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Women with coronary artery disease report worse health-related quality of life outcomes compared to men

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Abstract

Background: Although there have been substantial medical advances that improve the outcomes following cardiac ischemic events, gender differences in the treatment and course of recovery for patients with coronary artery disease (CAD) continue to exist. There is a general paucity of data comparing the health related quality of life (HRQOL) in men and women undergoing treatment for CAD. The purpose of this study was to compare HRQOL outcomes of men and women in Alberta, at one-year following initial catheterization, after adjustment for known demographic, co-morbid, and disease severity predictors of outcome.

Method: The HRQOL outcome data were collected by means of a self-reported questionnaire mailed to patients on or near the one-year anniversary of their initial cardiac catheterization. Using the Seattle Angina Questionnaire (SAQ), 5 dimensions of HRQOL were measured: exertional capacity, anginal stability, anginal frequency, quality of life and treatment satisfaction. Data from the APPROACH registry were used to risk-adjust the SAQ scale scores. Two analytical strategies were used including general least squares linear modeling, and proportional odds modeling sometimes referred to as the "ordinal logistic modeling".

Results: 3392 (78.1%) patients responded to the follow-up survey. The adjusted proportional odds ratios for men relative to women (PORs > 1 = better) indicated that men reported significantly better HRQOL on all 5 SAQ dimensions as compared to women. (PORs: Exertional Capacity 3.38 (2.75–4.15), Anginal Stability 1.23 (1.03–1.47), Anginal Frequency 1.70 (1.43–2.01), Treatment Satisfaction 1.27 (1.07–1.50), and QOL 1.74 (1.48–2.04).

Conclusions: Women with CAD consistently reported worse HRQOL at one year follow-up compared to men. These findings underline the fact that conclusions based on research performed on men with CAD may not be valid for women and that more gender-related research is needed. Future studies are needed to further examine gender differences in psychosocial adjustment following treatment for CAD, as adjustment for traditional clinical variables fails to explain sex differences in health related quality of life outcomes.

Introduction

Coronary artery disease (CAD) is the leading cause of death and disability for both women and men in Canada [1], and although there have been substantial medical advances that improve survival for cardiac ischemic events, gender differences in the pathophysiology, treatment, course of recovery and outcomes for patients with CAD continue to exist [1-6]. For example, it has been reported that women with CAD are older, have a higher burden of co-morbid illnesses [7], are more often widowed, more likely to live alone, have more depressive symptoms, have poorer psychosocial adjustment following a CAD event [3,8,9] and lower referral/participation in cardiac rehabilitation programs compared to men [10]. Further, there is growing evidence that suggests CAD presents differently in women and men [11], which in turn contributes to gender differences in the delivery of care [7]. The differences between men and women with CAD have great relevance particularly when addressing secondary prevention programs. If these programs are to be successful, it is not only crucial to carry out comprehensive follow-up, but to recognize that men and women may require different approaches to achieve maximal benefit from treatment for CAD.

There is a general paucity of data comparing men and women with CAD for differences with respect to health-related quality of life (HRQOL) outcomes. Although researchers have explored the association between gender, heart disease and HRQOL, the results are contradictory depending on the subset of patients studied and the definitions used for HRQOL. To our knowledge, no studies have explored the association between gender, CAD and HRQOL outcomes, using a comprehensive sample of patients with single or multi-vessel CAD and a disease specific HRQOL measure. The sex of patients with CAD has been reported to be associated with factors such as demographic, co-morbid illnesses, and clinical presentation [2,12-21]. Women with CAD are older, have a higher burden of co-morbid illnesses [7], and have poorer psychosocial adjustment following a CAD event [3,8,9]. We therefore hypothesized that following statistical adjustment women would also experience worse HRQOL outcomes compared to men. Therefore, the purpose of this study was to compare the HRQOL outcomes of men and women in Alberta with CAD at or near one-year following initial catheterization, after adjustment for known demographic, co-morbid, and disease severity predictors of outcome.

Methods

Selection of patient population

Eligible subjects included all adult Alberta residents over the age of 18 years, undergoing their first cardiac catheterization with 2 or more coronary arteries having $\geq 50\%$

occlusion (Duke Coronary Index between 3 and 13 [22]) registered in the Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH®) database. Patients were excluded if they did not consent to become part of the APPROACH follow-up cohort. APPROACH is a province-wide inception cohort of all adult Alberta residents undergoing cardiac catheterization for ischemic heart disease. The APPROACH project was initiated to study provincial outcomes of care and to facilitate quality assurance/quality improvement for patients with CAD in Alberta [23]. The APPROACH database contains detailed clinical and treatment information for adult patients with known or suspected CAD. The data provide a unique opportunity to study outcomes in an unselected patient population.

Collection of clinical data

Data collection sheets were completed at the time of catheterization by the referring cardiologists and were entered by cardiac catheterization laboratory staff into on-site computers, linked via Ethernet to a server located at the University of Alberta. Data collected at catheterization includes; sociodemographic characteristics (sex, age, residence address and postal code), presence or absence of comorbidities (renal insufficiency, hypertension, hyperlipidemia, diabetes mellitus, peripheral vascular disease, cerebrovascular disease, smoking status, pulmonary disease, liver/gastrointestinal disease, malignancy), disease specific variables (congestive heart failure, prior myocardial infarction, prior thrombolytic therapy, and coronary angiography results including coronary anatomy, extent of coronary stenosis, left ventricular ejection fraction). A treatment modality grouping was identified as the first treatment the patient received following the initial cardiac catheterization. Subsequent revascularization procedures were also collected in the APPROACH database.

Collection of HRQOL data

The HRQOL outcome data were collected by means of a self-reported questionnaire mailed to patients on or near the one and three year anniversary of their initial cardiac catheterization. Consent to follow-up was acquired at the time of catheterization and ethical committees at each of the participating hospitals approved the study. The self-administered questionnaire included the Seattle Angina Questionnaire (SAQ). The SAQ is a 19 item self-administered questionnaire. Five dimensions of CAD are measured: exertional capacity (functional status), anginal stability, anginal frequency, quality of life, and treatment satisfaction, generating five independent scales. Each question is measured on an ordinal scale with 1 indicating the lowest/poorest response. Based on the results of validity, responsiveness and reliability testing, the SAQ has been judged to be a valid, responsive and reliable instrument [24]. Specifically, it has been suggested that the SAQ

is sensitive to clinical changes in patient's CAD, and that it focuses on symptoms and impairments in health that are unique to coronary disease [24]. The Medical Outcomes Trust has adopted the SAQ as a HRQOL measure for patients with CAD. Furthermore, the SAQ has been translated into 16 languages for use in Europe, the Middle East and North America [25], and is in widespread use worldwide. Notification of patient death occurred either through the family by return mail or through a bi-annual merge with data from the Alberta Bureau of Vital Statistics.

Participants were provided with two options for completing the follow-up questionnaire. They could complete the questionnaire and mail it back in a stamped addressed envelope or they could telephone a toll free line and respond to a verbally administered questionnaire, which was recorded and transcribed daily. A second questionnaire was sent to non-responders 13 months post-catheterization with the same options for completion. In the case of a questionnaire being returned due to an incorrect address, letters were sent to the referring cardiologist to obtain current/correct mailing addresses and questionnaires were resent. Finally, at 15 months post-catheterization, a third reminder was sent to non-responders.

Statistical analysis

Baseline clinical and demographic characteristics of patients who completed the questionnaire (responders) and those with surveys that remained outstanding (non-responders) were compared using chi-square analysis for the categorical variables and students t-test for continuous variables. Baseline clinical, demographic and co-morbid characteristics of women and men were compared using chi-square analysis for the categorical variables and students t-test for continuous variables.

Scoring the SAQ

The SAQ is scored by assigning each response an ordinal value, beginning with 1 for the response that implies the lowest level of functioning, and summing across items within each of the five dimensional scales. As suggested by the developers, scale scores are then transformed to a 0 to 100 range by subtracting the lowest possible score, dividing by the range of the scale and multiplying by 100. [24] These scores were used as outcome variables for linear regression modeling. Additionally, as the distributions of the SAQ dimensional scores were graphically non-normal, we wished to have the option of analyzing the data using non-parametric statistics. Consequently, the original scores from each of the 5 scale scores were also added together and divided by the number of questions that made up the scale to create a mean dimensional score for each respondent. To maintain the ordinal nature of the data, frequencies of the scores were run for each of the 5 scales and categories were created based on quintiles.

Risk adjusting the SAQ scores

An analysis done comparing 4 regression models to analyze SAQ dimensional scores [26] led us to conclude that a combination of the results derived from a least squares linear regression model and an ordinal regression model (risk adjusted SAQ scores and proportional odds ratios) produced the most comprehensive interpretation of the data from a quantitative as well as qualitative perspective. Therefore, two strategies were used to risk adjust the SAQ scores. The first strategy was to use general least squares linear modeling (GLM) relying on the central-limit theorem (i.e., where one has a large dataset with a large number of cases, statistical inferences can be made based on the approximate normality of the regression estimates even when raw data and residuals are non-normal). The second strategy was to use the proportional odds model sometimes referred to as the "ordinal logistic model" [27]. Maximum likelihood estimates were used to estimate summary odds ratios while least square means were used to estimate risk adjusted mean SAQ scores. The regression coefficients for the covariates in the GLM models were multiplied by the individual covariate values and then summed, thereby producing risk adjusted scores. Meanwhile, the beta coefficients derived from the covariates in the ordinal regression models yield probabilities that are converted into proportional odds ratios (PORs). Ten regression models were constructed (5 models using ordinal regression and 5 models using GLM) with separate models for each SAQ dimensional scale for both the one-year and the three year questionnaires. All demographic, co-morbid and clinical variables were included and entered at the same time into the regression models. All statistical analyses were conducted using SPSS version 11.5.

Results

A total of 10,108 consenting patients who underwent cardiac catheterization between January 1996 and December 1998 in the province of Alberta were sent one-year follow-up surveys. Of these, 4,344 patients were eligible for this study among whom 3392 (78.1%) patients responded to the follow-up survey while 952 (21.9%) surveys remained outstanding. Among responders, 3243 surveys were returned completed and 149 surveys were returned notifying the investigators that the patient had died prior to completion of the survey.

An analysis of the differences in the baseline demographic data and clinical characteristics of responders and non-responders demonstrated a few significant differences (Table 1). Compared with responders, non-responders tended to be younger, were more likely to have diabetes mellitus ($p < 0.001$) and a lower ejection fraction ($p = 0.001$). As well, non-responders were more likely to have been treated with medical therapy during the first year

Table 1: Clinical Characteristics of Responders and Non-Responders

Variables	Responders (N = 3243)	Non-responders (N = 952)	P value
Sex (% Female)	22.2%	20.7%	0.322
Age Category (% per Quintile)			
30–57 years	25.0%	36.3%	
58–65 years	25.0%	24.8%	
66–75 years	25.0%	20.6%	<0.001
>75 years	25.0%	18.3%	
Pulmonary disease	6.9%	6.3%	0.514
Cerebrovascular Disease	4.8%	5.9%	0.198
Renal Disease	1.7%	1.6%	0.849
Congestive Heart Failure	10.5%	11.4%	0.413
Dialysis	1.0%	0.90	0.844
Hypertension	53.6%	56.8%	0.081
Hyperlipidemia	47.9%	46.5%	0.442
Liver/Gastrointestinal Disease	2.9%	3.6%	0.313
Malignancy	3.3%	2.2%	0.085
Prior Myocardial Infarction	43.2%	45.9%	0.144
Peripheral Vascular Disease	7.5%	8.2%	0.495
Diabetes Mellitus	18.0%	23.7%	<0.001
Left Ventricular Ejection Fraction			
>50%	58.0%	59.1%	
<30%	4.4%	6.6%	
30–50%	24.6%	25.1%	0.001
V-gram ^c not done due to instability	2.7%	2.4%	
Missing	10.3%	6.7%	
Coronary Anatomy			
2 Vessel Disease	37.1%	39.1%	
3 Vessel Disease	50.0%	50.0%	0.124
Left Main Disease	12.9%	10.5%	
Treatment within 1 st year following Index catheterization			
Medical Management	26.7%	35.1%	
CABG ^a	38.6%	32.6%	<0.001
PCI with/without stent ^b	34.7%	32.4%	

a. Coronary artery bypass graft surgery b. Percutaneous coronary intervention with/without stent c. Ventriculogram

following their index catheterization (35.1% versus 26.7% $p < 0.001$).

The mean age of the responders at the time of the index catheterization was 64.6 years and the median age was 65.7 years. Seventy-eight percent of the sample were men. Baseline demographic and clinical characteristics of the analytic cohort grouped by sex are described in Table 2. Women were significantly older (mean age: women = 66.7 years, men = 63.9 years $p < 0.001$), and this difference was most pronounced in the oldest age quintile (women > 72 years 35.1%, men > 72 years 21.9%). Compared to men, women were more likely to have congestive heart failure ($p = 0.001$), hypertension ($p < 0.001$) and diabetes mellitus ($p < 0.001$). Women were also more likely to have 2 vessel disease, although the same percentage of women and men had left main disease. Finally, women were more likely to have an ejection fraction >50%, have unstable angina as the indication for

catheterization, and to be treated medically or with percutaneous coronary intervention.

Proportional odds ratios for men relative to women, risk adjusted for all independent variables in the 5 models, are presented in Figure 1. When comparing two groups, PORs > 1.00 indicate better HRQOL scores. Overall, the risk adjusted proportional odds ratios, adjusted for demographic and clinical characteristics, indicated that men had significantly higher scores (better HRQOL) on all 5 SAQ dimensions as compared to women.

Risk-adjusted mean SAQ scores (scored on a scale from 0 to 100) for men and women at 1 year follow-up are presented in Figure 2. At one-year follow-up, differences between risk-adjusted mean SAQ scores of men compared to women were statistically significant ($P \leq 0.001$). Similar to the ordinal regression analysis, men reported significantly higher scores in all 5 SAQ dimensions compared to

Table 2: Difference in Demographic Data and Co-morbidities Between Men and Women

Variables	Men (N = 2523)	Women (N = 720)	P value
Age Category (% per Quintile)			
18–52 years	13.2%	11.1%	
53–59 years	19.4%	14.2%	
60–65 years	22.3%	16.0%	<0.001
66–72 years	23.2%	18.3%	
>72 years	21.9%	35.1%	
Pulmonary disease	6.9%	7.1%	0.833
Cerebrovascular Disease	4.3%	6.7%	0.010
Renal Disease			
Creatinine >200 mg.	1.0%	0.8%	
Creatinine >200 mg./Dialysis	1.0%	1.3%	0.749
Congestive Heart Failure	9.6%	13.8%	0.001
Hypertension	51.1%	62.6%	<0.001
Hyperlipidemia	47.7%	48.8%	0.626
Liver/Gastrointestinal Disease	2.7%	3.9%	0.083
Malignancy	3.3%	3.3%	0.954
Prior Myocardial Infarction	43.7%	41.5%	0.295
Peripheral Vascular Disease	7.4%	7.9%	0.651
Diabetes Mellitus	16.8%	22.2%	0.001
Left Ventricular Ejection Fraction			
>50%	56.6%	63.1%	
<30%	4.6%	3.5%	
30–50%	25.9%	20.0%	0.003
V-gram not done due to instability	2.9%	2.1%	
Missing	10.0%	11.4%	
Coronary Anatomy			
2 Vessel Disease	34.6%	43.3%	
3 Vessel Disease	51.2%	41.9%	<0.001
Left Main Disease	12.7%	12.5%	
Missing	1.5%	2.2%	
Treatment within 1 st year following Index catheterization			
Medical Management	25.5%	30.8%	
CABG	40.5%	31.8%	<0.001
PCI with Stent	24.0%	26.3%	
PCI without Stent	9.9%	11.1%	
Indication for catheterization			
Stable Angina	40.8%	33.9%	
Myocardial Infarction	23.1%	23.8%	<0.001
Unstable Angina	27.4%	34.4%	
Other	8.6%	9.9%	

women at the one-year follow-up and the differences between men and women were still present at the three-year follow-up. Pairwise comparisons of men and women's one-year follow-up risk adjusted SAQ scores are presented in Table 3. Spertus et al have indicated that a clinically significant difference in SAQ dimensional scores is between 5 and 8 points [28]. Accordingly, there is a *clinically significant difference* between men and women's one-year functional status as measured by the exertional capacity scale (mean difference 14.49 points). The differences between men and women in the anginal frequency scale (mean difference 6.73 points) and quality of life scale (mean difference 7.46 points) also surpass this threshold

for clinical significance. GML coefficients for the five models of the SAQ are presented in Table 4.

Discussion

It has been well recognized that important differences exist between women and men with regard to the function and progression of diseases of the cardiovascular system. [29] Further it has been suggested that for optimal treatment of CAD it is necessary to recognize gender differences and their impact on the outcomes of care [30]. The results of this study indicate that women have worse HRQOL than men one year after cardiac catheterization. Similar to published reports [7-9], the women in our

Figure 1. Quality of Life Outcomes at One-year Follow-up

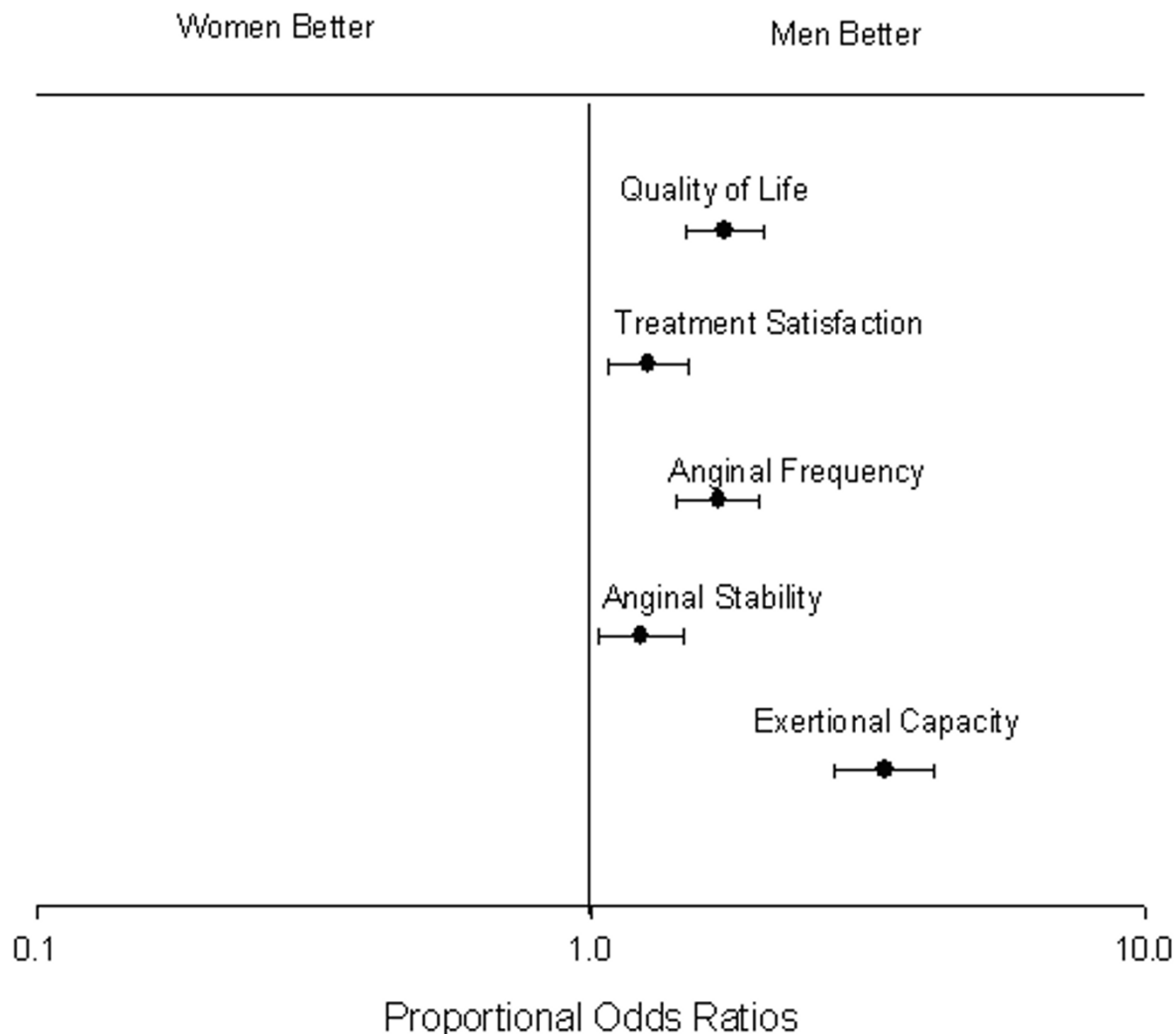


Figure 1
Quality of life outcomes at one-year follow-up

study were significantly older, and more likely to have more co-morbid illnesses compared to men. At the same time the women were more likely to be treated medically or with PCI whereas the men were more likely to be treated with CABG. Although some studies have suggested that women have less access to care or have poorer outcomes, consistent findings are still unavailable [31-34]. Despite these crude differences in co-morbid illnesses,

ejection fraction and treatment modality, after risk adjusting the SAQ dimensional scores for all demographic, clinical, co-morbid and treatment variables, gender remained independently associated with HRQOL outcomes with women reporting worse HRQOL outcomes compared to men.

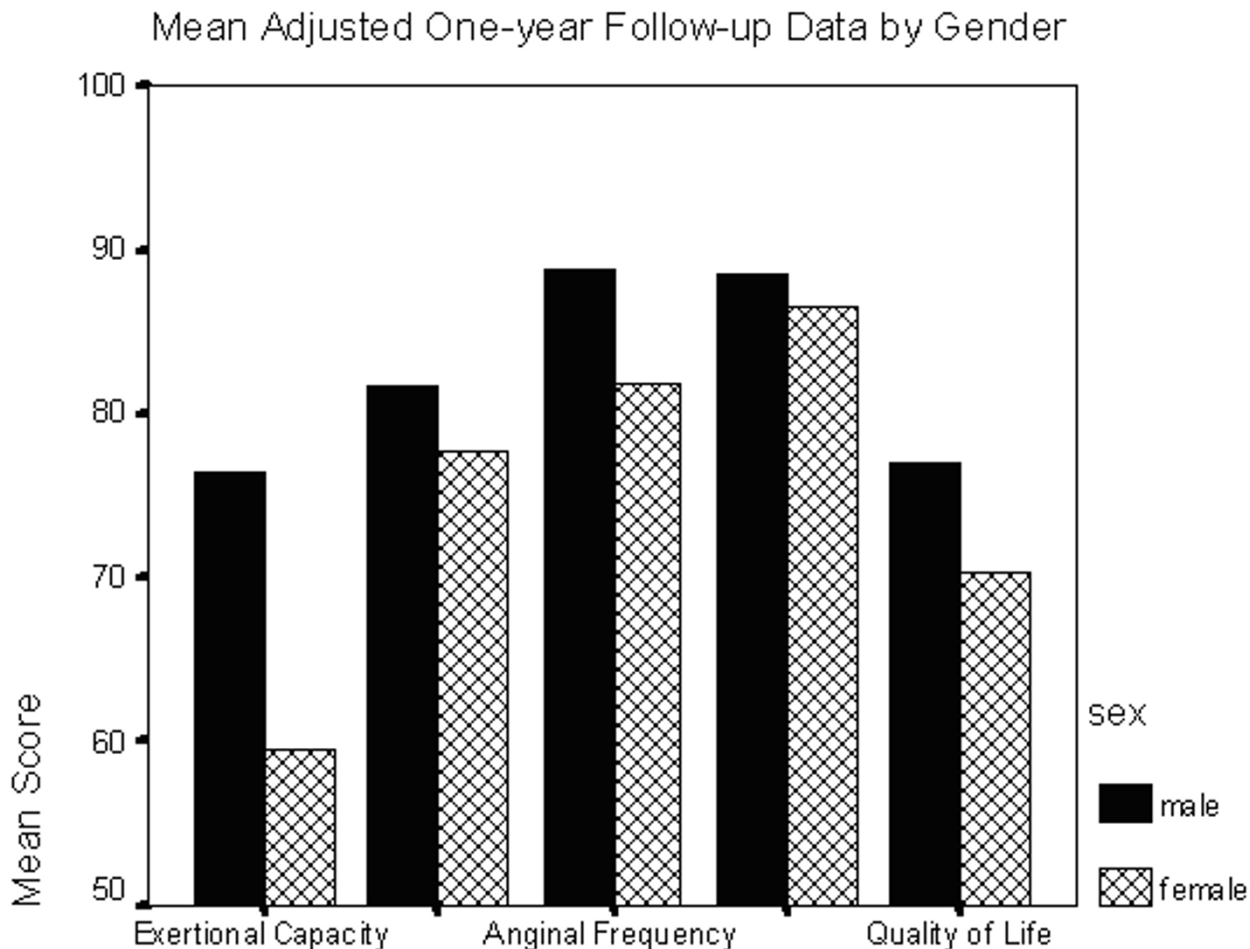


Figure 2
Mean Adjusted Seattle Angina Questionnaire Dimensions by Gender at one-year follow-up.

Figure 2
Mean adjusted Seattle Angina Questionnaire dimensions by gender at one-year follow-up

Table 3: Risk-Adjusted Mean SAQ Scores by Sex.

Variable	Exertional Capacity		Anginal Stability		Anginal Frequency		Treatment Satisfaction		Quality of life	
Treatment	Mean Score	95% lower and upper CI	Mean Score	95% lower and upper CI	Mean Score	95% lower and upper CI	Mean Score	95% lower and upper CI	Mean Score	95% lower and upper CI
Men	75.92	74.9–76.9	81.76	80.7–82.8	88.79	88.0–89.6	88.59	87.9–89.3	77.36	76.5–78.2
Women	61.43	59.4–63.5	77.98	75.9–80.0	82.06	80.5–83.6	86.39	85.1–87.7	69.90	68.2–71.6
Mean Difference	14.49	p < 001	3.79	p = 0.001	6.73	p < 0.001	2.19	p = 0.005	7.46	p < 0.001

The mean SAQ scores are risk adjusted for sex, age, renal insufficiency, hypertension, hyperlipidemia, diabetes mellitus, peripheral vascular disease, cerebrovascular disease, pulmonary disease, liver/gastrointestinal disease, malignancy, congestive heart failure, prior myocardial infarction, prior thrombolytic therapy, coronary anatomy, extent of coronary stenosis, and left ventricular ejection fraction.

Table 4: General Linear Model Coefficients

Variables (numerical coding)	Exertional Capacity Score	Anginal Stability Score	Anginal Frequency Score	Treatment Satisfaction Score	Quality of Life Score
Intercept	95.28	59.27	73.21	69.89	41.60
Sex Male (1)	14.49	3.79	6.74	2.19	7.46
Age Category (% per Quintile)	-2.39	0.42	0.03	0.73	1.43
18-52 years (1)					
53-59 years (2)					
60-65 years (3)					
66-72 years (4)					
>72 years (5)					
Pulmonary disease (0/1)*	-6.83	-3.99	-2.78	-0.25	-3.78
Cerebrovascular Disease (0/1)	-5.11	-2.85	-1.81	-1.50	-1.59
Renal Disease (0/1)	-4.56	4.86	2.28	0.27	4.61
Congestive Heart Failure (0/1)	-7.41	-0.31	0.52	0.49	-1.58
Hypertension (0/1)	-0.40	-0.05	-0.31	-0.34	0.15
Hyperlipidemia (0/1)	2.12	-0.57	1.01	0.92	1.32
Liver/Gastrointestinal Disease (0/1)	0.24	0.32	0.85	0.02	0.19
Malignancy (0/1)	1.32	-1.80	0.68	0.11	0.07
Prior Myocardial Infarction (0/1)	-2.05	0.19	0.32	0.75	0.56
Peripheral Vascular Disease (0/1)	-6.54	4.49	-0.49	0.43	0.30
Diabetes Mellitus (0/1)	-5.87	-1.78	-2.92	-0.53	-2.51
Left Ventricular Ejection Fraction	-0.04	-0.02	-0.02	0.01	-0.11
>50% (0)					
<30% (1)					
30-50% (2)					
V-gram not done due to instability (3)					
Missing (4)					
Coronary Anatomy	-0.49	3.41	1.82	1.39	2.19
2 Vessel Disease (2)					
3 Vessel Disease (3)					
Left Main Disease (4)					
Missing (0)					
Treatment within 1st year following Index catheterization	3.59	4.11	3.88	2.16	3.19
Medical Management (0)					
CABG (1)					
PCI with/without Stent (2)					
Indication for catheterization	-0.75	0.001	-0.26	-0.17	-6.14
Stable Angina (0)					
Myocardial Infarction (1)					
Unstable Angina (2)					
Other (4)					

*(0/1) 0 = absent 1 = present

The literature on gender differences in HRQOL for patients with CAD is sparse and somewhat contradictory. Three studies examined gender differences in HRQOL following acute myocardial infarction, and these reported no gender differences in HRQOL [13,35,36], yet found that women reported higher levels of depression and less social support [13], were at increased risk of death and long length of stay in subsequent hospitalizations [36], and less likely to undergo rehabilitation if diagnosed as hypertensive [35]. In contrast, two studies [37,38] reported that women reported worse HRQOL following acute myocardial infarction compared to men as measured by elevated levels of anxiety, depression, poorer general health [37] and overall worse psychosocial profiles [38]. One study investigated the HRQOL of patients with stable angina on a waiting list for coronary revasculariza-

tion, and reported that women had higher frequencies of chest pain, dyspnea and more sleep disorders [39]. King and colleagues [40] used the McMaster Health State Profile to examine the effect of gender on short-term recovery from cardiac surgery and found that although the women in the study were more functionally limited and reported lower life satisfaction and social support *pre-operatively* compared to men, there were in fact few significant differences between men and women 3 months *postoperatively* aside from persistently lower social support. Finally, two studies that examined the gender differences in HRQOL of patients with heart failure [41,42] reported that women had worse HRQOL ratings than men particularly for physical health status and activities of daily living. Based on the conflicting nature of these studies, one might speculate that higher levels of depression [13,15,16] and less

social support [13,18] in women following a cardiac event may have influenced their overall reported HRQOL.

The predictive value of psychosocial factors such as social support and depression in CAD outcomes is not well understood, regardless of gender. The influence of psychosocial factors in the course and outcomes of CAD has generated considerable interest since traditional risk factors have been unable to provide a comprehensive explanatory model, accounting for, at best, 50% of the variance in morbidity and mortality outcomes. These two variables should be included in future studies of HRQOL in patients with CAD as they may explain some of the gender differences in HRQOL in this population. Indeed, in our study, adjustment for a number of measured clinical variables did not 'explain away' sex differences in HRQOL, leaving us to speculate that variables that we did not measure – like social support and depression – may be contributing to sex differences in outcome.

A systematic review of the SAQ identified 62 studies that either referenced or used the SAQ to measure HRQOL outcomes [43]. Although the SAQ was tested and determined to be a valid, reliable, responsive instrument to measure the HRQOL of patients with CAD [24], and has been used in a variety of settings with a variety of samples including men and women, the original scale was validated on a sample of older men who were inpatients or outpatients at a Veterans Medical Centre. Consequently the items that make up the dimensional scores may be gender biased. There is growing evidence to suggest that women may experience angina differently than men. Rather than a heavy localized chest pain that some refer to as the typical 'Hollywood Heart Attack', women often report more diffuse, hot, burning chest pain, jaw pain, shoulder blade pain [44] and/or nausea [45-49]. As a result, the items that make up the exertional capacity scale that address the limitations in activities of daily living due to 'chest pain, chest tightness and/or shortness of breath' [24], may actually *overestimate* women's exertional capacity. The results of this study indicate that women reported greater limitations in exertional capacity compared to men indicating that regardless of how angina is manifested, the items in the exertional capacity scale appear to be identifying limitations to functional status resulting from CAD.

There are limitations to this study. This study is an observational study based on a clinical registry that although quite detailed, may lack information on clinical variables that may confound the association between gender and quality of life. Consequently, the observed differences between genders in HRQOL outcomes may be due to residual confounding. Since HRQOL outcomes may be associated with a variety of demographic and clinical

characteristics, we have attempted to adjust for baseline differences in our analysis. A second limitation is that HRQOL outcomes for this study were measured only at one time point, one-year post catheterization. As such we are not able to determine exactly when the HRQOL gender differences noted in this study emerge. Further research is required to analyze when HRQOL gender differences begin in the natural history of coronary artery disease, and the subsequent HRQOL "trajectories" that ensue for men and women. To that end a study is presently underway in which we collect 'baseline' HRQL data at one-week post catheterization.

Notwithstanding these limitations, this study is unique on several fronts. Of primary significance is the fact that the study covered a large geographically defined study population that yielded a high response rate to a one-year follow-up questionnaire. HRQOL questionnaires are particularly beneficial at enhancing the scope of outcome measures beyond the traditional ones of disability and/or death. By using a validated HRQOL measure (SAQ), we were able to evaluate the HRQOL outcomes of treatment for patients with CAD. More importantly, this study provides the opportunity to gain knowledge, insight, and a better understanding of the impact of CAD, and 'real world' HRQOL outcomes of a population based cohort with multi-vessel CAD.

Conclusion

CAD imposes a great influence on HRQOL outcomes. Women report poorer HRQOL than do men at one year following treatment for multi-vessel CAD. Gender differences were noted in all 5 dimensions measured by the SAQ including exertional capacity, anginal stability, anginal frequency, treatment satisfaction and quality of life. These findings underline the fact that conclusions based on research performed on men with CAD may not be valid for women and that more gender-related research is needed. Future studies are needed to further examine gender differences in psychosocial adjustment following treatment for CAD, as adjustment for traditional clinical variables fails to explain sex differences in quality of life outcomes.

List of abbreviations

CAD: Coronary artery disease

HRQOL: Health related quality of life

SAQ: Seattle Angina Questionnaire

APPROACH: The Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease

PORs Proportional Odds Ratio

Authors' contributions

CMN conceived of the study, participated in the design, performed the statistical analysis, and drafted the manuscript. WAG participated in the design, oversaw the statistical analysis, and edited initial draft copies of the manuscript. PDG edited drafts of the manuscript, read and approved the final manuscript. MMG edited drafts of the manuscript, read and approved the final manuscript. LAJ edited drafts of the manuscript, read and approved the final manuscript. MLK is the principal investigator of the APPROACH project and read and approved the final manuscript. The APPROACH Investigators read and approved the final manuscript.

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