ORIGINAL RESEARCH

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Household income and LDL-C goal attainment in patients with diabetes and dyslipidemia in a Canadian dataset

Abstract

Purpose: There is evidence of a social disparity pertaining to the epidemiology and burden of illness of diabetes. The purpose of this study was to assess the association between household income strata and therapeutic goal achievement rates for LDL-cholesterol (LDL-C) (< 2.5 mmol/L) in Canadian diabetic patients.

Methods: Data (household income, cardiovascular risk factors, drug profile, clinical and laboratory variables) were obtained from a previous cross-sectional study of diabetic patients who filled a prescription for a lipid-lowering drug in selected pharmacies across Canada. Telephone interviews were conducted. Physicians, identified by the participating patients, were requested to complete a short questionnaire for clinical data. Achievement of LDL-C goals according to the Canadian diabetes guidelines were assessed and incorporated into regression models corresponding to household income strata.

Results: Seven household income strata were defined in the cohort (from less than 20,000 CDN\$, up to 70,000 CDN\$ by increments of 10,000 CDN\$). LDL-C goals were attained in 34% of patients in the total cohort. There were no significant differences amongst household income strata for LDL-C goal achievement ($p = 0.80$). There were no significant differences in patient characteristics (age, sex, BMI) and cardiovascular risks according to the household income strata in this cohort, except age more than 65 in the lower income strata.

Conclusion: This study demonstrates that household income was not a factor to achieve therapeutic goals for LDL-C for patients with diabetes in this dataset, although goal attainment was less than ideal overall. Future studies should address limitations of this work including small sample size, recruitment bias and lack of data on third party insurance coverage.

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Manuscript submitted 22nd October, 2013
Manuscript accepted 2nd January, 2014

Clin Invest Med 2014; 37 (1): E47-E6.

Diabetes is a chronic disease with high incidence, and prevalence, and a significant burden of illness [1]. An estimated 285 million people worldwide are affected by diabetes [2]. With a further 7 million people developing diabetes each year, this number is expected to reach 438 million by 2030 [2]. There are vast social and ethnic disparities regarding the epidemiology and burden of illness of diabetes [3]. Differences in morbidity and mortality related to diabetes are associated with socioeconomic status, ethnicity and gender, and socioeconomic status is a key factor affecting quality of health and health disparity [4]. A large proportion of the total health inequality is due to income-related health inequality and income may be a mediator of disparity in health care [5]. The objective of this study was to assess the association of household income strata with Canadian therapeutic goal achievement rates for LDL-C (less than 2.5 mmol/L) in diabetic patients in a Canadian dataset.

Methodology

The data were derived from a previous cross-sectional study [6,7]. Patients filling a prescription for a lipid-lowering drug between September 2004 and June 2005 in selected pharmacies in Nova Scotia, Quebec, Ontario and British Columbia were eligible to participate in this study. Patients were given an information sheet and a consent form. Patients who agreed to participate signed a consent form giving permission for: (1) the research team to contact them by telephone to ask questions about their lipid lower medication utilization and health; (2) the pharmacist to release the patient's medication profile for the previous 12 months; and, (3) the family physician to release to the research team medical information related to dyslipidemia therapy and cardiovascular risk, from the patient's medical record. Patients with any of the following criteria were excluded from study: (1) unable to speak either English or French; (2) hearing impaired; (3) cognitively impaired; (4) did not have their own telephone; and, (5) non-community dwelling (i.e., institutionalized). Eligible patients were subsequently interviewed over the telephone by trained interviewers using computer-assisted interviewing software (CATI). Physicians who were identified by the participating patients as their health care provider were requested to complete a short questionnaire pertaining to information that would be in the patient's medical record. The data obtained from the patient telephone interviews, pharmacist medication dispensing histories and physician medical records included patient characteristics (age, sex, education, height, weight, income, racial background), lipid profile (total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides), duration and dose of lipid-lowering medication use, adverse events and adherence (including reasons for dis-

continuation of prior therapy), non-pharmacological interventions (i.e., dietary modifications and exercise), co-morbid conditions (e.g., peripheral vascular disease, diabetes, etc), co-medications, cardiovascular risk factors and quality of life (SF-12). A subset of this cohort who had diabetes was selected for the present study (277 patients). A power analysis for a sample size of 277 patients, with type one error of 5% and a difference of LDL-C goal achievement of 10% indicates a power of more than 90%. With a difference of LDL-C goal achievement of 5% and 8%, the power would be 40% and 80%, respectively.

The data used for the present study included patient characteristics and socioeconomics data (household income, age, sex, BMI), presence of CV risk factors other than diabetes and dyslipidemia (i.e., peripheral vascular disease, hypertension, previous CV events, family history of premature coronary heart disease or stroke, smoking) and lipid profile (LDL-cholesterol). In this cross-sectional study the latest LDL-C post-therapy was reported by primary healthcare providers. As the data was gathered in 2004 and 2005, the 2003 Canadian guidelines for the management of diabetes and dyslipidemia were used to assess LDL cholesterol goal achievement [8,9]. The threshold of successful treatment for reduction of LDL-C at that time was LDL-C less than 2.5 mmol/L according to 2003 Canadian guidelines; however, the guidelines have since been changed and in 2006 the LDL-C goal for diabetes was reduced to a target of less than 2.0 mmol/L [10-12]. Of note, assessment of goal attainment for blood glucose using HgbA1c was not possible, as the data for HgbA1c was not available for almost one-third of the patients with diabetes.

The cohort of patients was ranked according to household income. Seven household income strata were defined in the cohort from less than 20,000 CDN\$, up to more than 70,000 CDN\$ by increments of 10,000 CDN\$. Achievement of LDL-C goal for each income strata according to the Canadian guidelines was assessed and then incorporated into logistic regression models corresponding to household income strata. The analyses were adjusted for covariates including age, sex, cardiovascular risk factors or metabolic syndrome status. The data are presented as means (standard deviations) and number (percentage). All statistical analyses were performed using SPSS program version 9.0.

Results

The diabetes cohort contained 277 patients. Data describing the cohort are presented in Tables 1 and 2. Mean age was 64 years with a standard deviation of 10 years. Average (standard deviation) number of cardiovascular risk factors per patient was 3.9 (0.9). The mean BMI was 30 kg/m² and 77% of the

TABLE 1. Baseline demographic, cardiovascular risk and goal achievement by household income strata

Income (x1000, \$)	N (%)	Age (years)	Older than 65 years (%)	Male (%)	BMI	Aggregate CV RF	Metabolic Syndrome	LDL-C Goal
0 to 20	48 (17%)	65 (11)	27 (56%)	17 (35%)	29 (7)	4.0 (1.1)	41 (85%)	17 (35%)
20 to 30	56 (20%)	65 (11)	32 (57%)	32 (57%)	30 (6)	4.0 (0.9)	44 (78%)	19 (34%)
30 to 40	45 (16%)	64 (9)	23 (51%)	25 (55%)	29 (8)	4.0 (1.0)	36 (80%)	13 (29%)
40 to 50	57 (21%)	64 (10)	13 (22%)	30 (52%)	29 (6)	4.0 (1.0)	39 (68%)	20 (35%)
50 to 60	27 (10%)	62 (9)	12 (44%)	16 (59%)	30 (7)	3.7 (0.9)	21 (77%)	8 (29%)
60 to 70	13 (5%)	65 (10)	7 (53%)	5 (38%)	28 (6)	3.8 (0.8)	9 (69%)	6 (46%)
> than 70	31 (11%)	65 (10)	11 (35%)	21 (67%)	30 (6)	4.1 (1.1)	24 (77%)	13 (42%)
Total	277	64 (10)	125 (45%)	146 (52%)	30 (7)	3.9 (0.9)	214 (77%)	96 (34%)
P-value		0.60	0.001	0.10	0.90	0.80	0.50	0.80

Aggregate CV RF: number of cardiovascular risk factors according to Framingham's Criteria

TABLE 2. Baseline demographic, cardiovascular risk and goal achievement by clustered household income strata

Income (clustered) (x1000, \$)	N (%)	Age (years)	Older than 65 years (%)	Male (%)	BMI	Aggregate CV RF	Metabolic Syndrome	LDL-C Goal
0 to 40	149 (54%)	65 (11)	82 (55%)	74 (49%)	30 (7)	4.0 (1.0)	121 (81%)	49 (33%)
Above 40	128 (46%)	63 (10)	43 (33%)	72 (56%)	29.9 (6)	3.9 (1.0)	93 (73%)	47 (37%)
P-value		0.15	0.0003	0.35	0.80	0.45	0.10	0.50

cohort met the criteria for metabolic syndrome. The rank of income strata divided the cohort into 7 levels with an increment of 10,000 CDN\$ from less than 20,000 CDN\$, up to more than 70,000 CDN\$ (Table 1). The results demonstrated that there were no significant differences in patient characteristics (age, sex, BMI) and cardiovascular risks according to the household income strata in this cohort. Although, the mean ages of patients in all household income strata were similar, more patients in lower income strata were older than 65 (P-value = 0.001). LDL-C goal was attained in 34% of patients in the total cohort. There was no significant difference amongst household income strata for LDL-C (P-value = 0.80) goal achievement. An additional analysis was conducted dichotomizing household income into less than or equal to 40,000 CDN\$ and more than 40,000 CDN\$ (Table 2). With a single cut point of 40,000 CDN\$, the outcomes for LDL-C goal attainment were not significantly different: 33% versus 37% (P-value = 0.30).

Discussion

The current study demonstrates that, in this dataset, household income was not a factor for diabetic patients to achieve the therapeutic goal for LDL-C. This may reflect that in the Canadian healthcare system, in which healthcare delivery including providers' fees, hospitalization and medication costs for pa-

tients older than 65 is reimbursed by the government for all patients who seek therapeutic interventions, household income is not a determinant of LDL-C goal achievement.

Studies on the relationship between income inequality and health have been conducted using various levels of data, from the census track level to the national level based on cross sectional and time series data. The measures of health outcome also varies; including self-assessed health status, mortality rate and life expectancy. The present study is different from other Canadian studies regarding outcome measures, patient population and the level of approach. The present study included a small sample size and used a cross-sectional data; however, the data are derived from individual patients (particularly important for the outcome of LDL-C). Although patients were represented in all the income strata, the patients included in the study were already able to refill their medications based on the recruitment process. The results of this study should be interpreted with the recognition that this study has several limitations including small sample size, a potential recruitment bias and a lack of data on third party insurance coverage. Using recruitment from pharmacies limits the generalizability of the results to the Canadian population able to afford filling a prescription for a lipid lowering drug. Also, there was a higher percentage of patients in lower income strata that were older than 65 years despite a similar mean age across the income

strata. In most provinces in Canada, patients older than 65 years are eligible for medication coverage through their provincial governmental. With or without adjustment for age, LDL-C goal achievement did not change in this study.

Another Canadian study using a population-based administrative database found a difference in mortality that was related to income-related differences among people with diabetes [13]. The study reported an overall mortality decreased by more than 30% from 1994/95 to 2005/06; however, analysis by income quintile demonstrated that the improvement in mortality was significantly smaller among people in lower income neighbourhoods than among those in wealthier neighbourhoods. The outcome measure was all-cause mortality and, therefore, it could not conclude whether the causes of death were similar across income groups. Also, the study did not have income data at the individual level, just neighbourhood income. The paradox of the results for that study and our present study could indicate the important differences between individual level data for a patient versus administrative databases for the population, as well as differences between cross-sectional studies using surrogate endpoints *versus* longitudinal cohort studies using hard endpoints.

In another Canadian cross-sectional study, low income patients presenting to a diabetes clinic were older, heavier and had a more atherogenic lipid profile than high income patients [14]. Overall medication use was higher among the lower income group, suggesting that differences in clinical profiles were not the result of under-treatment, thus invoking lifestyle factors as potential contributors to these findings [14]. In our study, the patients' characteristics (age and BMI) as well as cardiovascular risks were distributed similarly by household income strata, which could reflect more homogeneity in this patient population compared to the study by Rabi *et al.* In another study, the same group of researchers used data from a regional Diabetes Education Centre (DEC), the Canadian National Diabetes Surveillance System (NDSS) and the 2001 Canadian Census [15]. Their analysis illustrated that low income was associated with a higher prevalence of diabetes and a higher population rate of referral to the regional DEC; however, after accounting for diabetes prevalence, the equal proportions referred to the DEC across all the income groups suggested that there was no access bias based on income [15]. This could indicate that in the Canadian publicly-funded system, access to healthcare providers including doctors, diabetes educators and diabetes nurses is independent of income.

In contrast, a random-digit dialling study on patients with diabetes in Ontario demonstrated low socioeconomic status (as characterized by annual household income <\$30,000) and ab-

sence of supplemental health insurance as key barriers to accessing and using diabetes care [16]. In this study, younger age was an independent predictor of non-adherence with diabetes medication, glucose testing and the purchase of healthy foods due to cost.

In a population-based retrospective cohort study using administrative health claims from Ontario, employing a composite outcome of death, nonfatal acute myocardial infarction (AMI) and nonfatal stroke in adults with diabetes, the results demonstrated that socioeconomic differences in CVD burden diminished substantially after age 65 years [17]. The study suggested that the results were a reflection of the difference between the comprehensive access to medications and diabetes testing products for patients aged more than 65 years in Ontario compared with the variable coverage for persons less than 65 years. In our study, the mean age was close to 65 years and many patients in this cohort were from Ontario. As aforementioned, a higher percentage of patients in the lower income strata were older than 65 years despite a similar mean age across the strata; however, LDL-C goal achievement did not change with or without adjustment for age.

A study using the aggregate data from the Public Use Microdata Files (PUMF) of Canadian National Population Health Survey to estimate income-related health inequalities across the ten Canadian provinces concluded that health inequalities favoring the higher income people do exist in all provinces when health status is either self-assessed or measured by the health utility index [18]. The outcome measure for LDL-C was not included in the population health survey.

Wilkinson and Pickett in 2006 compiled the results from 155 published peer-reviewed papers on the relationship between income inequality and population health [19]. Approximately 70% of the results suggested that health status was lower in societies where income was more unequal. Wagstaff and van Doorslaer also reported that approximately 25% of the total health inequality was due to income-related or socioeconomic inequality amongst Canadian adults [20]. Furthermore, van Doorslaer and Jones found that around 30-40% of health inequalities in Canada could be contributed to income-related health inequality [21].

On the other hand, Subramanian and Kawachi in 2004 reviewed the literature that investigated the empirical relationship between income inequality and health [22]. They found that the evidence implicating income disparities as a determinant factor for population health inequality was far from complete. They argued that better data and more sophisticated analytical methods are essential for connecting income inequality to public health [22]. Wagstaff and van Doorslaer in 2000 re-

viewed the literature on the negative effects of income inequality on population health [23]. Various hypotheses were identified that explained the observed association between measures of income inequality and population health. They concluded that data from aggregate-level studies of the effect of income inequality on health, i.e. studies at the population and community levels, were largely insufficient to discriminate between competing hypotheses. They also found that only individual-level studies had the potential to discriminate between most of the advanced hypotheses. Overall, the absolute-income hypothesis was the most likely to explain the frequently observed strong association between population health and income inequality levels [23]. Deaton and Lubotsky found that after controlling for the racial composition of a population in a city, the effect of income inequality on health disappeared [24]. Cross-section regressions across American states and cities showed that, conditional on racial composition, income inequality did not raise the risk of mortality. Gravelle and colleagues examined the validity of income-related inequality and health status using aggregate data [25]. The purported relationship between income inequality and population health was not significant in any of their models. They also contended that there were serious conceptual difficulties in using aggregate cross-sections as a means of testing hypotheses about the effect of income, and its distribution, on the health of individuals.

In conclusion, this study demonstrates that household income was not a factor to achieve therapeutic goals for LDL-C for patients with diabetes in this dataset, although goal attainment was less than ideal overall. It would, however, be desirable to develop large databases that capture clinical outcomes at a patient level for future research studies on the impact of income on health/disease status, instead of relying on large administrative population-based databases that utilize a cluster of information from the population level to tease out the outcomes in the patients' individual level.

Acknowledgments

The database, which was accessed for this study, was originally created by a supporting grant from AZ Canada.

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