# THE EFFECT OF EMAIL COMMUNICATION ON ADHERENCE AND COMPLIANCE IN A CARDIAC REHABILITATION EXERCISE PROGRAM

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## ABSTRACT

JAMIE SIMERLY: The Effect of Email Communication on Adherence and Compliance in a Cardiac Rehabilitation Exercise Session
(Under the direction of Dr. Bonita L. Marks)

This study investigated the impact of weekly email communication and email content on attendance adherence and exercise prescription compliance in a cardiac rehabilitation program. Fifteen cardiac rehabilitation patients aged 36 to 87 (7 males, 8 females) volunteered and were randomly assigned into one of three groups (informational email group, motivational email group, and control group). The informational email group received weekly emails with precise programmatic information, the motivational group received weekly emails with generic motivational sayings, and the control group received no emails. During the 12-week intervention, subjects' exercise session attendance and attained heart rate, rating of perceived exertion, and duration at all exercise sessions were tracked. A one-way ANOVA found there was no difference in attendance adherence rates between groups ($F = 3.161$, $p = 0.079$). A 3 x 2 Chi Square test for independence found a significant difference between the three groups in heart rate compliance rates ($\chi^2(2, n = 540) = 19.5$, $p < 0.0001$),rating of perceived exertion compliance rates($\chi^2(2, n = 540) = 19.1$, $p < 0.0001$), and duration compliance rates ($\chi^2(2, n = 540) = 6.1$, $p = 0.047$).Descriptive statistics found the control group to have the highest compliance rates. A 2 x 2 Chi Square test for independence found a significant difference between the informational email group and the motivational email group in heart rate compliance($\chi^2(1, n = 360) = 6.778$, $p = 0.009$), rating of perceived exertion compliance($\chi^2(1, n = 360) = 6.334$, $p = 0.012$), and duration compliance ($\chi^2(1, n = 360) = 5.378$, $p = 0.020$). In summary, email communication did not improve attendance adherence but an informational email may improve exercise prescription compliance more than a generic motivational email.

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| | |
|---|---|
| AACVPR | American Association of Cardiovascular and Pulmonary Rehabilitation |
| ACSM | American College of Sports Medicine |
| AHA | American Heart Association |
| BMI | Body Mass Index |
| HR | Heart Rate |
| MET | Metabolic Equivalent |
| RPE | Rating of Perceived Exertion |
| SES | Socioeconomic Status |
| UNC | University of North Carolina |
| WHO | World Health Organization |

# CHAPTER ONE

## Introduction

Over 64 million people in the United States have one or more types of cardiovascular disease, resulting in substantial disability, loss of productivity, and considerable contribution to the rising cost of healthcare (Giannuzzi et al., 2003; Brooks, Fahey, and Baldwin, 2005). To diminish these negative outcomes, cardiac rehabilitation is offered after cardiac events to aid in the recovery and prevention of further cardiac illness (Dalal, Zawada, Jolly, Moxham, and Taylor, 2010). Studies have shown that a comprehensive approach to lifestyle changes, including regular exercise interventions and behavior modification strategies, can greatly reduce the effects of cardiovascular disease. This approach has been found to be the most effective and economically justified approach for cardiovascular disease risk reduction with cardiac patients (Giannuzzi et al., 2003).

Despite the potential benefits of structured cardiac rehabilitation courses, many patients fail to attend and patient participation is suboptimal (Cooper, Jackson, Weinmann, and Horne, 2002; Dalal et al., 2010). Studies suggest that only 63% to 80% of enrolled patients will complete the three month center based program (Balady et al., 1994; Vongvanich, Paul-Labrador, and Merz, 1996; Sundararajan, Bunker, Begg, Marshall, and McBurney, 2004). Many studies have been conducted introducing intervention methods with the aim of improving adherence and participation in cardiac rehabilitation patients. These interventions include signed contracts between patients and cardiac rehabilitation staff (Oldridge, 1983), implementing behavior change practices and planning strategies (Wyer, Earll, Joseph, Harrison, Giles, and Johnston, 2001; Sniehotta, Scholz, and Schwarzer, 2006), and persuasive telephone communication (Daltroy, 1985).

Recent studies indicate that over 77% of all adults use the internet on an occasional basis; therefore the internet can reach an expansive number of patients (U.S. Census Bureau, 2011a). Email can connect patients with health care providers, thereby increasing access to care, enhancing patient education, and improving adherence to treatment plans (Mandl, Kohane, and Brandt, 1998). In health related fields, internet communication between health care providers and patients has proven to be effective in promoting adherence. Internet communication studies have found beneficial effects in weight control, symptom management following coronary artery bypass grafts, glucose level control in diabetic patients, and management of depression (Balas et al., 2007; Barnason, Zimmerman, Nieveen, and Hertzog, 2006;Robertson, Smith, Castle, and Tannenbaum, 2006; Tate, Jackvony, and Wing, 2006) . Internet based interventions have the potential to change risk factor profiles in patients with cardiovascular disease (Kuhls, 2006); however, few studies have explored the impact of communication technologies, particularly email, on attendance in cardiac rehabilitation patients.

**Statement of the Problem**

Internet communication has emerged as an innovative way of delivering healthcare interventions. Studies utilizing this new and emerging technology need to be explored in cardiac rehabilitation settings (Thompson and Clark, 2009). Few studies have investigated the impact of email communication on adherence and compliance in a cardiac rehabilitation exercise program. The primary purpose of this study was to determine the impact of email communication on adherence rates and exercise prescription compliance in a cardiac rehabilitation exercise program. A secondary purpose of this study was to determine if email content is related to adherence rates and exercise prescription compliance in cardiac patients.

## Aims and Hypotheses

The first aim of this study was to determine the effects of two distinct types of weekly email communication versus standard (no email) communication on patient adherence rates in a cardiac rehabilitation exercise program. The second aim of this study was to determine the effects of two distinct types of weekly email communication versus standard (no email) communication on exercise prescription compliance: attainment of prescribed duration (time in minutes), target heart rate (HR) range in beats per minute (bpm), and rating of perceived exertion(RPE) range. The research questions and hypotheses are listed below:

**Research Question One: Will weekly email communication impact patient adherence to cardiac rehabilitation sessions?**

**Hypothesis 1a:** Simply an email, regardless of content, will improve adherence rates in comparison to no email intervention.

**Hypothesis 1b:** An email that contains precise programmatic information will be more effective in improving adherence than a more generic email.

**Research Question Two: Will weekly email communication impact patient compliance to the cardiovascular stimulus period of the exercise session?**

**Hypothesis 2a:** Simply an email, regardless of content, will improve exercise prescription compliance (attainment of prescribed ranges for HR, RPE, and cardio-exercise duration) in comparison to no email intervention.

**Hypothesis 2b:** An email that contains precise programmatic information will be more effective in improving exercise prescription compliance than a more general email.

## Definitions of Terms and Abbreviations

**Adherence:** In this study, adherence was defined as the proportion of sessions a subject attends out of the number of sessions available.

**Body Mass Index (BMI):** an estimate of overweight status using the following formula: BMI = Body weight (kg) ÷ height ($m^2$).

**Compliance:** The extent to which a person's behavior coincides with the medical advice (Oldridge, 1982). In this study, compliance was defined as the proportion of sessions that a subject meets the prescribed ranges for time, HR, and RPE.

*Rating of Perceived Exertion (RPE) Range:* A scale used to quantify an individual's subjective perception of exertion as a means of determining exercise intensity (Skinner, Hutsler, Bergsteinova, and Buskirk, 1973). In this study RPE ranges were measured using a modified category-ratio RPE scale of one to ten.

*Target Heart Rate (HR) Range:* A way to assess intensity level of exercise as a percentage of maximal heart rate (Swain, Abernathy, Smith, Lee, and Bunn, 1994).In this study, target HR range was 40% to 85% of the maximal heart rate achieved during a prescreening graded exercise test.

**Metabolic Equivalent (MET):** The resting metabolic rate (equal to an oxygen consumption of 3.5 ml/kg/min) that is used to express exercise intensity as a proportion to the resting rate (Brooks et al., 2005). For this study, each subject's MET peak was determined before beginning the cardiac rehabilitation program and after completing the cardiac rehabilitation program using a graded exercise test on a motorized treadmill.

**Peak Aerobic Capacity ($VO_2$ peak):** The estimated peak rate at which an individual can consume oxygen. It is an important determinant of peak power output, physical work capacity, perceived exertion, and cardiovascular fitness (Brooks et al., 2005).For this study, $VO_2$ peak was determined using the equation:

$VO_2$ peak (ml/kg/min) = MET x 3.5ml/kg/min (Brooks et al., 2005)

**Premature Drop-Out:** A subject was considered a premature drop-out from the exercise program if he/she never attended the exercise program and/or declared s/he was dropping out within the first week of the intervention program.

## Delimitations

This study was delimited to incoming patients from a south/central North Carolina hospital who were entering the hospital's community-based cardiac rehabilitation program as outpatients. This study was delimited to patients with email accounts and weekly access to the internet.

## Limitations

Generalizability of this study was limited to cardiac rehabilitation patients in south/central North Carolina. This study was limited by the assumption that the subjects in the email communication groups are reading the weekly emails. To improve compliance for reading emails, all email notifications were sent out before noon on Sunday, a day which may be less hectic and allowed patients to check their emails as they prepared for the upcoming week. Automated delivery receipts were attached to all emails to ensure that the emails were received by all subjects in the email intervention groups.

Subject comorbidities can limit adherence separate from the email grouping. Psycho-social and physiological comorbidities have been shown to effect adherence rates in cardiac rehabilitation

patients. Comorbidities that have been shown to have a negative impact on adherence include age, gender, obesity, smoking, lack of spousal/family support, and job related factors (Moore et al., 1998; Oldridge, 1991). Random assignment of all subjects was used in aims to distribute bias from comorbidities unrelated to the email intervention.

Another limitation was that subjects recorded the HR, RPE level, and duration attained at each exercise session on their individual exercise logs. Studies have shown that self-reported data can be inaccurate, with subjects misreporting physical activity measures by up to 51% of actual measures (Lichtman et al., 1992). To encourage more accurate records, the exercise physiologists and registered nurses at the cardiac rehabilitation program assisted the subjects with obtaining their HR, provided charts to aid subjects in determining their RPE level, and helped subjects accurately fill out their exercise logs.

**Significance of the Study**

The significance of the study is that it can provide valuable insight on the impact of email communication for improving attendance adherence and exercise prescription compliance in cardiac rehabilitation exercise programs. Improving attendance adherence and exercise prescription compliance can lead to greater health and fitness improvements in patients throughout the cardiac rehabilitation program. This can also provide cardiac rehabilitation centers with a convenient and inexpensive method to improve attendance adherence and exercise prescription effectiveness of their programs.

# CHAPTER TWO

## Review of Literature

### Cardiac Rehabilitation Programs

Cardiac rehabilitation programs were first introduced in the 1960s after it was discovered that physical activity was beneficial to cardiac patients during prolonged hospitalization following coronary events. This led to the development of structured rehabilitation programs that were overseen by physicians and included electrocardiogram monitoring (Giannuzzi et al., 2003). These programs were originally limited to survivors of "uncomplicated myocardial infarctions". Now, cardiac rehabilitation encompasses a broader array of conditions such as revascularization, transplants, heart failure, or those simply with known risk factors (Giannuzzi et al., 2003).

The World Health Organization (WHO) indicates that cardiac rehabilitation programs should provide activities to favorably influence the underlying causes of cardiovascular disease in order for patients to resume a normal place in society (Thompson et al., 2009). Likewise, the American Heart Association (AHA) and the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) recognize that all cardiac rehabilitation programs should contain components that aim to optimize cardiovascular risk reduction, foster healthy behaviors and compliance to healthy behaviors, reduce disability, and promote an active lifestyle for patients with cardiovascular disease (Balady et al., 1994; Balady et al., 2000).

The AHA and AACVPR have developed specific exercise training guidelines for center-based cardiac rehabilitation programs. All sessions should include a warm-up, cool-down, and flexibility exercises. Aerobic exercise training should be conducted three to five days a week at an intensity of 50% to 80 % of exercise capacity for 20 to 60 minutes each session. Resistance training should be completed two to three days a week with ten to fifteen repetitions of one to three sets. Resistance training should focus on eight to ten upper and lower body exercises using elastic bands, hand weights, free weights or weight machines. Each patient's exercise regimen should be reviewed by the program medical director and modified based upon risk stratification and comorbidities (Balady et al., 2007).

**Rating of Perceived Exertion**

Self-monitoring is an important component of exercise training for it allows an individual to adjust the exercise intensity in order to reach a level that is best suited for their state of health and fitness. Subjectively assessing exercise intensity is a continuous process involving self-monitoring of internal cues and external cues (Ceci and Hassmen, 1991). Internal cues involve the integration of signals elicited from the peripheral working muscles and joints, and from the central cardiovascular, respiratory, and nervous systems (Borg, 1982). External cues involve the environment surrounding the individual, such as wind speed and velocity (Ceci and Hassmen, 1991). An individual's perceived exertion is a product of configuring all of these signals.

Borg (1982) developed a linear perceived exertion scale that relates these subjective perceptions to objective measures, the Borg RPE scale. The category-scale values range from 6 to 20 and can be used to denote heart rate ranges from 60-200 bpm. Several studies have found correlations of 0.80-0.90 between RPE and heart rate (Borg, 1982). Another study found that RPE is a good predictor of maximal oxygen uptake, with only a $\pm$ 2% error rate (Noble, 1982). Correlation coefficients ranging from 0.81-0.94 have been found between minute ventilation and RPE

(Robertson, 1982). This suggests that though there is some variance, RPE is a good indicator of these physiological responses to exercise.

Borg also developed the category-ratio RPE scale to correlate perceived exertion with nonlinear physiological responses, such as lactate, that are a better indicator of fatigue (Noble, Borg, Jacobs, Ceci, and Kaiser, 1983). The category-ratio RPE scale ranges from 0 to 10+ and is anchored by verbal expressions that are simple and understandable by most people (Borg, 1982). With this scale, the use of decimals and going beyond 10 is permitted. Noble et al. (1983) found that the category-ratio scale had high correlations (0.995-0.999) with heart rate, power output and blood lactate. Borg (1982) also determined that the category-ratio scale is suitable for "determining subjective symptoms, such as breathing difficulties, aches and pains".

### Rating of Perceived Exertion and Cardiac Patients

The category-ratio scale is used in cardiac rehabilitation exercise programs for a variety of reasons. One reason is the ease in understanding the verbal cues that are associated with the scale. The scale was designed to be easily understood by those who are unfamiliar with perceived exertion ratings (Borg, 1982). Also, the category-ratio scale can be used to express subjective symptoms such as fatigue, breathlessness and pain (Capodaglio, 2002). Cardiac patients are an at-risk population, and focusing on these symptoms is important during exercise. The ability to express these symptoms makes the use of this scale more appropriate for a clinical setting.

## Adherence and Compliance to Cardiac Rehabilitation Programs

The long-term success of any secondary prevention program is directly related to patient adherence and compliance to the program (Balady et al., 1994). Meta-analyses of randomized control trials have shown that patients who adhere to cardiac rehabilitation programs have demonstrated a 20 to 31 % reduction in mortality from heart disease, improved functional capacity, reduction in cardiac

risk factors, and improvement in emotional health and quality of life (Oldridge, 1991; Dolansky, Stepanczuk, Charvat, and Moore, 2010). However, studies have repeatedly shown poor attendance and high program dropout rates, which reduces the health benefits associated with regular cardiac rehabilitation program participation. It has been generally acknowledged that adherence rates (proportion of sessions attended) to center-based cardiac rehabilitation programs range from 75% to 80% (Balady et al., 1994; Sundararajan et al., 2004). Predictor variables for lower adherence rates include women, the elderly, smokers, lower socio-economic class, low self-motivation, lack of support, anxiety, distress, and mood disturbance (Oldridge, 1991; Moore et al., 1998).

Limited studies have investigated patient compliance to specific exercise prescriptions in center-based cardiac rehabilitation programs. One study at the Cedars-Sinai Medical Center Preventive and Rehabilitative Cardiac Center found that patient compliance to prescribed heart rate and metabolic energy equivalent (MET) ranged from 63% to 77% (Vongvanich et al., 1996). Other studies have assessed exercise prescription compliance in qualitative terms, finding patient compliance to be "generally poor" (Oldridge, 1991) and "suboptimal" (Dalal et al., 2010). Studies have suggested that there is a need for research for adherence and compliance enhancing strategies to optimize the probability for all patients to gain the potential benefits of cardiac rehabilitation (Oldridge, 1991).

**Previous Cardiac Rehabilitation Interventions**

Various studies have investigated the effects of different intervention protocols on adherence and compliance to cardiac rehabilitation programs with limited success. Effective studies involved the use of agreements, letters, and detailed action plans(Oldridge and Jones, 1983; Wyer et al., 2001; Sniehotta et al., 2006).Oldridge and Jones (1983) conducted a controlled trial having subjects sign an agreement to comply with program protocols and to use self-monitoring techniques throughout the

duration of the program. Results indicated a significant difference in compliance to prescribed exercise protocols in the intervention group compared to the control group with compliance rates of 65 % and 42 %, respectively ($p < 0.01$). Wyer et al. (2001) conducted a randomized control trial using letters based on the theory of planned behavior in an attempt to increase cardiac rehabilitation attendance. Cardiac rehabilitation attendance was 86% in the intervention group, which was significantly greater than the 57% attendance in the control group ($p < 0.002$). Sniehotta et al. (2006) examined the impact of action planning (having patients form plans of when, where, and how they intended to exercise) and coping planning (having patients proactively plan for unwanted behaviors and situations) in cardiac rehabilitation. Patients who made use of both action and coping planning reported significantly more daily exercise than those who made use of only action planning ($p < 0.01$) or none of the planning types ($p < 0.01$).

Less effective treatments were conducted by Leslie and Schuster (1991) and Daltroy (1985). Although Leslie and Schuster's study used written exercise contracts which were individually negotiated with each subject plus a reward system upon completion of the contract, no significant differences in compliance were found between the intervention and control group (90% and 89%, respectively). A more novel approach using oral commitments by the subject, as well as telephone education interventions for both the subject and significant other, failed to significantly improve subject exercise adherence rates (Daltroy, 1985). The intervention group had an attendance rate of 63.8% whereas the adherence rate for the control (neither telephone intervention nor oral commitment) was 62.2% ($p > 0.05$).

**Internet Communication Studies**

According to the most recent reports by the United States Census Bureau, 79% of all adults use the internet on an occasional basis (U.S. Census Bureau, 2011a). Of those internet users, 94% either send or receive email (U.S. Census Bureau, 2011b). Thus, the internet has emerged as an

effective medium for reaching patients. Employing technology to support exercise and activity adherence embraces a new way to decrease participation barriers (Dirkin, 1994). A study by Nigg (2002) suggested that the coupling of technology and physical activity interventions can allow for the distribution of physical activity interventions to large numbers of individuals in a way that is efficacious yet also cost-effective.

The terms tele-health and tele-medicine have become common place in describing communication using phone, internet, and video conference between the patient and healthcare provider (Balas et al., 1997; Thompson and Clark, 2009). Studies employing tele-medicine have shown that computer-based communication is an effective means for promoting behavior change and adherence in health related fields.

Barnason, Zimmerman, Nieveen, and Hertzog (2006) conducted a study using a two-way messaging device with patients undergoing coronary artery bypass grafts ($n = 50$). The researchers randomized subjects into a control group and an intervention group. The intervention group received daily messages encompassing strategies to manage recovery-related symptoms, education on coronary artery bypass graft recovery, and positive reinforcement to increase patients' self-efficacy with symptom management and functioning. Compared to the control group, the intervention group reported significantly higher general health functioning ($p < 0.01$), and higher perceptions of their current and future health status, suggesting that informational messaging is beneficial for coronary artery bypass graft recovery. The current study aimed to expand on this by exploring the use of informational and motivational email messages in a cardiac rehabilitation exercise program.

A study by Tate, Jackvony, and Wing (2006) evaluated the use of email correspondence in an internet weight loss program. All subjects had access to an interactive weight loss website where they could track their weight and get weight loss tips and recipes. The automated email group received automated weekly email reminders about tracking their weight on the website and general behavior change lessons. The human counselor group received emails specifically tailored to their progress from a human counselor. These emails included reminders and praise or feedback to build motivation

for self-monitoring. The control group received no emails throughout the study. After three months, the automated email group and the human counselor email group had lost significantly more weight than the control group ($p = 0.005$ and $p = 0.001$, respectively). This supported the need for the current study because the groups that received emails benefitted from greater weight loss than the control group, suggesting that adherence and compliance may also be improved through the use of email reminders in cardiac patients.

Four studies of computer-based communication found beneficial effects in the management of patients with diabetes. Two studies by Balas et al. (1997) documented significant decreases in glycohemoglobin levels in diabetic patients who electronically communicated their glucose values to their physicians. Robertson, Smith, Castle, and Tannenbaum (2006) conducted a study using email adherence reminders and internet based monitoring for the treatment of depression. Improvements were found in medication adherence, reduction in depression severity, and enhanced patient/physician relationships. These studies infer that electronic communication is beneficial in adherence to physician instructed protocols for the treatment of depression. However, the direct interaction with the physician may have motivated the subjects to adhere to protocol which confounds the use of email messaging. To prevent this from occurring in current study, primary investigators had no direct contact with the subjects during exercise sessions in order to limit the influence on their behavior.

Tele-health has emerged as an innovative way to deliver health interventions. In particular, internet-based behavioral change interventions show promise in their effectiveness and accessibility (Hurling et al., 2007). Previous studies have explored the use of internet-based communication on weight loss, diabetes, depression, and coronary artery bypass graft recovery. Currently, more research is necessary involving email interventions specific to the needs of cardiac patients (Kuhls et al., 2006). The current study addressed this by utilizing email communication with intention to improve attendance adherence and exercise prescription compliance. It replicated these previous tele-health studies by having a group that receives informational emails that involve reminders and information pertinent to the cardiac rehabilitation program. The current study aimed to expand upon

the other studies by incorporating a group that receives a motivational email, with no information pertaining to the cardiac rehabilitation program, to assess if it is simply the email that improves adherence or the content of email.

## Conclusion

Center-based cardiac rehabilitation has proven to be effective in reducing cardiovascular disease risk factors, reducing morbidity and mortality, and improving the quality of life in cardiac patients. However, these benefits are only achieved when patients adhere and comply to the cardiac rehabilitation program. Many studies have been conducted to improve retention rates to cardiac rehabilitation programs, but few have explored newer advanced technologies for adherence enhancement. In other health fields, the use of technology has been beneficial in improving patient adherence to designated protocol. Therefore, the purpose of this study was to determine the efficacy of email communication as a strategy to improve attendance adherence and exercise prescription compliance to center-based cardiac rehabilitation programs by the enrolled patients. Information derived from this study can provide a convenient method for improving both attendance adherence and exercise prescription compliance in cardiac rehabilitation programs.

# CHAPTER THREE

## Methodology

### Subjects

Due to recruitment problems and graduation hardships, the proposed sample size of 30 subjects (10 subjects per group) was reduced to a sample size of 15 (5 subjects per group).With an estimated adherence rate of 90% and an estimated power of 0.50, the sample size for each group with continuity correction was determined to be five per a power analysis using the Primer of Biostatistics software program **(**Glantz, 2012). Statistically, five subjects in each group was adequate to perform the originally proposed analyses of one way ANOVA and Chi Square tests. Fifteen Caucasian subjects were recruited for this 12-week study. All subjects were previous inpatients at a south/central North Carolina hospital who were entering as outpatients into the hospital's community-based cardiac rehabilitation program. Subjects were required to have weekly access to the internet. Access could be at home, work, public network, or a cellular phone with email capabilities. Adult men and women (aged 18+) without known cognitive deficits were eligible to participate in this study based upon the cardiac rehabilitation program admission criteria and the patient's weekly internet access to email. Patients without an ability to access email on a weekly basis were not eligible for this study. All subjects read and signed an informed consent document, after a verbal review with a study investigator or trained staff member. All forms were approved by the University's Office of Human Research Ethics Institutional Review Board and the cardiac rehabilitation program director. Subjects signed an agreement to be randomized into one of three study groups (described below) as well as agreed to check their email weekly if randomized into an email study group.

Premature Drop-Outs

A subject would have been considered a premature drop-out from the exercise program if he/she never attended the exercise program and/or declared he/she was dropping out within the first week of the intervention program. There were no premature drop outs in this study, eliminating the need for subject replacement due to premature drop out.

**Group Assignment**

Upon signing the consent and agreement forms for this study, patients were randomly assigned using a random assignment generator software program (Haahr, 2012), without replacement, into one of three study groups:

Group 1 (n = 5): Information email intervention. Throughout the 12-week center-based program, subjects received a standardized email every Sunday. This email included the following:

- Reminders about the center-based exercise session dates and times
- Reminders about the time and intensity they have been instructed to follow at the center-based exercise sessions
- Encouragement to attend the center-based exercise sessions and comply to the prescribed time and intensity at these sessions

Appendix A contains the text of the informational emails.

Group 2 (n = 5): Attention control email intervention. Throughout the 12-week center-based program, subjects received a standardized email every Sunday. This email included an encouraging or motivational saying, but did not include information related to the

cardiac rehabilitation program. Appendix B contains the text of the attention control emails.

Group 3 (n = 5): Standard care control group. This group did not receive any emails throughout the 12-week center-based program.

**Instrumentation**

The GE Marquette T2000 (Milwaukee, Wisconsin) was used by the cardiac rehabilitation center for all pre-screening graded exercise peak testing. All emails were sent to the subjects from an IBM ThinkPad R60 laptop (Armonk, New York) via the Microsoft Outlook (New York, New York) student email system at the student investigator's university. A modified Borg's category-ratio RPE scale was used for all RPE recordings (Table1). The subjects' center-based exercise logs, which were used to record cardio-exercise duration (time), HR (bpm) and RPE, are property of the cardiac rehabilitation program.

**Table 1.** *Modified category-ratio RPE scale (Borg, 1982).*

| Level | Associated Feeling |
|---|---|
| 1 | I am resting |
| 2 | I am hardly working |
| 3 | Light effort, can talk easily |
| 4 | Starting to feel a little tired |
| 5 | Increased effort, slightly breathless |
| 6 | Moderately tired |
| 7 | Working hard |
| 8 | Very strenuous, I can't talk easily |
| 9 | Extremely tired, I need to stop soon |
| 10 | Maximal effort, I have to stop now |

## Procedures

### Measuring Adherence Rates

For this study, adherence was defined as the proportion of sessions that a subject attended out of the number of sessions available to them. All subjects were expected to attend the cardiac rehabilitation program sessions three days per week, for a total of 36 sessions during the 12-week intervention period. Adherence rate was determined by reviewing the attendance records for the 12-week intervention period for each subject at the cardiac rehabilitation program.

### Measuring Compliance Rates

As part of the cardiac rehabilitation program, all subjects were given a specific exercise prescription before beginning any cardiac rehabilitation sessions. During the cardiovascular portion of the exercise sessions, subjects were prescribed to exercise for 30 minutes at an RPE of 3-7 (using the 1-10 RPE category-ratio scale). Subjects were prescribed a progressive target HR range of 40% to 85% of the peak heart rate the subject achieved in a pre-screening graded exercise test on a motorized treadmill. Although this exercise protocol is slightly different than the one recommended in the literature review by Balady et al (2000), this is the standardized prescription guideline designed by this particular cardiac rehabilitation program, and is based upon the American College of Sport Medicine guidelines for clinical exercise prescription in cardiac patients (ACSM, 2010).

As part of the cardiac rehabilitation program, subjects kept exercise logs of the duration (min), HR (bpm), and RPE score that they attained during the cardiovascular portion of the exercise sessions (Appendix C). Subjects recorded their HR and RPE halfway through the exercise session (15 minutes) and at the end of the exercise session (30 minutes).Subjects also recorded the total exercise duration at the end of the exercise session. This study evaluated the subjects' mean HR values (bpm), RPE scores, and total exercise duration (min) per each exercise session. The individual session results were then averaged into 12-week cumulative totals for the group comparisons.

Compliance was determined by reviewing the subject's exercise log entries. Based upon each subject's specific exercise prescription, it was determined if the subject attained the prescribed duration and ranges for RPE and HR for each exercise session. The subjects were considered compliant if they attained 80% of the prescribed dosages for duration, RPE range, and HR range. Compliance rates were also reported as a proportion of sessions that the subject averaged over the 12-week program for the prescribed doses of duration (min), RPE, and HR. If a subject did not attend a session or did not record required information on the exercise log, it was determined the subject was non-compliant for that particular session and/or variable.

**Statistical Design and Analyses**

This was a true randomized prospective experimental design utilizing a convenient subject sample. The independent variable for this study was email intervention type, and the dependent variables were exercise session attendance rate and exercise session compliance rates (duration, HR range, and RPE range). One-way ANOVAs were used to determine descriptive statistics (means, standard deviations) and between group differences for age, BMI, estimated peak $VO_2$, attendance and compliance rates. Socioeconomic status (SES) variables were optional self-report descriptive data and included age, gender, ethnicity, highest level of education attained, and approximate annual income (see Appendix D). Chi Square Analyses with Cramer's V adjustment were used to determine if the subjects were compliant to their prescribed regimens (HR range, RPE range, exercise duration). The specific data analyses for each research hypothesis are detailed below. Power analyses conducted with the Primer of Biostatistics $7^{th}$ Edition software package (Glantz, 2012). All other statistical analyses were completed using SPSS Grad Pack Version 20.0 (IBM solutions, Durham, NC). For all analyses, the alpha level was set a priori at the $p \leq 0.05$ level of significance.

**Research Question One: Will weekly email communication impact patient adherence to cardiac rehabilitation sessions?**

**Hypothesis 1a:** Simply an email, regardless of content, will improve adherence rates in comparison to no email intervention.

**Hypothesis 1b:** An email that contains precise programmatic information will be more effective in improving adherence than a more generic email.

***Statistical Analysis:*** A simple one-way ANOVA was performed (three intervention groups x adherence total) with Tukey's HSD post hoc analysis to determine specific between group differences.

**Research Question Two: Will weekly email communication impact patient compliance to the cardiovascular stimulus period of the exercise session?**

**Hypothesis 2a:** Simply an email, regardless of content, will improve exercise prescription compliance (attainment of prescribed ranges for HR, RPE, and duration) in comparison to no email intervention.

**Hypothesis 2b:** An email that contains precise programmatic information will be more effective in improving exercise prescription compliance than a more general email.

***Statistical Analysis:*** Three separate 3 x 2Chi Square Analyses ("test for independence") with Cramer's V adjustment were performed to determine relationships between group and compliance (yes, complied versus no, did not comply) specific to each dependent variable (attainment of prescribed HR range, RPE range, and duration).

# CHAPTER FOUR

## Results

### Subject Characteristics

Fifteen Caucasian subjects (8 females aged 64.0 ± 16.7 years and 7 males aged 64.8 ± 11.5 years) volunteered to participate and complete this study. A one-way ANOVA verified that the age distribution between the three treatment groups was not statistically different (Group 1 = 64.4 ± 10.7 years; Group 2 = 61.4 ± 9.6 years; Group 3 = 67.4 + 21.4 years; overall F = 0.202; p = 0.804). Similarly, there were no significant differences between groups at baseline for body mass (overall F = 0.045; p = 0.956), BMI (overall F = 0.038; p = 0.963), or aerobic fitness (overall F = 0.835; p = 0.458). Table 2 provides group information on body mass, BMI, and aerobic fitness for both pre- and post-intervention.

**Table 2**. *Body composition and aerobic fitness of subjects per group (mean ± SD).*

| | **Informational Email Group 1 (n = 5; 2 males)** | | **Motivational Email Group 2 (n = 5, 3 males)** | | **Control Group 3 (n = 5, 2 males)** | |
|---|---|---|---|---|---|---|
| **Variable** | **Pre** | **Post** | **Pre** | **Post** | **Pre** | **Post** |
| **Body Mass (kg)** | 179.6 ± 63.49 | 177.4 ± 59.63 | 189.0 ± 37.98 | 188.4 ± 36.89 | 183.1 ± 44.51 | 180.3 ± 38.53 |
| **BMI ($kg/m^2$)** | 28.68 ± 10.78 | 28.26 ± 9.97 | 27.34 ± 7.08 | 27.28 ± 6.89 | 27.76 ± 4.56 | 27.36 ± 3.70 |
| **$VO_2$ Peak (ml/kg/min)** | 25.83 ± 13.59 * | 36.05 ± 17.42 | 30.59 ± 11.42 | 40.25 ± 12.73 | 35.14 ±8.62 | 35.77 ± 7.22 |

* Indicates a significant difference in pre to post intervention values ($p < 0.05$)

One-way ANOVAs on the difference scores detected no significant differences for either body mass change or BMI change pre- to post-intervention between groups (overall $F \leq 0.33$; $p \geq 0.72$), however; a one-way ANOVA on the difference scores detected a significant difference for $VO_2$peak change pre- to post-intervention between groups (overall $F = 4.36$; $p = 0.038$,Bonferroni correction for multiple comparisons). Independent samples T-tests found the informational email group (Group 1) had a significant improvement in $VO_2$ peak in comparison to the control group (Group 3) ($t = 2.781$; $p = 0.024$). No significant difference was found between the informational email group (Group 1) and the motivational email group (Group 2) ($t = 1.688$; $p = 0.130$), or between the motivational email group (Group 2) and the control group (Group 3) ($t = 1.394$; $p = 0.201$).

Of the total sample, sixty-seven percent (n=10) of the subjects voluntarily reported their educational and economic status level. Two completed high school, two completed college, two had some post graduate training, and four had a post graduate degree. The majority of these subjects had incomes in excess of $100,000 (n = 7), two had annual incomes between $60-80,000, and one's annual income was less than $21,000. Specific group distributions can be seen in Table 3.

**Table 3.** *Frequency table for self-reported educational level and annual income*

| | **Informational Email, Group 1 (n = 3)** | **Motivational Email, Group 2 (n = 3)** | **Control, Group 3 (n = 4)** | **Total (N = 10) (missing n = 5)** |
|---|---|---|---|---|
| **Highest Level of Education** | | | | |
| **High School Degree** | 0 | 1 | 1 | 2 |
| **College Degree** | 1 | 0 | 1 | 2 |
| **Some Post Graduate** | 0 | 0 | 2 | 2 |
| **Post Graduate Degree** | 2 | 2 | 0 | 4 |
| **Annual Household Income** | | | | |
| **$20,000 or less** | 0 | 1 | 0 | 1 |
| **$60,000-$80,000** | | | 2 | 2 |
| **$100,000+** | 3 | 2 | 2 | 7 |

**Impact of Email Communication on Attendance Adherence**

The following research question and corresponding hypotheses statements were posed:

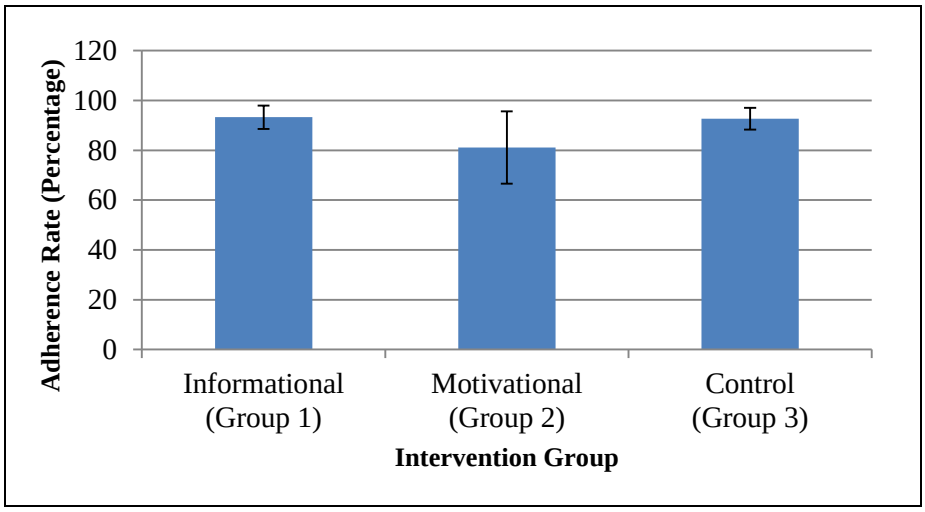
***Research Question One: Will weekly email communication impact patient adherence to cardiac rehabilitation sessions?***

***Hypothesis 1a: Simply an email, regardless of content, would improve adherence rates in comparison to no email intervention.***

***Hypothesis 1b: An email that contains precise programmatic information would be more effective in improving adherence than a more generic motivational email.***

All subjects completed the 12-week cardiac rehabilitation program, thus there were no premature drop-outs, thereby eliminating the need for replacement subjects. As shown in Figure 1, no significant differences were found between intervention groups for attendance adherence (one-way ANOVA, overall $F = 3.161$; overall $p = 0.079$). Although the informational email intervention group (Group 1) had a higher mean attendance adherence rate (33.6 sessions/36.0 sessions) than the motivational email intervention group (Group 2, 29.2 sessions/36 sessions), that difference was not statistically significant (Tukey HSD post hoc analyses, $p = 0.098$). Attendance adherence for the no-email control group (Group 3) was similar to the informational email group (Group 3, 33.4 sessions/36 sessions). A power analysis demonstrated the power to obtain a significant difference for this variable to be only 11.8%. In order to obtain a significant difference, an n of at least 33/group would be needed, yielding a power of 60% ability to detect a significant difference (Glantz, 2012).

**Figure 1.** *Attendance adherence rates (mean± SD) per group*




**Impact of Email Communication on Exercise Prescription Compliance**

The following research question and corresponding hypotheses statements were posed:

***Research Question Two: Will weekly email communication impact patient compliance to the cardiovascular stimulus period of the exercise session***

***Hypothesis 2a: Simply an email, regardless of content, would improve exercise prescription compliance (attainment of prescribed ranges for HR, RPE, and duration) in comparison to no email intervention.***

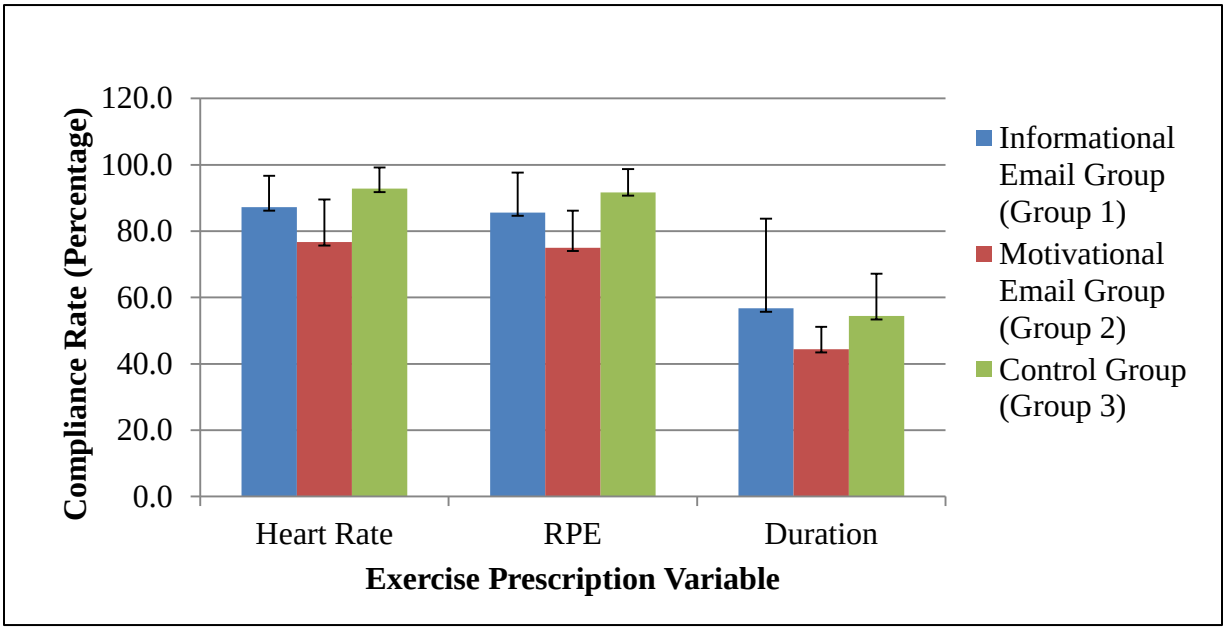
Descriptive statistics were used to determine mean (± SD) compliance for HR, RPE, and duration prescription for all three groups. Values are reported as the mean number of sessions that prescribed variable ranges were attained, with 36 being 100% session compliance. For HR prescription compliance, the control group (Group 3) had the highest mean with 33.4 ± 2.3 out of 36 sessions, followed by the informational email group (Group 1) with 31.4 ± 3.4 out of 36 sessions, and the motivational email group (Group 2) with 27.6 ± 4.6 out of 36 sessions. A power analysis demonstrated the power to obtain a significant difference for this variable to be only 17.5%. In order to obtain a significant difference, an n of at least 18/group would be needed, yielding a power of 60% ability to detect a significant difference (Glantz, 2012).

For RPE compliance, the control group had the highest mean with 33 ± 2.5 out of 36 sessions, followed by the informational email group with 30.8 ± 4.3, and the motivational email group with 27.0 ± 4.0 out of 36 sessions. A power analysis demonstrated the power to obtain a significant difference for this variable to be only 16%. In order to obtain a significant difference, an n of at least 18/group would be needed, yielding a power of 60% ability to detect a significant difference (Glantz, 2012).

The informational email group had the highest mean session compliance for duration with 20.4 ± 9.7 out of 36 sessions, followed by the control group with 19.6 ± 4.6 out of 36 sessions, and the motivational email group with 16.0 ± 2.4 out of 36 sessions. A power analysis demonstrated the power to obtain a significant difference for this variable to be 95%. Therefore, an n = 5 should be sufficient to detect a significant difference (Glantz, 2012).

In summary, across all three variables, the motivational email group (Group 2) was the least compliant. Descriptive data of the percentage compliance based upon the above means is provided in Figure 2 for the three treatment groups and the three exercise prescription variables.

**Figure 2**. *Mean (± SD) compliance percentage rates for HR, RPE, and duration for informational email group, motivational email group, and control group.*



Chi Square tests were run on each dependent variable (HR, RPE, duration) to determine if there were significant differences between groups for the total number of recordings possible over the 12-week intervention period (i.e. 5 subject recordings/session x 3 sessions/week x 12 weeks = 180 possible recordings per group x 3 groups = 540 total recordings possible).

A 3 x 2 Chi Square test for independence using Cramer's V adjustment found a significant difference in HR compliance rates between the three groups $\chi^2(2, n = 540 = 19.5, p < 0.0001$. There was also a significant difference found in the RPE compliance frequencies $\chi^2(2, n = 540) = 19.1, p < 0.0001$, and in the duration compliance frequencies $\chi^2(2, n = 540) = 6.1, p = 0.047$. Tables 4, 5, and 6 provide the total variable compliance frequencies of all subjects and exercise sessions.

**Table 4.** *Frequency rates of compliance for prescribed HR range.*

| Compliance | Group 1 | Group 2 | Group 3 | Total |
|---|---|---|---|---|
| Yes | 157 | 138 | 167 | 462 |
| No | 23 | 42 | 13 | 78 |
| Total | 180 | 180 | 180 | 540 |

**Table 5.** *Frequency rates of compliance for prescribed RPE range.*

| Compliance | Group 1 | Group 2 | Group 3 | Total |
|---|---|---|---|---|
| Yes | 154 | 135 | 165 | 454 |
| No | 26 | 45 | 15 | 86 |
| Total | 180 | 180 | 180 | 540 |

**Table 6.** *Frequency rates of compliance for prescribed duration range.*

| Compliance | Group 1 | Group 2 | Group 3 | Total |
|---|---|---|---|---|
| Yes | 102 | 80 | 98 | 280 |
| No | 78 | 100 | 82 | 260 |
| Total | 180 | 180 | 180 | 540 |

***Hypothesis 2b: An email that contains precise programmatic information would be more effective in improving exercise prescription compliance than a more general email.***

In order to verify that the compliance rates were significantly different between the two email groups, 2 x 2 Chi Square test for independence with continuity correction were run for each of the three variables. In each analysis, the informational email (Group 1) compliance was significantly greater than the motivational email (Group 2) compliance. The results were as follows:

HR Chi Square analysis result: $\chi^2(1, n = 360) = 6.778, p = 0.009$

RPE Chi Square analysis result: $\chi^2(1, n = 360) = 6.334, p = 0.012$

Duration Chi Square analysis result: $\chi^2(1, n = 360) = 5.378, p = 0.020$

In summary, the informational email resulted in significantly greater compliance rates to the exercise prescription variables of target HR range, RPE range, and duration of exercise. Although there was no hypothesis proposed to compare the informational email (Group 1) to the control group (Group 3), due to the similar compliance rates illustrated in Figure 2, three additional 2 x 2 Chi Square analyses were run to confirm that no significant differences existed between Groups 1 and 3. The results were as follows:

HR Chi Square analysis result: $\chi^2(1, n = 360) = 3.086, p = 0.079$

RPE Chi Square analysis result: $\chi^2(1, n = 360) = 3.331, p = 0.068$

Duration Chi Square analysis result: $\chi^2(1, n = 360) = 0.180, p = 0.671$

As can be seen from these Chi Square analyses, the compliance rates for HR, RPE, and duration were not significantly different between the informational email group and the control group. However; the control group did report the highest compliance rates for HR and RPE.

# CHAPTER FIVE

## Discussion

The primary purpose of this study was to determine the impact of email communication on adherence rates and exercise prescription compliance in a cardiac rehabilitation exercise program. A secondary purpose of this study was to determine if email content is related to adherence rates and exercise prescription compliance in cardiac patients. No significant difference was found between attendance adherence rates in the informational email intervention group, motivational email intervention group, and the control group ($p = 0.079$). A significant difference was found between groups for exercise prescription compliance (overall p value $< 0.008$) for all variables (i.e. attainment of prescribed HR range, RPE range, and duration). The following discussion focuses on the aforementioned results followed by a review of limitations in this study.

### Impact of Email Communication on Attendance Adherence

The present study found that email intervention did not significantly increase attendance adherence to the 12-week cardiac rehabilitation program. It was also determined that an email intervention with specific programmatic information did not significantly increase attendance adherence compared to a more generic motivational email. One explanation for why the present study failed to find a significant difference in attendance adherence between the email intervention groups and the control group is that all groups reported relatively high attendance adherence rates (ranging from 81.1% to 93.3%) compared to average cardiac rehabilitation program adherence rates of 75% to 80% (Balady et al., 1994; Sundararajan et al., 2004). This suggests that subjects may have been more

intrinsically motivated to attend cardiac rehabilitation sessions, lessening the impact of an extrinsic informational or motivational email on attendance adherence. The pre-intervention $VO_2$peak measures also suggest that intrinsic motivation could have been a factor in attendance adherence. Previous studies have shown that a lack of physical activity and lower measures of physical fitness prior to beginning a cardiac rehabilitation program is a predictor of poor uptake and a barrier to adherence at cardiac rehabilitation program sessions (Lane et al., 2001). Though there was no significant difference found between the pre-intervention $VO_2$peak measures of the three treatment groups, the control group began the program with the highest $VO_2$peak of 35.14 $\pm$8.62 ml/kg/min. This suggests that the control group began the cardiac rehabilitation program with the highest level of cardiovascular fitness compared to both email intervention groups. With a higher level of physical fitness, the control group may have been more motivated to exercise, while the lower $VO_2$peaks of the informational and motivational email groups (25.83 $\pm$ 13.59 ml/kg/min and 30.59 $\pm$ 11.42 ml/kg/min, respectively) could have been external factors limiting adherence to the cardiac rehabilitation program. Subject comorbidities could have also limited adherence rates independent from the email interventions. Psycho-social and physiological comorbidities have been shown to effect adherence rates in cardiac rehabilitation patients. Comorbidities that have been shown to have a negative impact on adherence include age, gender, obesity, smoking, lack of spousal/family support, and job related factors (Moore et al., 1998; Oldridge, 1991).

Another factor that could explain the failure to find significance in attendance adherence rates between the informational email group, motivational email group, and control group is the small sample size of the study. Due to recruitment hardships, the study sample size was reduced from a total of 30 subjects to 15 subjects, thus having 5 subjects for each group. With a smaller sample size, it is possible that high variability in the data could have impacted the overall outcomes (Dowell, 2007).

The differences between the informational email group (Group 1) and the motivational email group (Group 2) provide implications for future research. Even with a small sample size (n = 5 per group), the difference between attendance adherence in the informational and motivational email

group approached significance ($p = 0.079$), suggesting that a study with an adequate sample size could potentially find a difference in attendance adherence rates between the two different email intervention groups. This suggests that email content could have an impact on attendance adherence, but more research with a larger sample population of at least 18 subjects per group would be needed.

**Impact of Email Communication on Exercise Prescription Compliance**

The present study found that there was a significant difference between treatment groups and exercise prescription compliance. As noted in the results, the compliance rates to the prescribed HR range, RPE range, and duration during the cardiac rehabilitation program exercise sessions was found to be significantly different between treatment groups. However, the mean percentage of compliance suggests that this significance may be due to confounding factors and not the email intervention per se. As shown in Figure 2, the control group (which received no emails throughout the 12-week intervention) had the highest rates of HR prescription compliance at 92.8% and the highest rates of RPE prescription compliance at 91.7%, whereas the informational email intervention group had the highest rates of duration prescription compliance with 56.79%. A 2 x 2 Chi Square analysis showed that none of the variables were significantly different between the informational email group and the control group. Similar to the results with attendance adherence, an explanation for these findings could be that the control group was more intrinsically motivated to adhere and comply with the cardiac rehabilitation program due to being more physically fit before beginning the cardiac rehabilitation program. Also, other barriers to physical activity that are beyond the control of the subject could have affected compliance rates. Common barriers to physical activity include: lack of transportation, conflicts with work schedules, unforeseen illness or injury, limited insurance coverage, and lack of social support (Dishman, 1994). All of these factors can contribute to limited compliance to the prescribed exercise sessions independent of treatment group.

Also, a type II error cannot be ruled out. As suggested in the results, larger sample sizes are needed for the majority of the variables in order to make sure that the null hypothesis was indeed true and not due to a lack of power from insufficient subject numbers.

Focusing solely on the email intervention groups, the findings suggest that email content may have a positive association with exercise prescription compliance. A significant difference was found between the informational email group compliance frequencies and the motivational email group compliance frequencies. The mean compliance percentage rates support the notion that exercise compliance may be related to email content, given that the informational email group had at least 10% higher prescription compliance rates for all three exercise variables than did the motivational email group. This suggests that if emails are used, weekly emails with precise information about the cardiac rehabilitation program and exercise prescription reminders could be more effective in motivating subjects to attain prescribed values compared to a more generic motivational email. That being said, it is unclear if an email is necessary at all since there were no significant differences between the no-email control group and the informational email group. Therefore, future research needs to replicate this study with larger sample sizes for all three groups in order to: 1) discern if email correspondence is efficient use of staff members' time in terms of improving adherence and compliance to the exercise prescription and, 2) better discern if email content has a significant impact on improving exercise adherence and prescription compliance rates to HR, RPE, and duration recommendations in a cardiac rehabilitation program.

**Limitations**

The present study had a few limitations that need to be acknowledged. All exercise logs (attained HR, RPE, and duration) from the cardiac rehabilitation program sessions were self-reported by the subjects. The inaccuracy of self-reporting physical activity measures can be as much as 51% of

the actual measures attained (Lichtman et al., 1992).To help counteract this, the exercise physiologists and nurses at the cardiac rehabilitation program helped the subjects obtain an accurate HR, and assisted subjects with filling out the exercise logs with the correct attained RPE and duration. This may have helped to diminish the inaccuracy of the self-reported exercise logs, but cannot eliminate this confounding factor.

This study was limited by the assumption that the subjects in the email communication groups read the weekly emails. To improve compliance for reading emails, all email notifications were sent out before noon on Sunday, a day which may be less hectic and allowed patients to check their emails as they prepared for the upcoming week. Automated delivery receipts were attached to all emails to ensure that the emails were received by all subjects in the email intervention groups, but there is no indication as to if the emails were actually read by the subjects.

Another limiting factor in the present study is the lack of socioeconomic diversity in the composition of the groups. Previous studies have shown that lower levels of education and lower annual household income are indicators of lower attendance and higher dropout rates in cardiac rehabilitation patients (Cooper et al., 2002). Of the 10 subjects (67% of total subjects) that completed the optional socioeconomic status questionnaire, 8 of them had completed a college degree or higher. Similarly, 7 out of the 10 subjects that completed the questionnaire reported an annual household income of $100,000 or more. Both of these variables suggest that subjects were more educated and had higher annual household incomes, which traditionally correlate with greater attendance rates. This could diminish the effect of an informational or motivational email on adherence and compliance rates because subjects may be more intrinsically motivated to attend cardiac rehabilitation sessions based on their socioeconomic status. Future studies focusing on demographics (e.g. lower educational levels, lower annual household incomes) are needed to determine if similar results would be obtained for both adherence rates and compliance to the exercise prescription.

In summary, a larger, more diverse population sample is needed in order to clarify and better generalize the study's findings to the broader cardiac rehabilitation population.

# CHAPTER SIX

# Conclusion

## Summary

The purpose of this study was to determine the impact of email communication on adherence rates and exercise prescription compliance in a cardiac rehabilitation exercise program. A secondary purpose of this study was to determine if email content is related to adherence rates and exercise prescription compliance (attainment of prescribed HR range, RPE range, and duration) in cardiac patients. Attendance records and exercise logs from a cardiac rehabilitation program were analyzed to determine if an email intervention program focusing on specific exercise goals would be effective in increasing adherence and prescription compliance rates in comparison to a motivational email or no email (standard program protocol).

This study did not find evidence that an email intervention significantly improved attendance adherence in a cardiac rehabilitation program. Both email intervention groups and the control (no email) group reported relatively high attendance adherence rates compared to normative data of cardiac rehabilitation program attendance, but no significant differences were found between the three groups. Similarly, the study did not find evidence that email content significantly improved attendance adherence in a cardiac rehabilitation program.

This study did not find evidence that exercise prescription compliance was associated with treatment group (informational email, motivational email, and control), as the highest compliance rates were found in the control group and not the email groups. However, in comparison to the motivational email group, this study did find that the informational email group had at least 10%

better exercise prescription compliance for all three prescription variables (HR, RPE, and duration). This suggests that if an email is to be used, an email containing precise information about cardiac rehabilitation exercise prescription may be more effective in improving exercise prescription compliance than a more generic motivational email.

## Conclusions

Based on the results of the present study, the following research questions and hypotheses were addressed:

**Research Question One:** Will weekly email communication impact patient adherence to cardiac rehabilitation sessions?

**Hypothesis 1a:** Simply an email, regardless of content, will improve adherence rates in comparison to no email intervention.

This hypothesis was rejected because there were no significant differences in attendance adherence rates between the informational email group, motivational email group, and control group.

**Hypothesis 1b:** An email that contains precise programmatic information will be more effective in improving adherence than a more generic email.

This hypothesis was rejected because there was no significant difference in attendance adherence rates between the informational email group and the motivational email group.

**Research Question Two:** Will weekly email communication impact patient compliance to the cardiovascular stimulus period of the exercise session?

**Hypothesis 2a:** Simply an email, regardless of content, will improve exercise prescription compliance (attainment of prescribed ranges for HR, RPE, and cardio-exercise duration) in comparison to no email intervention.

This hypothesis was rejected because the control (no email intervention) group had the highest overall levels of exercise prescription compliance.

**Hypothesis 2b:** An email that contains precise programmatic information will be more effective in improving exercise prescription compliance than a more general email.

This hypothesis was accepted because the informational email group that received emails with precise programmatic information had significantly higher compliance rates for all prescribed variables compared to the motivational email group that received more generic emails.

**Practical Application and Suggestions for Future Research**

To the knowledge of the investigator, this study was a novel approach to examining the effects of email communication and email content on adherence and compliance in a cardiac rehabilitation program. The results of this study suggest that future research is warranted to further explore the use of email interventions in cardiac rehabilitation programs. Though the current study had no significant findings on the impact of email intervention on attendance adherence rates, the differences in attendance adherence rates between the informational email group and the motivational email group approached statistical significance. This suggests that if emails are used, informational emails may be more effective in improving attendance adherence rates. Also, the significant association between email intervention group and exercise prescription compliance suggests that programmatic informational emails could be more beneficial in motivating cardiac rehabilitation patients to comply with prescribed exercise protocols. Thus, if emails are to be used, precise programmatic emails may be a practical and effective intervention method for improving adherence

and compliance to cardiac rehabilitation programs when compared to more generic motivational emails.

Future studies need to recruit a larger sample size to eliminate mean outcome variance due to outlier data and should also focus on subpopulations that traditionally have lower attendance adherence rates, such as those with lower levels of education and lower levels of annual household income. Lower annual household incomes may limit cardiac rehabilitation program enrollment and attendance due to insufficient funds, inability to obtain time off from work, or lack of medical insurance coverage. Furthermore, lower education levels may result in less awareness and less perceived value regarding the health benefits of consistent participation in cardiac rehabilitation sessions. In addition, those with less financial resources may not have reliable access to computers or other electronic devices with email capabilities. Therefore, future studies could be designed to provide each subject a personal electronic device that can receive emails. Emails would be preferred over text-messaging systems as emails would not require expensive monthly telecommunication plans. IPads and other similar tablets could be considered for this type of study as email address set up and applications are free to users and these devices can connect to wireless internet networks free of charge. The use of this type of technology could both benefit the subject and facilitate community/corporate partnerships for the research endeavor.

In summary, informational email notifications may be a beneficial tool to encourage cardiac patients to successfully comply with rehabilitation programs. Individuals with known lower motivation to adhere and comply with rehabilitation protocol should be targeted in these intervention efforts.

## APPENDIX A

Informational Email Templates

Week 1

Dear (subject),

Welcome to the cardiac rehab program! We look forward to seeing you at the (time) sessions this week. Attending your scheduled sessions is a positive step towards improved health!
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 2

Dear (subject),

We wanted to remind you of your exercise sessions scheduled for (time) Monday, Wednesday, and Friday. This week, we would like to encourage you to meet your prescribed time and intensity at all exercise sessions. By regularly coming to these sessions you will likely see greater health improvements!
We look forward to seeing you this week,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 3

Dear (subject),

We look forward to seeing you at the (time) exercise sessions this week! A friendly reminder to focus on attaining your prescribed heart rate range and your prescribed rating of perceived exertion range at all exercise sessions.
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 4

Dear (subject),

Keep up the hard work at your (time)am sessions this week! And keep striving to meet your prescribed duration, heart rate, and RPE at all exercise sessions. By complying to your prescribed exercise program you will likely see greater health improvements!
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 5

Dear (subject),

We hope you enjoyed your weekend and we are looking forward to seeing you at the (time)am exercise sessions this week! Here's a reminder of the duration, RPE level, and heart rate you should strive for at each exercise session:

- Duration:
- RPE level:
- Heart Rate:

You are doing great things for your health by regularly attending these sessions!

Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 6

Hi (subject),

Congratulations on completing the first half of your cardiac rehabilitation program! As you continue to attend your (time) workout sessions and meet your prescribed duration, heart rate, and RPE ranges, you are more likely to see improved health and fitness measures. Keep up the great work!

Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 7

Hi (subject),

We are excited to see you at the (time)am exercise sessions this week. Keep up the great work of meeting your prescribed time, heart rate, and RPE level! You have made a strong commitment to your health, and as Virgil once said "the greatest wealth is health".

Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 8

Hi (subject),

Congratulations on completing eight weeks of the cardiac rehabilitation program! You are making a great choice for your health by attending all of your (time)am sessions. Keep up the great work and keep striving to meet your prescribed duration, RPE, and heart rate range at every session!

Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 9

Hi (subject),

We hope you had a great weekend and we are excited to see you at the (time)am exercise sessions this week! Keep striving to meet your prescribed time of (30-45) min, RPE of level 3 to 6, and heart rate of (  ) beats per minute. This exercise prescription is designed to provide you with a safe and effective workout to help you attain your fitness goals!
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 10

Hi (subject),

Keep working hard these last few weeks of the cardiac rehabilitation program! You are making a great choice for your health by attending all of your (time)am sessions. Keep up the great work and keep striving to meet your prescribed duration, RPE, and heart rate range at every session!
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 11

Hi (subject),

Congratulations, you are down to the final two weeks of the cardiac rehabilitation program! You have made a strong commitment to your health by attending the Monday, Wednesday, and Friday exercise sessions. Keep up the hard work these last two weeks and try to meet all of your prescribed ranges at your last few sessions.
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 12

Hi (subject),

We hope that you enjoyed your time at the cardiac rehabilitation center, and have learned useful tools to incorporate exercise and healthy eating into your life. You have worked hard these past three months and we hope you will continue to make positive choices for your health. Let's make this last week the best one yet by attending all exercise sessions and complying to your exercise prescription ranges!
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

## APPENDIX B

Attention Control Email Templates

Week 1

Dear (subject),

Welcome to the cardiac rehabilitation program! We are excited for you to be joining our program and hope this is a great experience for you. Here is a quote to help motivate you through your first week of workouts:

"Continuous effort --- not strength or intelligence --- is the key to unlocking our potential."
– Winston Churchill

Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 2

Dear (Subject),

We hope you enjoyed your weekend and are looking forward to the week ahead. Here is a fun quote we thought you might enjoy:

"Nothing great was every achieved without enthusiasm." – Ralph Waldo Emerson

Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 3

Dear (subject),

Keep up the great work! You are doing great things for your health by committing to this program. Don't forget: "It's never too late to be what you might have been." –George Elliot

Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 4

Dear (subject)

"Life is meant to be a celebration! It shouldn't be necessary to set aside special times to remind us of this fact. Wise is the person who finds a reason to make every day a special one." –Leo Buscaglia

We look forward to seeing you at the wellness center this week!

Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 5

Hi (patient's name),
Here's an inspirational thought just for you:
"The only thing that you can carry with you on your travels is your heart. So fill your heart with good things and good things will follow you for the rest of your life." –Scott Murray
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 6

Hi (patient's name),
"Success is to be measured not so much by the position that one has reached in life, as by the obstacles one has overcome trying to succeed." –Booker T. Washington
Keep up the hard work and you will succeed!
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 7

Hi (patient's name),
Here's a motivational thought just for you:
"As human beings, our greatness lies not so much in being able to remake the world... as in being able to remake ourselves." –Mahatma Ghandi
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 8

Hi (subject),
Congratulations on completing over two months of the cardiac rehabilitation program! You have made a strong commitment to your health, and as Virgil once said "the greatest wealth is health".
Best regards,
Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 9

Hi (subject),

"Motivation is what gets you started. Habit is what keeps you going." -Jim Ryan

We hope that the cardiac rehabilitation program has motivated you to focus on your health, and has helped to instill healthy habits that you can incorporate in your daily life.

Best regards,

Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 10

Hi (subject),

Keep working hard towards your health and fitness goals! "In order to succeed, your desire for success should be greater than your fear of failure." – Bill Cosby

Best regards,

Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 11

Hi (subject),

We hope you enjoyed the weekend and are ready to make the most out of your last few weeks of the cardiac rehabilitation program!

"To keep the body in good health is a duty... otherwise we shall not be able to keep our mind strong and clear." - Buddha

Best regards,

Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

Week 12

Hi (subject),

We hope that you enjoyed your time at the cardiac rehabilitation center, and have learned useful tools to incorporate exercise and healthy eating into your life. You have worked hard these past three months and we hope you will continue to make positive choices for your health.

Best regards,

Jamie Simerly, B.A., Graduate Student in UNC Exercise Physiology

(Lindsay, 2009)

## APPENDIX C

Exercise Log Template for Center Based Cardiovascular Exercise Sessions

| | Date | Equipment: | | | Equipment: | | |
|---|---|---|---|---|---|---|---|
| | | Time | Heart Rate | RPE | Time | Heart | RPE |
| Week 1 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 2 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 3 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 4 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 5 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 6 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 7 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 8 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 9 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 10 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 11 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |
| Week 12 | Mon: | | | | | | |
| | Wed: | | | | | | |
| | Fri: | | | | | | |

## APPENDIX D

Optional Subject Characteristic Questionnaire

Please answer the following questions to the best of your ability. These questions are optional and will not affect your participation in this study.

1. Please indicate which ethnicity you most identify with.
   __Asian or Pacific Islander
   __African American
   __Caucasian
   __Hispanic
   __Native American
   __Other: _____

2. What is your highest level of education?
   __ Some high school
   __ High school degree
   __ Some college/university
   __ College/university degree
   __ Some post graduate
   __ Post graduate degree

3. Please approximate your household annual income
   __$20,000 or less
   __$20,000-$40,000
   __$40,000-$60,000
   __$60,000-$80,000
   __$80,000-$100,000
   __$100,000 or higher

## REFERENCES


American College of Sports Medicine. (2010). Exercise Prescription for Patients with Cardiac Disease. *ACSM's Guidelines for Exercise Testing and Prescription* (8th ed). Baltimore, MD: Lippincott, Williams, and Wilkins.

Balady G.J., Ades P.A., Comoss P., Limacher M., Pina I.L., Southard D., Williams M.A., and Bazzarre T., (2000). Core Components of Cardiac Rehabilitation/Secondary Prevention Programs: A Statement for Healthcare Professionals From the American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation Writing Group. *Circulation*, 102:1069-1073.

Balady G.J., Fletcher B.J., Froelicher E.S., Hartley L.H., Krauss R.M., Oberman A., Pollock M.L., and Taylor B., (1994). Cardiac Rehabilitation Programs: A Statement for Healthcare Professionals From the American Heart Association. *Circulation,* 90 (3):1602-1610.

Balady G.J., Williams M.A., Ades P.A., Bittner V., Comoss P., Foody J.M., Franklin B., Sanderson B., and Southard D., (2007). Core Components Cardiac Rehabilitation/Secondary Prevention Programs: 2007 Update. *Circulation*, 115:2675-2682.

Balas E.A., Jaffrey F., Kuperman G.J., Boren S.A., Browm G.D., Pinciroli F., and Mitchell J.A., (1997). Electronic communication with patients: Evaluation of distance medicine technology. *Journal of the American Medical Association,* 278(2):152-159.

Barnason S., Zimmerman L., Nieveen J., and Hertzog M., (2006). Impact of a tele-health intervention to augment home health care on functional and recovery outcomes of elderly patients undergoing coronary artery bypass grafting. *Heart and Lung*; 35(4):225-233.

Borg G.A.V., (1982). Physiological bases of perceived exertion. *Medicine and Science in Sports and Exercise*, 14(5):377-381.

Brooks G.A., Fahey T.D., and Baldwin K.M. (2005).*Exercise Physiology: Human Bioenergetics and Its Applications*(4th ed.).New York: MacGraw-Hill.6, 574.

Brown C.D., Higgins M., Donato K.A., Rohde F.C., Garrsion R., Obarzanek E., Ernst N.D., and Horan M. (2000). Body mass index and the prevalence of hypertension and dislipidemia. *Obesity Research*, 8(9): 605-619.

Capodaglio P. (2002). The use of subjective rating of exertion in ergonomics. *Giornale Italiano Di Medicina Del Lavoro Ed Ergonomia,* 24(1):84-89.

Ceci R., and Hassmen P., (1991). Self-monitoring exercise at three different RPE intensities in treadmill vs field running. *Medicine and Science in Sports and Exercise*, 23(6):732-738.

Cooper A.F., Jackson G., Weinman J., and Horne R. (2002). Factors associated with cardiac rehabilitation attendance: a systematic review of the literature. *Clinical Rehabilitation,* 16: 541-552.

Dalal H.M., Zawada A., Jolly K., Moxham T., and Taylor R.S. (2010). Home based versus centre based cardiac rehabilitation: Cochrane systematic review and meta-analysis. *British Medical Journal,* 340:5631.

Daltroy L.H. (1985). Improving cardiac patient adherence to exercise regimens: a clinical trial of health education. *Journal of Cardiac Rehabilitation*, 5:40-49.

Dirkin G. (1994). Technological Supports for Sustaining Exercise. In Dishman R.K. (Eds). *Advances in Exercise Adherence* (237-247).

Dishman R.K. (1994). *Advances in Exercise Adherence.* Illinois: Human Kinetics. 188-197.

Dolansky M.A., Stepanczuk B., Charvat J.M., and Moore S.A. (2010). Women's and men's exercise adherence after a cardiac event: Does age make a difference?. *Research in Gerontolocial Nursing*, 3(1):30-38.

Doswell C.A. (2007). Small sample size and data quality issues illustrated using tornado occurrence data. *E-Journal of Severe Storms Meteorology*, 2(5).

Eston R.G., and Williams J.G, (1988). Reliability of ratings of perceived effort regulation of exercise intensity. *British Journal of Sports Medicine*, 22(4):153-155.

Garrouste-Orgeas M., Trouche G., Azoulay E., Caubel A., Lassence A., Cheval C., Montesino L., Thuong M., Vincent F., Cohen Y., and Timsit J.F., (2004). Body mass index: An additional prognostic factor in ICU patients. *Intensive Care Medicine*, 30:437-443.

Gianuzzi P., Saner H., Bjornstad H., Fioretti P., Mendes M., Cohen-Solol A., Dugmore L., Hambrecht R., Hellemans I., McGee H., Perk J., Vanhees L., and Veress G., (2003).Secondary Prevention Through Cardiac Rehabilitation: Position Paper of the Working Group on Cardiac Rehabilitation and Exercise Physiology of the European Society of Cardiology. *European Heart Journal*; 24:1273-1278.

Glantz S.A. (2012). Primer of Biostatistics, Seventh Edition. CD-ROM Computer Software Package. New York: McGraw Hill.

Haahr M. (1998). True Random Number Generator [computer software]. Available from http://www.random.org/. *Last accessed March 2012.*

Hurling R., Catt M., De Boni M., Fairley B.W., Hurst T., Murray P., Richardson A., Sodhi J.S., (2007). Using the Internet and Mobile Phone Technology to Deliver an Automated Physical Activity Program: Randomized Controlled Trial. *Journal of Medical Internet Research*; 9(2):e7.

Kuhls E.A., Sears S.F., and Conti J.B., (2006). Internet-based behavioral change and psychosocial care for patients with cardiovascular disease: A review of cardiac disease-specific applications. *Heart and Lung*, 35:374-382.

Lane D., Carroll D., Ring C., Beevers D.G., and Lip G.Y.H., (2001). Predictors of attendance at cardiac rehabilitation after myocardial infarction. *Journal of Psychosomatic Research*, 51(3): 497-501.

Leslie M., and Schuster P.A., (1991). The effect of contingency contracting on adherence and knowledge of exercise regimens. *Patient Education and Counseling*, 18:231-241.

Lichtman S.W., Pisarska K., Berman E.R., Pestone M., Dowling H., Offenbacher E., Weisel H., Heshka S., Matthews D.E., Heymsfield S.B., (1992). Discrepancy between self-reported and actual caloric intake and exercise in obese subjects. *New England Journal of Medicine*, 327:1893-1898.

Lindsay P., (2009). *Now Is the Time; 170 Ways to Seize the Moment*. New York: MFJ Books.

Mandl K.D., Kohane I.S., and Brandt A.M., (1998). Electronic Patient-Physician Communication: Problems and Promise. *Annuals of Internal Medicine*, 129:495-500.Milani R.V., and Lavie C.J., (1998).The effects of body composition changes to observed improvements in cardiopulmonary parameters after exercise training with cardiac rehabilitation. *Chest*, 113(3):599-601.

Moore S.M., Ruland C.M., Pashkow F.J., and Blackburn G.G., (1998).Women's patterns of exercise following cardiac rehabilitation. *Nursing Research*, 47(6):318-324.

Nigg C.R., (2003).Technology's influence on physical activity and exercise science: the present and the future. *Psychology of Sport and Exercise*, 4:57-65.

Noble B.J., (1982). Clinical applications of perceived exertion. *Medicine and Science in Sports and Exercise*, 14(5):406-411.

Noble B.J., Borg G.A.V., Jacobs I., Ceci R., and Kaiser P., (1983). A category-ratio perceived exertion scale: relationship to blood and muscle lactates and heart rate. *Medicine and Science in Sports and Exercise*, 15(6):523-528.

Oldridge, N.B., (1982).Compliance and exercise in primary and secondary prevention of coronary heart disease: A review. *Preventive Medicine*, 11:56-70.

Oldridge, N.B., (1991). Compliance with cardiac rehabilitation services. *Journal of Cardiopulmonary Rehabilitation*, 11:115-127.

Oldridge N.B., and Jones N.L., (1983).Improving patient compliance in cardiac rehabilitation; Effects of written agreement and self-monitoring. *Journal of Cardiopulmonary Rehabilitation*, 3:257-262.

Robertson L., Smith M., Castle D., and Tannenbaum D., (2006). Using the internet to enhance the treatment of depression. *Australian Psychiatry*, 14(4):413-417.

Robertson R.J., (1982). Central signals of perceived exertion during dynamic exercise. *Medicine and Science in Sports and Exercise*, 14(5):390-396.

Skinner J.S., Hutsler R., Bergsteinova V., Buskirk E.R., (1973). The validity and reliability of a rating scale of perceived exertion. *Medicine and Science in Sports*, 5(2):94-96.

Sniehotta F.F., Scholz U., and Schwarzer R., (2006). Action plans and coping plans for physical exercise: A longitudinal intervention study in cardiac rehabilitation. *British Journal of Health Psychology*, 11:23-27.

Sundararajan V., Bunker S.J., Begg S., Marshall R., and McBurney H., (2004).Attendance rates and outcomes of cardiac rehabilitation in Victoria, 1998.*Medical Journal of Australia*, 180:268-271.

Swain D.P., Abernathy K.S., Smith C.S., Lee S.J., and Bunn S.A., (1994). Target heart rates for the development of cardiorespiratory fitness. *Medicine and Science in Sports and Exercise*, 26:112-116.

Tate D.F., Jackvony E.H., and Wing R.R., (2006). A randomized trial comparing human e-mail counseling, computer-automated tailored counseling, and no counseling in an internet weight loss program. *Archives of Internal Medicine*; 166:1620-1625. Thompson D.R., and Clark A.M., (2009). Cardiac rehabilitation: into the future. *Heart*, 95:1897-1900.

Tortora G.J., and Derrickson B. (2009).*Principles of Anatomy and Physiology* (13th ed). New Jersey: John Wiley and Sons, Inc. G4, G16.

United States Census Bureau. (2011a). *Adult Computer and Adult Internet Users by Selected Characteristics: 2000 to 2010*[Data File]. Retrieved from http://www.census.gov/compendia/statab/2011/tables/11s1157.pdf *Last accessed August 2012.*

United States Census Bureau . (2011b). *Internet Activities of Adults by Type of Home Internet Connection* [Data File]. Retrieved from http://www.census.gov/compendia/statab/2011/tables/11s1157.pdf *Last accessed August 2012.*

Vongvanich P., Paul-Labrador M.J., and Merz N.B., (1996).Safety of Medically Supervised Exercise in a Cardiac Rehabilitation Center. *The American Journal of Cardiology*, 77:1383-1385.

Warburten D.E.R, Nicol C.W., Bredin S.S.D., (2006). Prescribing exercise as preventative therapy. *Canadian Medical Association Journal*, 174(7):961-974

Wyer S.J., Earll L., Joseph S., Harrison J., Giles M., and Johnston M., (2001).Increasing attendance at a cardiac rehabilitation programme: an intervention study using the Theory of Planned Behaviour. *Coronary Health Care*, 5:154-159.