Asymptomatic long-term survivors of coronary artery bypass surgery enjoy a quality of life equal to the general population

Pamela J. Bradshaw, PhD,[a,d] Konrad D. Jamrozik, MBBS, DPhil,[b] Ian S. Gilfillan, MBChB, FRACS,[c] and Peter L. Thompson, MD[d] ***Toronto, Ontario, Canada; Brisbane, Queensland, and Fremantle, Western Australia, Australia***

Background Health-related quality of life (HRQOL) among long-term survivors of coronary artery bypass surgery is an important outcome that has been little studied at the population level.

Methods A postal survey was conducted in 1999 to 2000 in patients 6 to 20 years after coronary artery bypass graft (CABG) surgery in Western Australia. A random stratified sample of 2500 was drawn from 8910 patients who had their first CABG surgery in 1980 to 1993. Health-related quality of life was measured with Short Form 36 and EuroQol visual analogue scale.

Results Response was 82% (n = 2061). Health-related quality of life declined with age and was similar for men and women, although scores for women were worse for physical functioning. Compared with Australian population norms, the age- and sex-standardized scores of survivors of CABG were generally worse, mainly in the physical domain. Reported angina at the time of follow-up (33%), symptoms of heart failure equivalent to New York Heart Association (NYHA) classes II to IV (34%), and comorbidities such as diabetes and hypertension were associated with poorer HRQOL. For both men and women without angina or heart failure at follow-up, HRQOL was no different from that of the general population.

Conclusion Overall, the quality of life among long-term survivors of CABG is worse than that of the general population, the difference being mainly attributable to recurrent symptoms and comorbidities. Quality of life for those without angina or heart failure at follow-up was equivalent to the population norms, providing an incentive to maximize efforts to abolish angina and ameliorate heart failure symptoms. (Am Heart J 2006;151:537-44.)

Coronary artery bypass graft surgery (CABG) prolongs life for those at high risk of premature death from coronary heart disease (CHD).[1] However, CHD is a chronic condition; angina and symptoms of heart failure may persist, recur, or worsen after CABG. Survivors of CABG surgery require ongoing preventive treatment of CHD and for contributing conditions such as hypertension and hypercholesterolemia. Living with CHD is associated with a reduction in quality of life compared with the general population.[2] Given the low operative mortality for the procedure, the frequency with which it is performed, and the potential for extended survival, it is important to examine health-related quality of life (HRQOL) among survivors of CABG.

Reports of HRQOL after CABG surgery are mostly focused on the first postoperative year; fewer have followed up patients beyond 12 months. There is information on longer-term outcomes from some prospective studies,[3-5] clinical trials,[6,7] and studies of CABG versus percutaneous catheter-based intervention.[8] Follow-up studies have compared QOL of survivors with population norms,[2,9,10] but there are a very few studies with follow-up beyond 5 years[10] and none with large numbers. This study presents information on HRQOL 6 to 20 years after CABG surgery in a state population.

From the [a]Institute for Clinical Evaluative Sciences (ICES) Toronto, Ontario, Canada, [b]Department of Epidemiology, University of Queensland, Brisbane, Queensland, Australia, [c]Department of Cardiothoracic Surgery, Fremantle Hospital, Fremantle, Western Australia, Australia, and [d]Medicine and Population Health, University of Western Australia and Cardiologist, Sir Charles Gairdner Hospital, Nedlands, Western Australia, Australia.

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Reprint requests: Pamela Bradshaw, PhD, Institute for Clinical Evaluative Sciences (ICES), 2075 Bayview Avenue, Toronto, Ontario, Canada M4N 3M5.

E-mail: pamela.bradshaw@ices.on.ca

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Methods

A postal survey of a randomly selected sample was drawn from a Western Australian population database of 8910 patients who had undergone first CABG surgery, without concomitant valve surgery, between 1980 and March 1993. The population database was compiled from records held by the only cardiothoracic surgical unit in the state which performed CABG surgery during that period.[11]

Between October and November 1999, each of 2500 patients was sent a questionnaire for self-completion, together with a reply-paid envelope. A second questionnaire was posted in December to 665 patients who had not replied.

The study complies with the Declaration of Helsinki and was approved by the Western Australian Health Department Confidentiality in Health Information Committee and the Committee for Human Rights at the University of Western Australia.

Participants

We used electronic record linkage to the mortality records compiled by the Registrar General for Western Australia and to the National Death Index in Canberra to identify deaths in the inception cohort. There were 5836 survivors in August 1999, of whom 1223 were women.

A sample size of 2500 participants was estimated. Allowing for a nonresponse of 25%, this provided ample power with $\alpha = .001$ to detect a difference of 10% overall in reported angina at follow-up, a major outcome affecting HRQOL. Samples were randomly drawn from each of 4 patient groups—men and women <60 years and >60 years at the time of surgery. The sampling fraction was 0.43. The study group comprised 1980 men and 520 women. The proportion of women was low (21%), especially of those <60 years, but there was modest power, 65% at $\alpha = .05$, to find a difference in the prevalence in angina between younger and older women.

The last known address was checked for completeness, and a further electronic check of the Western Australian Death Register was performed in August 1999 before finalization of the mailing database.

Questionnaire

The questionnaire included several tools previously used to measure HRQOL and aspects of lifestyle in patients with CHD, including the National Heart Foundation Risk Factor Prevalence Study, the Short Form 36 (SF-36) Health Survey, the Seattle Angina Questionnaire, and the visual analogue scale (VAS) from the EuroQol 5D survey. Permission to use the instruments was obtained. Additional questions ascertained return to work, symptoms of heart failure and angina, and use of medications.

Main measures of outcome

Health-related quality of life was measured with SF-36 Version 1 English Language Adaptation (United Kingdom, Australia, and New Zealand) and EuroQol VAS. The EuroQol VAS is a "thermometer" with a zero minimum (worst imaginable health state) and a maximum of 100 points (best imaginable health state). Participants were instructed to draw a line from a box to the point on the scale that indicates their current state of health. Any clearly identifiable mark on the scale was considered a valid response.

Table I. Health status measured with EuroQol VAS and SF-36 score by age group at the time of survey for survivors of CABG surgery

Age group (y)	40-54 (n = 94)	55-64 (n = 384)	65-74 (n = 860)	≥75 (n = 658)
EuroQol VAS*				
Mean	71.6	73.0	70.2	64.0
95% CI	67.8-75.5	71.2-74.5	68.9-71.5	62.3-65.6
SF-36 (mean and 95% CI)				
Physical function*	75.2	73.9	63.2	48.3
	69.5-80.9	71.6-76.2	61.5-65.0	46.1-50.6
Physical Role*	76.6	68.9	56.9	40.3
	68.9-84.3	64.8-73.0	54.0-59.8	36.9-43.7
Bodily Pain*	72.8	71.0	67.7	63.9
	68.8-76.8	68.8-73.1	66.1-69.3	62.0-65.9
General Health*	60.2	60.0	57.9	52.7
	55.3-65.2	57.6-62.4	56.3-59.4	50.9-54.5
Vitality*	57.0	59.3	55.6	49.4
	52.7-61.5	57.1-61.4	54.1-57.1	47.6-51.2
Social Function*	80.1	84.5	80.0	70.7
	75.1-85.1	82.2-86.8	78.2-81.7	63.4-73.1
Emotional Role*	72.6	77.9	74.0	62.5
	64.4-80.9	74.0-81.7	71.4-76.6	59.1-65.9
Mental Health (NS)	72.1	76.0	75.7	74.3
	68.4-75.8	74.2-77.9	74.5-76.9	72.8-75.7

NS, Not significant.
*$P \leq .001$ for between groups difference.

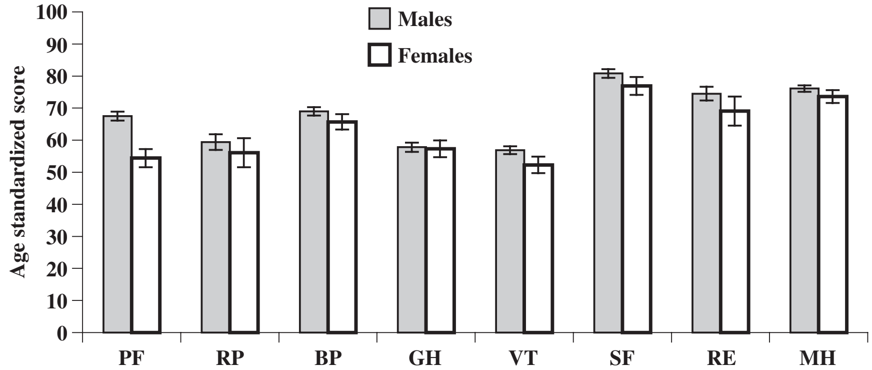
Statistical analysis

Missing data (<3%) for SF-36 items were replaced, if most responses were present, with the person-specific average of valid values for the item. The scores for the 8 domains of the SF-36 were calculated according to the methods determined by the authors of the questionnaire.[12] The SF-36 scores were not normally distributed, so they were tested using nonparametric methods. The associations between scores on domains of the SF-36 were examined using the Spearman correlation coefficient. Differences between mean HRQOL scores for groups determined by a dichotomous outcome, such as the presence or absence of angina, were tested with the Mann-Whitney *U* test and the Kruskal-Wallis test for variables with >2 categories. Analysis of variance was used to examine the differences between groups in mean scores on the EuroQol VAS.

Multiple linear regression models were constructed to identify factors independently and significantly associated with the EuroQol VAS and SF-36 domains. Backward elimination was used to refine models constructed from variables that had significant univariate associations with the dependent variable and clinically important variables. The predictor variables tested for their association with HRQOL at follow-up were the patient characteristics at the time of follow-up including sex, current age, risk factor status, comorbid conditions and a history of myocardial infarction (MI) in the year before first CABG, and factors related to the index CABG including the number of bypass grafts placed and use of an arterial (internal mammary artery [IMA]) graft. Interval events of revascularization and the number of years elapsed since the first CABG surgery were also included in the models.

The outcomes from the SF-36 survey were compared with the SF-36 Australian population norms measured during

Figure 1



Age-standardized SF-36 scores (95% CI) for men and women in the long term after CABG. *PF*, Physical function; *RP*, role physical; *BP*, body pain; *GH*, general health; *VT*, vitality; *SF*, social function; *RE*, role emotional; *MH*, mental health.

Table II. Independent predictors of health status measured with EuroQol VAS

Factor	β coefficient	95% CI	*P*
NYHA classes II-IV	−16.3	−18.0 to −14.5	<.001
Angina	−6.6	−8.3. to −4.8	<.001
Age at follow-up (y)	−0.28	−0.37 to −0.19	<.001
History of hypertension	−2.2	−3.8 to −0.29	.007
Diabetes	−2.6	−4.6 to −0.55	.013
Repeat revascularization	−2.1	−3.9 to −0.3	.023

Adjusted R^2 0.26.Variables not significantly associated with EuroQol VAS: sex, BMI, current smoking, history of high cholesterol, years since first CABG, number of grafts at first CABG, use of an IMA graft, and acute MI prior first to CABG.

Table III. Independent predictors of SF-36 PCS and MCS scores

	β coefficient	95% CI	*P*
SF-36 PCS			
NYHA II-IV	−9.18	−10.26 to −8.11	<.001
Angina	−4.00	−5.10 to −2.90	<.001
Age at follow-up (y)	−0.40	−0.46 to −0.34	<.001
Diabetes	−2.49	−3.74 to −1.24	<.001
Hypertension	−2.44	−3.43 to −1.45	<.001
BMI	−0.23	−0.35 to −0.10	<.001
Female sex	−2.13	−3.46 to −0.79	.002
SF-36 MCS			
NYHA II-IV	−5.48	−6.66 to −4.29	<.001
Angina	−4.05	−5.25 to −2.85	<.001
Diabetes	−1.43	−2.80 to −0.06	.04

Adjusted R^2 PCS 0.36 and MCS R^2 0.12. Variables not significantly associated with PCS: current smoking, years since first CABG, history of high cholesterol, number of grafts at first CABG, use of an IMA graft, and acute MI before first CABG. Variables not significantly associated with MCS: sex, BMI, current smoking, years since first CABG, history of high cholesterol, hypertension or diabetes, number of grafts at first CABG, use of an IMA graft, and acute MI before first CABG.

the 1995 National Health Survey.[13] The SF-36 scores for the post-CABG patients were age-, and age- and sex-standardized by the direct method to the 1995 Australian population aged ≥55 years. The published mean scores for the age- and sex-specific strata of the Australian population aged ≥55 years were also standardized against the same population to enable comparison with the CABG patients. As the number of CABG patients <55 years at follow-up was small (n = 94, 10 women), with the 95% CI overlapping those of the total, that age group was excluded from the age standardization to improve precision. The SF-36 Physical Component Summary (PCS) and Mental Component Summary (MCS) measures were calculated according to the standard method.[14] The scoring algorithm developed from the 1990 US population means, SDs, and factor coefficients was used, as Australian weights for these summary measures were not available.

Two-tailed tests of significance were used, with a *P* value of <.05 considered significant. The 95% CIs are provided.

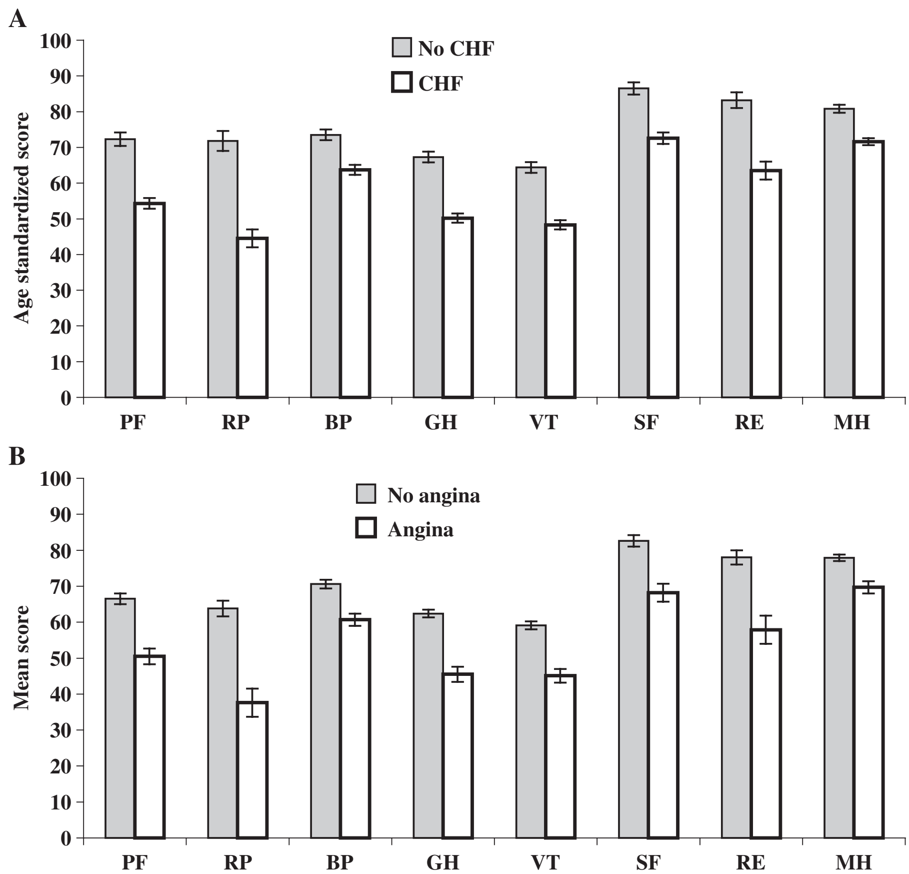
The data were analyzed using SPSS for Windows version 10.0 (SPSS, Chicago, IL) software.

Results

The response was 82% (n = 2061). The median age of the respondents was 71 years, ranging from 40 to 94 years, and 80% of respondents were men. Only 18% had arterial grafts placed during their first CABG, and these were predominantly the left IMA. Most cases using IMA grafts were from the last period of the baseline surgery (1990 to March 1993). One quarter reported at least one revascularization procedure since their first CABG, 10% each of redo CABG and angioplasty, and 5% had undergone at least one of each procedure.

There were near-complete data for the SF-36 for 1984 (96%) respondents, and 1996 (97%) completed the EuroQol VAS with scores ranging from zero reported by 3 (0.2%) to 100 (2.5%) respondents. The median score was 72 (mean 68.7, SD 19.8). The EuroQol VAS correlated best with the General

Figure 2



A, Mean age- and sex-standardized SF-36 scores (95% CI) for CABG survivors with and without symptoms of heart failure. **B**, Mean SF-36 scores (95% CI) for CABG survivors with and without reported angina.

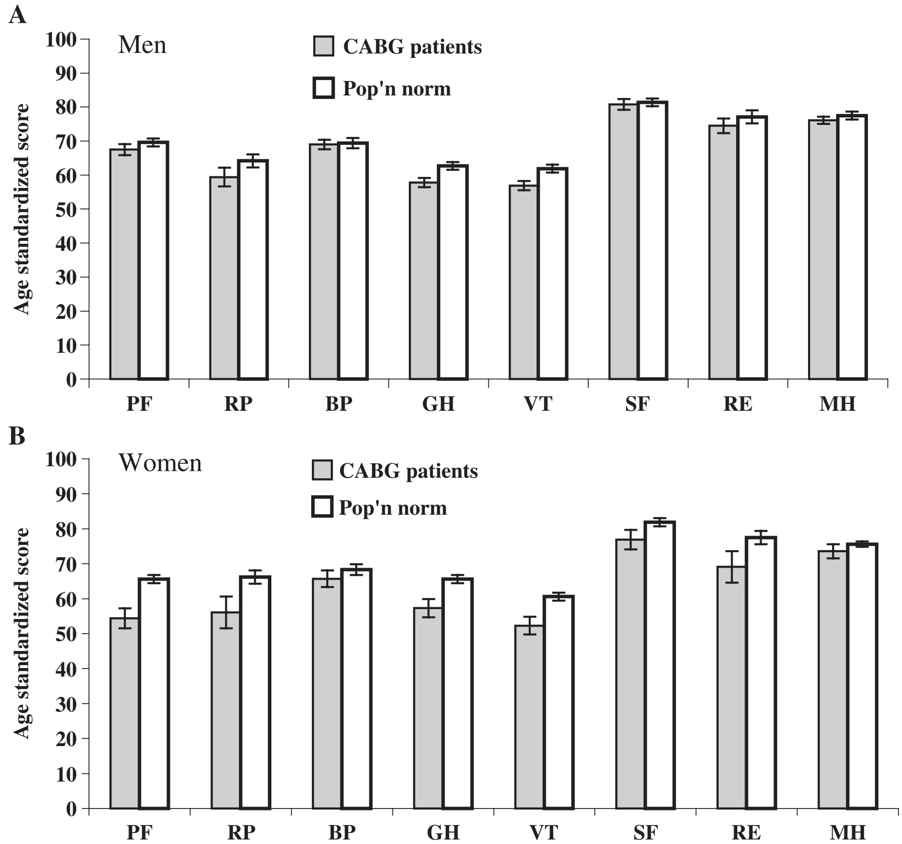
Health domain of the SF-36 (0.77) and least with the Emotional Role domain (0.43). The unadjusted SF-36 PCS was 42.6 (SD 10.8), falling below the US 1990 standardized norm of 50, and the MCS was 54.0. (SD 10.8). The correlation between these summary measures and the EuroQol VAS was stronger for the PCS (0.65) than the MCS (0.48).

Health status measured by the EuroQol VAS was significantly worse for participants aged ≥75 years at follow-up, and SF-36 scores in each domain declined significantly with increasing age, although the scores for the youngest patients, those aged <55 years, were lower than all except the oldest patients in the domains related to mental and emotional health. The differences were not statistically significant (Table I).

The raw SF-36 scores were similar for men and women aged <70 years, but scores for women worsened in comparison with men after that age, especially in the domains of Physical Function and Vitality. This relationship remained after age standardization, the score for Physical Function in particular being lower for women (54.4, 95% CI 51.6-57.2 vs 67.5, 95% CI 66.0-68.9). Women's scores in each of the other domains were also lower, but with CIs overlapping those of men (Figure 1).

Mean EuroQol VAS scores declined significantly in proportion to the self-reported degree of breathlessness on exertion, ranging from 75.3 (95% CI 74.4-76.2) for 1304 patients in the equivalent to New York Heart Association (NYHA) class I, to 42.1 (95% CI 37.9-46.3) for 82 patients in class IV. One third of patients were in classes II to IV. The age- and sex-standardized scores were worse in every domain of the SF-36 for those in NYHA classes II to IV compared with class I (Figure 2, *A*). The unadjusted means of both PCS and MCS scores were also worse, being 32.9 (95% CI 32.1-33.7) versus 44.6 (95% CI 44.1-45.2) and 46.7 (95% CI 45.8-47.6) versus 53.4 (95% CI 52.9-53.9), respectively.

Figure 3



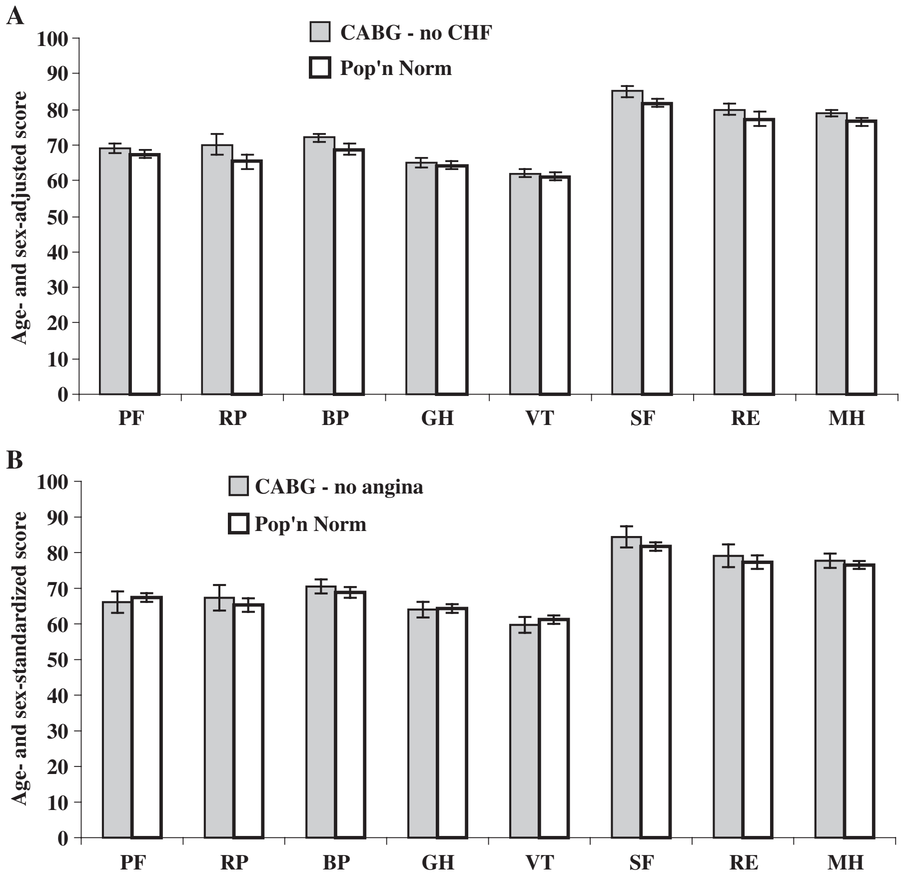
A, Age-standardized SF-36 scores (95% CI) for CABG survivors aged ≥55 years versus Australian population norms—men. **B**, Age-standardized SF-36 scores (95% CI) for CABG survivors aged ≥55 years versus Australian population norms—women.

Similarly, the mean EuroQol VAS score was significantly worse for the 33% of participants who reported angina at the time of follow-up (60.7, 95% CI 59.1-62.3) than for those who did not (72.7, 95% CI 71.7-73.7), as were the SF-36 PCS (35.7, 95% CI 34.8-36.6 vs 43.1, 95% CI 42.5-43.7) and MCS (47.5, 95% CI 46.6-48.4 vs 52.9, 95% CI 52.4-53.5). The SF-36 profiles for patients with and without angina are shown in Figure 2, *B*, the difference being greatest for Physical and Emotional Role limits and General Health and Vitality.

Aside from a third of survivors reporting current angina at follow-up, 25% of all respondents had undergone at least one additional revascularization (reoperative CABG or percutaneous catheter-based intervention), 20% had diabetes, and 54% reported a history of hypertension. The significant independent associations with health status measured by the EuroQol VAS are shown in Table II. Those same variables—NYHA class, angina, age, hypertension, diabetes, and body mass index (BMI)—were variously independent predictors of each domain of the SF-36 (not shown), and with the SF-36 PCS and MCS (Table III). Angina, any revascularization, and symptoms of heart failure were univariate associates of increasing time since surgery, but, except for a weak association with Physical Function, the time elapsed since surgery was not an independent predictor of any aspect of HRQOL once age was taken into account. In addition, female sex and obesity (BMI ≥30) at the time of follow-up were significant predictors of poorer Physical Function. Obesity was also associated with increased likelihood of Bodily Pain. Current smoking and an acute MI before the first CABG were associated only with poorer Mental Health. The inclusion of components of the SF-36 into each of the models added 20% to 30% to the proportion of variance explained by the models, but the available covariates accounted for ≤55% for any outcome.

Long-term survivors of CABG had generally worse HRQOL than the population norms for both men and women (Figure 3, *A* and *B*). Female scores fell

Figure 4



A, Age- and sex-standardized SF-36 scores (95% CI) for CABG survivors without symptoms of CHF versus Australian population norms. **B**, Age- and sex-standardized SF-36 scores (95% CI) for CABG survivors without reported angina versus Australian population norms. *CHF*, congestive heart failure.

significantly below the population norm in each domain, except for Bodily Pain and Mental Health. Scores for men were close to population norms, although Vitality and General Health fell below the population norms by ≥5 points, and the 95% CIs did not overlap those of the Australian norms.

The SF-36 scores for patients who did not report symptoms of heart failure at follow-up were not significantly different from the Australian population norms. This was also the case for patients without angina (Figure 4, *A* and *B*).

Discussion

The participants in this study have lived for 6 to 20 years after their first CABG—they are "healthy survivors." We do not have information about changes in HRQOL from the time of surgery, but CABG surgery has been shown to significantly improve HRQOL for up to 2 years postoperatively,[3,6,7] including among elderly patients.[9] In a longer follow-up, study improvement in HRQOL after surgery was still evident among survivors at 5 years but had diminished compared with that measured at 2 years.[5]

Declining graft patency, evidenced by an increasing proportion of patients with angina, has been associated with a decrease in physical function and vitality with the passage of time,[4] but we did not find an independent association between HRQOL and the time since surgery. Although the use of an arterial graft (predominantly IMA) had an important impact on survival and rehospitalization for a major cardiac event in this population,[11] the use of an IMA graft was not an independent predictor of HRQOL.

Overall, survivors of CABG have lower scores for HRQOL than the age- and sex-matched Australian population. The deficit ranged from 11.2 (Physical

Function for CABG women vs Australian norm) to 0.4 (Bodily Pain for CABG men versus Australian norm) points. The clinical significance of the differences between age-specific scores or between standardized scores and population norms is not well understood, although a 10-point decrement on the PCS score (a composite of the SF-36 items relating to the physical domain) was an independent predictor of 6-month mortality after CABG in a cohort of veterans.[15] In that study, there was no association between the MCS and mortality. The importance of similar differences among long-term survivors is unknown. Large differences are apparent between young and old, and between people with and without serious health problems. In the National Health Survey, compared with those without heart disease, the scores of Australians who reported "any heart disease" was between 4.5 (Mental Health) and 25.9 (Physical Role) points lower. By contrast, the difference between those with and without hay fever was only a few points in all domains.[13]

The post-CABG patients reported an HRQOL lower than the Australian age-matched norms especially for Physical Function, Vitality, and the limits to the Emotional Role. This may be due in part to the considerable comorbidity which the CABG patients suffer; hypertension and diabetes were independently associated with poorer HRQOL in our study and have been associated with a reduced HRQOL in both post-CABG populations[16] and the general community.[17-19] Recurrent angina and the symptoms of heart failure also were associated with significantly reduced HRQOL scores across all domains, as would be expected.[20,21] However, among these long-term survivors, freedom from angina or symptoms of heart failure was associated with a HRQOL no different from, or exceeding, population norms. The poorer quality of life for patients with angina, heart failure symptoms, and comorbid conditions such as diabetes was confirmed by the differences in the SF-36 PCS and MCS and the EuroQol VAS. The decrement of HRQOL with increasing age in general terms, especially in the physical domain, was not seen in the mental health domain. In this elderly population, the unadjusted PCS was lower than the US 1990 norm, even for those free of angina or heart failure, whereas the relative preservation of mental health in older patients is confirmed by the higher MCS.

There was little difference between men and women in this study, except for Physical Function. Female sex was an independent predictor of a worse score only in that domain of the SF-36. Others have found women to have poorer QOL after CABG than men. For example, Sjoland et al[22] found women to suffer a greater proportion of preoperative comorbidities known to have a negative influence on QOL and to have poorer QOL both before and after CABG surgery. Women's QOL, however, improved to a greater extent than did that of men after surgery. The HRQOL among women in our study reflects that of the Australian population, where the scores for women are generally slightly lower than those for men.[13]

Limitations

As the median age at first CABG surgery in this population was 60 years, our study of long-term survivors has been undertaken against a background of the natural pattern of mortality for a middle-aged and older population. In the 6 to 20 years from the first CABG to follow-up, 35% of all patients had died. More than 400 (18%) of the survivors did not respond. There were 39 recent deaths, and 27 patients were reported to be too unwell to respond for reasons including dementia, stroke, and cancer. Nonresponders were, however, not significantly older, nor did they differ on the limited number of baseline clinical variables. In the absence of current information about the nonresponders, it is not possible to estimate the effect of the impact of nonresponse on the outcomes. It is likely that any effect would be toward an overestimation of the QOL of survivors, but given the high response, the effect is unlikely to be important.

Conclusion

Among long-term survivors of CABG, HRQOL is somewhat worse than that of the age- and sex-matched general population, principally in the physical domain. This was mainly due to the presence of symptoms of angina or heart failure, and to comorbidities such diabetes and hypertension. However, those study participants who did not report symptoms of angina or heart failure enjoyed a HRQOL equivalent to the Australian population norms. Continued efforts to free patients of angina and to ameliorate the symptoms of heart failure are likely to be rewarded by improvement in quality of life.

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