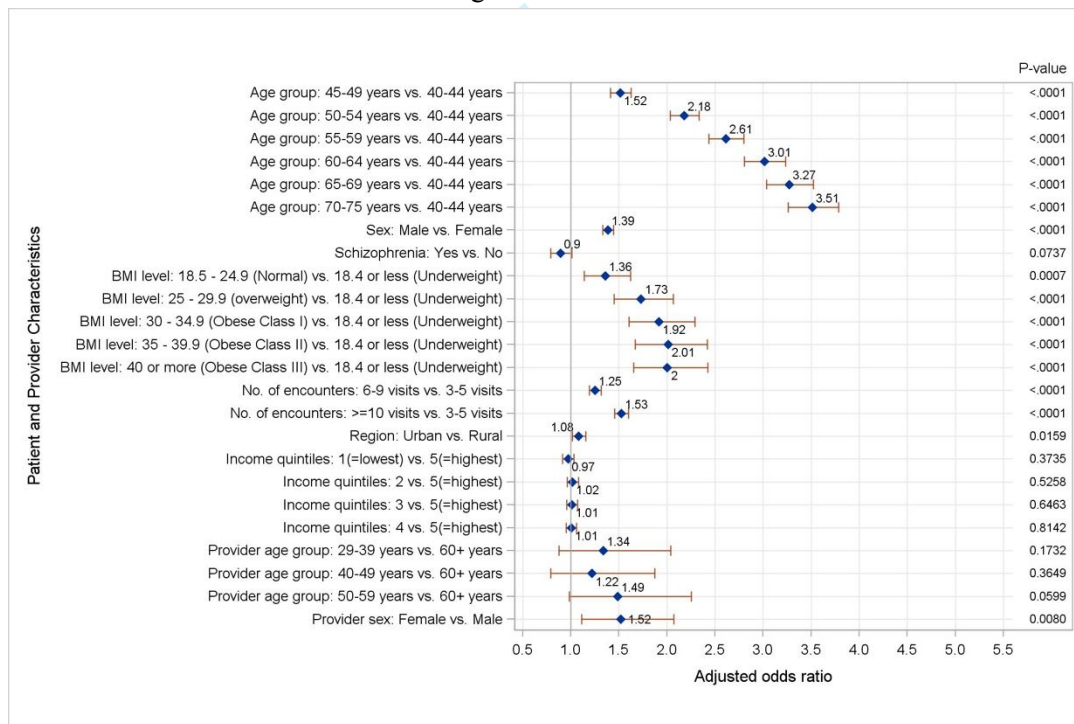
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523 Table 3: Calculable Framingham score with respect to patient, provider and geographical  
524 characteristics

	Calculable Framingham Score				Total N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
<b>Schizophrenia</b>					
No	111564	58.0%	80863	42.0%	192427
Yes	2681	54.9%	2201	45.1%	4882
<b>BMI level (Kg/m<sup>2</sup>)</b>					
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
<b>No. of encounters</b>					
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
<b>Income Quintiles</b>					
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 N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
<b>Region</b>					
Missing	2284	73.6%	819	26.4%	3103
Rural	11590	59.7%	7833	40.3%	19423
Urban	100371	57.4%	74412	42.6%	174783
<b>Provider age</b>					
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
<b>Provider sex</b>					
Female	52950	54.2%	44655	45.8%	97605
Male	61295	61.5%	38409	38.5%	99704
<b>Total</b>	114245	57.9%	83064	42.1%	197309

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



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536 **Supplementary tables**

537 Table S1: Unadjusted odds ratios for calculable Framingham score using random-effects multilevel  
 538 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

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550 Table S2: Adjusted odds ratios for calculable Framingham score using random-effects multilevel logistic  
 551 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

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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
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1 2
<b>Introduction</b>			
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
<b>Methods</b>			
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 (b) For matched studies, give matching criteria and number of exposed and unexposed	6
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 (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	7
<b>Results</b>			
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 (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	7/8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	8

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Outcome data	15*	Report numbers of outcome events or summary measures over time	8
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For peer review only

1	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	8
2			(b) Report category boundaries when continuous variables were categorized	
3			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
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9	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
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11	<b>Discussion</b>			
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13	Key results	18	Summarise key results with reference to study objectives	9
14	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
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16	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
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19	Generalisability	21	Discuss the generalisability (external validity) of the study results	10
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21	<b>Other information</b>			
22	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
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\*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>.

# BMJ Open

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

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<b>Primary Subject Heading</b>:	General practice / Family practice
Secondary Subject Heading:	Cardiovascular medicine, Health services research, Mental health
Keywords:	Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, Cardiology < INTERNAL MEDICINE, MENTAL HEALTH, PRIMARY CARE, PREVENTIVE MEDICINE, Schizophrenia & psychotic disorders < PSYCHIATRY

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7 3 **Cardiovascular risk factor documentation and management in primary care electronic**  
8 4 **medical records among people with schizophrenia: retrospective cohort study**  
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12 6 Braden O'Neill<sup>1,2,3</sup>, Sumeet Kalia<sup>2</sup>, Babak Aliarzadeh<sup>2</sup>, Frank Sullivan<sup>1,4</sup>, Rahim Moineddin<sup>3</sup>,  
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42  
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46 26 Canada.  
47

48 27 There was no patient and public involvement in the design or conduct of this study.  
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50 28 Keywords: cardiovascular diseases; schizophrenia; primary health care; electronic health  
51 29 records; primary prevention  
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53 30 Word count: 2384  
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**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  $\geq 10$  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.

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### 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

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7 94 **Introduction**8  
9 9510 96 High quality, comprehensive data are needed to understand health and how to improve it. Risk  
11 97 factors must be known and documented so that interventions can be planned and implemented.12  
13  
14 98 One of the key challenges in primary care research has been the availability and quality of data.

15 99 When Julian Tudor Hart conducted research on patients accessing care in his practice in Wales in

16 100 the 1970s, it required laboriously searching through individual paper charts to collect necessary

17 101 data.(1) Today, electronic medical records are widely used and can facilitate instant searches at

18 102 the practice level as well as at local and national levels through databases that aggregate data

19 103 from multiple practices. However, several studies have demonstrated that important data – for

20 104 example, regarding cardiovascular risk factors such as smoking and whether someone has a

21 105 diagnosis of hypertension – remain incomplete.(2,3)

22  
23  
24 106 People with serious mental illnesses, particularly those with schizophrenia, die 8 to 10 years

25 107 earlier than those without these conditions.(4,5) This is primarily due to higher rates of

26 108 cardiovascular disease.(5-7) While the long-term metabolic effects of antipsychotic medications

27 109 used to treat schizophrenia are unclear, their use is associated with increased weight and blood

28 110 glucose.(8,9) Patients may also face challenges with self-care or accessing appropriate medical

29 111 care.(10) To date there is sparse evidence about how to improve physical health status in these

30 112 patients; a recent review of ‘collaborative care’ where both physical and mental health are

31 113 attended to for these patients did not find any evidence of reductions in cardiovascular disease

32 114 risk.(11)

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34  
35 115 The primary prevention of cardiovascular disease includes addressing risk factors such as

36 116 tobacco use and hypertension; these are commonly managed in primary care. This is particularly

37 117 true for people with serious mental illness, who are seen more frequently by family physicians

38 118 than by psychiatrists.(12) The prevalence of schizophrenia in the general adult population is 1-

39 119 3%, making it a relatively common condition.(13,14) The prevalence and frequency of

40 120 interaction strongly supports the important role played by family medicine in reducing the risk of

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3 121 cardiovascular disease for people with mental illness. To do this effectively it is necessary to  
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5 122 understand what that risk is and what variables should be focused on.  
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7 123 As a first step in establishing patients' physical health status and identifying who to target for  
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9 124 interventions to improve health, it is necessary to understand their health status. Whether data  
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11 125 completeness concerns regarding cardiovascular disease risk are general to all patients or  
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13 126 whether they are more pronounced amongst those with serious mental illness is unknown.  
14

15 127 Our study objectives were: to describe documentation of cardiovascular disease risk factors  
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17 128 (HDL, LDL, total cholesterol; blood pressure; smoking status) among patients with and without  
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19 129 schizophrenia; and to explore patient and provider characteristics associated with sufficient  
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21 130 documentation of these risk factors to calculate the Framingham risk score for patients with  
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23 131 schizophrenia.  
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## 26 133 **Methods**

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30 135 This is an observational retrospective cohort study design. We applied the STrengthening the  
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32 136 Reporting of OBServational studies in Epidemiology checklist for reporting observational  
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34 137 studies.(15) Ethics approval was obtained from the North York General Hospital Research Ethics  
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36 138 Board, approval #18-0006.  
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### 39 140 *Setting and data sources*

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42 142 We used data from the University of Toronto Practice-Based Research Network (UTOPIAN)  
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44 143 Data Safe Haven, a primary care electronic medical record (EMR) database; data extracted as of  
45  
46 144 April 1 2018 were used for this project.(16) The UTOPIAN Data Safe Haven contains EMR  
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48 145 records from over 550 000 patients who access care in primary care practices in the Greater  
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50 146 Toronto Area in Ontario, Canada. Physicians have consented to the provision of de-identified  
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52 147 data, housed in a secure environment. These data are used for quality improvement and research  
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54 148 purposes. The UTOPIAN database includes validated definitions for eight long-term conditions:  
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56 149 osteoarthritis, diabetes, epilepsy, parkinsonism, dementia, hypertension, COPD,  
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3 150 depression.(17,18) Neighbourhood level income quintiles are also available from patient  
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5 151 residential postal codes using Statistics Canada's Postal Code Conversion Files.(19,20)  
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11 154 *Study population*  
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14 156 We included patients 40-75 years of age because Canadian guidelines recommend regular  
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16 157 screening for cardiovascular disease (CVD) risk in this age range. There is no clear consensus on  
17  
18 158 the recommended interval for screening, which varies between yearly to every 5 years.(21-23)  
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20 159 Guidelines suggest yearly CVD risk assessment for patients with schizophrenia (24); however  
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22 160 these are not routinely followed in primary care practice and this increased frequency is  
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24 161 consensus-based and not necessarily supported by strong evidence. We therefore chose to look at  
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26 162 a two year interval in which screening could have taken place, recognizing that there may be  
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28 163 some patients for whom it may be appropriate to screen less often. The most commonly used  
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30 164 CVD risk assessment tool in Canadian primary care practice is the Framingham risk calculator  
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32 165 (25), which includes the following items: (i) age, (ii) sex, (iii) smoking history, (iv) presence of  
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34 166 diabetes, (v) systolic blood pressure (SBP), (vi) whether a patient is currently on medication to  
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36 167 reduce blood pressure, (vii) total cholesterol, and (viii) high density lipoprotein (HDL)  
37  
38 168 cholesterol. This is a validated risk stratification tool that establishes a patient's risk of  
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40 169 developing cardiovascular disease (CVD; including: coronary death, myocardial infarction,  
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42 170 coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack,  
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44 171 peripheral artery disease, heart failure) within the next 10 years. It is valid for patients 30 – 74  
45  
46 172 years of age.(25)  
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48 173

49 174 We identified patients that were 40-75 years of age as of March 31, 2018. We limited our cohort  
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51 175 definition to those that had at least 3 primary care visits in the 2 year period between April 1,  
52  
53 176 2016 and March 31, 2018. To identify outcomes we looked at whether people had CVD risk  
54  
55 177 factors as outlined above documented at least once in the above period. This definition ensured  
56  
57 178 that we included patients likely to be routinely followed by the providers whose records are  
58  
59 179 included in the database, and is consistent with our usual approach for studies using this  
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180 database. We identified patients with schizophrenia using the same definition used in a previous

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3 181 study using the same database, using a combination of encounter diagnoses used for billing  
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5 182 purposes as well as documentation of the condition in the electronic medical record.(26)

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10 185 *Statistical analysis*

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13 187 We compared the documentation of cardiovascular disease (CVD) risk factors included in the  
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15 188 Framingham risk calculator between those with and without schizophrenia using a chi-square  
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17 189 test. P-values derived from multiple hypothesis tests were adjusted using false discovery rates. In  
18  
19 190 particular, the CVD risk factors included: HDL cholesterol, SBP, total cholesterol measured in  
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21 191 the last two years of study follow-up, and whether smoking status had ever been recorded. The  
22  
23 192 relationship between the complete documentation of all Framingham elements was also assessed  
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25 193 with respect to patient characteristics (age, sex, number of encounters in two years of study  
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27 194 follow-up, diagnosis of schizophrenia, most recent body mass index in the last two years of study  
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29 195 follow-up), provider characteristics (age, sex) and geographical characteristics (income quintiles,  
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31 196 rurality). A mixed-effects multilevel logistic regression was used to estimate unadjusted and  
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33 197 adjusted odds ratios for the complete documentation of all Framingham elements (i.e. calculable  
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35 198 Framingham score). Providers were specified as a random effect in the regression model.

36 199

37 200 All statistical analyses were generated using SAS software, version 9.4 M4 (SAS Institute). A  
38 201 fixed nominal level of 0.05 was used to determine statistical significance in this study.

39 202

## 40 203 **Results**

41 204 *Cohort generation*

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44 206 Data from 376 physicians practicing in 96 different clinic sites were included. In total, 197,309  
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46 207 patients were identified with age between 40-75 years old (as of March 31, 2018), recorded sex  
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48 208 and had at least 3 visits in the two years of interest (Figure 1). Out of 197,309 patients, 83,064  
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50 209 patients (40.4%) had adequate data to calculate a Framingham risk score using the most recent  
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52 210 data available for HDL, SBP, and total cholesterol in the last 2 years and smoking status ever  
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3 211 recorded. Of these, 4880 patients met the definition of schizophrenia and 2130 (43.8%) of these  
4 212 patients with schizophrenia had complete documentation to calculate the Framingham risk score.

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8 214 FIGURE 1 HERE

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10 216 *Individual Framingham Data Elements*

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12 218 We compared the presence of individual Framingham elements between 4882 patients with  
13 219 schizophrenia and 192247 patients without, over a two year look back window (April 1, 2016 –  
14 220 March 31, 2018) (Table 1). Framingham elements were documented more completely among  
15 221 those with schizophrenia: 25.5% of those with schizophrenia and 32.7% of those without had no  
16 222 documented blood pressure readings over the last two years ( $p < 0.0001$ ). 39.2% of those with  
17 223 schizophrenia and 42.1% of those without did not have any cholesterol readings ( $p < 0.0001$ ).  
18 224 There was no difference in documentation of smoking status between the two groups ( $p = 0.084$ ),  
19 225 with documentation missing in approximately 20% of all charts.

20 226

21 227 TABLE 1 HERE

22 228

23 229 *Patient, provider and geographical characteristics as predictors of calculable Framingham*  
24 230 *score*

25 231

26 232 Individual patient characteristics between those who had complete documentation of  
27 233 Framingham score factors and those who did not are in Table 2 and Table 3. Unadjusted and  
28 234 adjusted odds ratios for the complete documentation of Framingham score are in supplementary  
29 235 Table S1 and Table S2.

30 236

31 237 Patients with schizophrenia did not have statistically significant decreased adjusted odds for the  
32 238 complete documentation of Framingham score as compared to patients without schizophrenia,  
33 239 (OR = 0.90, 95% CI 0.79 – 1.01,  $p$ -value=0.10) (Figure 2). The adjusted odds for the complete  
34 240 documentation of Framingham factors increased with respect to the patient's age (70-75 years vs  
35 241 40-44 years OR = 3.51, 95% CI 3.26 – 3.78). Male patients had increased adjusted odds of

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3 242 calculable Framingham score as compared to female patients (male vs. female OR = 1.39, 95%  
4 243 CI 1.33 – 1.45). An increase in the BMI level was associated with an increase in adjusted odds  
5 244 for calculable Framingham score (Obese class III vs. Underweight, OR = 2.00, 95% CI 1.66 –  
6 245 2.43) (Table 3). An increase in the total number of encounters also led to increased adjusted odds  
7 246 for the complete documentation of Framingham factors (more than 10 visits vs. 3-5 visits in last  
8 247 two years OR = 1.53, 95% CI 1.46 – 1.60).  
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15 248  
16 249 TABLE 2 HERE

17 250 Patients residing in urban regions had higher adjusted odds for the complete documentation of  
18 251 Framingham factors as compared to patients residing in rural regions (OR=1.08, 95% CI: 1.02 –  
19 252 1.16). However, no significant differences in adjusted odds ratios were detected across the five  
20 253 levels of income quintiles (1 vs 5, OR=0.97, 95% CI: 0.91-1.03, p-value=0.43). Female  
21 254 physicians had increased adjusted odds for the complete documentation of Framingham factors  
22 255 as compared to male physicians (OR=1.52, 95% CI: 1.12 – 2.07). However, provider age did not  
23 256 contribute to increased or decreased adjusted odds for calculable Framingham score (29-39 years  
24 257 vs. 60+ years, OR=1.49, 95% CI: 0.98 – 2.26, p-value=0.08).  
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31 258  
32 259 TABLE 3 HERE  
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## 37 260 38 261 **Discussion** 39 262

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41 263 In this study of primary care electronic medical records from the University of Toronto Practice-  
42 264 Based Research Network, we found better documentation of cardiovascular risk factors among  
43 265 people with schizophrenia as opposed to those without the condition. However, overall  
44 266 documentation was inadequate.  
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49 267 Other studies on preventive health for people with schizophrenia, such as those addressing  
50 268 cancer screening, have found lower rates of preventive care when compared with the general  
51 269 population.(27) We actually found more complete documentation of some risk factors among  
52 270 people with schizophrenia when compared to those without, such as blood pressure. There are  
53 271 various recommendations for frequency of cardiovascular disease risk screening in the general  
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3 272 population; Allan et al suggested every 5 years for men over 40 and women over 50.(23) More  
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5 273 complete documentation of risk factors would be expected based on guidelines suggesting more  
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7 274 frequent cardiovascular disease risk assessment among people who are on antipsychotic  
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9 275 medication.(14) To some extent the present study demonstrates a promising finding, suggesting  
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11 276 that patients with schizophrenia are receiving at least as good care from this perspective as those  
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13 277 without the condition. It is, however, quite concerning that there are substantial gaps in  
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15 278 documentation of particular risk factors such as smoking cessation. Nearly 20% of patients did  
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17 279 not have smoking status documented in the chart. We suggest that if it is not documented, then it  
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19 280 is extremely unlikely that smoking cessation has been addressed at a primary care visit. Smoking  
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21 281 is highly prevalent among people with schizophrenia; Canadian estimates range from 47% (28)  
22  
23 282 and 78% (29). There are many effective interventions to support patients with schizophrenia to  
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25 283 stop smoking.(30) It is therefore essential to document smoking status for all patients with  
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27 284 schizophrenia and to make smoking cessation a priority.

26 285 We found several factors associated with what we assessed to be ‘appropriate’ documentation of  
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28 286 risk factors sufficient for cardiovascular risk assessment.

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31 287 Limitations of this study include the use of EMR data, which is known to have deficiencies  
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33 288 around data quality and completeness.(31, 32) UTOPIAN, as part of the Canadian Primary Care  
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35 289 Sentinel Surveillance Network, is disproportionately comprised of more providers in academic  
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37 290 practices and has an older population than the Canadian average.(33) These findings therefore  
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39 291 may not be generalizable to all Canadian primary care settings. UTOPIAN contains data from  
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41 292 multiple EMR vendors and as a consequence there is the possibility that some data may be  
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43 293 missing as a result of errors in database formation; these data are extracted with the best  
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45 294 available approaches and regular data cleaning attempts to minimize these errors. Other studies  
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47 295 have found some deficiencies, particularly related to documentation of health conditions, in  
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49 296 EMR data in the Canadian setting.(3) There are no Canadian national standards for necessary  
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51 297 elements of EMR documentation in primary care. In Ontario, laboratory results enter most  
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53 298 physicians’ EMRs through the Ontario Laboratory Information System (34) which is an  
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55 299 automatic process, reducing the extent to which documentation is incomplete because of  
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57 300 provider error. Our focus on ‘documentation’ in this study is as a result of the practical principle  
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59 301 that if something is not documented, it cannot be acted on; therefore data documentation and  
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3 302 completeness are being taken as a proxy for their consideration in clinical decision-making. It is  
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5 303 not possible from the data considered in this study to ascertain whether a provider has attempted  
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7 304 to intervene towards smoking cessation, or whether someone has addressed blood pressure  
8  
9 305 management. There are other available risk stratification approaches available both for the  
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11 306 general population [such as QRISK2 (35)] and specifically for people with serious mental illness  
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13 307 [PRIMROSE (36)]. We chose to focus on the Framingham assessment because it is the most  
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15 308 commonly used in Canadian primary care and therefore would be most relevant to the study  
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17 309 context.

18 310 In summary, we found slightly more complete documentation of cardiovascular risk factors and  
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20 311 their management among people with schizophrenia as opposed to those without this condition.  
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22 312 However, overall documentation of these risk factors remains incomplete. Adequate  
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24 313 cardiovascular disease risk assessment is essential to identifying and addressing risk factors,  
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26 314 particularly among people with schizophrenia who have much higher mortality from  
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28 315 cardiovascular disease (and other conditions) than the general public. Efforts should be  
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30 316 undertaken in primary care to improve data completeness and CVD risk assessment and  
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32 317 management.

33 318

35 319 **Conflicts of interest:** All authors report that they have no conflicts of interest to declare.

37 320 **Data statement:** Data from this study are held by the University of Toronto Practice-Based  
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39 321 Research Network; ethics approval for this study does not allow unrestricted public access to the  
40  
41 322 data. Please contact the corresponding author for information on how to access.

43 323 **Author statement:** BO, SK, BA, FS, RM, MK, MG contributed to the initial conception of the  
44  
45 324 study. BO, SK, BA, RM made substantial contributions to the statistical methodology, analysis  
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47 325 and data interpretation. BO and SK wrote the first draft of the manuscript. BO, SK, BA, FS, MK,  
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49 326 MG provided substantial revisions to the manuscript.

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## Tables

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

	Schizophrenia				P-values*
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	
<b>Age range (years)</b>					-
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%	
<b>Sex (M/F)</b>					-
Female	106841	55.5%	2539	52.0%	
Male	85586	44.5%	2343	48.0%	
<b>HDL level (mmol/L)</b>					<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%	
<b>Total cholesterol (mmol/L)</b>					<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%	
<b>Systolic blood pressure (mmHg)</b>					<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				P-values*
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	
160 mmHg or more	1889	1.0%	53	1.1%	
<b>Smoking Status</b>					0.0843
Missing	40109	20.8%	968	19.8%	
Non-smoker	125796	65.4%	2633	53.9%	
Smoker	26522	13.8%	1281	26.2%	
<b>Type II Diabetes Mellitus</b>					-
No	168151	87.4%	3953	81.0%	
Yes	24276	12.6%	929	19.0%	
<b>Anti-Hypertensive medication</b>					-
No	140415	73.0%	3486	71.4%	
Yes	52012	27.0%	1396	28.6%	
<b>Total</b>	192427	100.0%	4882	100.0%	-

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

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

	Calculable Framingham Score				Total N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
<b>Age range (years)</b>					
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
<b>Sex (M/F)</b>					
Female	63352	57.9%	46028	42.1%	109380
Male	50893	57.9%	37036	42.1%	87929
<b>HDL level (mmol/L)</b>					
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
<b>Total cholesterol (mmol/L)</b>					
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 N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
6.2-7.19 mmol/L	3167	27.6%	8310	72.4%	11477
7.2+ mmol/L	1667	33.0%	3382	67.0%	5049
<b>Systolic blood pressure (mmHg)</b>					
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
<b>Smoking Status</b>					
Missing	41077	100.0%	.	.	41077
Non-smoker	58342	45.4%	70087	54.6%	128429
Smoker	14826	53.3%	12977	46.7%	27803
<b>Type II Diabetes Mellitus</b>					
No	105354	61.2%	66750	38.8%	172104
Yes	8891	35.3%	16314	64.7%	25205
<b>Anti-Hypertensive medication</b>					
No	92342	64.2%	51559	35.8%	143901
Yes	21903	41.0%	31505	59.0%	53408
<b>Total</b>	114245	57.9%	83064	42.1%	197309

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

507 characteristics

	Calculable Framingham Score				Total N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
<b>Schizophrenia</b>					
No	111564	58.0%	80863	42.0%	192427
Yes	2681	54.9%	2201	45.1%	4882
<b>BMI level (Kg/m<sup>2</sup>)</b>					
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
<b>No. of encounters</b>					
Missing	42673	86.0%	6952	14.0%	49625



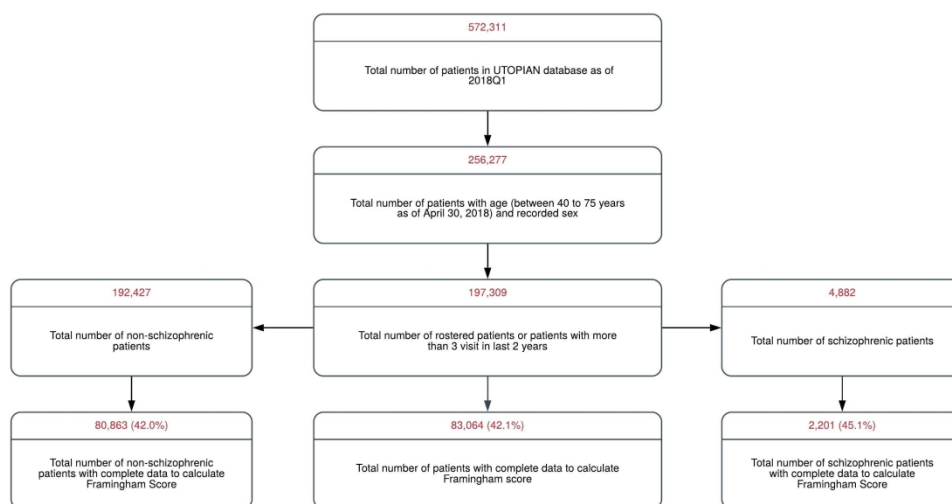
	Calculable Framingham Score				Total N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
3-5 visits	25915	58.6%	18311	41.4%	44226
6-9 visits	19861	48.8%	20830	51.2%	40691
>=10 visits	25796	41.1%	36971	58.9%	62767
<b>Income Quintiles</b>					
Missing	14795	58.9%	10326	41.1%	25121
1	15851	58.7%	11162	41.3%	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
<b>Region</b>					
Missing	2284	73.6%	819	26.4%	3103
Rural	11590	59.7%	7833	40.3%	19423
Urban	100371	57.4%	74412	42.6%	174783
<b>Provider age</b>					
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
<b>Provider sex</b>					
Female	52950	54.2%	44655	45.8%	97605
Male	61295	61.5%	38409	38.5%	99704
<b>Total</b>	114245	57.9%	83064	42.1%	197309

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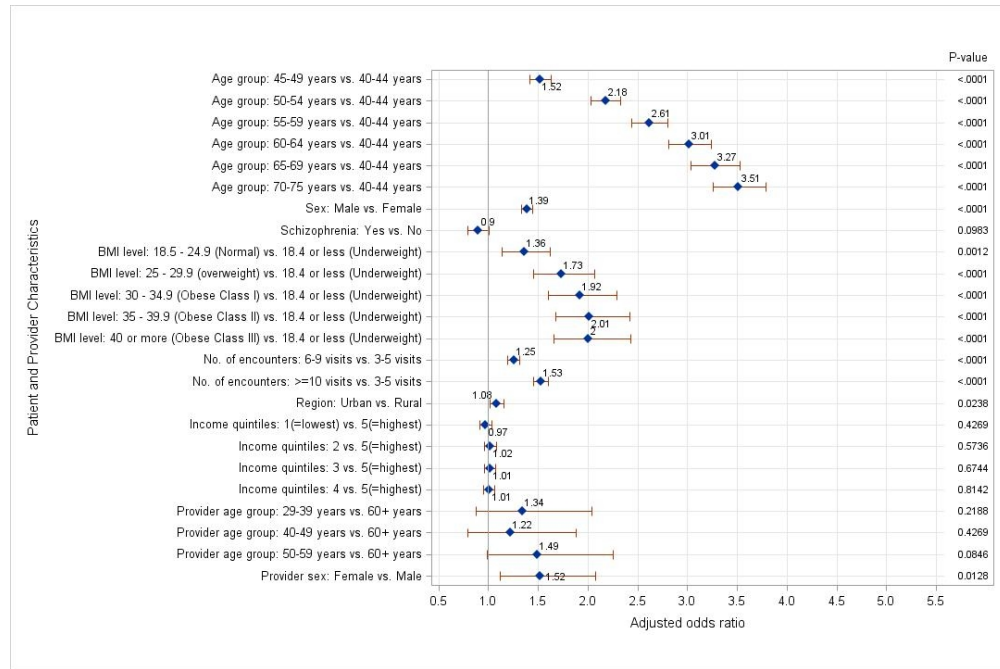
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Distribution of Framingham risk factors among patients with and without schizophrenia

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
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1 2
<b>Introduction</b>			
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
<b>Methods</b>			
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 (b) For matched studies, give matching criteria and number of exposed and unexposed	6
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 (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	7
<b>Results</b>			
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 (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	7/8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	8

1	Outcome data	15*	Report numbers of outcome events or summary measures over time	8
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For peer review only



1	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	8
2			(b) Report category boundaries when continuous variables were categorized	
3			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
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9	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
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11	<b>Discussion</b>			
12				
13	Key results	18	Summarise key results with reference to study objectives	9
14	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
15				
16	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
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19	Generalisability	21	Discuss the generalisability (external validity) of the study results	10
20				
21	<b>Other information</b>			
22	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
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\*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>.

# BMJ Open

## 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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Keywords:	Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, Cardiology < INTERNAL MEDICINE, MENTAL HEALTH, PRIMARY CARE, PREVENTIVE MEDICINE, Schizophrenia & psychotic disorders < PSYCHIATRY

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7 3 **Cardiovascular risk factor documentation and management in primary care electronic**  
8 4 **medical records among people with schizophrenia in Ontario, Canada: retrospective**  
9 5 **cohort study**  
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13 7 Braden O'Neill<sup>1,2,3</sup>, Sumeet Kalia<sup>2</sup>, Babak Aliarzadeh<sup>2</sup>, Frank Sullivan<sup>1,4</sup>, Rahim Moineddin<sup>3</sup>,  
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48 28 Canada.

50 29 Keywords: cardiovascular diseases; schizophrenia; primary health care; electronic health  
51 30 records; primary prevention

53 31 Word count: 2384  
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**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  $\geq 10$  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.

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### 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

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3 934  
5 946  
7 95 **Introduction**8  
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10 97 High quality, comprehensive data are needed to understand health and how to improve it. Risk  
11 98 factors must be known and documented so that interventions can be planned and implemented.

14 99 One of the key challenges in primary care research has been the availability and quality of data.

16 100 When Julian Tudor Hart conducted research on patients accessing care in his practice in Wales in  
17 101 the 1970s, it required laboriously searching through individual paper charts to collect necessary  
18 102 data.(1) Today, electronic medical records are widely used and can facilitate instant searches at  
19 103 the practice level as well as at local and national levels through databases that aggregate data  
20 104 from multiple practices. However, several studies have demonstrated that important data – for  
21 105 example, regarding cardiovascular risk factors such as smoking and whether someone has a  
22 106 diagnosis of hypertension – remain incomplete.(2,3)

29 107 People with serious mental illnesses, particularly those with schizophrenia, die 8 to 10 years  
30 108 earlier than those without these conditions.(4,5) This is primarily due to higher rates of  
31 109 cardiovascular disease.(5-7) While the long-term metabolic effects of antipsychotic medications  
32 110 used to treat schizophrenia are unclear, their use is associated with increased weight and blood  
33 111 glucose.(8,9) Patients may also face challenges with self-care or accessing appropriate medical  
34 112 care.(10) To date there is sparse evidence about how to improve physical health status in these  
35 113 patients; a recent review of ‘collaborative care’ where both physical and mental health are  
36 114 attended to for these patients did not find any evidence of reductions in cardiovascular disease  
37 115 risk.(11)

45 116 The primary prevention of cardiovascular disease includes addressing risk factors such as  
46 117 tobacco use and hypertension; these are commonly managed in primary care. This is particularly  
47 118 true for people with serious mental illness, who are seen more frequently by family physicians  
48 119 than by psychiatrists.(12) The prevalence of schizophrenia in the general adult population is 1-  
49 120 3%, making it a relatively common condition.(13,14) The prevalence and frequency of  
50 121 interaction strongly supports the important role played by family medicine in reducing the risk of

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3 122 cardiovascular disease for people with mental illness. To do this effectively it is necessary to  
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5 123 understand what that risk is and what variables should be focused on.  
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7 124 As a first step in establishing patients' physical health status and identifying who to target for  
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9 125 interventions to improve health, it is necessary to understand their health status. Whether data  
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11 126 completeness concerns regarding cardiovascular disease risk are general to all patients or  
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13 127 whether they are more pronounced amongst those with serious mental illness is unknown.  
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15 128 Our study objectives were: to describe documentation of cardiovascular disease risk factors  
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17 129 (HDL, LDL, total cholesterol; blood pressure; smoking status) among patients with and without  
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19 130 schizophrenia; and to explore patient and provider characteristics associated with sufficient  
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21 131 documentation of these risk factors to calculate the Framingham risk score for patients with  
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23 132 schizophrenia.  
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## 26 134 **Methods**

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30 136 This is an observational retrospective cohort study design. We applied the STrengthening the  
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32 137 Reporting of OBServational studies in Epidemiology checklist for reporting observational  
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34 138 studies.(15) Ethics approval was obtained from the North York General Hospital Research Ethics  
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36 139 Board, approval #18-0006.  
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### 39 141 *Setting and data sources*

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42 143 We used data from the University of Toronto Practice-Based Research Network (UTOPIAN)  
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44 144 Data Safe Haven, a primary care electronic medical record (EMR) database; data extracted as of  
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46 145 April 1 2018 were used for this project.(16) The UTOPIAN Data Safe Haven contains EMR  
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48 146 records from over 550 000 patients who access care in primary care practices in the Greater  
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50 147 Toronto Area in Ontario, Canada. Physicians have consented to the provision of de-identified  
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52 148 data, housed in a secure environment. These data are used for quality improvement and research  
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54 149 purposes. The UTOPIAN database includes validated definitions for eight long-term conditions:  
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56 150 osteoarthritis, diabetes, epilepsy, parkinsonism, dementia, hypertension, COPD,  
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3 151 depression.(17,18) Neighbourhood level income quintiles are also available from patient  
4 152 residential postal codes using Statistics Canada's Postal Code Conversion Files.(19,20)

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11 155 *Study population*

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14 157 We included patients 40-75 years of age because Canadian guidelines recommend regular  
15 158 screening for cardiovascular disease (CVD) risk in this age range. There is no clear consensus on  
16 159 the recommended interval for screening, which varies between yearly to every 5 years.(21-23)  
17 160 Guidelines suggest yearly CVD risk assessment for patients with schizophrenia (24); however  
18 161 these are not routinely followed in primary care practice and this increased frequency is  
19 162 consensus-based and not necessarily supported by strong evidence. We therefore chose to look at  
20 163 a two year interval in which screening could have taken place, recognizing that there may be  
21 164 some patients for whom it may be appropriate to screen less often. The most commonly used  
22 165 CVD risk assessment tool in Canadian primary care practice is the Framingham risk calculator  
23 166 (25), which includes the following items: (i) age, (ii) sex, (iii) smoking history, (iv) presence of  
24 167 diabetes, (v) systolic blood pressure (SBP), (vi) whether a patient is currently on medication to  
25 168 reduce blood pressure, (vii) total cholesterol, and (viii) high density lipoprotein (HDL)  
26 169 cholesterol. This is a validated risk stratification tool that establishes a patient's risk of  
27 170 developing cardiovascular disease (CVD; including: coronary death, myocardial infarction,  
28 171 coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack,  
29 172 peripheral artery disease, heart failure) within the next 10 years. It is valid for patients 30 – 74  
30 173 years of age.(25)

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32 175 We identified patients that were 40-75 years of age as of March 31, 2018. We limited our cohort  
33 176 definition to those that had at least 3 primary care visits in the 2 year period between April 1,  
34 177 2016 and March 31, 2018. To identify outcomes we looked at whether people had CVD risk  
35 178 factors as outlined above documented at least once in the above period. This definition ensured  
36 179 that we included patients likely to be routinely followed by the providers whose records are  
37 180 included in the database, and is consistent with our usual approach for studies using this  
38 181 database. We identified patients with schizophrenia using the same definition used in a previous

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3 182 study using the same database, using a combination of encounter diagnoses used for billing  
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5 183 purposes as well as documentation of the condition in the electronic medical record.(26)

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10 186 *Statistical analysis*

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14 188 We compared the documentation of cardiovascular disease (CVD) risk factors included in the  
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16 189 Framingham risk calculator between those with and without schizophrenia using a chi-square  
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18 190 test. P-values derived from multiple hypothesis tests were adjusted using false discovery rates. In  
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20 191 particular, the CVD risk factors included: HDL cholesterol, SBP, total cholesterol measured in  
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22 192 the last two years of study follow-up, and whether smoking status had ever been recorded. The  
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24 193 relationship between the complete documentation of all Framingham elements was also assessed  
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26 194 with respect to patient characteristics (age, sex, number of encounters in two years of study  
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28 195 follow-up, diagnosis of schizophrenia, most recent body mass index in the last two years of study  
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30 196 follow-up), provider characteristics (age, sex) and geographical characteristics (income quintiles,  
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32 197 rurality). A mixed-effects multilevel logistic regression was used to estimate unadjusted and  
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34 198 adjusted odds ratios for the complete documentation of all Framingham elements (i.e. calculable  
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36 199 Framingham score). Providers were specified as a random effect in the regression model.

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40 201 All statistical analyses were generated using SAS software, version 9.4 M4 (SAS Institute). A  
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42 202 fixed nominal level of 0.05 was used to determine statistical significance in this study.

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46 204 **Patient and public involvement:** There was no patient and public involvement in the design or  
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48 205 conduct of this study.

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## 53 54 208 **Results**

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56 209 *Cohort generation*

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60 211 Data from 376 physicians practicing in 96 different clinic sites were included. In total, 197,309  
212 patients were identified with age between 40-75 years old (as of March 31, 2018), recorded sex

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3 213 and had at least 3 visits in the two years of interest (Figure 1). Out of 197,309 patients, 83,064  
4 214 patients (40.4%) had adequate data to calculate a Framingham risk score using the most recent  
5 215 data available for HDL, SBP, and total cholesterol in the last 2 years and smoking status ever  
6 216 recorded. Of these, 4880 patients met the definition of schizophrenia and 2130 (43.8%) of these  
7 217 patients with schizophrenia had complete documentation to calculate the Framingham risk score.  
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10 218

11 219 FIGURE 1 HERE

12 220

13 221 *Individual Framingham Data Elements*

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15 223 We compared the presence of individual Framingham elements between 4882 patients with  
16 224 schizophrenia and 192247 patients without, over a two year look back window (April 1, 2016 –  
17 225 March 31, 2018) (Table 1). Framingham elements were documented more completely among  
18 226 those with schizophrenia: 25.5% of those with schizophrenia and 32.7% of those without had no  
19 227 documented blood pressure readings over the last two years ( $p < 0.0001$ ). 39.2% of those with  
20 228 schizophrenia and 42.1% of those without did not have any cholesterol readings ( $p < 0.0001$ ).  
21 229 There was no difference in documentation of smoking status between the two groups ( $p = 0.084$ ),  
22 230 with documentation missing in approximately 20% of all charts.  
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35 232 TABLE 1 HERE

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37 234 *Patient, provider and geographical characteristics as predictors of calculable Framingham*  
38 235 *score*  
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44 237 Individual patient characteristics between those who had complete documentation of  
45 238 Framingham score factors and those who did not are in Table 2 and Table 3. Unadjusted and  
46 239 adjusted odds ratios for the complete documentation of Framingham score are in supplementary  
47 240 Table S1 and Table S2.  
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52 242 Patients with schizophrenia did not have statistically significant decreased adjusted odds for the  
53 243 complete documentation of Framingham score as compared to patients without schizophrenia,  
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244 (OR = 0.90, 95% CI 0.79 – 1.01, p-value=0.10) (Figure 2). The adjusted odds for the complete  
245 documentation of Framingham factors increased with respect to the patient's age (70-75 years vs  
246 40-44 years OR = 3.51, 95% CI 3.26 – 3.78). Male patients had increased adjusted odds of  
247 calculable Framingham score as compared to female patients (male vs. female OR = 1.39, 95%  
248 CI 1.33 – 1.45). An increase in the BMI level was associated with an increase in adjusted odds  
249 for calculable Framingham score (Obese class III vs. Underweight, OR = 2.00, 95% CI 1.66 –  
250 2.43) (Table 3). An increase in the total number of encounters also led to increased adjusted odds  
251 for the complete documentation of Framingham factors (more than 10 visits vs. 3-5 visits in last  
252 two years OR = 1.53, 95% CI 1.46 – 1.60).

253

254 TABLE 2 HERE

255 Patients residing in urban regions had higher adjusted odds for the complete documentation of  
256 Framingham factors as compared to patients residing in rural regions (OR=1.08, 95% CI: 1.02 –  
257 1.16). However, no significant differences in adjusted odds ratios were detected across the five  
258 levels of income quintiles (1 vs 5, OR=0.97, 95% CI: 0.91-1.03, p-value=0.43). Female  
259 physicians had increased adjusted odds for the complete documentation of Framingham factors  
260 as compared to male physicians (OR=1.52, 95% CI: 1.12 – 2.07). However, provider age did not  
261 contribute to increased or decreased adjusted odds for calculable Framingham score (29-39 years  
262 vs. 60+ years, OR=1.49, 95% CI: 0.98 – 2.26, p-value=0.08).

263

264 TABLE 3 HERE

265

## 266 Discussion

267

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

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

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3 274 population.(27) We actually found more complete documentation of some risk factors among  
4  
5 275 people with schizophrenia when compared to those without, such as blood pressure. There are  
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7 276 various recommendations for frequency of cardiovascular disease risk screening in the general  
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9 277 population; Allan et al suggested every 5 years for men over 40 and women over 50.(23) More  
10  
11 278 complete documentation of risk factors would be expected based on guidelines suggesting more  
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13 279 frequent cardiovascular disease risk assessment among people who are on antipsychotic  
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15 280 medication.(14) To some extent the present study demonstrates a promising finding, suggesting  
16  
17 281 that patients with schizophrenia are receiving at least as good care from this perspective as those  
18  
19 282 without the condition. It is, however, quite concerning that there are substantial gaps in  
20  
21 283 documentation of particular risk factors such as smoking cessation. Nearly 20% of patients did  
22  
23 284 not have smoking status documented in the chart. We suggest that if it is not documented, then it  
24  
25 285 is extremely unlikely that smoking cessation has been addressed at a primary care visit. Smoking  
26  
27 286 is highly prevalent among people with schizophrenia; Canadian estimates range from 47% (28)  
28  
29 287 and 78% (29). There are many effective interventions to support patients with schizophrenia to  
30  
31 288 stop smoking.(30) It is therefore essential to document smoking status for all patients with  
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33 289 schizophrenia and to make smoking cessation a priority.

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35  
36 290 We found several factors associated with what we assessed to be ‘appropriate’ documentation of  
37  
38 291 risk factors sufficient for cardiovascular risk assessment.

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40 292 Limitations of this study include the use of EMR data, which is known to have deficiencies  
41  
42 293 around data quality and completeness.(31, 32) UTOPIAN, as part of the Canadian Primary Care  
43  
44 294 Sentinel Surveillance Network, is disproportionately comprised of more providers in academic  
45  
46 295 practices and has an older population than the Canadian average.(33) These findings therefore  
47  
48 296 may not be generalizable to all Canadian primary care settings. UTOPIAN contains data from  
49  
50 297 multiple EMR vendors and as a consequence there is the possibility that some data may be  
51  
52 298 missing as a result of errors in database formation; these data are extracted with the best  
53  
54 299 available approaches and regular data cleaning attempts to minimize these errors. Other studies  
55  
56 300 have found some deficiencies, particularly related to documentation of health conditions, in  
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58 301 EMR data in the Canadian setting.(3) There are no Canadian national standards for necessary  
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60 302 elements of EMR documentation in primary care. In Ontario, laboratory results enter most  
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304 303 physicians’ EMRs through the Ontario Laboratory Information System (34) which is an

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3 304 automatic process, reducing the extent to which documentation is incomplete because of  
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5 305 provider error. Primary care providers therefore receive test results from all other providers  
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7 306 involved in a patient's care, making primary care records an appropriate location to assess these  
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9 307 parameters. Our focus on 'documentation' in this study is as a result of the practical principle  
10  
11 308 that if something is not documented, it cannot be acted on; therefore data documentation and  
12  
13 309 completeness are being taken as a proxy for their consideration in clinical decision-making. We  
14  
15 310 acknowledge that this approach may result in 'overestimation' of the extent to which  
16  
17 311 cardiovascular disease risk screening is occurring for patients with schizophrenia. It is possible to  
18  
19 312 have all of the Framingham items documented in the medical record but not to have brought  
20  
21 313 them together to estimate overall cardiovascular risk. However, given the primary conclusion  
22  
23 314 that cardiovascular risk screening is inadequate in this sample, the study methods biasing  
24  
25 315 towards 'overestimation', if anything, support this main finding. It is not possible from the data  
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27 316 considered in this study to ascertain whether a provider has attempted to intervene towards  
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29 317 smoking cessation, or whether someone has addressed blood pressure management. There are  
30  
31 318 other available risk stratification approaches available both for the general population [such as  
32  
33 319 QRISK2 (35)] and specifically for people with serious mental illness [PRIMROSE (36)]. We  
34  
35 320 chose to focus on the Framingham assessment because it is the most commonly used in Canadian  
36  
37 321 primary care and therefore would be most relevant to the study context.

38  
39 322 In summary, we found slightly more complete documentation of cardiovascular risk factors and  
40  
41 323 their management among people with schizophrenia as opposed to those without this condition.  
42  
43 324 However, overall documentation of these risk factors remains incomplete. Adequate  
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45 325 cardiovascular disease risk assessment is essential to identifying and addressing risk factors,  
46  
47 326 particularly among people with schizophrenia who have much higher mortality from  
48  
49 327 cardiovascular disease (and other conditions) than the general public. Efforts should be  
50  
51 328 undertaken in primary care to improve data completeness and CVD risk assessment and  
52  
53 329 management.

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56  
57 331 **Conflicts of interest:** All authors report that they have no conflicts of interest to declare.  
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3 332 **Data statement:** Data from this study are held by the University of Toronto Practice-Based  
4  
5 333 Research Network; ethics approval for this study does not allow unrestricted public access to the  
6  
7 334 data. Please contact the corresponding author for information on how to access.

8  
9 335 **Author statement:** BO, SK, BA, FS, RM, MK, MG contributed to the initial conception of the  
10  
11 336 study. BO, SK, BA, RM made substantial contributions to the statistical methodology, analysis  
12  
13 337 and data interpretation. BO and SK wrote the first draft of the manuscript. BO, SK, BA, FS, MK,  
14  
15 338 MG provided substantial revisions to the manuscript.

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19 340 Figure legends:

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22 341 Figure 1: Distribution of Framingham risk factors among patients with and without  
23 342 schizophrenia

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26  
27 344 Figure 2: Adjusted odds ratios for calculable Framingham score using random-effects multilevel  
28 345 logistic regression model

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## Tables

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

	Schizophrenia				P-values*
	No		Yes		
	N	Column Percent (%)	N	Column Percent (%)	
<b>Age range (years)</b>					-
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%	
<b>Sex (M/F)</b>					-
Female	106841	55.5%	2539	52.0%	
Male	85586	44.5%	2343	48.0%	
<b>HDL level (mmol/L)</b>					<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%	
<b>Total cholesterol (mmol/L)</b>					<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%	
<b>Systolic blood pressure (mmHg)</b>					<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%	
<b>Smoking Status</b>					0.0843
Missing	40109	20.8%	968	19.8%	
Non-smoker	125796	65.4%	2633	53.9%	
Smoker	26522	13.8%	1281	26.2%	
<b>Type II Diabetes Mellitus</b>					-
No	168151	87.4%	3953	81.0%	
Yes	24276	12.6%	929	19.0%	
<b>Anti-Hypertensive medication</b>					-
No	140415	73.0%	3486	71.4%	
Yes	52012	27.0%	1396	28.6%	

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

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

522

523

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

	Calculable Framingham Score				Total N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
<b>Age range (years)</b>					
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
<b>Sex (M/F)</b>					
Female	63352	57.9%	46028	42.1%	109380
Male	50893	57.9%	37036	42.1%	87929
<b>HDL level (mmol/L)</b>					
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
<b>Total cholesterol (mmol/L)</b>					
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
<b>Systolic blood pressure (mmHg)</b>					
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
<b>Smoking Status</b>	41077	100.0%	.	.	41077

	Calculable Framingham Score				Total N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
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
<b>Total</b>	<b>114245</b>	<b>57.9%</b>	<b>83064</b>	<b>42.1%</b>	<b>197309</b>

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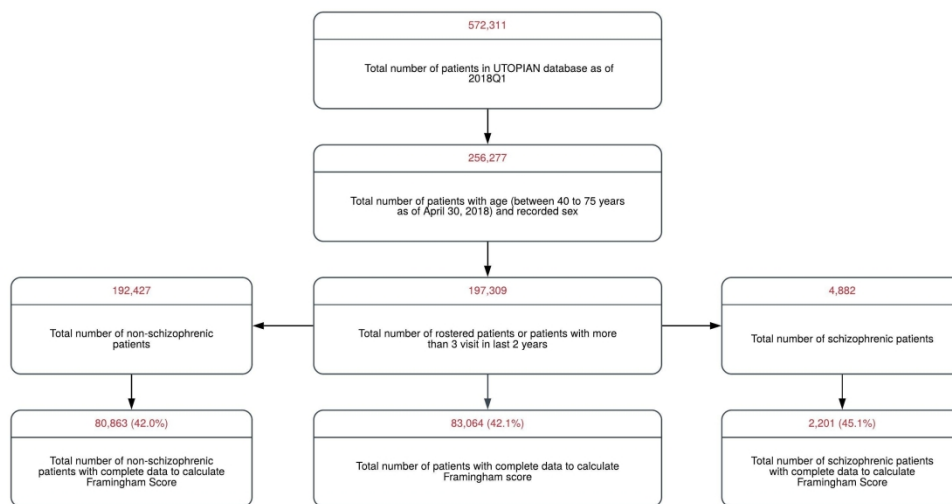
529 Table 3: Calculable Framingham score with respect to patient, provider and geographical

530 characteristics

	Calculable Framingham Score				Total N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
Schizophrenia					
No	111564	58.0%	80863	42.0%	192427
Yes	2681	54.9%	2201	45.1%	4882
BMI level (Kg/m <sup>2</sup> )					
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 N
	No		Yes		
	N	Row Percent (%)	N	Row Percent (%)	
Missing					
Rural	11590	59.7%	7833	40.3%	19423
Urban	100371	57.4%	74412	42.6%	174783
<b>Provider age</b>					
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
<b>Provider sex</b>					
Female	52950	54.2%	44655	45.8%	97605
Male	61295	61.5%	38409	38.5%	99704
<b>Total</b>	114245	57.9%	83064	42.1%	197309

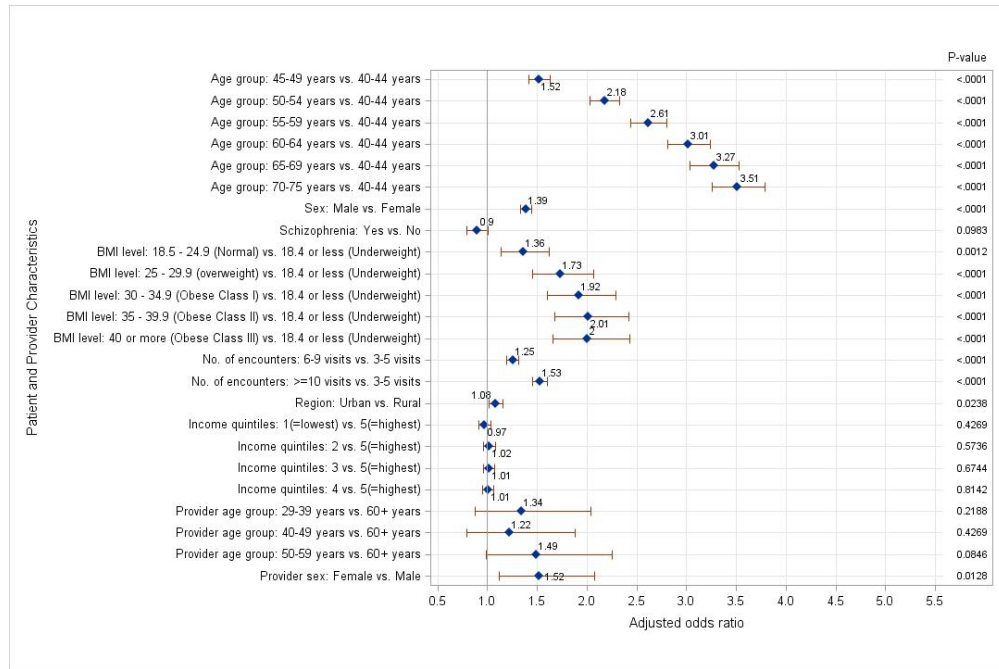
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Distribution of Framingham risk factors among patients with and without schizophrenia

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
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1 2
<b>Introduction</b>			
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
<b>Methods</b>			
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 (b) For matched studies, give matching criteria and number of exposed and unexposed	6
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 (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	7
<b>Results</b>			
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 (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	7/8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	8

1	Outcome data	15*	Report numbers of outcome events or summary measures over time	8
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1	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	8
2			(b) Report category boundaries when continuous variables were categorized	
3			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
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9	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
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11	<b>Discussion</b>			
12				
13	Key results	18	Summarise key results with reference to study objectives	9
14	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
15				
16	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
17				
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19	Generalisability	21	Discuss the generalisability (external validity) of the study results	10
20				
21	<b>Other information</b>			
22	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
23				
24				

\*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>.