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Lower-Socioeconomic Status Patients in Cardiac Rehabilitation: Clinical Characteristics, Attendance, and Implications for Future Practice

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Abstract:

The importance of cardiac rehabilitation after many coronary events such as a myocardial infarction and bypass surgery, as well as heart failure more recently is well established in the medical community. Cardiac rehabilitation has been shown to decrease the rate of the atherosclerotic process and reduce rates of subsequent coronary events (Haskell et al, 1994). It has additionally been shown that those who attend cardiac rehabilitation (CR) have reduced rates of mortality from both cardiovascular-specific as well as cardiovascular-nonspecific causes and rehospitalization (Ades, 2001; Heran et al, 2011). One variable consistently correlated with poor attendance is lower-socioeconomic status (lower-SES). Even when referred to a cardiac rehabilitation program, individuals with a lower socioeconomic status are less likely to attend cardiac rehabilitation than higher-SES individuals (Cooper et al, 2002; Valencia et al, 2011). The purpose of this research was to characterize lower-SES population in the CR program at University of Vermont Medical Center. By examining the lower-SES population on clinical characteristics, attendance, and clinical improvement within the program we can determine if this population has special needs and if the program needs to be tailored to help the lower-SES population both to stay in CR and to get the most out of the program. Notable results included that lower-SES patients tend to be younger than higher-SES patients at intake, and that they tend to have worse fitness and depression scores and be more likely to smoke, but have fewer comorbidities. The lower-SES population also had a higher dropout rate in the first eleven sessions. Within completers, the lower-SES and higher-SES populations both tended to make significant gains in fitness, quality of life, depression, strength, and body composition.

Chapter 1: Introduction

Introduction:

The importance of cardiac rehabilitation after many coronary events such as a myocardial

infarction and bypass surgery, as well as heart failure more recently is well established in the

medical community. Cardiac rehabilitation has been shown to decrease the rate of the

atherosclerotic process and reduce rates of subsequent coronary events (Haskell et al, 1994). It

has additionally been shown that those who attend cardiac rehabilitation have reduced rates of

mortality from both cardiovascular-specific as well as cardiovascular-nonspecific causes and

rehospitalization (Ades, 2001; Heran et al, 2011), which could be a significant improvement in

both quality and length of life for the 865,000 individuals in the United States who experience a

myocardial infarction each year (CDC, 2008), as well as those with related conditions. Despite

these benefits, only 20-35% of eligible individuals in the United States participate in a cardiac rehabilitation program (Ades, 2001; CDC, 2008).

Cardiac Rehabilitation:

Cardiac rehabilitation (CR) is a formal program of supervised, individualized exercise and supplemental educational classes on topics such as nutrition, smoking cessation, and stress management, with a goal of increasing cardiopulmonary fitness and reducing cardiac risk factors (Savage et al, 2009). These programs are typically carried out by a team of cardiologists, exercise physiologists, and nurses, among others. The typical length of a CR program varies, but Medicaid and Medicare insurance cover thirty-six sessions, with most patients attending two to three sessions per week. The general goal is to work up to 45 minutes of cardiovascular exercise as well as strength training when appropriate.

Socioeconomic Status and Risk:

Certain populations are at increased cardiac risk and should be given special attention. For example, lower-socioeconomic status (SES) patients, generally measured by education (Harlan et al, 1995) or income, tend to have higher-risk cardiac profiles characterized by current smoking status (Oberg et al, 2009), lower levels of physical activity (Ding et al, 2015), depression (Lane et al, 2001), diabetes (Dokken et al, 2008), and obesity (Szalewska et al, 2015).These populations are also at increased risk for morbidity and mortality following a cardiac event (Bernheim et al, 2007).

This Project:

Due to the high-risk profile and increased chance of morbidity and mortality in the lower-SES population it is important to examine their characteristics in order to help shape CR

programs to better suit the needs of lower socioeconomic individuals. Accommodating this population is crucial because it has been shown that they have more comorbidities and benefit just as much from cardiac rehabilitation. Accordingly, the purpose of this research project is to better characterize lower-SES patients in cardiac rehabilitation. The purpose of this project was to better understand the lower-SES population in the CR program at University of Vermont Medical Center. All patient data for patients enrolled in CR at this center from 2009-2015 was examined for a total of 2,090 patients. By examining the lower-SES population on clinical characteristics, attendance, and clinical improvement within the program we can determine if this population has special needs and if the program needs to be tailored to help the lower-SES population both to stay in CR and to get the most out of the program. To do this we examined if this population differs significantly in terms of demographics, fitness, depression and quality of life on entrance to CR as well as on number of sessions of CR completed. In order to do this, the population was first characterized in comparison to higher-SES patients on demographic variables, intake fitness and fitness-related variables, and depression and quality of life measures. Next, the two population subsets were compared in their CR adherence patterns, including how long they stayed in the program and if the program was completed, as well as reasons for premature termination of the course of CR. Additionally, it is important to look at gains incurred during CR within completers in order to get a full picture of how well lower-SES patients fare in CR currently. To do this, gains in fitness, fitness-related variables, depression, and quality of life were examined within completers as a determinant of where efforts need to be focused in helping the lower-SES population in CR to make the most out of their time in the program. The findings of this project are crucial as they will provide knowledge about this high risk population which will allow improvement of the program in order to better serve the lower-SES population.

Hypotheses included that lower-SES individuals would come in with poorer fitness and more risk factors than the higher-SES patients, and would adhere to fewer sessions, but that within completers both populations would make significant gains in fitness and quality of life.

Chapter 2: Characterization

<u>Introduction:</u>

<u>Socioeconomic Status and Risk:</u>

Lower-socioeconomic status can be described in different ways but is often defined as those with lower levels of educational attainment or lower income levels (Harlan et al, 1995). It can be most easily operationalized in the medical context, however, as being eligible for Medicaid (Ku et al, 2005; Suaya et al, 2007; Foraker et al, 2010) or being in collections (Sweet et al, 2013). As explained in Chapter 1, many risk factors such as current smoking status (Oberg et al, 2009) lower levels of physical activity (Ding et al, 2015) and depression (Lane et al, 2001) have been associated with lower-socioeconomic status.

Lower-SES populations in CR have been shown to exhibit more risk factors coming into the program. Patients with lower-socioeconomic status potentially have more disadvantages when coming into the program such as smoking status and depression (Govil et al, 2009). One study showed that lower-SES individuals coming into CR are 14% more likely to have high blood pressure and 14% more likely to have diabetes, statistically significant differences (Alter et al, 2006). The increased rate of diabetes is particularly of concern because diabetes can cause damage to the vasculature as well as to the actual heart muscle that can increase the rate of the atherosclerotic process and increase the risk of another cardiac event or stroke, separately from

all other risk factors (Dokken, 2008). Individuals in the lower-SES population also have higher rates of many exercise limiting comorbidities. For example, one United States based survey study showed that individuals reporting less than $20,000 in income per year made up only 19.1% of individuals in the study not affected by prediabetes or insulin resistance, even though they comprised 27% of the study population (Yang et al, 2015). Diabetes has been correlated with more difficulty in losing weight because of the effect of insulin dysregulation on glucose metabolism (Boutcher and Dunn, 2009) Individuals in the lower-SES population also have very high rates of obesity, with one study showing that 42.7% of lower-SES individuals in a CR population within the lower-SES group met the criteria for obesity (Szalewska et al, 2015).

Many of these risk factors can also affect CR attendance and mediate further risk factors. For example, depression has also been shown to correlate with other difficulties in achieving the best possible outcome in cardiac rehabilitation and CR attendance, as well as with more clinical difficulties (Caulin-Glaser et al, 2007). Depression has also been shown to directly correlate with lower cardiorespiratory fitness (Papasavvas et al, 2015). This shows that it is important to examine this variable in any study of a CR population not just for the purposes of best understanding their psychiatric needs, but additionally as a potential effector of fitness. Smoking has also been shown to be a predictor of both future cardiac events and of attending fewer sessions of CR (Gaalema et al, 2015), as well as to interfere with fitness gains (Waseem et al, 2012).

Given the increased risk profile described above, it is not surprising that the lower-SES population also exhibits higher morbidity and mortality when exhibiting cardiac problems. Patients from lower-SES neighborhoods have up to a 27% 30 day rehospitalization rate as compared to 21% for higher-SES neighborhoods, a relative increase of nearly 30% (Kind et al,

2014). Evidently, lower-SES individuals in many populations may vary on several variables of clinical relevance. It is necessary to understand in any given CR population how fitness, depression, and demographic variables are different in order to be able to best tailor the program to suit unique needs of the lower-SES patient population.

Methods:

The first step that was taken to examine SES differences in CR was to examine differences in general demographic variables, fitness, depression, and quality of life at the start of the program. Measures examined included sex, age, race, diagnosis, smoking status, exercise-limiting comorbidities, pVO_2 and estimated METS for fitness, GDS score for depression, PHQ-9 score and MOS score for quality of life, waist circumference and BMI for body composition, and hand grip for strength measurements. Race was operationalized as either white or non-white self-identification. Diagnosis was defined as either surgical or nonsurgical. Smoking status was defined as either current or former smoker, or never having smoked. Exercise-limiting comorbidities were any pre-existing conditions such as PVD (Peripheral Vascular Disease) or COPD (Chronic Obstructive Pulmonary Disease) that the medical team determined to potentially inhibit the patient's ability to exercise in an effective manner.

Fitness was measured by both peak oxygen velocity (pVO_2) and estimated METs (estMETs). Peak oxygen velocity is a measure of oxygen consumption of the body that can be approximated during a stress test upon entry to CR. It is considered the gold standard for measuring of fitness in cardiac patients, with values declining in tandem with heart function and age, and also tends to be lower in individuals of female sex (Ades et al, 2006). Estimated METs is an estimate of working metabolic rate compared to resting metabolic rate, which has been demonstrated to correlate with fitness (Branco et al, 2016). Higher values on both of these

measures are considered preferable. Additional health-related measures included BMI (Body Mass Index) and waist circumference in inches. These were used because they have both been independently associated with fitness and are related to cardiac health (Fogelholm et al, 2006). Hand grip was also included in order to assess strength because there was no other measure that directly addressed this. Hand grip is measured by the weight in kilograms that can successfully be held by the dominant hand for three 30-second intervals, which can vary widely between individuals but often runs in the range of 30-40 kilograms (Al-Shreef, et al, 2015).

Depression and quality of life were measured by GDS (Geriatric Depression Scale), PHQ-9, and MOS scores at intake. The GDS is typically used to measure depression in patients aged 65 or older, with support for an optimal cutoff score at either 5 or 6 (Sheikh et al, 1986). The version used contained 15 items. It is important to note that there are many CR participants under the age of 65, and thus not all participants fit the intended age characteristics of this measure. The Patient Health Questionnaire 9 (PHQ-9) is typically used to measure depression in adults; with ten being the clinical cutoff score (Manea et al, 2012). The PHQ-9 can also be considered a quality of life measure; with higher scores indicating lower quality of life. The Measures of Quality of Life Core Survey (MOS) is a more traditional quality of life measure, with higher scores correlating with a higher quality of life (Hays et al, 1993), the opposite of the scoring with the PHQ-9.

Data was averaged separately for the lower-SES and higher-SES groups. The lower-SES group was defined as individuals insured through Medicaid, in collections, or on patient assistance. While Medicaid data was available for all years, collections data was not available for the patients from 2015. Patients in collections tend to be lower-SES (Sweet et al, 2013), and Medicaid status has been shown to correlate almost one-to-one with being below the poverty line

(Ku et al, 2005; Suaya et al, 2007; Foraker et al, 2010). Patient assistance is not offered unless patients have demonstrated extreme financial need. All available data for UVM Medical Center CR patients from 2009-2015 was examined. T-tests were run to examine significant differences on continuous variables including age, number of comorbidities, fitness, depression, quality of life, body composition, and hand grip. Chi-squared tests were used for variables coded in a nominal manner including sex, race, diagnosis and smoking status.

The next step was to examine fitness status as a function of age, separated by SES and sex. This was done with both pVO_2 and estimated METs as fitness outcome measures due to the fact that it has been established that pVO_2 is a better fitness measure, but more data was available for estimated METs scores.

Finally, a linear regression was done to examine the effects of SES on incoming fitness with additional possible contributing variables being added in, including age, sex, diagnosis, and smoking status. This regression was run twice with pVO_2 and estimated METs for outcome measures for the same reason the graphical analysis was done with both measures.

Results:

The initial step in examining lower-SES patients within CR was to examine how lower- and higher-SES populations differed on basic characteristics such as general demographic variables, fitness, depression, and quality of life at time of intake into CR (Table 1). No statistically significant differences were indicated in the percentage of patients self-identifying as female, or in the percentage with a surgical versus nonsurgical diagnosis. Lower-SES patients were significantly younger, with a mean age of approximately seven years younger. A higher number of lower-SES identified as non-white. The lower-SES population also consisted of a

significantly higher proportion of current smokers and a significantly lower portion of former

smokers and individuals who had never smoked.

Contrary to previous findings in the literature, lower-SES patients had significantly fewer

exercise-limiting comorbidities. However, fitness measures showed significantly lower pVO_2 and

estimated METS scores in the lower-SES population. The lower-SES population also had

significantly greater means for waist circumference and BMI. Depression scores (GDS and

PHQ) were significantly higher in lower-SES patients, indicating higher levels of depression. In

terms of quality of life, the lower-SES population had significantly lower MOS scores, which

indicate lower quality of life.

Table 1. Demographic characteristics of UVM Medical Center CR patients from 2009-2015. N-values are included on variables for which data more than 5% of data was not available on all patients in the database. Percentages are out of the available data. The *p*-values for categorical variables were obtained with chi-squared analyses, and for continuous variables using t-tests.

	Higher SES (*n* = 1715)	Lower SES (*n* = 375)	*p*
Female	464 (27.1%)	113 (30.1%)	0.227
Age (years)	65.87	57.64	<.001
Race- Any Non-white ID	19 (1.15%)	15 (4.09%)	<.001
Diagnosis			
Nonsurgical	1127 (67.4%)	243 (67.5%)	0.984
Surgical	544 (32.6%)	117 (32.5%)	
Smoking status		(n=358)	
Never	695 (50.8%)	151 (42.2%)	<.001
Former	603 (44.0%)	139 (38.8%)	
Current	71 (5.2%)	68 (19.0%)	
No. comorbidities	0.6	0.55	<.001
pVO2 (ml/min/kg)	19.77 (n=1014)	19.14 (n=240)	<.001
estMETs (kcal/kg/hour)	6.11 (n=1507)	5.84 (n=329)	<.001
GDS	2.82 (n=1127)	4.19 (n=203)	<.001
PHQ-9	3.93 (n=880)	6.24 (n=117)	<.001
MOS	66.96 (n=1083)	62.53 (188)	<.001
Waist Circ. (in.)	39.8 (n=1178)	41.35 (n=269)	<.001
BMI	29.34	30.88	<.001
Hand Grip (kg)	36.2 (n=1112)	36.15 (n=250)	<.001

Generally fitness declines with age. As incoming fitness was lower in the lower-SES group, despite this group also being younger, fitness was examined more in depth. Fitness was examined by age separated by SES status. The initial analysis of this relationship was done with pVO_2 as it has been established as the gold standard of fitness measures in CR, and is represented graphically below (Figures 1 and 2). The graphs are separated into separate female and male graphs, as typical fitness was different by sex at each age. It is clear that in both populations, pVO_2 values are declining with age. However, there is a downward shift in this linear relationship for the lower-SES group for both males and females, indicating that the trend is the same but that lower-SES individuals tend to have lower fitness at all ages. It is important to note that this data was only available for 1,254 of the patients in the sample of 2,090. Therefore, this analysis was repeated with estimated METS (Figures 3 and 4), which is also a commonly used measure of fitness and was available for more patients (n=1,836). The trends seen in peak VO2 were replicated in the METS analysis.

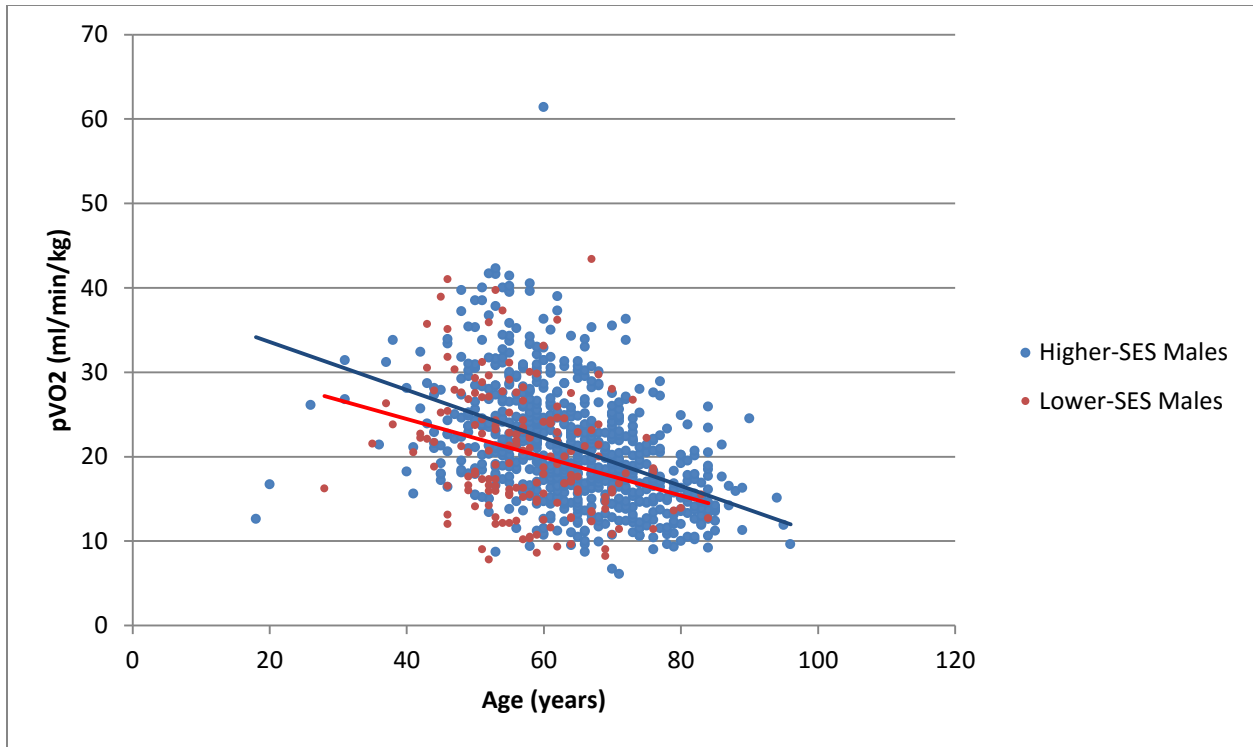Figure 1. Peak oxygen velocity (pVO$_2$) in males as a function of age, separated by higher-SES and lower-SES.
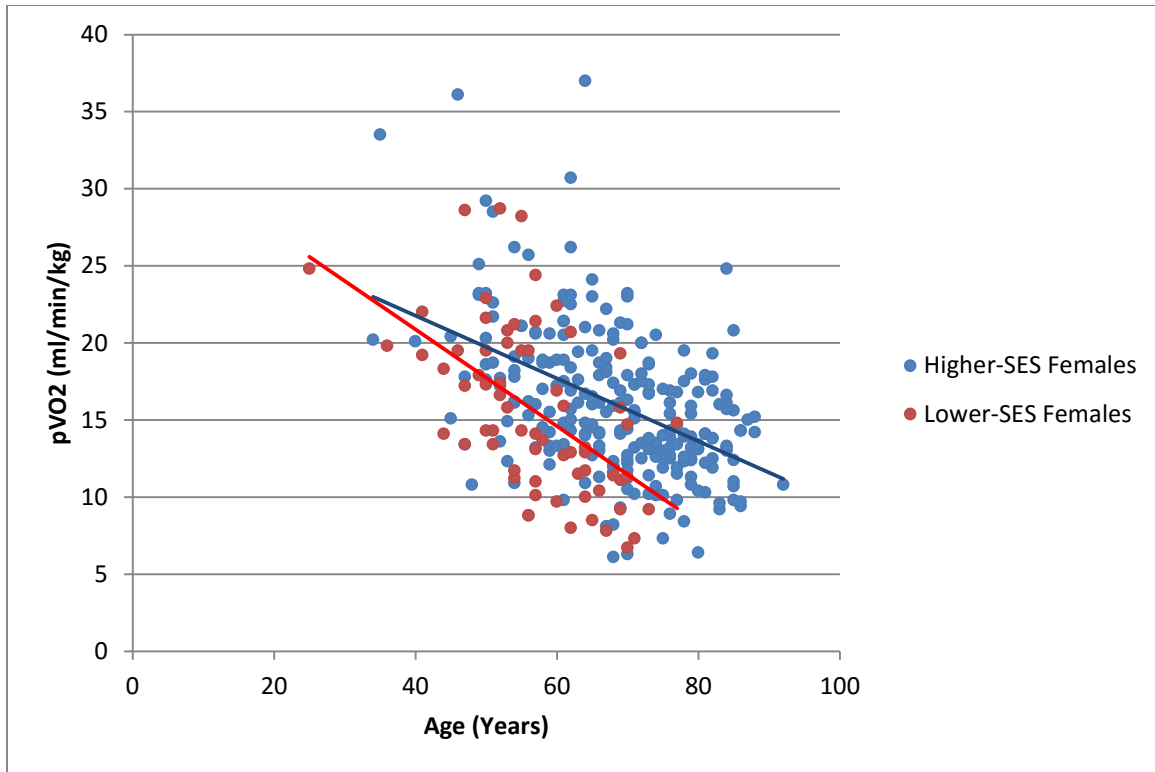
Figure 2. Peak oxygen velocity (pVO$_2$) in females as a function of age, separated by higher-SES and lower-SES.
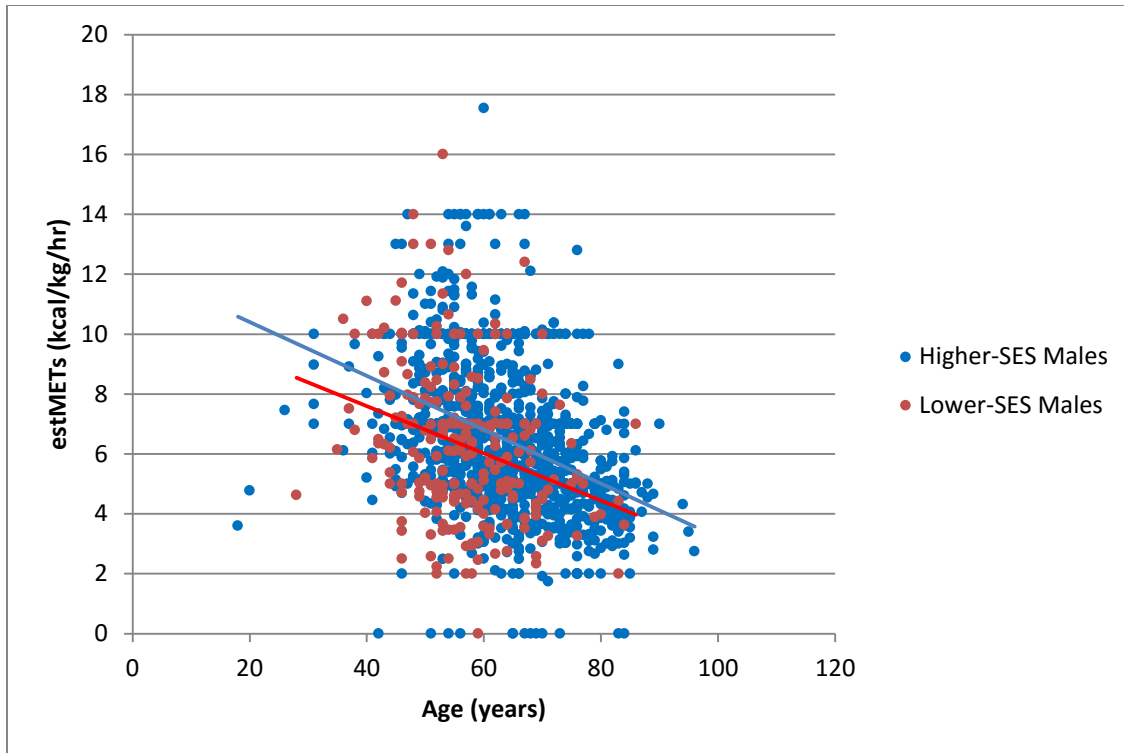
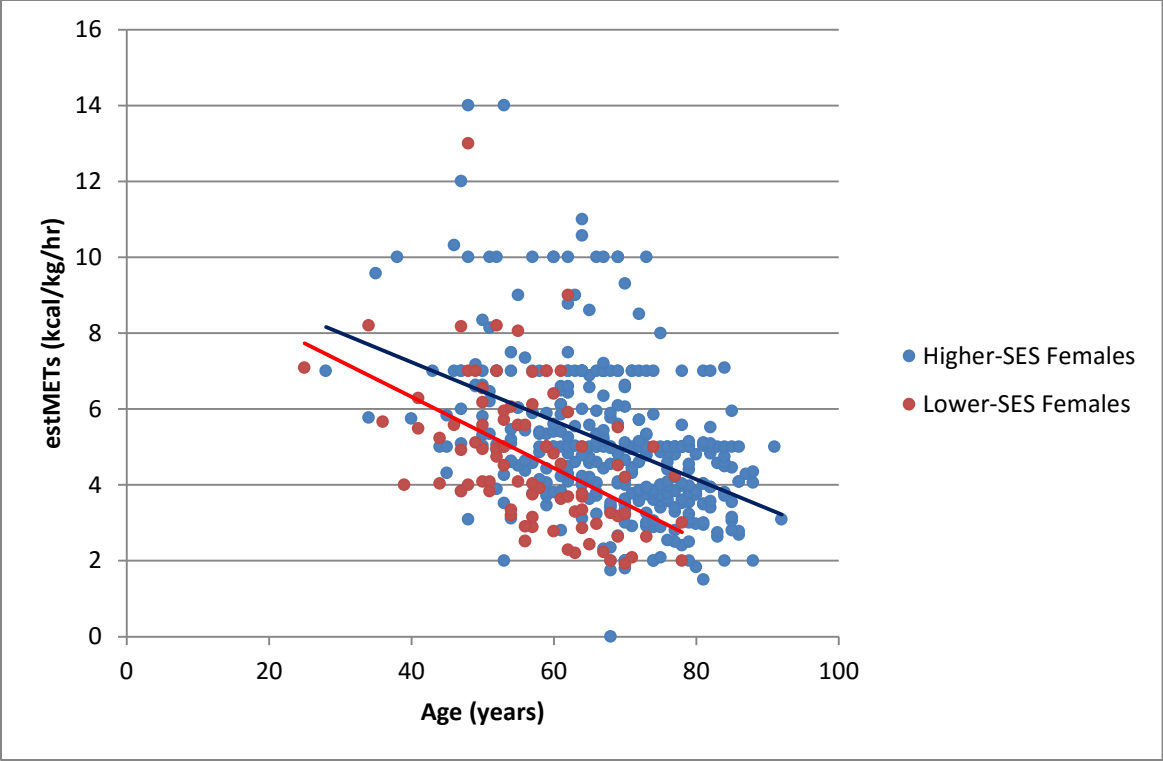Figure 3. Estimated METs in males as a function of age, separated by higher-SES and lower-SES males.

Figure 4. Estimated METs in females as a function of age, separated by higher-SES and lower-SES females.

The final analysis that was done was to look at univariate linear regressions of the effect

of SES on incoming fitness (VO2) as it interacts with other possibly contributing variables. The

following variables were entered into the regression as possible covariates: age, sex, diagnosis,

and smoking status. The initial regression examined the relationship of these variables not

accounting for SES (Table 2). This showed a significant effect of age, sex, diagnosis, and

smoking status on fitness. Figures 1-4 indicate that older age, female sex, and current smoking

status are correlated with lower incoming fitness (Table 2). The regression was then run with the

additional variable of SES (Table 3). All of these variables continued to have a significant effect

on incoming fitness, and lower-SES was shown from this analysis to have an additional

independent contribution to lower incoming fitness. As it has been established that while pVO_2 is

the best measure of fitness but the sample analyzed contains more data for estimated METS, the

regression was run again using estimated METS as an outcome variable (Table 4) in order to

analyze fitness with both the best measure and the most available data. These findings replicated

the relationships described when pVO_2 was used as the outcome measure.

Table 2. Regression examining the effects of age, sex, diagnosis, and smoking status at the time of entry to CR on pVO$_2$ at entry. Data was available on all variables for 1,021 patients.

	Parameter	SE	t-score	*p*	95% CI
Age (older=worse)	-0.226	0.016	-13.873	<.001	(-.0258, -0.194)
Sex (female=worse)	-4.631	0.424	-10.915	<.001	(-5.464, -3.798)
Diagnosis (Surgical- worse vs. Non-Surgical)	3.051	0.381	7.998	<.001	(2.302, 3.800)
Smoker (Current-worse vs. Never vs. Former)	-1.430	0.281	-5.084	<.001	(-1.982, -0.878)

Table 3. Regression examining the effects of age, sex, diagnosis, and smoking status at the time of entry to CR, as well as SES, on pVO_2 at entry. Data was available on all variables for 1,021 patients.

	Parameter	SE	t-score	*p*	95% CI
Age	-0.252	0.017	-14.983	<.001	(-0.285, -0.219)
Sex	-4.461	0.420	-10.621	<.001	(-5.286, -3.637)
Diagnosis (Surgical vs. Non-Surgical)	3.035	0.377	8.061	<.001	(2.297, 3.774)
Smoker (Current vs. Never vs. Former)	-1.245	0.280	-4.448	<.001	(-1.794, -0.696)
SES (Low-worse vs. High)	-2.399	0.455	-5.272	<.001	(-3.292, -1.506)

Table 4. Regression examining the effects of age, sex, diagnosis, and smoking status at the time of entry to CR, as well as SES, on estimated METs at entry. Data was available on all variables for 1,500 patients.

	Parameter	SE	t-score	p	95% CI
Age	-0.086	0.005	-17.023	<.001	(-0.096, -0.076)
Sex	-1.341	0.123	-10.900	<.001	(-1.583, -1.100)
Diagnosis (Surgical vs. Non-Surgical)	1.093	0.111	9.884	<.001	(0.876, 1.310)
Smoker (Current vs. Never vs. Former)	-0.485	0.083	-5.850	<.001	(-0.647, -0.322)
SES (Low vs. High)	-0.854	0.136	-6.272	<.001	(-1.121, -0.587)

<u>Discussion:</u>

In examining the general intake data at the UVM Medical Center CR program, the most important conclusion that can be drawn is that the lower-SES patients are coming in with more difficulties than the higher-SES patients, including worse scores on fitness and health-related measures, increased smoking rates, higher depression scores, and worse scores on quality of life measures. It is crucial to note these differences because of the potential impact they have not only on how this population can best be served at the CR center, but potentially on adherence as well. For example, depression has been associated with lower levels of attendance of CR programs (Lane et al, 2001; Swardfager et al, 2007). Additionally, smoking is a predictor of both future cardiac events and of attending fewer sessions of CR (Gaalema et al, 2015).

The only inconsistent variable with the characterization of lower-SES patients having more difficulties coming into CR is their slightly but significantly lower average number of exercise-limiting comorbidities coming into the CR program. It can be speculated that some people with extremely high numbers of exercise-limiting comorbidities are not starting the program at all, however this hypothesis cannot be examined within the context of this dataset because it only looks at individuals who have at least entered into the CR program. However, there is some previous research evidence in support of this idea. It has been shown that individuals are less likely to enroll in CR after a referral as their number of comorbidities increases (Marzolini et al, 2016). Additionally, it is also possible that the severity of the comorbidities in the lower-SES population is greater, but there is no objective way to assess this in a retrospective study, and even if some sort of a severity scale rating were available, it would be very difficult to avoid subjectivity. It is more likely, however, that comorbidities increase

with age, so the number of age-adjusted comorbidities could be the same or higher in the lower-SES patients.

The specific analyses of fitness confirmed that males tend to have higher fitness than females, and that fitness scores tend to decline with age. These trends are consistent for both the higher and lower-SES populations. However, the lower-SES population showed a downward shift indicating that lower-SES individuals tend to have worse fitness scores at intake, even accounting for both age and sex. This is important because the demographic analysis indicated that lower-SES patients are significantly younger, and should thus have higher fitness scores. However, they average worse on fitness measures both when age-adjusted and without age adjustment, even though their scores are also declining with age.

Further, an association between SES and fitness scores were observed even when adjusted for all of diagnosis, age, sex, and smoking status. This is crucial information because increased likelihood of current smoking status was associated with lower-SES in the demographic analysis. The regression run showed that both smoking status and lower-SES are independent risk factors for lower fitness at intake, even though they are interrelated. This is important because it indicates that smoking interventions are especially necessary in the lower-SES group due to both the prevalence in this population and the additional burdens on fitness individuals with both of these risk factors may experience. Although pVO_2 is the gold standard of fitness measures in CR (Ades et al, 2006), the estimated METs analysis needed to be run in order to include as much data as possible, as the pVO_2 measure could possibly have been subject to sampling error. Therefore, this relationship was indicated using estimated METs and was replicated using the most highly supported measure of fitness in this population.

Chapter 3: Attendance and Characteristics

<u>Introduction:</u>

<p align="center"><u>Characteristics of Non-Participation:</u></p>

As CR has been demonstrated to be highly beneficial to cardiac patient outcomes (Ades et al, 2001), the estimated participation rates of 20-35% of those who are eligible is troubling. Further, as there is a demonstrated dose-response relationship in CR, with more sessions corresponding to stronger health improvements (Suaya et al, 2009) it is important to determine which characteristics are predictive of completing fewer sessions. There are many factors that can lead to nonparticipation in cardiac rehabilitation. One factor that predicts individuals not coming is depression (Lane et al, 2001), which is also associated with more clinical difficulties in CR patients (Caulin-Glaser et al, 2007). Depression is also correlated with lower-SES, with one study showing an odds ratio of 1.81 (Lorant et al, 2003).

Other correlates of nonparticipation include lack of frequent exercise prior to the event that spurred the referral to cardiac rehabilitation (Lane et al, 2001), low social support from family or friends in attending the program (Daly et al, 2002), and current status as a smoker (Oberg et al, 2009). Female sex and older age have also been associated with lower rates of attendance (Pardaensi et al, 2015; Suaya et al, 2007, Grace et al, 2009). Having cancer or diabetes has also been correlated with decreased likelihood of CR usage (Suaya et al, 2007). In addition, identifying as an ethnic minority is correlated with lower rates of CR attendance, and higher rates of rehospitalization and death following the event that qualified them for CR (Suaya et al, 2007; Midence et al, 2014; Valencia et al, 2011). Personal factors such as embarrassment about attending or not understanding the purpose of CR or the causes of and treatments for cardiovascular disease are also correlated with poor attendance (Neubeck et al, 2012).

Living further away from a CR center is also correlated with low participation, with one study showing a decrease in participation by 71% between qualified individuals living within 1.5 miles of a CR program and patients living 15 or more miles away from the nearest center (Suaya et al, 2007; Valencia et al, 2011). Living alone as a single adult was also correlated with a 48.5% decrease in participation in one study from 72.5% to 24%, a significant difference within a 95% confidence interval (Nielsen et al, 2008). Similarly, lack of transportation has also been correlated with lower attendance (Neubeck et al, 2012). Lower-SES patients have also been shown to have difficulties finding transportation to a CR center, causing a significant difference in attendance as compared to lower-SES individuals who are able to find transportation to a center (Shanmugasegaram et al, 2013).

One variable consistently correlated with poor attendance is lower-socioeconomic status (lower-SES). Even when referred to a cardiac rehabilitation program, individuals with a lower socioeconomic status are less likely to attend cardiac rehabilitation than higher-SES individuals (Cooper et al, 2002; Valencia et al, 2011). Another study showed individuals utilizing Medicaid, a predictor of lower-SES, were less likely to utilize CR, particularly after a myocardial infarction (Suaya et al, 2007). Additionally, low educational attainment has also been shown to correlate with nonparticipation independently of socioeconomic status (Harlan et al, 1995).

Considerations in Non-Participation:

Medicaid status is a well-established, objective way to determine lower socioeconomic status in health care research (Suaya et al, 2007; Foraker et al, 2010). Direct cost is not likely a primary factor affecting CR participation for the current lower socioeconomic population because Medicaid does not require co-pays for CR in the state of Vermont (Suaya et al, 2007),

and because a waiver of direct costs did not increase participation in similar populations (Harlan et al, 1995).

Given the benefits of attending additional sessions of CR the next step was to examine patterns in adherence to CR in the lower-SES population. Additionally, it was important to look at why patients of different socioeconomic statuses were withdrawing from the program and to compare these distributions between the lower-SES and higher-SES groups.

Methods:

The first step in looking at the adherence data was to create a survival graph to examine proportion of patients remaining in the program at each session number separated by SES status, which was operationalized as described in the methods section of Chapter 2. All data from the database was examined from zero to 36 sessions completed, and differences in slope and dropout rates at various time points were examined. The full course of CR is considered to be 36 sessions.

Following this, a regression was run to examine the effects of age, sex, smoking status, number of comorbidities, fitness as assessed by estimated METS (to increase the N), GDS scores, and SES on adherence in order to examine the independent contributions of these factors on adherence. While it was importance to include the GDS to look at the effects of depression, the regression was run again without this variable as the GDS was missing for a sizable number of patients. These variables were operationalized as described in the methods section of Chapter 2.

The final step in analyzing adherence was to look at differences in completion codes, which indicated if CR was completed, and if not, reasons for drop out. A chi squared test was run

to examine if the distribution of the codes was significantly different between the higher-SES and lower-SES populations. Following this, differences on individual completion codes were examined between the groups.

Results:

The first step in analyzing CR adherence and SES was to look at proportion of individuals remaining by session number differentiated by higher-SES and lower-SES patients (Figure 5). This analysis showed that dropout rates are much higher for the first eleven sessions in the lower-SES group, but after that the rate of drop-out tends to equalize as indicated by the lines becoming parallel.
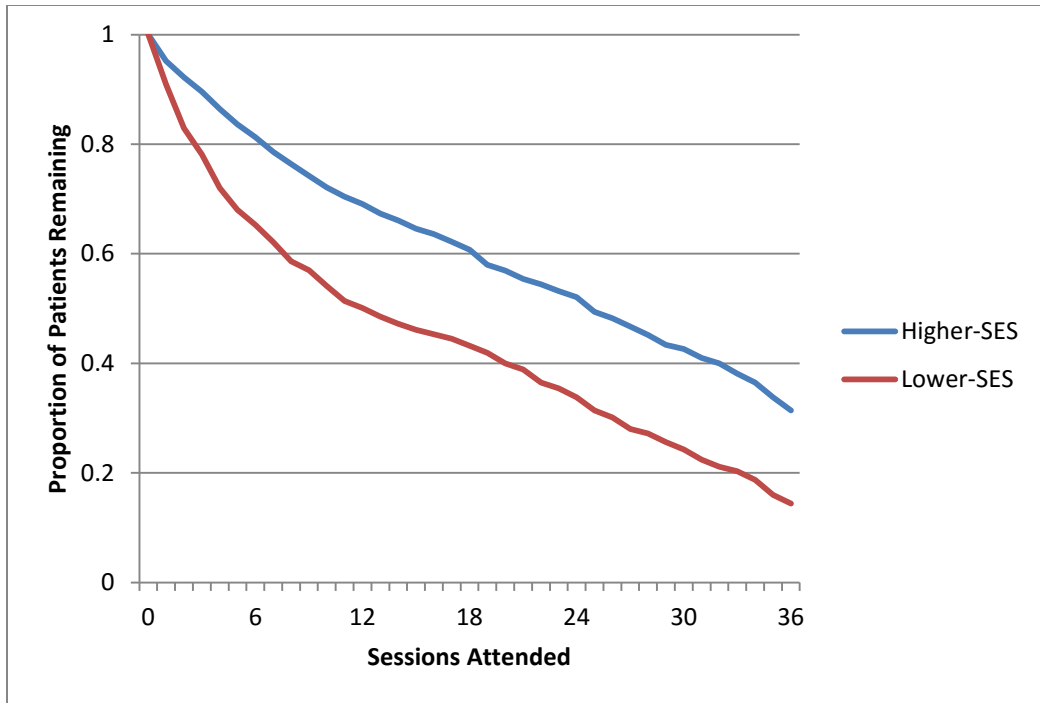
Figure 5. Survival graph showing proportion of patients remaining in the CR program as a function of sessions attended separated into the higher-SES and lower-SES populations. This information was available for all 2,090 patients in the database.

The next step in analyzing adherence and SES was to run a regression looking at the effect of age, sex, smoking status, number of comorbidities, fitness, depression, and SES on sessions attended (Table 5). Younger age, current smoking status, higher initial fitness as measured by estimated METS, and lower-SES were all significantly correlated with fewer sessions attended. Sex, number of exercise-limiting comorbidities, and depression scores did not appear to have a significant independent effect on adherence. Due to the fact that sample size was limited by GDS score availability, and that the scores did not show a significant effect on adherence, the analysis was run again without this variable (Table 6). This analysis with a larger sample indicated that exercise-limiting comorbidities did significantly increase premature dropout, but the possibility of an interaction with depression cannot be ruled out.

Table 5. Regression showing the effects of age, sex, smoking status, number of exercise-limiting comorbidities, estimated METs at entry, GDS score at entry, and SES on number of CR sessions attended. Data was available on all variables for 889 CR participants.

	Parameter	SE	t-score	*p*	95% CI
Age (younger=worse)	0.169	0.042	4.769	<.001	(0.086, 0.252)
Sex	-0.047	0.972	4.010	0.962	(-1.954, 1.861)
Smoker (Current-worse vs. Never vs. Former)	-1.987	0.668	-0.048	0.003	(-3.298, -0.676)
No. Comorbidities	0.557	0.387	-2.974	0.151	(-0.203, 1.316)
estMETs (kcal/kg/hour – lower is worse)	-0.701	0.204	1.439	0.001	(-1.101, -0.301)
GDS	0.076	0.153	-3.444	0.618	(-0.225, 0.378)
SES (higher vs. lower-worse)	-5.521	1.114	0.499	<.001	(-7.707, -3.335)

Table 6. Regression showing the effects of age, sex, smoking status, number of exercise-limiting comorbidities, estimated METs at entry, and SES on number of CR sessions attended, ignoring GDS scores at entry. Data was available on all variables for 1,489 CR participants.

	Parameter	SE	t-score	*p*	95% CI
Age	0.205	0.035	5.904	<.001	(0.137, 0.274)
Sex	-0.388	0.797	-0.486	0.627	(-1.951, 1.176)
Smoker (Current vs. Never vs. Former)	-1.801	0.526	-3.422	0.001	(-2.833, -0.768)
No. Comorbidities (more=worse)	0.702	0.300	2.341	0.019	(-0.114, 1.290)
estMETs (kcal/kg/hour)	-0.422	0.159	-2.646	0.008	(-0.734, -0.109)
SES (higher vs. lower)	-4.015	0.866	-4.638	<.001	(-5.712, -2.317)

The final piece of adherence data analysis looked at type of completion or reason for non-completion by SES (Table 7), which showed a significant difference in distribution by SES group. More than twice as many lower-SES individuals were listed as dropping out proportionately than in the higher-SES group. Approximately two thirds of the proportion of lower-SES individuals finished all 36 sessions compared to the higher-SES group. Proportionately approximately twice as many higher-SES individuals left because of a move. Stopping CR for medical reasons by a doctor's orders happened much more frequently in the lower-SES group. Exercising on their own with a home-exercise plan was much more common in higher-SES individuals who did not complete CR. Having been through CR before, and dropping out due to a return to work were also more common in the higher-SES group. Being lost to follow-up and lack of transport were comparable between the groups.

Table 7. Distribution of completion or reason for non-completion broken down by SES. A chi-squared analysis showed the higher-SES and lower-SES groups differed significantly in their completion category distribution at $p<0.001$.

	Higher SES (n = 1642)	Lower SES (n = 362)
Drop Out	243 (14.8%)	122 (33.7%)
36 Sessions	953 (58.0%)	146 (40.3%)
18 Sessions Straight	53 (3.2%)	14 (3.9%)
18 Sessions Extended	1 (0.1%)	0 (0.0%)
Facility Transfer	4 (0.2%)	0 (0.0%)
Lost	18 (1.1%)	5 (1.4%)
Limited Insurance	13 (0.8%)	3 (0.8%)
Moved	45 (2.7%)	4 (1.1%)
Medical Orders	115 (7.0%)	41 (11.3%)
Been Through CR	18 (1.1%)	2 (0.6%)
Return to Work	100 (6.1%)	16 (4.4%)
Lack of Transport	31 (1.9%)	5 (1.4%)
Never Started	7 (0.4%)	2 (0.6%)
Lack of Insurance	1 (0.1%)	0 (0%)
Death	8 (0.5%)	1 (0.3%)
Exercise on Own	20 (1.8%)	1 (0.3%)
Other	2 (0.1%)	0 (0%)

<u>Discussion:</u>

Previous research has indicated lower rates of CR attendance in the lower-SES population (Cooper et al, 2002; Valencia et al, 2011). However, the current research examined this relationship further on a session-by-session basis in an analysis of adherence. At all session numbers, there was a higher proportion of higher-SES individuals of the total who enrolled remaining than among the lower-SES group. However, it is crucial to make the distinction between proportion remaining and the slope of that graph, which indicates dropout rate by session. For the first eleven sessions, the lower-SES patients at UVM Medical Center had a much higher dropout rate than the higher-SES patients. However, beginning at session twelve, dropout starts to look relatively similar when comparing the higher-SES and lower-SES groups.

There are two possibilities in explaining the normalization of the dropout in the lower-SES patients at session twelve. It is very possible that patients are able to ascertain whether or not they want or are able to stay in the program in the first eleven sessions, and thus the population differs after this time point. However, it cannot be ruled out that making it past eleven sessions could be somehow protective for lower-SES patients in finishing the CR program by means such as developing a sense of connection to the program or providers, being able to see tangible gains, or a feeling of already having invested a lot of time and not wanting to quit. A potential future direction of research in this area is an intervention to help keep lower-SES patients enrolled in the first twelve sessions in order to see if they have more success in adhering to the program after getting past the first third of it.

The next part of the analysis showed that SES was significantly correlated with number of sessions attended even when accounting for age, sex, smoking status, number of

comorbidities, fitness, and depression. Younger age, current smoking status, and fitness were all independently correlated with fewer sessions as well, even though these variables were previously shown to be correlated with lower-SES (See Chapter 2 Results). Number of comorbidities also had a significant effect on number of sessions attended when depression scores were removed from the model. However, it is not clear whether this effect is due to the widening of the sample due to the small percentage of patients with a recorded depression score, or because depression mediates the relationship between number of comorbidities and number of sessions attended. Future research with a higher percentage of patients with recorded GDS scores will be able to indicate the nature of this relationship without the possibility of sampling error.

Overall, the most important takeaway from the regression analyses is that lower-SES is correlated with significantly fewer sessions attended, independent of other variables known to have effects on attendance, and that some of these risk factors such as younger age and lower fitness are independently associated with lower-SES. This makes the lower-SES group at a particularly high risk of dropout of the CR program. From the graphical analysis, it is clear that the difference in dropout is most pronounced in the first eleven sessions.

The chi-squared analysis showed a significant difference in the distribution of completion and reasons for non-completion between the lower-SES and higher-SES groups. Lower-SES individuals were more likely to leave on medical orders or simply drop out without indicating a clear reason. Higher-SES individuals were more likely to complete the full 36 sessions. If they did leave the program early, they were more likely than lower-SES individuals to leave for reasons including moving, returning to work, having been through CR already, or having an alternative exercise facility available to them and making an exercise plan with a CR provider to exercise on their own at that facility. It might be beneficial for providers to strongly suggest

working on a home exercise plan together if lower-SES individuals choose to drop out of the program, and assessing the effectiveness of these plans as compared to when they are developed with higher-SES patients. If effective, this could encourage providers to do this with all their patients that choose to drop out. It is important to note that further data will need to be collected on the efficacy of these home exercise regimens.

One surprising finding in examining the distribution was that lack of transportation was not a common reason for dropout in any of the population, and was actually slightly, even if not significantly, less common in the lower-SES patients. This was surprising because previous research indicated that lower-SES individuals are more likely not to attend CR due to lack of transportation than higher-SES individuals (Shanmugasegaram et al, 2013). However, that study examined whether patients attended at all, whereas this study was examining dropout at various stages after enrollment. It is not only possible, but likely, given the previous and current research, that lower-SES individuals are enrolling in CR at UVM Medical Center at lower rates in the first place with one factor being lack of transportation. Once the population has been narrowed down to those who actually enroll in CR, it is also narrowed down to those who already have transportation. This would mean that what is being coded into the database as lack of transportation should more aptly be named loss of transportation. Further research should be done at UVM Medical Center and at other centers to examine all patients referred to CR to see how reasons for nonattendance differ among those who enroll and those who do not begin the program at all broken down by SES, in order to make conclusions about how to best serve lower-SES patients in all stages of their cardiac treatment.

Chapter 4: Fitness Gains

<u>Introduction:</u>

The final step in understanding the lower-SES population in CR was to examine gains in fitness, health-related variables, depression, and quality of life as compared to the higher-SES population among those who complete the program. It has been shown that fitness gains are to be expected by the end of a course of CR in most patients (Ades et al, 2001). Research in the area of differential fitness gains in CR based on SES is a largely ignored area of research, however some relevant discussions appear in the literature. One study showed that individuals with higher depression scores tend to improve less in terms of both pVO_2 and BMI over the course of CR (Caulin-Glaser et al, 2007), even among completers (Swardfarger et al, 2011). Since higher depression scores have been associated with lower-SES both in previous research (Lane et al, 2001) and in this sample (see Chapter 2 Results), it is likely that this association would also apply with lower-SES patients in this sample of CR patients and in CR patients in general, assuming no interaction among those variables.

In terms of directly looking at lower-SES patients, one Australian study showed that lower-SES patients were less likely to meet physical activity guidelines six weeks out from the completion of CR than the corresponding higher-SES sample, however this is not a direct measure of fitness attainment and may be more indicative of adherence (Le Grande et al, 2015). One recent study indicated that lower-SES patients and higher-SES patients made equivalent gains in METs, while the lower-SES patients showed less but still significant improvement in resting heart rate (Szalewska et al, 2015). However, this study was for a singular program that included both outpatient and telemedicine sessions, which is a deviation from a traditional program. Furthermore, SES was defined as being either a "blue collar" (lower-SES), or "white collar" (higher-SES) worker, a different definition than is used in the current study.

Methods:

Changes in fitness, depression, and quality of life scores were examined between the higher-SES and lower-SES populations within those who completed the program, excluding non-completers. Completers were defined as individuals who completed at least 30 sessions of CR to allow for discrepancies in the clinical record, and this number can be considered as completion. Change was first examined as an actual change in number, and then as a relative percent change. Significance was determined as a result of t-tests since all variables were numeric. Fitness and health-related variables examined included estimated METS, pVO_2, BMI, waist circumference, and hand grip. GDS and PHQ-9 scores were used to look at depression and MOS scores were used to examine quality of life. Fitness variables and health-related variables, and depression and quality of life measures were operationalized as described in the methods section of Chapter 2.

Results:

Changes in fitness, body composition, depression, and quality of life were examined, based on higher and lower-SES groups, as an actual change (Table 8) and as a relative percent change (Table 9). Fitness gains showed mixed results with gain in METS being higher in the lower-SES group while gains in VO_2 were higher in the higher-SES group. The lower-SES population also showed a significantly lower improvement in BMI and waist circumference, but a significantly greater improvement in hand grip. In terms of depression, GDS improvements were significantly greater in the lower-SES group. Quality of life measures showed a significantly greater improvement on both the PHQ-9 and the MOS in the lower-SES group. It should be noted that because lower-SES individuals have been demonstrated to start with worse scores on fitness, depression, and quality of life measures, they have more to gain.

Table 8. Mean change in fitness, depression, and quality of life separated by higher-SES and

lower-SES individuals within completers. All *p*-values were obtained using a one-sample t-test.

	Higher SES (*n* = 733)	Lower SES (*n* = 91)	*p*
pVO2 (ml/min/kg)	3.47 (n=362)	3.20 (n=48)	<.001
estMETs (kcal/kg/hour)	1.45 (n=574)	1.52 (n=74)	<.001
GDS	-0.82 (n=416)	-2.33 (n=40)	<.001
PHQ-9	-1.51 (n=334)	-3.16 (n=32)	<.001
MOS	17.07 (n=383)	17.66 (n=70)	<.001
Waist Circ. (in.)	-1.04 (n=426)	-0.94 (n=51)	<.001
BMI	-0.55 (n=611)	-0.44 (n=72)	<.001
Hand Grip (kg)	1.35 (n=393)	3.17 (n=47)	<.001

Table 9. Mean relative percent change in fitness, depression, and quality of life separated by higher-SES and lower-SES individuals. All *p*-values were obtained using a one-sample t-test.

	Higher SES (*n* = 733)	Lower SES (*n*= 91)	*p*
pVO2 (ml/min/kg)	19.50% (n=362)	20.06% (n=48)	<.001
estMETs (kcal/kg/hour)	27.83% (n=573)	33.63% (n=74)	<.001
GDS	-30.53% (n=344)	-55.65% (n=38)	<.001
PHQ-9	-39.55% (n=261)	-56.72% (n=28)	<.001
MOS	43.68% (n=382)	53.26% (n=32)	<.001
Waist Circ. (in.)	-2.51% (n=426)	-2.16% (n=51)	<.001
BMI	-1.76% (n=611)	-1.08% (n=72)	<.001
Hand Grip (kg)	4.50% (n=393)	12.82% (n=47)	<.001

<u>Discussion:</u>

Results on gains in fitness and fitness-related variables based on SES in CR at UVM Medical Center is clearly mixed. In terms of fitness, higher-SES individuals made significantly more gains in pVO_2, the more empirically supported measure (Ades et al, 2006), while lower-SES individuals made significantly more gains in estMETs, the fitness measure with a much larger sample. While it is impossible to say which is more accurate in depicting relative gains in fitness, both measures indicate that lower-SES individuals are making worthwhile improvements in fitness among those who completed the program.

In terms of fitness-related measures, waist circumference and BMI decreased significantly less among the lower-SES population; however these numbers still decreased among completers. Hand grip, the measure of strength, showed significantly more improvement in the lower-SES population than in the higher-SES population. Most importantly, lower-SES individuals showed improvement in all fitness and health-related measures, and in some cases more improvement within completers. It is important to note that as the lower-SES patients tended to come into CR with worse scores on all of these measures (see Chapter 2 Results), these patients had more room to improve. Lower-SES individuals seem to be improving more on the things that are directly affected by being at CR such as fitness and hand-grip. They are improving less on the things that require behavior change outside of CR such as waist and BMI. Therefore, the lower-SES patients may be benefiting as much while at CR, but not making as many changes outside the program, such as changing diet, as the higher-SES group.

The lower-SES population also showed significantly more improvement on depression and both quality of life measures than the higher-SES population within completers. These

measures were also significantly worse at intake in the lower-SES population (see Chapter 2 Results), indicating they had more room to improve in this area as well. It is likely that this greater room for improvement makes it more likely that patients will improve their scores during the course of CR.

One obvious limitation of the research on gains in fitness, fitness-related variables, depression, and quality of life is that the data is for those who completed the program. One reason for this choice was that final data is often unavailable for non-completers. More importantly, it was crucial to look at data within completers because it could indicate if lower-SES patients are making gains in their health and overall quality of life if they complete the CR program, and this research indicates that they did. However, the obvious problem of nonrandom assignment cannot be ignored. It is possible that there were differing characteristics of the patients that dropped out that made them benefit less from the program, which could have contributed to them dropping out, or they could have been independently more likely both to drop out and to benefit less from CR. However, the most probable situation is that if lower-SES individuals stayed in CR to completion, they would make significant gains in fitness, fitness-related variables, depression and quality of life, even without changes to the program to make it more accessible and usable for this population. The next step in this line of research is to look at a more geographically diverse sample of CR patients and to examine gains in fitness and the other outcome variables based on SES both within completers, as well as to collect data on non-completers and to look at gains in the total population. There is a substantial lack of knowledge in this area, and it is crucial that it be further explored.

Chapter 5: Recommendations and Clinical Implications

Process of CR:

There are many steps in the successful completion of CR. First, patients must be referred to the program. They must then complete a thorough intake where all necessary measures are collected such as pVO_2. Patients then need to begin their program sessions, as well as continue through with their sessions until the completion of the program. The findings generated from the current research can help inform improvements at these various time points.

Referral:

The first step in CR is referral to the program. One of the strongest predictors of attendance at CR is the strength of the physician referral (Ades et al, 2006). Accordingly, as we know lower-SES patients are less likely to enroll, physicians should give these patients strong recommendations to attend. It might be helpful to explain to lower-SES patients that if they have Medicaid there will typically not be a copay. Also, it should be explained that CR helps with medication management and diet, not just exercise.

In terms of understanding the communication process between physician to patient to the CR team, a study of who is not attending versus who is referred to CR could be helpful, especially in understanding the surprising finding on transportation. Previous research has indicated that lack of transportation is a common reason for CR nonattendance (Neubeck et al, 2012) and is more prevalent in the lower-SES population (Shanmugasegaram et al, 2013). However, the UVM Medical Center population shows consistently low rates of termination of the program for this reason. It is possible that these individuals are being referred but not even enrolling in the first place for this reason, and a formal transportation program such as a shuttle

that patients can be told about upon referral becomes important. The SSTA shuttle currently offers this service to lower-SES patients, but this needs to be explained during referral. Further, making all patients aware of this service could help to assess the differences in reasons potential patients may be not attending at all versus reasons they are dropping out, and how the lower-SES population could best be assisted in their session attendance at various points in the referral process versus during the actual course of their CR program.

<div align="center">Intake:</div>

Analysis of the demographic information indicates several important recommendations. First of all, more thorough data needs to be collected on depression and quality of life scores, both for purposes of future research and because previous studies indicated it can be predictive of attendance as well as outcomes.

Additionally, a more valid measure of depression may be helpful. The GDS is designed for individuals 65 years of age and older, and the mean age of the lower-SES population was much lower than this, making this measure even less applicable to them. Some of the lower-SES patients in the program are currently taking the Beck Depression Inventory (BDI) as part of another research study, and this is likely to be a better measure for the population as a whole because it is not age-specific and has shown efficacy in the context of CR (Rutledge et al, 2016). It would also be helpful to have an objective measure of smoking at intake such as CO because that is subject to report bias. Additionally, a measure of barriers to attendance would be helpful in order to potentially help patients before they dropped out if the providers knew exactly what the risk factors at play were.

Another measure for which there appeared to be poor collection was pVO_2. This was surprising because data at this center indicated in previous research that this is an incredibly

effective measure of fitness (Ades et al, 2006). In order to make the best recommendations about fitness differences as well as to best serve individual patients, it is absolutely crucial for this data to be collected on all patients coming into CR when possible. However, there are sometimes other reasons this data cannot be collected. For example, people who are severely deconditioned may not be able to do the pVO_2 stress test.

Comorbidity information was available for the majority of patients. This indicated that lower-SES patients tend to have 0.05 less comorbidities than the higher-SES group, which was suprising, but that the distribution was so small and the number of participants so high that this was considered significant. Previous research has indicated that lower-SES patients tend to have significantly more comorbidities in the context of CR (Alter et al, 2006). This makes the UVM Medical Center CR center unique in this regard. One possibility is that the lower-SES patients have the same number of comorbidities on average, but that they are more severe in nature. It is also possible that comorbidities increase with age and since the lower-SES patients tend to be younger, and actually have more than they should for their age, similar to the relationship observed with fitness. The best way to examine this going forward would be to have a severity checklist accompanying each typical comorbidity that a physician can fill out, which will result in a number for each comorbid condition, similar to a depression scale. Although this has potential for subjectivity, so do depression scales and those are very widely used. This could allow for a comparison of the severity of comorbidities, allowing for an understanding of what services might be best in accommodating the lower-SES CR patients if there is a difference in the nature or severity of comorbidities.

Program Design:

It is clear that the lower-socioeconomic status population can experience a great benefit from attending cardiac rehabilitation programs after a coronary event, even though there are low rates of attendance in this population. One study showed that among individuals who qualified to attend CR with Medicaid payment, completion of a full 36 sessions was correlated with a 47% lower risk of mortality and a 31% decreased risk of myocardial infarction over the six years following the commencement of CR as compared to those qualified individuals who only attended one session of CR (Hammill et al, 2010).

Despite the fact that there can be mitigating variables such as smoking status or comorbidities, cardiac rehabilitation programs can confer significant benefit the lower-SES population. However, smoking can affect lung capacity and ability to make fitness improvements. One study showed that only individuals who quit smoking showed significant fitness gains over three years, individuals who continued to smoke did not improve (Asthana et al, 2012). Comorbidities such as diabetes or pulmonary diseases can also affect the ability of people to be rehabilitated to the greatest possible extent. Although there may be correlations between these variables, it does not mean that substantial gains are not made.

However, lower-SES individuals still show a statistically significant decrease in weight (5 kg), blood pressure, triglycerides, LDL cholesterol, as well as HbA1c levels for diabetics, and increases in time spent engaging in exercise and stress management as compared to their numbers when entering the program if they stay through completion of all recommended CR sessions (Govil et al, 2009). It has also been shown that while individuals enrolled in Medicaid insurance are more likely than those on private insurance to be current smokers upon entry into CR, those who receive counseling in tobacco cessation as part of the program are equally likely to successfully quit smoking as smokers on private insurance (Friedman et al, 1997).

The lower-SES population may also benefit from tobacco cessation efforts in the context of the overall CR program, especially if their rates of smoking are increased. Looking at whether this population has increased smoking rates, and to what extent, can help to organize tobacco cessation efforts. One study has shown that 29% of Medicaid enrollees were current smokers in 2004 (CDC, 2005). In comparison, 21% of the overall United States population were current smokers in the same year (Cigarette, CDC, 2005), indicating the possibility of a disparity based on income. This trend has been increasing over time in the United States, as the gap between the percentage of smokers in lower-SES and high income and education groups showed an increasing trend between 1971 and 2002 due to disproportionate decreases in smoking in high income and education groups as compared to low income and education groups as illustrated by a 19% decreased smoking rate in high income individuals as compared to a 6% decreased smoking rate in low income individuals (Kanjilal et al, 2006).

Status as a current smoker was an overall characteristic of the lower-SES population that predicted both premature dropout and poorer incoming fitness. For both of these reasons, it is crucial that an intensive smoking cessation be integrated into the CR center so that these patients can get as much help as possible without having to go to extra or unfamiliar facilities for appointments since they are already struggling with session attendance. Previously, smoking cessation programs in heart disease patients as part of their care have been shown to have significant results in lowering smoking rates (Barth et al, 2008).

Alterations to the structure of the program could also benefit lower-SES patients. Remote monitoring has been shown to be effective at encouraging participation in the lower-socioeconomic status population, with one study showing an average of only 1.5 sessions missed in a home program (Szalewska et al, 2015). These programs allow initial training sessions to be

done at a CR site, with additional exercise occurring at home, with remote monitoring devices used to send information about the exercise completed to the CR center. The CR center is then able to provide feedback. This would be most helpful in program initiation rather than completion as the data from Chapter 4 indicates that lack of transportation was not as much of an issue once CR sessions had begun.

Other areas where population-specific needs could be addressed are with depression and flexible scheduling. Depression has been shown to be correlated with both lower-SES and non-participation (Lane et al, 2001; Lorant et al, 2003), so in-house psychiatric services could be helpful for continuity of care and increasing participation in this population. Definitive recommendations cannot be made based on the data in this study regarding depression until further data is collected. However, depression scores tended to be higher in the lower-SES population. Psychiatric interventions in the context of CR could be helpful for these patients, and there is previous support for the efficacy of this approach (Dusseldorp et al, 1999). Flexible scheduling could potentially help individuals having to work long hours without the flexibility to take time off of work for CR. Overall, adherence to the aspects of the program such as diet and lifestyle improvement should be emphasized in the lower-SES population as Chapter 4 showed they tended to struggle more with this than the direct fitness gains from the exercise component.

<u>Program Adherence:</u>

It is clear that getting lower-SES patients to start CR does not guarantee completion. This population has a much higher and earlier rate of dropout than their higher-SES counterparts. However, this seems to be a much bigger problem in the first twelve sessions. This could either be due to the first twelve sessions being somehow protective in future session attendance, or the individuals dropping out initially may be people figuring out early on that they do not want or

are not able to complete the program for some reason. One option to both assess this and to help with overall adherence would be to provide additional support in getting through the first twelve sessions, such as regular reminder phone calls. This does not appear to be necessary after the first twelve sessions anyway, because after that point the dropout rate equalizes with the higher-SES population. If this intervention was helpful, it could elucidate whether there is something unique about the patients dropping out in the first twelve sessions, or some unique impact of the first twelve sessions themselves.

One study intervention that is currently proving successful at UVM Medical Center's CR program is looking at financial incentives to help lower-SES patients be motivated to come to their CR sessions (Gaalema et al, 2016). As this has already being established as successful in the ongoing research, an additional study group where the incentives are only provided for the first twelve sessions could provide further insight into the reason for the high dropout rate in the first twelve sessions, and potentially help to ameliorate the situation.

One characteristic of dropout that was more common in the higher-SES population was coming up with a home exercise plan in tandem with one of the CR professionals. This should be standard practice as something that is not only offered but that is strongly encouraged with all patients leaving CR, regardless of their SES. Further research would need to be done to see how often this is being offered versus when it is taken advantage of, but it is most likely that this help is being offered to everyone and the rate of acceptance of the offer is different. A potential future direction of research could be to determine how different ways of presenting this opportunity affect patients' likelihood to take advantage of it.

Another aspect of leaving comorbidities that needs to be examined further is leaving CR for medical reasons. It is possible that doctors are perceiving patients with similar medical

situations differently because of their perceptions, or that patients perceive doctor's admonitions about being careful during exercise incorrectly. However, this increased rate of leave due to doctor's orders is inconsistent with the comorbidity findings. Either the comorbidities must be more severe or there is a breakdown somewhere in the process of medical orders, or both. Further research should be done to assess the interactions and evaluations that lead to medical orders to discontinue CR, and a standardization of the process to make this decision could potentially be beneficial.

Previous research has also indicated that lack of social support can be a reason for nonattendance, and this could potentially also be true for nonadherence (Daly et al, 2002). One study in a cancer exercise rehabilitation showed that having an assigned exercise partner in the program increased session attendance and health benefits (Rogers et al, 2005). A system such as this could be put in place initially, and could help some of the patients make it through more sessions if social support is an issue they are having because it will help them to build a network not just at the center, but possibly also facilitate connections outside of the center with friends or family of their exercise partner.

In terms of gains among completers, lower-SES patients tended to make equivalent gains overall in fitness, significant but fewer gains in BMI and waist circumference, and stronger improvements in depression, quality of life, and strength. If completers and non-completers are responding similarly to the effects of the program, this means that it is absolutely crucial to keep lower-SES patients in CR for the full duration of the program. Previous research has shown that individuals who do complete CR fare better than those who do not (Ades et al, 2001). Future research should examine scores on fitness and depression at the time of dropout versus for

individuals who keep attending sessions at each session number to compare relative gains. This could lead to a final determination that it is crucial to keep all patients in CR, regardless of SES.

Strengths and Limitations:

When making recommendations based on this research, it is important to note that while data was collected for a substantial amount of patients, they were all from the UVM Medical Center CR program. The obvious disadvantage of this is that the results may not generalize perfectly if there are geographic differences, and thus future research in SES and CR needs to use data from a variety of regions. In order to do this, however, more centers will need to collect SES data, as this is not currently common practice. Another advantage of having a larger sample would be to look further at the effects of race on outcomes. In this population more individuals in the lower-SES population identified as non-white. Previous research indicates that nonwhite individuals may respond less beneficially to statin treatment of heart disease; however this study failed to rule out a variety of confounds besides the socially constructed effects of race (Yood et al, 2006). This sample was not large enough to shed further light on this subject, but a larger sample could look at if the same or a different relationship is observed with exercise intervention, and if the two interact. The main advantage of looking at all patients over six years at one center is that these recommendations will apply very directly to the UVM Medical Center CR program, and will be very helpful to this center in helping to tailor the program to best fit the needs of the lower-SES population in their program.

Conclusions:

Overall, individuals of all socioeconomic status are seeing significant improvements in fitness, fitness-related variables, depression and quality of life among completers. Lower-SES individuals tend to come into CR with worse scores on these measures, and thus have even more

to gain from the program. Going forward, it will be essential to collect depression and fitness

data on all patients with the best measures possible. However, lower-SES individuals have a

much higher rate of dropout in the first twelve sessions, and thus the aforementioned actions

such as providing in-house psychiatric services and smoking cessation programs need to be taken

in order to make sure as many eligible lower-SES individuals as possible complete the program

of CR.

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