

BMJ Open Single and mixed dyslipidaemia in Canadian primary care settings: findings from the Canadian primary care sentinel surveillance network database

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ABSTRACT

Objectives: Dyslipidaemia is a major risk factor to cardiovascular disease (CVD)—the leading cause of death worldwide. Limited data are available about the prevalence of various dyslipidaemia in Canada. The objective of this study is to describe the prevalence of various single and mixed dyslipidaemia within the Canadian population in a primary care setting.

Setting: A cross-sectional study, using the Canadian Primary Care Sentinel Surveillance Network (CPCSSN), was undertaken.

Participants: Non-pregnant adults older than 20 years were included.

Outcome measures: Canadian guidelines were used to define dyslipidaemia. Descriptive statistics and multivariate regression analyses were conducted to compare the prevalence of single/mixed dyslipidaemia.

Results: 134 074 individuals with a mean age of 59.2 (55.8% women) were identified. 34.8% of this population had no lipid abnormality, whereas 35.8%, 17.3% and 3.2% had abnormalities in one, two and three lipid components, respectively. Approximately 86% of these patients did not receive any lipid-lowering medication. Among the medication users (14%), approximately 12% were on statin monotherapy. Statin users (n=16 036) had a lower rate of low-density lipoprotein dyslipidaemia compared to non-medication users (3% vs 17%), whereas the prevalence of high-density lipoprotein (HDL) (20% vs 12%) and triglycerides (TG) (12% vs 7%) dyslipidaemia were higher in statin users. Statin users had a greater prevalence of HDL, TG and combined HDL-TG dyslipidaemia compared to non-medication users (OR 1.44, 95% CI 1.36 to 1.53), (OR 1.18, 95% CI 1.10 to 1.27) and (OR 1.30, 95% CI 1.22 to 1.38), respectively, (all p values<0.0001).

Conclusions: One of every five patients in primary care settings in Canada is suffering from mixed dyslipidaemia. The overall prevalence of dyslipidaemia remains the same between treated and untreated groups, although the type of abnormal lipid component is considerably different. Among the CVD risk factors,

Strengths and limitations of this study

- To our knowledge, this is the first report describing single and mixed dyslipidaemia based on biochemical measurements of lipids in a large Canadian population.
- This study includes a large population of patients who visited family physicians across Canada within a 3-year period.
- The study describes the prevalence of various lipid disorders among individuals treated in accordance with Canadian guidelines. One of every five patients in primary care settings in Canada is suffering from mixed dyslipidaemia.
- The cross-sectional nature of the study does not provide insight on the patients' adherence to medication therapy.
- The study does not have any data on some of the life-style factors that are associated with lipid levels, such as diet and physical activity.

obesity has the greatest effect on the prevalence of all types of dyslipidaemia.

INTRODUCTION

In 2012, ischaemic heart disease and stroke (cardiovascular diseases—CVDs), were ranked together as the first cause of mortality with more than 14 million deaths worldwide.¹ The impact of CVDs in this mortality rate is more significant in countries with higher incomes.¹ In Canada, CVDs are responsible for 32% of deaths and its economic burden is estimated to be second only to musculoskeletal conditions.² Epidemiological studies have identified age, male gender, cigarette smoking, diabetes mellitus, dyslipidaemia, hypertension, obesity and a family history of CVDs as major risk factors contributing to

the majority of CVDs.^{3 4} Among these risk factors, dyslipidaemia, defined as abnormal blood lipid levels that include elevated total cholesterol (TC), low-density lipoprotein (LDL-C), triglycerides (TG) and decreased high-density lipoprotein (HDL), is considered as one of the most important and the easiest modifiable CVDs.⁵

LDL-C has long been presented as the major lipid component involved in the risk of CVDs.⁶ However, low serum levels of HDL-C, as well as high levels of TG, can also contribute to the risk of CVDs, irrespective of LDL-C levels;^{7–9} these two lipid components tend to be in correlation with each other.¹⁰ It is important, therefore, to consider the complete picture (which is composed of all serum lipids) when treating individuals who are at high risk.

Current CVDs prevention guidelines primarily focus on lowering LDL-C as the main goal in the treatment of dyslipidaemia.^{2 11} According to these guidelines, statin therapy, which is recommended as the treatment of choice for the management of elevated LDL-C, is not sufficient for patients suffering from a mixed dyslipidaemia—a combined elevation in LDL and TG levels that may be accompanied by low levels of HDL cholesterol¹²—those patients remain at substantial risk for developing CVDs.¹³ Prospective trials in acute coronary syndrome and stable patients with chronic heart disease have shown that elevated plasma levels of TG and low plasma concentrations of HDL-C are associated with high risks of recurrent CVD events, even at or below recommended LDL-C goals.^{14–16} As well, HDL-C has been identified as the second most important coronary risk factor after LDL-C in patients with type II diabetes.¹⁷ Therefore, to further address this residual risk, alternative guidelines have suggested that HDL-C and TG be managed among high-risk individuals and that other medications, such as niacin and fibrates, or a combination medication therapy be used.¹⁸

The prevalence of dyslipidaemia is reported to be high in Canada and the status of primary care management for lipid disorders does not appear to be sufficient. The Canadian Health Measure Survey (CHMS) reports that 45% of Canadian adults have dyslipidaemia among whom 57% are not aware of their condition.¹⁹ In a large cohort study representing Canadian primary care practice, only 36% of those with abnormal levels of lipid were receiving treatment for dyslipidaemia.²⁰ Despite reports, very little is known about the status of mixed dyslipidaemia in Canada. In describing the prevalence of dyslipidaemia in general and those with certain conditions imposing a higher risk of CVDs, including those with diabetes, a history of CVDs and the multiple risk factors will assist in CVD prevention. This information will also improve the quality of care for these groups through consideration of targeted therapies of mixed dyslipidaemia by either pharmacological or non-pharmacological measures.²¹ This is of particular importance, given that the mechanism underlying mixed dyslipidaemia is different from single

dyslipidaemia and mainly consists of hepatic overproduction of very low density lipoprotein particles, which lead to increases in TG and LDL cholesterol.²² The objective of this study, therefore, is to describe the prevalence of different types of lipid disorders among the general primary care Canadian population and those under treatment in accordance with Canadian guidelines. The association between CVD risk factors, including patients' characteristics and comorbidities, and various types of dyslipidaemia was also examined.

METHODS

Source of data

A cross-sectional study, using data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN) database, was undertaken.²³ This database contains electronic medical records of family physicians (EMRs) which are abstracted quarterly and uploaded to a de-identified system to regional and central pan-Canadian databases. The CPCSSN database is used for examining chronic diseases in primary care as well as for primary care research.^{24 25} At the time of this study, the pan-Canadian CPCSSN database included data from approximately 600 primary-care clinicians in rural and urban settings across 10 Canadian provinces, and involved medical records of 844 592 individuals over 20 years of age (equal to 3% of the Canadian population over the age of 20 years).

Study population

The study population includes non-pregnant adults older than 20 years of age who had a lipid profile in the CPCSSN database between 1 January 2010 and 31 December 2012. For identification and removal of pregnant women from the cohort, the text and/or ICD code records for every event related to pregnancy were queried.²⁶

Variables

Lipid variables

Canadian guidelines for the diagnosis and management of dyslipidaemia, the nationwide protocol for all practitioners in Canada, suggest a lipid screen for various age groups; that is, all men over the age of 40, all women over the age of 50, first-degree relatives with a history of CVD under the age of 60, all postmenopausal women, all individuals with diabetes, hypertension, obesity and current smokers. The routine screening test requires the measurement of all lipid components. In this study, the most recent lipid profiles (TC, HDL, LDL, and TG) for each individual were recorded. The ratio of TC to HDL was calculated by dividing the TC by HDL. Dyslipidaemia was defined using Canadian Guidelines for the Diagnosis and Treatment of Dyslipidemia (table 1).¹¹ Mutually exclusive dyslipidaemia (single dyslipidaemia) was defined as the existence of only one abnormal lipid element in the individual; whereas

Table 1 Healthy levels of serum lipids for Canadian adults (20–79 years of age)¹¹

Lipid component	Normal levels
Total cholesterol (TC)	<5.2 mmol/L
Triglycerides (TG)	<1.7 mmol/L
Low-density lipoprotein (LDL) cholesterol	<3.4 mmol/L
High-density lipoprotein (HDL) cholesterol	>1.0 mmol/L men; >1.3 mmol/L women
Ratio of TC to HDL	<5.0

mixed dyslipidaemia was defined as the existence of more than one lipid disorder. In the initial descriptive statistics of the study population, all five components were presented; however, in the subsequent analyses, the TC and ratio were not considered as they both contained elements of the other three components.

Demographic variables

The demographic variables including age, gender and place of residence were extracted from the database. The rural/urban residence was determined by using the second character of each individual's postal code address.²⁷ The rural/urban residence was included in the multivariate analysis as previous studies suggest that the CVD risk factors could differ between the rural and urban inhabitants.²⁸

Risk factors/comorbid conditions

The smoking status was extracted from the most recent record by the family physician at the time of the lipid test, and individuals were classified as non-smokers, past smokers and current smokers according to the text report and ICD code records in EMRs. Obesity was defined as individuals having a body mass index (BMI) ≥ 30 , whereas those individuals with a BMI lower than 30, but higher than 25, were classified as being overweight. To ascertain diabetes and hypertension, CPCSSN algorithms for chronic conditions were used.²⁸ These definitions have high sensitivity and specificity to detect diabetes and hypertension.²⁹ Diagnostic text and ICD code records in EMRs were also used for other chronic conditions, including dyslipidaemia and CVDs.^{30 31}

Medication use

Medication use was identified using the text record and/or Anatomical Therapeutic Chemical (ATC) codes.³² The use of lipid modifying agents (HMG-CoA reductase inhibitors, Fibrates, Bile Acid Sequestrants, Nicotinic Acid and other agents) was stratified into two categories: Medication Users (those with any record of lipid lowering agents (LLA) in the database during the 3 months before the date of a blood test); and Non-medication users (those with no record of lipid lowering medication use within 3 months before the date of a blood test).³² Among the medication users, those who

received statin monotherapy in accordance with Canadian guidelines were separated as a single group, and the status of single and mixed dyslipidaemia among them were compared to those with non-medication therapy. Since only less than 2% of the medication users in our study were under treatment with lipid modifying agents other than statins, the analyses including lipid-lowering medications focused on statin monotherapy versus non-medication use.

Recent use of other medications with unintended effects on lipid levels,³³ including thiazides, loop diuretics, β blockers, α blockers, ACE inhibitors, calcium channel blockers, oestrogen, progesterone, hormone replacement therapy, and corticosteroids were also extracted from EMRs.

Statistical analyses

General characteristics of the study population, as well as the prevalence of single and mixed dyslipidaemia among the general population and lipid lowering agent users, were summarised using descriptive statistics and were compared using classical tests of hypothesis including student's t test and the χ^2 test. Multivariate multinomial logistic regression modelling was performed to assess dyslipidaemia among lipid-lowering medication users and non-medication users for age, gender, place of residence and other potential influential factors. For variables with more than 5% of missing information; that is, smoking (~70% missing) and BMI (~50% missing), a code for missing values was considered wherever model-based analyses were performed; all other variables had missing rates below 5%. The statistical report was prepared according to the non-missing component of the data. In the multivariate analysis, individuals in the smoking category were compared with non-smokers; overweight and obese patients were compared with normal and underweight individuals; non-medication users and previous medication users were compared with current medication users as a baseline. A p value of less than 0.05 was considered statistically significant. STATA/IC V.11.2 (Stata Corp., College Station, Texas, USA) was used to perform all the statistical analyses.

Ethics

The study protocol was approved for ethics by the Health Research Ethics Authority (HREA) of Newfoundland and Labrador. Patient records and information were anonymous and de-identified prior to any analysis.

RESULTS

Population description

From 1 January 2010 to 31 December 2012, a total of 430 169 individuals were recorded in the CPCSSN database, among which 134 074 individuals (~30%) had completed a blood test for at least one lipid component

and met the study criteria. This population had a mean age of 59.2±15; 55% of them were females, and 23% were living in rural areas (table 2). A total of 13.82% of the population (n=18 534) were categorised as medication users, among whom the great majority (n=16 036) were classified as single statin users (table 2).

The average lipid levels in the study population are presented in table 2. Although the mean lipid levels are at normal ranges, the prevalence of dyslipidaemia for each component (regardless of the existence of other forms of dyslipidaemia) is 40% for TC, 29% for HDL, 26% for LDL, 26% for TG and 15% for ratio >5.

Single and mixed dyslipidaemia in patients of EMR primary care in Canada

A total of 111 726 individuals had lipid levels available for all three components of HDL, LDL and TG in their EMRs concomitantly; and, hence, were considered for further exploration. In approximately 35% of this population, all three components were in normal ranges, whereas 36%, 17% and 3% of the participants had abnormalities in one, two, and three lipid components, respectively. Figure 1 illustrates the prevalence of single (mutually exclusive dyslipidaemia) and mixed

dyslipidaemia among individuals suffering from abnormal levels of LDL, HDL or TG. As can be seen, the most commonly shared abnormality is between those with HDL and TG dyslipidaemia, representing 13% of the population. Consequently, these patients suffer from a higher rate of mixed dyslipidaemia than those with abnormal levels of LDL.

Comparison of single and mixed dyslipidaemia between lipid-lowering medication users and non-medication users

The prevalence of overall dyslipidaemia was similar among statin users and non-users (21% vs 20%); yet, the pattern was different. As shown in figure 2, approximately 45% of both groups had all three lipid components within the normal range. Among patients with single dyslipidaemia, the prevalence of high-LDL is lower among statin users (3% vs 17%, p value for $\chi^2 < 0.0001$), whereas the prevalence of HDL and TG dyslipidaemia is significantly 8% and 5% higher than untreated participants (p value from $\chi^2 < 0.0001$). Among patients with mixed dyslipidaemia, the combined abnormality of HDL and TG in statin users is almost twice as high as non-users (p value from $\chi^2 < 0.0001$); all other forms of mixed dyslipidaemia that contain LDL are much less prevalent among statin users than non-users.

The differences of TC and ratio dyslipidaemia before exclusion have been calculated in the overall population, both of which had a higher prevalence in non-medication users compared to statin users (TC (43.89% vs 13.57%, $p < 0.0001$), and ratio (15.57% vs 7.33%, $p < 0.0001$)).

Factors associated with single and mixed dyslipidaemia

The prevalence of each kind of dyslipidaemia has been stratified by the risk factors associated with CVDs in table 3. table 4 represents the results of the multinomial logistic regression modelling for factors associated with single and mixed dyslipidaemia. As shown in table 4, obese individuals are more likely to have any combination of dyslipidaemia, with the highest OR of 9.39 (95% CI 8.24 to 10.71) for combined HDL-TG dyslipidaemia, followed by an OR of 9.16 (95% CI 7.46 to 11.26) for mixed LDL-TG dyslipidaemia. Women are more likely to have dyslipidaemia containing HDL; that is, HDL dyslipidaemia (OR 1.45, 95% CI 1.39 to 1.51), HDL-LDL dyslipidaemia (OR 2.17, 95% CI 2.00 to 2.36), and HDL-LDL-TG dyslipidaemia (OR 1.61, 95% CI 1.50 to 1.74), whereas any dyslipidaemia containing TG is more common among men: TG dyslipidaemia (OR 0.55, 95% CI 0.53 to 0.58), and LDL-TG dyslipidaemia OR 0.58, 95% CI 0.55 to 0.62).

After controlling other risk factors, statin users were less likely to have single LDL dyslipidaemia (OR 0.18, 95% CI 0.16 to 0.20) as well as mixed dyslipidaemia of all lipid combinations that contain LDL, compared to non-medication users (LDL-HDL (OR 0.30, 95% CI 0.24 to 0.36)); LDL-TG (OR 0.28, 95% CI 0.24 to 0.32); LDL-HDL-TG (OR 0.31, 95% CI 0.26 to 0.37)).

Table 2 Demographic and clinical characteristics of the study population (n=134 074)

	All study population
Age*	59.18±15.00
BMI*	28.08±6.40
Gender (F)	55.8%
Residence (rural)	22.7%
Smoking (current)†	14.2%
Smoking (previous)†	40.7%
Hypertension	33.3%
Diabetes mellitus	15.1%
History of dyslipidaemia	21.7%
Cardiovascular diseases	35.4%
Drugs with unintended lipid effects	22.3%
Lipid lowering agent use	
Non-medication users	86.2%
Single statin users	11.9%
Combined medication users	1.3%
Single usage of other lipid modifying agents	0.6%
Lipid profile	
Total cholesterol*	4.94±1.09
HDL*	1.39±0.42
LDL*	2.91±0.93
Triglyceride*	1.42±0.92
Total cholesterol/HDL ratio*	3.79±1.60

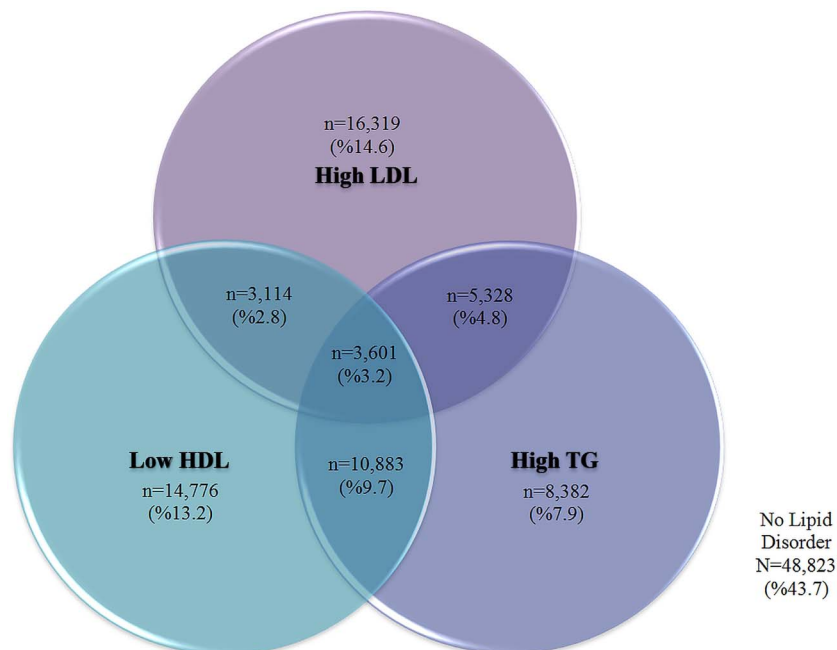
Figures are a percentage except for:

*Mean±SD.

†The statistics provided are according to the available information. Besides smoking and BMI which have missing rates close to 70% and 50%, respectively, the missing rates in all other variables are below 5% of the total population (n=134 074).

BMI, body mass index; HDL, high-density lipoprotein; TG, triglycerides.

Figure 1 Prevalence of single and mixed dyslipidaemia of LDL, HDL, and triglycerides in patients of EMR primary care settings in Canada (n=111 726). The figure does not account for the possibility of having the dyslipidaemia of total cholesterol or ratio. The sizes of the circles are schematic and do not represent their true values. EMR, electronic medical records of family physicians; HDL, high-density lipoprotein; LDL, low-density lipoprotein.



Statin users had a higher rate of single dyslipidaemia of TG (OR 1.18, 95% CI 1.10 to 1.27) and HDL (OR 1.44, 95% CI 1.36 to 1.53) as well as combined HDL-TG dyslipidaemia (OR 1.30, 95% CI 1.22 to 1.38) compared with non-medication users. No significant effect was observed from medications with unintended lipid effects.

DISCUSSION

Our study includes a large population of patients who visited family physicians across Canada. To our

knowledge, this is the first study describing single and mixed dyslipidaemia based on biochemical measurements of lipids in such a large Canadian population. The results suggest the importance of mixed dyslipidaemia in addition to the single lipid abnormalities in the Canadian population. While a substantial portion of Canadians suffer from various forms of dyslipidaemia, 20.5% have dyslipidaemia of more than one lipid component simultaneously; this group has a high risk for developing CVDs.^{7-9 34}

Mixed dyslipidaemia is an important subject which is not primarily addressed in current guidelines for the

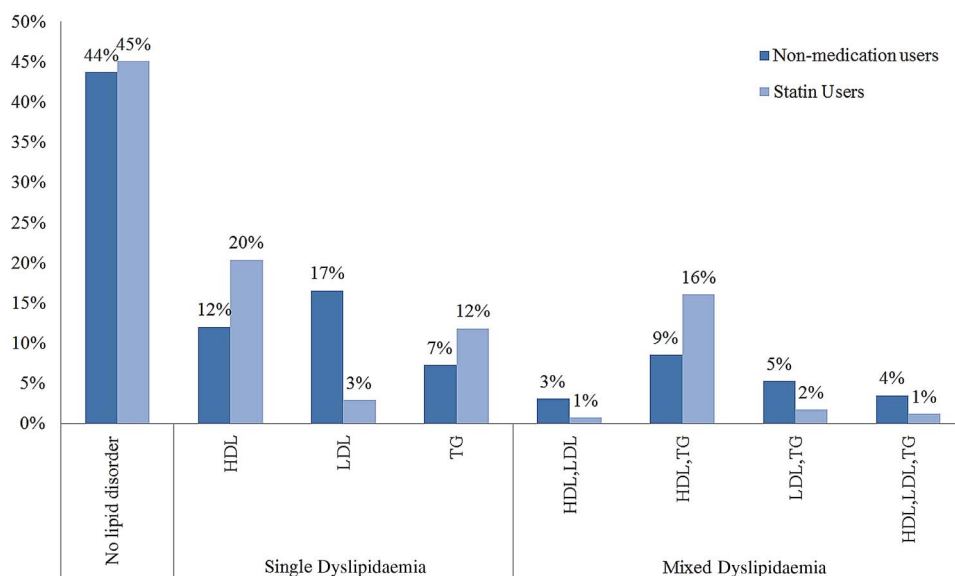


Figure 2 Lipid disorders in statin users and non-medication users in patients of EMR primary care settings in Canada (n=111 726). This figure shows the prevalence of each lipid abnormality among statin users (light blue), and non-medication users (dark blue). All comparisons are significant at $p < 0.0001$ and were obtained from the χ^2 tests. EMR, electronic medical records of family physicians.

Table 3 Prevalence of various combinations of dyslipidaemia by cardiovascular disease risk factors

	Males N=48 537 (%)	Females N=63 189 (%)	Non-smoker N=14 233 (%)	Past smoker N=13 065 (%)	Current smoker N=4560 (%)	Normal/ underweight N=12 206 (%)	Overweight N=15 312 (%)	Obese N=13 929 (%)	Non- hypertensive N=74 617 (%)	Hypertensive N=37 109 (%)	Non- diabetic N=94 826 (%)	Diabetic N=16 900 (%)	Non- medication user N=95 412 (%)	Statin user N=14 133 (%)
Normal	43	44	47	48	35	64	46	32	46	40	45	35	44	45
HDL	11	15	13	12	14	8	12	18	12	15	12	21	12	20
LDL	14	15	16	15	13	16	17	10	16	11	17	4	17	3
TG	11	6	7	8	10	4	8	10	7	10	7	11	7	12
HDL & LDL	2	4	2	2	4	1	2	3	3	2	3	1	3	1
LDL	10	9	8	8	12	2	7	17	8	14	8	22	9	16
TG	6	4	5	5	6	2	5	5	5	5	5	3	5	2
HDL & LDL & TG	2	4	2	2	5	1	2	4	3	3	3	3	4	1

LDL, low-density lipoprotein; HDL, high-density lipoprotein; TG, triglycerides.

treatment of dyslipidaemia, where the main goal of treatment has been lowering the LDL levels using statins.^{2 11} The comparison of statin users with non-medication users in our study shows the fulfilment of this approach by lowering LDL-C levels. All lipid measurements encompassing LDL, including TC and ratio dyslipidaemia, are dramatically lower in statin users. On the other hand, other forms of dyslipidaemia (TG and HDL) are not only more common than LDL dyslipidaemia, but they also have a higher prevalence in these patients than in non-medication users. A similar trend is observed for mixed dyslipidaemia where all combinations of dyslipidaemia, that include LDL, are less prevalent in statin users; whereas the opposite effect is seen for those who do not encompass LDL (figure 2). As demonstrated in table 4, adjusting the findings for other variables does not seem to change this trend. These observations are overall consistent with previous reports that statins exert their effect through lowering LDL and their influence on other lipid components is minimal. Similar to our results are the findings by Colquhoun *et al*³⁵ on Australian patients who were treated primarily with statins and among whom nearly one-third had mixed dyslipidaemia after medication therapy. Although lipid modification therapy considerably improved LDL-C goal attainment, a large proportion of the patients in that study, similar to our study, did not achieve normal HDL-C and TG levels.³⁵

The figures in our study, however, are lower than those from several other reports. Laforest *et al*³⁶ report that, of the total 2544 patients treated with statins in France, 51% and 32% of the participants had single and mixed dyslipidaemia, respectively; and, the figures were much higher for high-risk patients. In another study in France, 83% of the 946 patients treated for dyslipidaemia had single lipid disorders and 38% had mixed dyslipidaemia.³⁷ The patients from those studies were selected directly from general practice clinics and their sample sizes were relatively lower, which may account for the higher prevalence of dyslipidaemia.

The 2013 ACC/AHA guidelines,³⁸ which have the most recent available regulation of blood cholesterol to prevent CVDs, has similar recommendations to previous guidelines, except for adults aged 75 years and above. This group is recommended against the use of statins in the prevention of primary and secondary CVDs due to a lack of evidence on the effectiveness of such therapies in this target group. To further evaluate this recommendation, the same multinomial regression analysis was performed only for individuals aged over 75 years. Our findings were similar to the results from the analysis of the overall population; that is, statins are found to be effective on lowering LDL-C levels, however, they have minor effects on mixed dyslipidaemia (data not shown). Thus, it can be concluded that the lack of evidence for CVD protection in this group is either due to the shortage of clinical trials conducted on them, or because of the insufficient alternative beneficial effects of statins in

Table 4 Single and mixed dyslipidaemia and some associated factors in patients of EMR primary care settings in Canada (n=111 726)

	HDL	LDL	TG	HDL & LDL	HDL & TG	LDL & TG	HDL & LDL & TG
Gender (F)	1.45 (1.39 to 1.51)	0.99 (0.95 to 1.02) ^{NS}	0.55 (0.53 to 0.58)	2.17 (2.00 to 2.36)	1.03 (0.99 to 1.08) ^{NS}	0.58 (0.55 to 0.62)	1.61 (1.50 to 1.74)
Age	0.98 (0.98 to 0.99)	1.01 (1.01 to 1.01)	1.00 (1.00 to 1.00) ^a	0.98 (0.98 to 0.99)	0.99 (0.99 to 0.99)	1.00 (1.00 to 1.00) ^{NS}	0.99 (0.99 to 0.99)
Previous smoker*	0.98 (0.91 to 1.06) ^{NS}	0.98 (0.91 to 1.05) ^{NS}	0.99 (0.90 to 1.09) ^{NS}	1.14 (0.96 to 1.36) ^{NS}	1.00 (0.91 to 1.11) ^{NS}	0.96 (0.86 to 1.08) ^{NS}	1.10 (0.92 to 1.31) ^{NS}
Current smoker*	1.42 (1.27 to 1.58)	1.19 (1.07 to 1.33) ^a	1.59 (1.40 to 1.81)	2.61 (2.14 to 3.18)	1.90 (1.68 to 2.15)	1.45 (1.23 to 1.69)	3.52 (2.93 to 4.22)
Overweight†	1.93 (1.77 to 2.10)	1.55 (1.45 to 1.66)	2.06 (1.85 to 2.30)	3.15 (2.60 to 3.81)	3.68 (3.21 to 4.22)	2.89 (2.51 to 3.34)	3.79 (3.06 to 4.71)
Obese†	3.63 (3.34 to 3.95)	1.54 (1.42 to 1.67)	3.53 (3.16 to 3.94)	5.65 (4.68 to 6.83)	9.39 (8.24 to 10.71)	4.55 (3.93 to 5.26)	9.16 (7.46 to 11.26)
Rural residence	1.12 (1.07 to 1.17)	0.95 (0.91 to 1.00) ^a	1.24 (1.17 to 1.30)	1.04 (0.95 to 1.14) ^{NS}	1.34 (1.27 to 1.41)	1.06 (0.99 to 1.14) ^{NS}	1.33 (1.23 to 1.44)
Diabetes	2.12 (2.01 to 2.23)	0.35 (0.32 to 0.38)	1.51 (1.41 to 1.61)	0.72 (0.62 to 0.84)	3.05 (2.89 to 3.22)	0.70 (0.63 to 0.78)	1.11 (0.99 to 1.24) ^{NS}
Hypertension	1.12 (1.06 to 1.18)	0.85 (0.81 to 0.90)	1.50 (1.41 to 1.60)	0.96 (0.86 to 1.07) ^{NS}	1.45 (1.37 to 1.54)	1.18 (1.09–1.28)	1.29 (1.17 to 1.42)
Cardiovascular disease	1.25 (1.19 to 1.32)	0.89 (0.85 to 0.94)	1.08 (1.02 to 1.15) ^a	1.14 (1.02 to 1.27) ^a	1.26 (1.19 to 1.34)	0.98 (0.91 to 1.07) ^{NS}	1.08 (0.98 to 1.19) ^{NS}
Drugs with unintended lipid effects	1.09 (1.03 to 1.14) ^a	1.04 (0.99 to 1.09) ^{NS}	1.02 (0.96 to 1.08) ^{NS}	1.08 (0.98 to 1.20) ^{NS}	1.03 (0.97 to 1.08) ^{NS}	1.03 (0.95 to 1.11) ^{NS}	1.18 (1.08 to 1.29)
Statin monotherapy	1.44 (1.36 to 1.53)	0.18 (0.16 to 0.20)	1.18 (1.10 to 1.27)	0.30 (0.24 to 0.36)	1.30 (1.22 to 1.38)	0.28 (0.24 to 0.32)	0.31 (0.26 to 0.37)

Figures are ORs (95% CIs).

All the presented ORs are significant at $p < 0.0001$ except for:

^a $p < 0.05$.

NS, not significant ($p > 0.05$).

*Smoking status was compared with non-smokers.

†Obesity status was compared with normal and underweight individuals. Population with no lipid disorders was considered as the base in the analysis.

EMR, electronic medical records of family physicians; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TG, triglycerides.

the elderly. This conclusion may possibly be determined or revised following the conduct of future clinical trials.

There are several limitations in our study. We performed a cross-sectional study using EMRs of primary care settings in Canada to provide a snapshot of single and mixed dyslipidaemia in real practice. Our analyses showed 36%, 17%, and 3% of the study population had abnormalities in one, two and three lipid components, respectively. It should be taken into consideration that the actual figure could be higher as the real prevalence of dyslipidaemia could be masked due to the effect of medication therapy. Furthermore, the patients in our study were selected from the Canadian population under primary care who had a lipid profile conducted by their family physician; generally speaking, a population with higher morbidity and, thus, the finding may not represent the general Canadian population. Moreover, this cross-sectional study using secondary data does not provide information to identify if the lipid test was requested according to the Canadian guidelines or other factors including patient request or a clinical suspicion by the family physician.

The study also does not provide information on patient adherence to lipid-lowering medication and the effectiveness of this medication over a long-term period; however, several studies, including systematic reviews, have shown the effectiveness of statin use during a short-term period.³⁹ Further, we did not have any data on some of the life-style factors that are associated with lipid levels, such as diet and physical activity. Finally, our data only corresponds to the population in EMR primary care settings of the Canadian Primary Care Sentinel Surveillance Network. Many systematic reviews on the effects and cost-effectiveness of computerised decision-support systems, including EMRs, have shown a significant benefit of these systems on practitioners' performance outcomes, whereas they have not found that the use of computerised decision-support systems consistently improve the process of care measures and patient outcomes.^{40 41}

CONCLUSION

Our analysis indicates that a significant number of patients of EMRs primary care settings in Canada are suffering from single and mixed dyslipidaemia. The findings also demonstrate that the lipid management in a primary care setting is mainly focused on monotherapy of statins as recommended by Canadian guidelines. Although the statin therapy has significantly attained its LDL level goals among statin users, a significant number of these patients do not obtain the recommended levels for other components of lipids (12% TG; 20% HDL dyslipidaemia), and the overall portion of mixed dyslipidaemia remains the same (~20%) among treated and untreated patients. This finding should be taken into consideration in clinical settings and possibly be used to revise the current guidelines for the treatment and

prevention of CVDs, since statin-user patients can still remain unknowingly at high risk for future events from lipid components other than LDL-C. Further studies are required to determine the best therapeutic approaches that can be used for these patients.

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