Association of Median Household Income With Burden of Coronary Artery Disease Among Individuals With Diabetes

Doreen M. Rabi, MSc, MD; Alun L. Edwards, MB; Lawrence W. Svenson, BSc; Michelle M. Graham, MD; Merrill L. Knudtson, MD; William A. Ghali, MD, MPH; on behalf of the Alberta Provincial Project for Assessing Outcomes in Coronary Heart Disease Investigators

**Background**—Low income is associated with adverse cardiovascular outcomes. Diabetes is more prevalent among low income groups, and low income patients with diabetes have been shown to have a greater burden of cardiovascular risk factors and worse cardiovascular outcomes. The objective of this study was to determine whether income status was associated with burden of coronary atherosclerosis in patients with diabetes.

**Methods and Results**—All patients with diabetes presenting for cardiac catheterization between January 1, 2000, and December 31, 2002, in Calgary, Canada, were identified through the use of the Alberta Provincial Project for Assessing Outcomes in Coronary Heart Disease (APPROACH) database. This clinical database was merged with Canadian 2001 Census data on median household income per dissemination area using patient postal code data, and income quintiles were derived. Clinical profiles, severity of coronary atherosclerosis, and myocardial jeopardy were compared across income quintiles. Mean scores for severity and jeopardy were compared across income quintiles using analysis of variance. Multivariate linear regression was used to control for baseline differences across income groups.

A total of 4596 patients were eligible for inclusion in this study. Clinical profiles differed significantly across income quintiles, with the highest income quintile being younger (P<0.0005), more likely to be male (P=0.029), and having a lower prevalence of smoking (P=0.039). Low income groups were more likely to report a history of myocardial infarction (P<0.0005) or congestive heart failure (P<0.0005). The highest income groups has significantly less coronary atherosclerosis as measured by the weighted Duke index (6.67 versus 7.38, P<0.002), but there were no differences in lesion severity as measured by the Duke severity scale (2.31 versus 2.41, P=0.334). High income patients has significantly less myocardial jeopardy compared with the lowest income group as measured by the Duke and APPROACH scores (36.44 versus 46.23, P=0.0187, and 39.96 versus 45.36, P=0.0182, respectively). These differences remained significant even after controlling for baseline clinical differences in cardiovascular risk factor burden.

**Conclusions**—Low income is associated with a greater degree of atherosclerosis and greater myocardial jeopardy in patients with diabetes. More needs to be done to reduce cardiovascular risk factor burden in this vulnerable population. (*Circ Cardiovasc Qual Outcomes.* 2010;3:48-53.)

Key Words: atherosclerosis • diabetes mellitus • income • myocardial jeopardy • socioeconomic status

It is well established that socioeconomic standing is associated with cardiovascular disease (CVD) risk. Numerous studies have demonstrated, in several developed countries, that the risk of CVD is inversely related to socioeconomic status.\(^1\)\(^2\) Even more concerning is that others have demonstrated that the health disparity among the wealthy and the poor appears to be increasing.\(^3\)

Diabetes prevalence also demonstrates a socioeconomic gradient. It is well established that diabetes, along with risk factors for diabetes such as obesity, are also more prevalent among lower socioeconomic groups.\(^4\)\(^5\) We have previously shown that among those with diabetes, those in the lowest income groups present to specialty care with the highest cardiovascular risk profiles.\(^6\) Given the high cardiovascular risk inherent to diabetes, low income patients with diabetes would appear particularly vulnerable to CVD.

Whether low income is an independent risk factor for poor cardiovascular outcomes remains unclear. There are a number of factors that probably are mediating and modulating this low income–poor outcome association. Many established cardiovascular risk factors, such as diabetes and smoking, are more prevalent in low income populations.\(^3\)\(^7\) Low income status has also been shown to be associated with increased neurohormonal activation\(^8\) and increased markers of inflammation and thrombosis.\(^9\) In addition to these clinical and physiological differences, low income groups may have impaired access to care.\(^10\)\(^-\)\(^13\)

Received December 30, 2008; accepted September 14, 2009.
From the Department of Medicine (D.M.R., A.L.E., W.A.G.), the Department of Community Health Sciences (D.M.R., L.W.S., W.A.G.), and the Department of Cardiac Sciences (D.M.R., M.K., W.A.G.), University of Calgary, Calgary Canada; Alberta Health and Wellness (L.W.S.), Alberta, Canada; and the Division of Cardiology (M.M.G.), University of Alberta, Alberta, Canada.
Correspondence to Doreen M. Rabi, Room 2951, 3330 Hospital Dr NW, Calgary, Alberta, Canada, T2N 4N1. E-mail doreen.rabi@albertahealthservices.ca

*Circ Cardiovasc Qual Outcomes* is available at http://circoutcomes.ahajournals.org

DOI: 10.1161/CIRCOUTCOMES.108.840611

48
Together, these factors contribute significantly to the differential outcome noted among socioeconomic groups. Although there is a large amount of data demonstrating that low income is associated with a higher burden of cardiovascular risk factors, appears to have adverse physiological effects, and leads to poor cardiovascular outcomes, little is known about whether low income is associated with different degrees of coronary atherosclerosis. The extent of coronary atherosclerotic disease has been shown to be a valid predictor of increased cardiovascular mortality. This study seeks to determine whether income is associated with the degree and distribution of coronary atherosclerosis among a cohort of diabetic patients presenting for coronary catheterization.

WHAT IS KNOWN
- Socioeconomic status is inversely associated with both diabetes and cardiovascular disease risk.
- Poor health outcomes among those who are economically deprived may be mediated by a number of factors, including a higher burden of cardiovascular risk factors and impaired access to health care.

WHAT THIS ARTICLE ADDS
- The present study conducted in a cohort of patients with diabetes receiving care within a universal healthcare system showed that high income is still associated with a significantly lower burden of intraluminal atherosclerosis and lower myocardial jeopardy scores.
- This finding persists even when controlling for cardiovascular risk factor burden.

Methods
Participants
Data on all patients with diabetes who had presented for cardiac catheterization in Alberta between January 2000 and December 2002 were examined in this study. In the cardiac registry used in this study, a patient is identified as having diabetes if, at the time of cardiac catheterization, the patient reports a history of diabetes that was either diagnosed or treated by a physician. It should be noted that Alberta, like all Canadian provinces, has a provincially funded, universally accessible health care system. Theoretically, all residents of Alberta should have access to health care services, including cardiac catheterization.

Data Sources
The Alberta Provincial Project of Outcome Assessment in Coronary Heart Disease (APPROACH) is a prospective clinical data collection initiative including data on all adult patients undergoing cardiac catheterization in the province of Alberta.16 This database includes patient demographic information, baseline clinical data, and information pertaining to coronary anatomy and myocardial jeopardy.

Study Variables
Coronary anatomy is assessed at the time of coronary angiography by an invasive cardiologist and is recorded in a computerized data entry template used as the procedural report for the patient medical record (Heartview, Heart Ware, Durham, NC). From this template, the weighted Duke Index, Duke Severity, and myocardial jeopardy scores can be calculated. The weighted Duke Index is a measure of the extent and severity of coronary artery disease. It measures the number of diseased major vessels, presence or absence of left main coronary disease, and percent narrowing of the major vessels.14

Severity of coronary disease was determined using the Duke Severity scale. Using Heartview, a patient is assigned a severity score ranging from 1 to 5 as follows: 1, normal coronary arteries/no coronary stenoses; 2, minor disease (<50% diameter stenosis); 3, low risk disease/1-2 vessel disease with >50% stenoses; 4, high-risk group/2-vessel disease with proximal left anterior descending artery or 3-vessel disease; and 5, very high-risk group/left main disease.17 Myocardial jeopardy is defined as the area of myocardium subtended by coronary arteries with clinically significant atherosclerosis. In other words, myocardial jeopardy refers to the amount of myocardium at significant risk for ischemia and ischemic injury. Three jeopardy scores have been validated for use in APPROACH. These are the Duke Jeopardy Score, the BARI Myocardial Jeopardy Index, and the APPROACH Lesion Score.15 Although each score is a valid predictor of cardiovascular mortality in and of itself, the scores do differ on how myocardial jeopardy is calculated. Because of these differing jeopardy calculations, it was thought prudent to examine the association of income with each jeopardy score.

Derivation of Income Quintiles
The postal codes of patients registered in the APPROACH were linked to their corresponding dissemination area using the Statistics Canada Postal Code Conversion File. Neighborhood income data were obtained from Statistics Canada Census data (2001). We defined a neighborhood as equivalent to a census dissemination area (DA). Therefore, median household income per DA was the income measure used in this study. These data were merged with the APPROACH data on the variable DA.

Household income quintiles were generated from DA annual income data. The income quintiles, ranging from lowest to highest, were as follows: quintile 1 (<$40 577/y), quintile 2 ($40 578 to $48 056/y), quintile 3 ($48 057 to $55 545/y), quintile 4 ($55 546 to $66 548/y), and quintile 5 (> $66 549/y).

Statistical Analysis
Clinical characteristics are presented using proportions and descriptive statistics. Differences in dichotomous variables across income quintiles were analyzed using χ² analysis. Differences in continuous variables were examined using linear regression. Differences in ordinal scores across income quintiles were examined using analysis of variance.

To examine the association between continuous coronary anatomy variables and continuous myocardial jeopardy scores, linear regression modeling was used. In these analyses, the lowest income quintile (quintile 1) was used as the reference. Covariates considered in these analyses included age, sex, history of hypertension, dyslipidemia, and smoking. All statistical analyses were performed in Stata version 8.

Results
From January 2000 to December 2002, 5235 patients with diabetes underwent cardiac catheterization. Among these eligible patients, 639 patients lived out of province or had incomplete address information so that linkage to income data could not be performed. After excluding these individuals, 4596 patients remained eligible for inclusion in the study. The clinical profiles of these patients are tabulated by income quintile in Table 1. χ² analysis indicates that those in the highest income quintiles were younger (63 years [mean age highest income] versus 65 years [mean age lowest income], P<0.00005), more likely to be male (χ²=10.75, P=0.029), and less often had a history of acute myocardial infarction (42.9% versus 51.1%, χ²=21.08, P<0.0005) and congestive heart failure (20.8% versus 28.8%, χ²=24.57, P<0.0005). The wealthiest patients were less likely to be current smokers (19.7% versus 25.2%, χ²=10.1, P=0.039)
but otherwise were similar with respect to the prevalence of other risk factors such as hypertension or dyslipidemia. There were no significant differences with respect to the history of prior revascularization across income quintiles. A total of 268 patients had undergone previous coronary artery bypass grafting, and 258 had received a previous percutaneous coronary intervention. To be prudent, these patients were excluded from the analysis examining the association between the income and the burden of cardiovascular disease, because these procedures can modify the apparent extent of coronary disease. Results of our analysis comparing coronary disease burden and jeopardy scores across income quintiles are presented in Table 2. The highest income quintile had the least amount of coronary disease (as measured by the weighted Duke index) (6.67 [highest income] versus 7.38 [lowest income], \( P < 0.0002 \)) and the coronary artery disease among the wealthiest income quintile was graded as the least severe (2.31 [highest income] versus 2.41 [lowest income]) on the Duke severity scale; however, this latter finding was not statistically significant (\( P = 0.334 \)). The highest income quintiles also had significantly less myocardial jeopardy as measured by the Duke (36.44 [highest income] versus 46.23 [lowest income], \( P = 0.0187 \)) and APPROACH Jeopardy Scores (39.96 [highest income] versus 45.36 [lowest income], \( P = 0.0182 \)) and toward

### Table 1. Baseline Characteristics

<table>
<thead>
<tr>
<th>Clinical Characteristics</th>
<th>1 (n=920)</th>
<th>2 (n=923)</th>
<th>3 (n=915)</th>
<th>4 (n=919)</th>
<th>5 (n=919)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>65.2</td>
<td>65.1</td>
<td>64.7</td>
<td>63.6</td>
<td>63.1</td>
<td>&lt;0.00005</td>
</tr>
<tr>
<td>Men, %</td>
<td>63.15</td>
<td>63.38</td>
<td>64.70</td>
<td>65.29</td>
<td>69.53</td>
<td>0.029</td>
</tr>
<tr>
<td>BMI, median</td>
<td>31.2</td>
<td>38.6</td>
<td>31.5</td>
<td>32.2</td>
<td>30.7</td>
<td>0.2261</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>74.9</td>
<td>75.6</td>
<td>73.4</td>
<td>71.3</td>
<td>71.3</td>
<td>0.107</td>
</tr>
<tr>
<td>Dyslipidemia, %</td>
<td>64.5</td>
<td>67.6</td>
<td>69.8</td>
<td>70.0</td>
<td>68.2</td>
<td>0.076</td>
</tr>
<tr>
<td>Present smoker, %</td>
<td>25.2</td>
<td>20.26</td>
<td>21.4</td>
<td>21.9</td>
<td>19.7</td>
<td>0.039</td>
</tr>
<tr>
<td>Previous smoker, %</td>
<td>45.2</td>
<td>47.2</td>
<td>48.1</td>
<td>45.1</td>
<td>44.5</td>
<td>0.469</td>
</tr>
<tr>
<td>Renal disease, %*</td>
<td>10.1</td>
<td>9.4</td>
<td>7.3</td>
<td>6.4</td>
<td>7.8</td>
<td>0.24</td>
</tr>
<tr>
<td>On dialysis, %</td>
<td>4.6</td>
<td>5.6</td>
<td>4.6</td>
<td>4.5</td>
<td>4.7</td>
<td>0.760</td>
</tr>
<tr>
<td>Previous MI, %</td>
<td>51.1</td>
<td>50.0</td>
<td>52.7</td>
<td>50.5</td>
<td>42.9</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Cerebrovascular disease, %</td>
<td>12.7</td>
<td>9.5</td>
<td>10.8</td>
<td>10.1</td>
<td>7.62</td>
<td>0.008</td>
</tr>
<tr>
<td>PVD, %</td>
<td>13.7</td>
<td>11.8</td>
<td>13.9</td>
<td>12.7</td>
<td>10.2</td>
<td>0.108</td>
</tr>
<tr>
<td>Prior CABG, %</td>
<td>6.0</td>
<td>6.5</td>
<td>5.5</td>
<td>4.8</td>
<td>6.4</td>
<td>0.491</td>
</tr>
<tr>
<td>Prior CHF, %</td>
<td>28.8</td>
<td>24.2</td>
<td>21.3</td>
<td>20.8</td>
<td>20.8</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Prior lytic, %</td>
<td>2.7</td>
<td>4.1</td>
<td>3.3</td>
<td>3.2</td>
<td>2.2</td>
<td>0.174</td>
</tr>
<tr>
<td>Prior PTCA, %</td>
<td>4.46</td>
<td>6.4</td>
<td>5.7</td>
<td>6.0</td>
<td>5.6</td>
<td>0.458</td>
</tr>
<tr>
<td>Hx of malignancy, %</td>
<td>4.0</td>
<td>4.6</td>
<td>5.5</td>
<td>4.8</td>
<td>4.1</td>
<td>0.593</td>
</tr>
<tr>
<td>Hx of GI/liver disease, %</td>
<td>6.4</td>
<td>7.2</td>
<td>4.8</td>
<td>7.0</td>
<td>5.6</td>
<td>0.1</td>
</tr>
</tbody>
</table>

BMI indicates body mass index; MI, myocardial infarction; PVD, peripheral vascular disease; CABG, coronary artery bypass graft; CHF, congestive heart failure; PTCA, percutaneous coronary angioplasty; Hx, history; and GI, gastrointestinal.

*Serum creatinine >200 \( \mu \)mol/L.

### Table 2. Coronary Anatomy Scores

<table>
<thead>
<tr>
<th>Income Quintile</th>
<th>1 (n=829)</th>
<th>2 (n=814)</th>
<th>3 (n=822)</th>
<th>4 (n=833)</th>
<th>5 (n=822)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighted Duke Index</td>
<td>7.38 (4.5)</td>
<td>7.42 (4.5)</td>
<td>6.67 (4.6)</td>
<td>6.83 (4.5)</td>
<td>6.67 (4.6)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Duke Severity</td>
<td>2.41 (1.4)</td>
<td>2.43 (1.4)</td>
<td>2.41 (1.5)</td>
<td>2.33 (1.2)</td>
<td>2.31 (1.5)</td>
<td>0.334</td>
</tr>
<tr>
<td>Jeopardy Scores</td>
<td>46.23 (35.1)</td>
<td>41.03 (33.7)</td>
<td>39.04 (34.3)</td>
<td>39.33 (33.2)</td>
<td>36.44 (33.0)</td>
<td>0.0187</td>
</tr>
<tr>
<td>Duke</td>
<td>54.57 (35.4)</td>
<td>53.91 (35.1)</td>
<td>52.06 (35.7)</td>
<td>51.90 (35.1)</td>
<td>49.86 (35.8)</td>
<td>0.0604</td>
</tr>
<tr>
<td>BARI</td>
<td>45.36 (35.0)</td>
<td>44.37 (33.9)</td>
<td>42.60 (34.6)</td>
<td>43.29 (33.6)</td>
<td>39.96 (33.5)</td>
<td>0.0182</td>
</tr>
<tr>
<td>APPROACH</td>
<td>2.70 (2.4)</td>
<td>2.61 (2.3)</td>
<td>2.51 (2.4)</td>
<td>2.61 (2.4)</td>
<td>2.43 (2.3)</td>
<td>0.1822</td>
</tr>
<tr>
<td>Total lesions</td>
<td>2.47 (1.5)</td>
<td>2.50 (1.5)</td>
<td>2.49 (1.4)</td>
<td>2.47 (1.5)</td>
<td>2.37 (1.5)</td>
<td>0.3943</td>
</tr>
<tr>
<td>Lesions in LAD</td>
<td>2.20 (1.6)</td>
<td>2.26 (1.6)</td>
<td>2.13 (1.6)</td>
<td>2.17 (1.6)</td>
<td>2.05 (1.6)</td>
<td>0.1088</td>
</tr>
<tr>
<td>Lesions in RCA</td>
<td>2.37 (1.6)</td>
<td>2.38 (1.5)</td>
<td>2.32 (1.6)</td>
<td>2.43 (1.6)</td>
<td>2.43 (1.6)</td>
<td>0.7021</td>
</tr>
</tbody>
</table>

Data are presented as mean (SD). LAD indicates left anterior descending; RCA, right coronary artery.
lower BARI Jeopardy Scores; however, this did not reach significance (49.86 [highest income] versus 54.57 [lowest income], P=0.0604). Lesion counts did not differ significantly across income quintiles, but there was a trend toward the wealthiest patients having fewer lesions (P=0.1822). On further assessment of the reporting template, other significant differences between income quintiles were noted (see Table 3). The wealthiest were the least likely to have clinically significant lesions (ie, ≥70% stenosis) (P=0.021) compared with the lowest income quintile. However, this difference was attenuated somewhat in a multivariate analysis that adjusted for differences in risk factor profiles (P=0.056). The distribution of disease did not differ by income.

The regression analysis examining potential differences in myocardial jeopardy across income quintiles is presented in Table 4. The wealthiest patients had significantly lower jeopardy as measured by the Duke, BARI, and APPROACH Jeopardy scores. This difference remained significant after adjustment for differences in age, sex, and cardiovascular risk profile. A stratified analysis (Tables 5 and 6) was conducted to examine the association of income with myocardial jeopardy among individuals with and without traditional cardiovascular risk factors (smoking, hypertension, hyperlipidemia, or prior myocardial infarction or congestive heart failure). This analysis demonstrated that the highest income groups consistently had lower jeopardy scores when traditional risk factors were absent. However, this inverse association between income and jeopardy was attenuated in the presence of risk factors, suggesting that the putative protective effect of high income is greatest among those who would generally be considered low risk.

### Discussion

The present study demonstrates that in this cohort with diabetes, the wealthiest patients have the lowest burden of coronary disease as measured by the weighted Duke Index and 3 validated myocardial jeopardy scores. Because increasing Duke Index and jeopardy scores are associated with an increase risk of future cardiovascular mortality, this finding implies that the wealthiest patients in this study may have a survival advantage. Indeed, previous studies examining survival among the entire APPROACH cohort demonstrates that the odds of mortality among the wealthiest patients is approximately half that of the poorest (odds ratio, 0.49, 95% CI, 0.43 to 0.55).18

The results of this study reinforce that there are significant clinical differences across income groups, even within a universal health care system. Examination of the clinical profiles of these individuals at the time of catheterization shows that the lower income groups were older and were more likely to have a history of previous vascular events such as a previous myocardial infarction or stroke. However, although the previous cardiovascular event rate was higher among low income patients, the use of revascularization strategies was similar across income quintiles. This is an intriguing finding and suggests that there may be issues of inequitable access to revascularization procedures for lower income patients, but whether differential use of revascularization procedures by income group is related to patient (ie, presenting late with ischemic symptoms) or physician factors (choosing medical management versus revascularization in older patients with more comorbid illness) cannot be determined from the present study.

There is evidence that among patients with coronary disease, the wealthy probably are more effective at accessing...
coronary procedures than are the poor. Alter et al19 demonstrated that even within a universal health care system, high socioeconomic status is associated with a 23% increase in the use of acute percutaneous transluminal coronary angioplasty. Wealthy patients also receive treatment in a more expedient manner—high income was associated with a 43% reduction in wait time for cardiac procedures.19 Although previous research would indicate that individuals with diabetes access specialty diabetes care similarly across income groups,4 this may not be true for other forms of specialized care, where it has been shown that diabetic patients in general have impaired access to specialty cardiac services. In comparison to those without diabetes, diabetic patients are less likely to receive revascularization or be followed by a cardiologist.20

In addition to differential access to care, health-related behaviors are known to differ among the social classes. In this study, we showed that low income groups had a higher prevalence of smoking and a trend to more hypertension. However, we also demonstrate that high income is associated with significantly less coronary atherosclerosis even after controlling for prevalence of traditional cardiac risk factors. Therefore, the differences in coronary disease noted in this study may not be attributed solely to differences in traditional risk factors.

There is increasing evidence that there are several physiological differences across income groups that may mediate the development of coronary atherosclerosis. Dysregulation of the hypothalamic-pituitary-adrenal axis and particularly loss of diurnal variation in serum cortisol levels is more common among lower socioeconomic groups.21,22 This results in higher cortisol levels, which can lead to a number of metabolic and inflammatory abnormalities that can leave affected individuals more vulnerable to the development of atherosclerosis. Individuals of lower social standing have also been found to be more vulnerable to ischemia-related arrhythmias. Low income patients have been found to have higher resting heart rates and lower heart rate variability, leading researchers to suggest that low income patients may be experiencing autonomic dysfunction relative to their wealthier counterparts.8,23

The present study is limited in that it is a cross-sectional examination of the association between income and coronary disease. A longitudinal study examining exposure to various levels of income with serial coronary angiography would have enriched our understanding of how these 2 variables are related. We propose that low income is associated with an increase risk of coronary atherosclerosis. However, given the cross-sectional study design and the fact that lower income groups had a greater number of prior ischemic events, it is possible that disability from coronary disease compromised earning potential, such that advanced atherosclerosis resulted in low income. In this cohort of individuals with diabetes, we also could not account for level of glycemic control in our multivariate models. Given the established link between hemoglobin A1C and cardiovascular risk, this is a limitation.24–27 Although our previous study would indicate that HBA1C may not differ markedly across income quintiles,6 we cannot be certain that the differences in coronary disease across income groups in this population were not influenced by difference in glycemic control. Similarly, cardioprotective medication use across income quintiles is not known, nor do we have data on the degree to which other vascular risk factors such as hypertension and hypercholesterolemia were controlled. It is possible that the differences seen in coronary atherosclerosis across groups reflect differences in ability to access proven cardioprotective therapies and achieve established therapeutic targets.

The findings of this study appear to be intuitive, given the large amount of evidence documenting the socioeconomic gradients in cardiovascular risk factor burden and other studies that demonstrate that controlling for differences in risk factor burden and psychosocial stresses account for a

<table>
<thead>
<tr>
<th>Table 5. Duke Jeopardy Scores by Income Quintile in Those Without Cardiovascular Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Quintile</td>
</tr>
<tr>
<td>1 (low)</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

Data are presented as mean (SD). CHF indicates congestive heart failure; MI, myocardial infarction.
*Significantly lower than all other income quintiles, P<0.001.
†Significantly lower than income quintiles 2 and 3, P<0.001.

<table>
<thead>
<tr>
<th>Table 6. Duke Jeopardy Scores by Income Quintile in Those With Cardiovascular Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Quintile</td>
</tr>
<tr>
<td>1 (low)</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

Data are presented as mean (SD). CHF indicates congestive heart failure; MI, myocardial infarction.
*Significantly lower than groups 2, 3, and 4, P<0.001.
†Significantly lower than groups 2 and 3, P<0.001.
large proportion of the outcome disparities observed across socioeconomic groups. However, what this study adds, or perhaps reminds us, is that there are clear biological and anatomic ramifications of these clinical differences. Low income, diabetic patients in a Canadian city have more atherosclerosis than their wealthier counterparts. Clearly, more needs to be done to improve the health outcomes of the economically disadvantaged. Health care providers and policy makers need to be more cognizant of health risks associated with low income, so that we may be more proactive in preventing poor health outcomes in this vulnerable population. This study, conducted within a universal health care system, illustrates that access to care alone does not eliminate disparities in health. This might be due the fact that access to care depends on an individual’s assessment of their need for care and the importance of health relative to competing demands (ie, need to attend work to generate income). Community-sensitive and community-based disease prevention and health promotion strategies, particularly strategies that include significant political and environmental support, probably hold the greatest promise for improving health and health literacy among the economically disadvantaged.28,29 However, facilitating sick day reimbursement and health consultants in the workplace are other strategies that may facilitate access to health care and improve health in this population and warrant further study.

Sources of Funding
This project was led by Dr Rabi and was supported by funding from the Alberta Heritage Foundation for Medical Research.

Disclosures
None.

References
Association of Median Household Income With Burden of Coronary Artery Disease Among Individuals With Diabetes
Doreen M. Rabi, Alun L. Edwards, Lawrence W. Svenson, Michelle M. Graham, Merril L. Knudtson and William A. Ghali
on behalf of the Alberta Provincial Project for Assessing Outcomes in Coronary Heart Disease Investigators

Circ Cardiovasc Qual Outcomes. 2010;3:48-53; originally published online December 29, 2009;
doi: 10.1161/CIRCOU7COMES.108.840611
Circulation: Cardiovascular Quality and Outcomes is published by the American Heart Association, 7272
Greenville Avenue, Dallas, TX 75231
Copyright © 2009 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-7705. Online ISSN: 1941-7713

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://circoutcomes.ahajournals.org/content/3/1/48

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Cardiovascular Quality and Outcomes can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Cardiovascular Quality and Outcomes is online at:
http://circoutcomes.ahajournals.org//subscriptions/