Cardiac Rehabilitation Intervention and Quality of Life Indicators: A Validation Estimate of Ware's Model[1]

JOHN M. LAUX[2], ISADORE NEWMAN, JOHN QUEENER, JIM ROSNECK, AND RICHARD JOSEPHSON; Department of Counseling & Mental Health Services, The University of Toledo, Toledo, OH 43606; Department of Educational Foundations & Leadership, The University of Akron, Akron, OH 44325; Department of Counseling, Summa Health System, The University of Akron, Akron, OH 44325; Cardiac Rehabilitation Institute, Summa Health System, The University of Akron, Akron, OH 44304

ABSTRACT. The present study tests Ware's (1987, 1990) prediction that patient evaluations of quality of life (QOL) are related to physical ability. QOL data from 302 patients were collected prior to initiation and upon completion of a 12-week cardiac rehabilitation program. Physical ability was measured in metabolic equivalents (METS). Pearson product moment correlation coefficients were calculated for the variables under study. Multiple regression analyses were conducted to test these relationships covarying patient diagnosis, and pre-treatment QOL score and patient demographics. Significant improvements from pre- to post-CR were found for METs and all QOL variables. Improvements in physical ability were significantly correlated with improvements in physical health related QOL indices, but not with mental health QOL indices. These relationships were present even when moderating variables were co-varied. Improvements in physical ability were predictive of decreased expectations that physical health would interfere with work or other daily activities. As the physical capabilities of our patients increased, they reported feeling less physical pain and were less limited by any pain they did experience. And, increased physical ability was associated with a brighter outlook on current and expected future health status. These findings provide support for Ware's theory of QOL.

OHIO J SCI 105 (4):66–73, 2005

INTRODUCTION

According to the World Health Organization Quality of Life Group (1993), quality of life (QOL) is defined as a person's view of life in the context of culture and values and in relation to personal hopes, dreams, goals, expectations, standards, and concerns (Harper 1998). One of the most widely accepted approaches to measuring QOL was developed and presented by Ware (1987, 1990; Ware and Sherbourne 1993). Ware's (Ware and others 1991) approach to this construct is predicated upon the assumption of a relationship between physical ability and QOL indicators. Recent evidence (Brown and others 2002) has surfaced to suggest that Ware's model can be dichotomized as pertaining to physical health and mental health.

Cardiac rehabilitation (CR) is one area in which the study of QOL has flourished (Blumenthal and Emery 1988; Davis 1996; Denollet 1993b; Froelicher 1991; Milani and Lavie 1996; Cohen and others 1999; Marwick and others 1999; McEntee and Badenhop 2000; Simchen and others 2001; Lavie and Milani 2000; Morrin and others 2000). Although the primary focus of CR is improving cardiovascular functioning, researchers and practitioners alike now recognize that CR is a multidimensional and multidisciplinary process wherein improved QOL is an important treatment outcome (Rovario and others 1984; Shephard and Franklin 2001; Appels 1980). A cardiac population is an ideal sample in which to test Ware's (1987, 1990) theory because persons with cardiac diagnoses (Appels 1990; Appels and Mulder 1988, 1989; Bohachick 1984; Frasure-Smith and others 1993; Grant and others 1995; Kop and others 1994; Wenger and others 1995) and those who enter into cardiac rehabilitation (Jette and Downing 1994, 1996; Ware and others 1994) report significantly lower self-estimates of QOL than would be expected in the general population. Following completion of CR there is usually a significant improvement in physical performance and recent data demonstrate that there is often an improvement in self-perceived QOL (Cohen and others 1999; McEntee and Badenhop 2000; Simchen and others 2001; Lavie and Milani 2000; Morrin and others 2000; Bohachick 1984; Frasure-Smith and others 1993; Grant and others 1995). To our knowledge, no study has examined the relationship between improvements in QOL and completion of CR.

While links between physical illness and low QOL have been established and pre- to post-CR QOL improvements have been noted, the theorized relationship between changes in physical abilities and changes in QOL has yet to be fully examined. Therefore, the primary purpose of this study is to examine whether changes in physical work ability are associated with changes in physical health QOL. The secondary purpose of this study is to examine the relationship between changes in physical ability and mental health QOL. Because previous research has established a relationship between QOL and patient sex, age, and cardiac diagnosis (Jette and Downing 1994, 1996; Laux and others 2002), we will co-vary these demographic variables when testing our predicted relationships.

[1]Manuscript received 29 October 2003 and in revised form 17 October 2004 (#03-19).

[2]Corresponding Author: MS 119, HHS 2225, The University of Toledo, 2801 W. Bancroft Street, Toledo, OH 43606. Phone: 419/530-4705; Fax: 419/530-7879.

MATERIALS AND METHODS

A total of 302 patient charts were reviewed for this study. Data were collected at the Cardiac Rehabilitation Unit of Summa Health Care Systems, Akron, OH. The CR program is a large and comprehensive program that follows national guidelines (Feigenbaum and Carter 1988). The scope of the program, the demographics of its participants, and its growth and change over the last decade have been described elsewhere (Richardson and others 2000). Each cardiac rehabilitation therapy session lasts one and one-half hours and has two principle components: exercise and education. Patients typically meet three times a week for 12 weeks. Exercise sessions last a total of 1 hour and consist of at least 10 min of warm-up and stretching, 30 min of aerobic activity, and 10 min of cool-down and stretching. Education sessions last 30 min and consist of a variety of topics that focus on specific risk factors or heart disease related issues. Cardiac rehabilitation participants typically attend three physical exercise sessions per week for 4-12 weeks. The duration of a patient's therapy is a function of the following factors: beginning work capacity, diagnosis, physician orders, practical constraints (for example, return to work, wintering in Florida), individual risk factors, and progress in the program. The data represent patients who participated and completed CR collected between January 1999 and August 2000. Demographic, MET testing, and QOL data were gathered during the patients' initial interview with CR exercise physiology staff, which occurred within one week of beginning CR. QOL and MET data were collected again on each patient's last day of CR. All data were recorded in each patient's chart, which was stored in the Unit's filing system. A QOL self-report instrument, the Medical Outcomes Study Short Form Health Survey (SF-36: Ware and others 1994) was completed by patients prior to CR and following its completion. These patients' SF-36 scores, as well as study-specific demographic data, were collected upon entry to the program using a study-specific demographic data sheet. Historically (Richardson and others 2000), some patients provide invalid responses for some sub-scales and valid responses for others. As such, the total *N* size for each of the SF-36's sub-scales varies.

The mean age of the patients included in this study is 67.2 years (*SD* = 9.6, range = 21-86). There were 217 (71.9%) men and 85 (28.1%) women. There were 292 European Americans (97% of the sample). The remaining ten (3.3%) patients were African American. In accord with common CR policy, the patients were categorized by the most recent cardiovascular diagnosis that prompted their enrollment: CABG (*N* = 77, 25.5%), MI (*N* = 54, 17.9%), Angina (*N* = 35, 11.6%), and Other (for example, atrial fibrillation, stent, angioplasty, congestive heart failure, cardiomyopathy, and mitral valve replacement: *N* = 136, 45%). An analysis of the patients' area codes indicated that each patient lived within 50 miles of the hospital where CR was conducted. All data were archival in nature and represent patients who participated in and completed cardiac rehabilitation between March 1999 and August 2000.

Instruments

Physical ability in CR is commonly measured in terms of metabolic equivalents (METs), which are a multiple of basal body oxygen requirement (Roitman 1998). METs are calculated via estimated oxygen consumption on volitional maximal treadmill stress testing (Roitman 1998). One MET is equal to 3.5 mL of oxygen per kilogram of body weight per minute. The estimated total oxygen consumption is divided by 3.5 to arrive at the MET level during work.

The Medical Outcomes Study Short Form Health Survey (SF-36: Ware and others 1994) has proven useful, reliable, and valid across diagnostic groups (Baker 1995; Beaton and others 1996; Brazier and others 1993; Kaplan 1988; Osterhaus and others 1994).

The SF-36, a 36-item Likert-style measure of patients' self-perceived QOL, covers eight specific areas of functioning. The SF-36 is useful for this study because it is self-administered and can be completed in 5-10 minutes (Komaroff and Family 1996; Ware and others 1995). The SF-36, broadly used in medical settings (Krousel-Wood and others 2001), is recommended by American Association of Cardiovascular and Pulmonary Rehabilitation (1999).

Although originally standardized on patients with CAD diagnoses, the SF-36 has shown sensitivity in detecting post- and pre-treatment changes in many additional diagnostic categories. These include: arthroscopic partial meniscectomy (Katz and others 1992); substance abuse (Berman and others 1995), CABG (Allen and Figon 1995); cataract extraction and lens implantation in the elderly (Mangione and others 1994); perennial rhinitis (Bullinger and others 1994); coronary angioplasty versus patients with stable coronary artery disease (Spertus and others 1994); depression (Ware and others 1995; Wells and others 1992); desipramine, fluoxetine, or imipramine treatment for depressed adults (Simon and others 1996); diabetes education (Tilly and others 1995); and dialysis (Meyer and others 1994).

The SF-36 has repeatedly demonstrated considerable test-retest (for example, Nerenz and others 1992; Brazier and others 1993) and internal consistency (for example, Katz and others 1992; Kurtin and others 1994; Jenkinson and others 1993; Garratt, and others 1993; McHorney and others 1994; Jenkinson and others 1993), and reliability across medical settings, medical conditions, languages, and more recently, ethnic backgrounds.

The validity of the SF-36 has been demonstrated using a multi-method approach (Ware and others 1997). The SF-36 shares content areas with four other widely used HQOL measures: the Health Insurance Experiment (Brook and others 1979; Ware and others 1981); Sickness Impact Profile (Bergner and others 1981); Duke Health Profile (Parkerson and others 1990); and Dartmouth COOP Function Charts (Nelson and others 1987).

The SF-36 helps patients to supply a numeric value when questioned about their current health status (Osterhaus and others 1994), which is especially important since previous research (Baker 1995) has suggested that patients who identify and acknowledge their problems are more likely to follow a recommended

treatment program than patients who have not participated in the problem identification process. Further, the use of the SF-36 in this study is appropriate because patients are often unable or unwilling to openly relate many health-related issues with their primary care givers (Kurtin and others 1994; Oldridge 1997; Oldridge and others 1998).

The SF-36 (Ware and others 1994) consists of eight scales that cover Ware's comprehensive conceptualization of QOL. While the SF-36 and its eight scales have been described elsewhere (Laux and others 2002), it is important for our purposes to point out that four scales each comprise the physical and mental health aspects of quality of life (Brown and others 2002). The SF-36 subscales associated with physical health QOL are Physical Functioning (PF), Role Functioning-Physical (RP), Bodily Pain (BP), and General Health (GH). Vitality (V), Social Functioning (SF), Role Functioning-Emotional (RE), and Mental Health (MH) are the SF-36 subscales associated with mental health quality of life.

RESULTS

The pre- and post-CR means, standard deviations, and ranges of QOL scores for this patient population can be found in Table 1. Previous research using this sample's SF-36 data produced stable factors structures from pre- to post-CR treatment (Brown and others 2002). Therefore, the present researchers were confident that they were testing similar constructs when examining pre- to post-treatment QOL differences. Calculated two-tailed *t*-tests and the associated Cohen's *d* effect size calculations demonstrated that the post-treatment QOL scores were significantly higher ($p < 0.001$) than the sample's pre-treatment QOL scores (Table 1). Using Cohen's (1988) rubric for interpreting effect sizes, the pre- to post-treatment gains for MET, PF, BP, and SF were large. The gains for RP, V, and RE were moderate. And, the gains for GH and MH were small. Next, to test the relationship between changes in physical ability and changes in QOL, a MET change score was calculated relative to each SF-36 subscale. The mean amount of

TABLE 1

Pre and post cardiac rehabilitation SF-36 QOL means, standard deviations, range of scores and N*-sizes,* t*-test results, Cohen's* d*, and change means, standard deviations, range of scores and* N*-sizes.*

	Pre-Treatment QOL Descriptive Data								
	MET	PF	RP	BP	GH	V	SF	RE	MH
Mean	2.4	58.4	26.0	58.6	66.3	49.1	64.2	60.3	73.4
SD	.6	23.7	36.6	25.3	17.9	18.1	27.7	44.3	17.6
Range	1.3-5.2	0-100	0-100	0-100	20-100	0-99	0-100	0-100	24-100
N	302	293	293	299	298	294	299	291	296
	Post-Treatment QOL Descriptive Data								
	MET	PF	RP	BP	GH	V	SF	RE	MH
Mean	4.0	77.5	70.8	78.0	70.5	62.2	86.7	78.1	79.1
SD	1.0	21.5	36.7	21.4	17.8	16.2	19.2	34.3	16.8
Range	1.8-7.5	0-100	0-100	21-100	25-100	0-100	0-100	0-100	12-100
N	302	293	293	299	298	294	299	291	296
t	21.4	49.6	72.4	27.1	21.6	39.1	31.7	35.4	17.4
d	1.9	.86	.34	.82	.25	.42	.93	.46	.34
	Means, Standard Deviations, Ranges of Change in QOL								
		PFC	RPC	BPC	GHC	VC	SFC	REC	MHC
Mean		19.4	44.8	19.3	4.3	13.2	25.6	18.3	5.9
SD		24.5	45.5	26.8	16.8	20.4	28.7	46.4	19.2
Range		75-95	-99-100	-78-100	-47-52	-55-75	-62-100	-100-100	-59-96
N		299	298	300	300	301	301	299	300

Note: MET = METs; PF = Physical Functioning; RP = Role Functional-Physical; BP = Bodily Pain; GH = General Health; V = Vitality; SF = Social Functioning; RE = Role Functioning-Emotional; MH = Mental Health.

change in METs from pre- to post-CR was 1.55 (SD = 0.69, range = 0.2 – 4.6). The change scores for the eight SF-36 variables are located on Table 1.

Pearson product moment correlation coefficients were calculated to test whether there was a positive relationship between changes in quality of life from pre- to post-cardiac rehabilitation and pre- to post-cardiac rehabilitation changes in physical work capacity. Table 2 represents these Pearson product moment correlations used to answer our principle research questions. Statistically significant correlations were found between changes in metabolic equivalents and the QOL physical health measures. Changes in METs accounted for 1%, 2.6%, and 1% of the total variance in changes in RP, BP, and GH, respectively. Non-significant, but positive, correlations were found between changes in metabolic equivalents and the QOL mental health measures (Vitality Change, Role Functioning-Emotional Change, Social Functioning Change, and Mental Health Change). As such, the data support the conclusion that for subjects whose pre-treatment QOL scores are below those of the national reference population (Ware and Sherbourne 1992), there is a significant and positive relationship between changes in physical capacity and changes in Role-Functioning-Physical, Bodily Pain, and General Health.

Because patient QOL scores vary across patient age, sex, and CAD diagnoses, we tested Ware's theorized relationship by covarying these variables with a series of multiple regression analyses (McNeil and others 1996) using the respective METC, age, sex, and patient diagnoses as covariates and each QOL variables as the criteria. The results of these analyses (Table 3) indicate that when these variables are co-varied, changes in physical ability are significantly and positively predictive of changes in all physical health related QOL variables as well as some mental-health related QOL variables (VC and SFC). Specifically, under these conditions, METC accounted for 5% of the variance is PFC and RFC, 4% of the variance in BPC and VC, 2% of the variance in GHC and SFC.

DISCUSSION

The purpose of our study was to test the predicted relationship between changes in physical ability and physical health related QOL in particular, and all QOL in general. Additionally, we were interested in determining whether certain demographic variables were important moderators of this proposed relationship. Prior to testing these relationships, however, it was important to first test for improvements in QOL and METs over the course of treatment. As found in previous research (Cohen and others 1999; McEntee and Badenhop 2000; Simchen and others 2001; Lavie and Milani 2000; Morrin and others 2000), our patients entered CR with low QOL scores and demonstrated significant improvement in QOL scores following the completion of their treatment. Likewise, our patients' ability to exercise increased significantly. Therefore, we proceeded to test the research hypotheses that changes in physical work capacity are related to changes in QOL.

Our findings provide support for the theorized association between improvements in physical ability and improvements in QOL. We found positive relationships between improvements in physical ability and every QOL indicator. Further, as predicted by Ware's (Ware 1990) theory, we found statistically significant positive relationships between physical ability and the majority of those QOL indicators that are conceptually consistent with physical health related QOL. Improvements in physical ability were predictive of decreased expectations that physical health interfere with work or other daily activities. As the physical capabilities of our patients increased, they reported feeling less physical pain and were less limited by any pain they did experience. And, increased physical ability was associated with a brighter outlook on current and expected future health status. These three relationships were consistent even when patient age, sex, cardiac diagnosis, and pre-CR treatment QOL scores were co-varied. Interestingly, even though our patients' physical functioning scale score, the fourth SF-36 scale associated with physical health QOL, increased nearly 20 points, representative of both statistically and clinically significantly improvements, evidence suggesting that this gain was statistically related to improvement in physical ability only when age, sex, cardiac diagnosis and pre-treatment PF scores were co-varied.

While changes in the physical health component of QOL were significantly and positively predictive of

TABLE 2

Pearson Correlation Coefficients between Measures of Change QOL and Respective METC.

	METC	PFC	RPC	BPC	GHC	VC	SFC	REC	MHC
METC	—	0.06	0.11*	0.16**	0.11*	0.07	0.08	0.06	0.04

Note: METC = MET change; PFC = Physical Functioning change; RPC = Role Functional-Physical change; BPC = Bodily Pain change; GHC = General Health change; VC = Vitality change; SFC = Social Functioning change; REC = Role Functioning-Emotional change; MHC = Mental Health change.

*p <0.05.

**p <0.01

TABLE 3

Multiple Linear Regression for Changes in METs Predicting Changes in Quality of Life Holding Age, Gender CAD Diagnosis and Pre-CR QOL Score Constant.

Variable	Standardized regression weights	*p*
Physical Functioning Change		
Age	-0.100	0.025*
Males	0.001	0.490
Angina	-0.149	0.002*
Myocardial infarction	-0.164	0.001*
CABG	0.062	0.104
Pfpre	0.403	0.001*
METC	0.258	0.001*
df = 1, 291. R^2 Full = 0.34. R^2 change = 0.05. F = 20.5.		
Role Functioning-Physical Change		
Age	-0.053	0.183
Males	-0.125	0.016*
Angina	0.015	0.398
Myocardial infarction	-0.014	0.409
CABG	-0.046	0.208
RPpre	0.214	0.001*
METC	0.244	0.001*
df = 1, 291. R^2 Full = 0.13. R^2 change = 0.05. F = 5.81.		
Bodily Pain Change		
Age	-0.018	0.376
Males	0.063	0.129
Angina	-0.048	0.198
Myocardial infarction	-0.104	0.032*
CABG	-0.009	0.431
BPpre	0.356	0.001*
METC	0.200	0.001*
df = 1, 298. R^2 Full = 0.19. R^2 change = 0.04. F = 9.46.		
General Health Change		
Age	0.017	0.369
Males	-0.070	0.065
Angina	-0.033	0.257
Myocardial infarction	0.002	0.481
CABG	0.034	0.238
GHpre	0.562	0.001*
METC	0.146	0.003*
df = 1, 298. R^2 Full = 0.35. R^2 change = 0.02. F = 22.2.		
Vitality Changes		
Age	-0.047	0.190
Males	-0.080	0.071
Angina	0.154	0.005*
Myocardial infarction	-0.027	0.313
CABG	-0.014	0.394
Vpre	0.286	0.001*
METC	0.219	0.001*
df = 1, 293. R^2 Full = 0.23. R^2 change = 0.04. F = 12.17		
Social Functioning Changes		
Age	0.040	0.243
Males	-0.183	0.001*
Angina	-0.017	0.386
Myocardial infarction	-0.042	0.236
CABG	-0.007	0.449
SFpre	0.303	0.001*
METC	0.143	0.009*
df = 1, 293. R^2 Full = 0.13. R^2 change = 0.02. F = 6.302		
Role Functioning-Emotional Changes		
Age	-0.074	0.103
Males	-0.060	0.149
Angina	-0.022	0.350
Myocardial infarction	-0.046	0.214
CABG	-0.056	0.160
REpre	0.349	0.001*
METC	0.070	0.084
df = 1, 290. R^2 Full = 0.14. R^2 change = 0.01. F = 6.79.		
Mental Health Changes		
Age	0.002	0.486
Males	-0.029	0.293
Angina	-0.039	0.237
Myocardial infarction	0.061	0.132
CABG	0.117	0.014*
MHpre	0.462	0.001*
METC	0.064	0.129
df = 1, 295. R^2 Full = 0.23. R^2 change = 0.003. F = 12.31.		

*p <0.05

improvements in physical ability, the relationship between changes in physical ability and mental health QOL were mixed. The amount of change in physical ability were related to changes in vitality and social

functioning; however, those SF-36 scales that are theorized to most closely measure the mental health component of QOL (RE and MH) were not. Thus, the theory that changes in physical ability are related to changes in QOL was supported only among those variables that have substantial validity for measuring the physical health component of QOL, but not those that measure the mental health component. This suggests that other modalities of cardiac rehabilitation, perhaps, for example, counseling, stress reduction, and so forth, are indeed necessary to effect desired improvements in the mental health related QOL components. As such, the results of the present study suggest that a CR population is better suited for testing the relationship between physical ability and physical health related QOL variables, and not physical ability and mental health related QOL variables. These findings suggest that in order to receive mental health benefits from CR, a multidisciplinary and multidimensional approach is needed. This conclusion regarding mental health related aspects of QOL is consistent with that of Worcester and others (1993), who concluded that the intensity of physical work was not related to changes in anxiety or depression. Also, Oldridge and others (1991) found that patients who completed CR were no less depressed or anxious than a control group that did not receive CR. This conclusion regarding mental health QOL variables is divergent, however, from the research of others (Hertzeanu and others 1993; Denollet 1993a), who found evidence of a relationship between physical exercise and mental health QOL.

One way to understand the divergence in results between this and previous studies is to examine the manner in which these studies reached their conclusions. Other researchers, too (Hertzeanu and others 1993; Denollet 1993a), found that patients who completed a physical exercise based treatment program experienced less anxiety and depression compared to their pretreatment levels of these variables. However, in conducting their experiments, these authors did not determine whether changes in physical ability or even the amount of physical activity produced less depression and anxiety. While establishing that physical activity was related to changes in these variables, they did not examine whether it was the physical activity itself, improvements in physical ability, or some other non-physical ability related factor that caused changes in these MH variables such as the impact of vibrant and enthusiastic CR staff, or socialization with persons of similar affliction, for example.

There are several valuable aspects to this study. First, the large volume of patients included in this study provided the researchers with confidence in the magnitude of the effect sizes. Second, although this study's sample was predominantly male (71.9%), to our knowledge no other QOL study was as inclusive of female subjects. Across all QOL variables, female participants showed greater improvement than did males. This finding supports the need to examine whether the aggregation of QOL data masks potential gender differences. Third, while previous research efforts have included a broad range of QOL variables in pre- and post-treatment descriptive format, none to date have examined whether changes in these variables are associated with changes in physical ability. Fourth, physicians and other health care providers can use this information to encourage participation in CR with the expectation that treatment will improve physical health and exercise capacity, and that gains in exercise ability will correlate with patients' self-perceived QOL. Finally, this study is an improvement on previous research because the multivariate nature of the statistical analyses allowed the researchers to ask more complex questions than previously addressed.

Readers should be aware of this study's limitations. We employed an ex post facto research design with alternative hypotheses (Campbell and Stanley 1966; Pedhazur and Schmelkin 1991), the most rigorous manner of ex post facto research. Such an approach does not allow one to imply a causal relationship between physical improvements in ability and changes in QOL (Newman and Newman 1994). Also, the amount of variance accounted for in QOL variables by changes in physical ability is admittedly small.

The results of this study raise several suggestions for future research. It is unclear whether the physical ability-related improvements in QOL are sustained over time. Future researchers may wish to reassess CR graduates several weeks to several months post-treatment to learn whether the observed improvements in QOL are maintained over time. Continued research is needed to determine whether continued exercise is required to maintain achieved improvements in QOL. Additional inquiry is warranted to determine why some QOL variables showed gains from pre- to post-treatment, but were not related to MET gains.

The researchers tested Ware's (1990) theory using participants in a CR setting. There are a wide variety of alternative medical settings in which similar research could be conducted. This study co-varied CAD diagnoses. It might prove interesting to conduct similar studies in treatment programs designed to aid in the recovery of a wide variety of illnesses. Persons utilizing an exercise-based form of recovery from such debilitating illnesses as knee or hip replacement surgery, back injuries, or limb amputation may serve as a fertile sample in which to conduct additional tests of Ware's hypothesized relationships. Persons planning on receiving certain corrective surgeries such as hernia repairs or knee surgery may provide a population in which to study the effects of an acute illness and recovery on QOL.

Future researchers who are interested in examining the impact that changes in exercise capacity have on QOL are encouraged to include greater numbers of women and minority subjects in order to provide greater opportunity to test the influence of sex and ethnicity on the research hypotheses. Also, future researchers may wish to expand upon Ware's (1990) conceptualization of QOL by including other variables such as those represented on the Health Insurance Experiment (Brook and others 1979; Ware and others 1981); Sickness Impact

Profile (Bergner and others 1981); Duke Health Profile (Parkerson and others 1990); and Dartmouth COOP Function Charts (Nelson and others 1987). Much of Ware's view of QOL relates to the valence he placed on a person's ability to perform physical abilities required at a place of work (Ware and others 1997). With the increasingly diverse conceptualization of work, a definition of QOL that is less biased towards physical ability may be more appropriate to the changing world of work environments. Variables of interests that are not necessarily health or work-related include living arrangements, neighborhood, standard of living, financial situation, family life, and friendships.

LITERATURE CITED

Allen LW, Figon L. 1995. AHSR & FHSR Annual Meeting Abstract Book. Proceedings of the 12th Annual AHSR & FHSR Annual Meeting. 4-6 June, Chicago, IL. p 51.

American Association of Cardiovascular and Pulmonary Rehabilitation. 1999. Guidelines for Cardiac Rehabilitation and Secondary Prevention Programs. 2nd ed. Champaign (IL): Human Kinetics. 281 p.

Appels A. 1980. Psychological prodromata of myocardial infarction and sudden death. J Psychosom Res 34:187-95.

Appels A. 1990. Mental precursors of myocardial infarction. Br J of Psychiatry 156:465-71.

Appels A, Mulder P. 1988. Excess fatigue as a precursor of myocardial infarction. Eur Heart J 9:758-64.

Appels A, Mulder P. 1989. Fatigue and heart disease: the association between 'vital exhaustion' and past, present and future coronary heart disease. J Psychosom Res 33:727-38.

Baker C. 1995. A functional status scale for measuring quality of life outcomes in head and neck cancer patients. Cancer Nurs 18:452-7.

Beaton DE, Bombardier C, Hogg-Johnson SA. 1996. Measuring health in injured workers: a cross-sectional comparison of five generic health status instruments in workers with musculoskeletal injuries. Am J Ind Med 6:628-31.

Bergner M, Bobbitt RA, Carter WB, Gilson BS. 1981. The Sickness Impact Profile: development and final revision of a health status measure. Med Care 19:787-805.

Berman WH, Hurt SW, Darling H. 1995. In 1995 AHSR & FHSR Annual Meeting Abstract Book. Proceedings of the 12th Annual AHSR & FHSR Annual Meeting. 4-6 June, Chicago, IL. p 52.

Blumenthal JA, Emery CF. 1988. Rehabilitation of patients following myocardial infarction. J Consult Clin Psychol 56:374-81.

Bohachick P. 1984. Progressive relaxation training in cardiac rehabilitation: effect of psychological variables. Nurs Res 33:283-7.

Bousquet J, Bullinger M, Fayol C, Marquis P, Valentin B, Burtin B. 1994. Assessment of quality of life in patients with perennial allergic rhinitis with the French version of the SF-36 Health Status Questionnaire. J Allergy Clin Immunol 94:182-8.

Brazier JE, Jones N, Kind P. 1993. Testing the validity of the EuroQOL and comparing it with the SF-36 Health Survey Questionnaire. Qual Life Res 2:169-80.

Brook RH, Ware JE, Davies-Avery A, Stewart AL, Donald CA, Rogers WH, Williams KN, Johnston SA. 1979. Overview of adult health status measures fielded in Rand's health insurance study. Medical Care 17 (Suppl. 7): iii-x, 1-131.

Brown R, Zarski J, Newman I, Waechter D, Rosneck J, Josephson R. 2002. Stability of the second order factor structure of the SF-36 from pre to post test in phase II cardiac rehabilitation treatment. Paper presented at the Annual Conference of the Eastern Educational Research Association. Sarasota, FL.

Campbell DT, Stanley JC. 1966. Experimental and quasi-experimental designs for research. Boston: Houghton Mifflin. 83 p.

Cohen J. 1988. Statistical power analysis for behavioral sciences. 2nd ed. Mahwah (NJ): Lawrence Erlbaum.

Cohen RA, Moser DJ, Clark MM, and others. 1999. Neurocognitive functioning and improvement in quality of life following participation in cardiac rehabilitation. Am J Cariol 83:1374-8.

Davis HB. 1996. The quality of life improvement model: a means to guide practice. Crit Care Nurs Q 19:85-90.

Denollet J. 1993a. Sensitivity of outcome assessment in cardiac rehabilitation. J Consult Clin Psychol 61:686-95.

Denollet J. 1993b. Emotional distress and fatigue in coronary heart disease: the Global Mood Scale (GMS). Psychol Med 23:111-21.

Feigenbaum E, Carter E. 1988. Cardiac rehabilitation services. Health technology assessment report, 1987, no. 6. Rockville (MD): US Department of Health and Human Services, Public Health Service, National Center for Health Services Research and Health Care Technology Assessment. DHHS publication no. PHS 88-3427, 1988.

Frasure-Smith N, Lesperance F, Talajic M. 1993. Depression following myocardial infarction: impact on 6-month survival. JAMA 270:1819-25.

Froelicher VF. 1991. Cardiac rehabilitation. In: Catterjee K, Cheitlin MD, Korliner J, Parmley WW, Rapaport E, Scheinman M, editors. Cardiology: An Illustrated Text/Reference. Philadelphia: Lipponcott. 7.204-7.21.

Garratt AM, Ruta DA, Abdalla MI, Buckingham JK, Russell IT. 1993. The SF 36 health survey questionnaire: an outcome measure suitable for routine use within the NHS? BMJ 1993 306:1440-4.

Grant GM, Salcedo V, Hynan LS, Frisch MB, Puster K. 1995. Effectiveness of quality of life therapy for depression. Psychol Rep 76:1203-8.

Harper MB. 1998. Quality of life therapy and assessment in health care. Clinical Psychology: Science and Practice 5:19-40.

Hertzeanu HL, Shemesh J, Aron LA, and others. 1993. Ventricular arrhythmias in rehabilitated and non-rehabilitated post-myocardial infarction patients with left ventricular dysfunction. Am J Cardiol 71:24-7.

Jenkinson C, Coulter A, Wright L. 1993. Short form 36 (SF-36) health survey questionnaire: normative data for adults of working age. Brit Med J 306:1437-40.

Jette DV, Downing J. 1994. Health status of individuals entering a cardiac rehabilitation program as measured by the Medical Outcomes Study 36-Item Short-Form Survey (SF-36). Phys Ther 74:521-7.

Jette DV, Downing J. 1996. The relationship of cardiovascular and psychological impairments to the health status of patients enrolled in CR programs. Phys Ther 76:130-9.

Kaplan RM. 1988. Health-related quality of life in cardiovascular disease. J Consul Clin Psychol 565:382-92.

Katz JN, Larson MG, Phillips CB, Fossel AH, Liang MH. 1992. Comparative measurement sensitivity of short and longer health status instruments. Med Care 30:917-25.

Komaroff AL, Family L. 1996. Medical assessment of fatigue and chronic fatigue syndrome. Chronic Fatigue Syndrome: An Integrative Approach to Evaluation and Treatment. New York: Guilford Pr. 317 p.

Kop WJ, Appels AP, Mendes de Leon CF, de Swart HB, Bar FW. 1994. Vital exhaustion predicts new cardiac events after successful coronary angioplasty. Psychosom Med 56:281-7.

Krantz DS. 1980. Cognitive processes and recovery from heart attack: a review and theoretical analysis. J Human Stress 6:27-38.

Krousel-Wood MA, Re RN, Abdoh A, and others. 2001. The effect of education on patients' willingness to participate in a telemedicine study. J Telemed Telecare 7:281-7.

Kurtin PS, Landgraf JM, Abetz L. 1994. Patient-based health status measurements in pediatric dialysis: expanding the assessment of outcome. Am J Kidney Dis 24:376-82.

Laux JM, Queener J, Newman I, Rosneck J, Josephson R. 2002. A comprehensive study of the relationship between cardiac rehabilitation intervention and quality of life indicators: an application of Ware's Model. Summa Health System, Cardiac Rehabilitation Department. Akron, OH. Paper submitted for publication.

Lavie CJ, Milani RV. 2000. Disparate effects of improving aerobic exercise capacity and quality of life after cardiac rehabilitation in young and elderly coronary patients. J Cardiopulmonary Rehabil 20:235-40.

Mangione CM, Phillips RS, Lawrence MG, Seddon JM, Orav EJ, Goldman L. 1994. Arch Ophthalmology 112:1419-25.

Marwick TH, Zuchowski C, Lauer MS, Secknus MA, Williams MJ, Lytle BW. 1999. Functional status and quality of life in patients with heart failure undergoing coronary bypass surgery after assessment of myocardial viability. J Am Coll Cardiol 33:750-8.

McEntee DJ, Badenhop DT. 2000. Quality of life comparisons: gender and population differences in cardiopulmonary rehabilitation. Heart Lung 29:340-7.

McHorney CA, Ware JE Jr, Lu JFR, Sherbourne CD. 1994. The MOS 36-Item Short-Form Health Survey (SF-36). III. Test of data quality, scaling assumptions, and reliability across diverse patient groups.

Med Care 32:40-66.
McNeil K, Newman I, Kelly FJ. 1996. Testing Research Hypotheses with the General Linear Model. Carbondale (IL): Southern University Pr.
Meyer KB, Espindle DM, DeGiacomo JM, Jenuleson CS, Kurtin PS, Davies AR. 1994. Monitoring dialysis patients' health status. Am J Kidney Dis 24:267-79.
Milani RV, Lavie CJ. 1996. Behavioral differences and effects of cardiac rehabilitation in diabetic patients following cardiac events. Am J Med 100:517-23.
Morrin L, Black S, Reid R. 2000. Impact of duration in a cardiac rehabilitation program on coronary risk profile and health-related quality of life outcomes. J Cardiopulmonary Rehabil 20:115-21.
Nelson EC, Wasson J, Kirk J, Keller A, Clark D, Dietrich A, Stewart A, Zubkoff M. 1987. Assessment of function in routine clinical practice: description of the COOP Chart method and preliminary findings. J Chron Dis 40(Suppl 1):55S-69S.
Nerenz DR, Repasky DP, Whitehouse FW, Kahkonen DM. 1992. Ongoing assessment of health status in patients with diabetes mellitus. Med Care 30:112-24.
Newman I, Newman C. 1994. Conceptual statistics for Beginners. 2nd ed. Lanham (MD): University Pr of America.
Oldridge NB. 1997. Outcome assessment in cardiac rehabilitation: health-related quality of life and economic evaluation. J Cardiopulm Rehabil 17:179-94.
Oldridge NB, Gottlieb M, Guyatt G, Jones N, Streiner D, Feeny D. 1998. Predictors of health-related quality of life with cardiac rehabilitation after acute myocardial infarction. J Cardiopulm Rehabil 18:95-103.
Oldridge NB, Guyatt G, Jones N, and others. 1991. Effects on quality of life with comprehensive rehabilitation after acute myocardial infarction. Am J Cardiol 67:1084-9.
Osterhaus JT, Townsend RJ, Gandek B, Ware JE. 1994. Measuring the functional status and well-being of patients with migraine headache. Headache 34:337-43.
Parkerson GR Jr, Broadhead WE, Tse CK. 1990. The Duke Health Profile. A 17-item measure of health and dysfunction. Med Care 28:1056-72.
Pedhazur EJ, Schmelkin LP. 1991. Measurement, design, and analysis: an integrated approach. Hillsdale (NJ): Lawrence Erlbaum. 819 p.
Richardson LA, Buckenmeyer PJ, Bauman BD, Rosneck JS, Newman I, Josephson RA. 2000. Contemporary cardiac rehabilitation: Patient characteristics and temporal trends over the past decade. J Cardiopulm Rehabil 20:57-64.
Roitman JL. 1998. ACSM's Resource Manual for Guidelines for Exercise Training and Prescription. 3rd ed. Baltimore: Williams & Wilkins. 368 p.
Rovario A, Holmes DS, Holmsten RD. 1984. Influence of a cardiac rehabilitation program on the cardiovascular, psychological, and social functioning of cardiac patients. J Behav Med 7:61-81.
Shephard RJ, Franklin B. 2001. Changes in the quality of life: a major goal of cardiac rehabilitation. J Cardiopulm Rehabil 21:189.
Simchen E, Naveh I, Zitser-Gurevich Y, and others. 2001. Is participation in cardiac rehabilitation programs associated with better quality of life and return to work after coronary artery bypass operations? The Israeli CABG study. Israeli Med Assoc J 3:399-403.
Simon GE, VonKorff M, Heiligenstein JH, Revicki DA, Grothaus L, Katon W, Wagner EH. 1996. JAMA 75:1897-902.
Spertus JA, Winder JA, Dewhurst TA, Deyo RA, Fihn SD. 1994. Monitoring the quality of life in patients with coronary artery disease. Am J Cardiol 74:1240-2.
Tilly KF, Belton AB, McLachlan JFC. 1995. Continuous monitoring of health status outcomes: experience with a diabetes education program. Diabetes Educ 21:413-9.
Ware JE. 1987. Standards for validating health measures: definition and content. J Chronic Dis 40:473-80.
Ware JE. 1990. Measuring patient function and well-being: some lessons from the Medical Outcomes Study. In: Heitgoff KA, Lohr KN, editors. Effectiveness and outcomes in health care. Proceedings of an invitational conference by the Institute of Medicine, Division of Health Care Services. Washington (DC): National Academy Pr. 107-19.
Ware JE, Brook RH, Davies AR, Lohr KN. 1981. Choosing measures of health status for individual in general populations. Am J Pub Health 71:620-5.
Ware JE, Keller SD, Gandek B, Brazier JE, Sullivan M. 1995. Evaluating translations of health status questionnaires. Int J Technol Assess Health Care 11:525-51.
Ware JE, Kosinksi M, Keller SD. 1994. SF-36 Physical and Mental Health Summary-Scales: A User's Manual. Boston: The Health Institute. 237 p.
Ware JE, Sherbourne CD. 1992. The MOS 36-Item Short-Form Health Survey (SF-36). I. Conceptual framework and item selection. Med Care 30:473-83.
Ware JE, Snow KK, Kosinski M, Gandek B. 1997. SF-36 Health Survey manual and interpretation guide. Boston: The Health Institute.
Wells KB, Burnam MA, Rogers W, Hays R, Camp P. 1992. The course of depression in adult outpatients: results from the Medical Outcomes Study. Arch Gen Psych 49:788-94.
Wenger NK, Froelicher ES, Smith LK, and others. 1995. Cardiac Rehabilitation as Secondary Prevention. Clinical Practice Guideline Number 17. Cardiac Rehabilitation Guideline Panel. US Dept of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research, National Heart, Lung, and Blood Institute. ANCPR Publication Number 96-0672.
Worcester MC, Hare DL, Oliver RG, Reid MA, Goble AJ. 1993. Early programmes of high and low intensity exercise and quality of life after acute myocardial infarction. British J Medicine 307:1244-7.
World Health Organization Quality of Life Group. 1993. Study protocol for the World Health Organization project to develop a quality of life assessment instrument (WHOQOL). Qual Life Res 2:153-9.