A FORMATIVE ASSESSMENT ON THE EFFECTIVENESS OF USING VIDEOCONFERENCE FOR RESISTANCE EXERCISE: A PILOT STUDY

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A FORMATIVE ASSESSMENT ON THE EFFECTIVENESS OF USING VIDEOCONFERENCE FOR RESISTANCE EXERCISE: A PILOT STUDY

The following faculty members have examined the final copy of this thesis/dissertation for form and content, and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Education with a major in Exercise Science.

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ABSTRACT

Despite the growth of telemedicine as an area of research, few studies to date have applied an interactive audio/video technology to exercise. To date, no publications utilizing a formative assessment process to help determine the effectiveness of an exercise intervention conducted via videoconference. Therefore, the purpose of this study was to develop an applicable formative assessment of resistance exercise conducted via videoconference using the Polycom telenetworking system. Seven college students were randomized into either a videoconferencing (VC) group (n=4) or a home-based (HB) group (n=3). Each group was participated in a three week, three day/week resistance exercise intervention utilizing resistive elastic bands. The VC group conducted all exercise sessions via the Polycom Viewstation with an instructor located at a separate location. The effectiveness of each treatment was assessed with a push-up test, isokinetic testing of the chest press movement, participant adherence and compliance to exercise, and overall acceptance of the technology. No differences in exercise adherence or compliance were noted between the groups. The VC group showed significant improvements in number of push-ups completed (1.75 ± 0.96) and peak torque during the chest press (12.6 ± 7.05 ft·lbs; 16.65 ± 9.19 ft·lbs), while pressing and pulling respectively, when compared to baseline. VC participants related high levels of acceptance for the use of videoconferencing with exercise. This study is the first to provide a foundational framework for the formative assessment of video technologies in exercise and provide evidence to support the use of videoconferencing technologies in larger and more complex exercise study designs.
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CHAPTER 1
INTRODUCTION

In recent years, the interest for use of technology in exercise interventions has grown significantly. Fueling this growing body of research are two distinct phenomena: a) The need to find effective interventions for increasing exercise behaviors in a characteristically sedentary population and b) find ways to reach populations currently underrepresented in the research literature. This pilot study sought to create a formative assessment of the effectiveness and efficiency of a resistance exercise intervention conducted via videoconference by answering the following questions:

1. How do exercise adherence and compliance differ between participants of exercise conducted via videoconference from those exercising on their own at home?
2. Is resistance exercise instructed via videoconference more effective than home based interventions for improving muscular strength and endurance?
3. What are participants’ perceptions of the use of videoconferencing technology for resistance exercise training?
4. What limitations exist for conducting group exercise training with the Polycom system?

This chapter is organized in the following sections: (1) overview of the issues, (2) statement of the problem, (3) purpose of the study, (4) significance of the study, (5) limitations of the study (6) definition of terms, and (7) conclusions.
Overview of the Issues

Over the last few decades, the importance of exercise and physical activity behaviors as a measure of public health has grown across many scientific disciplines (Haskell, Blair, & Hill, 2009; Haskell et al., 2007). The perception among health professionals that regular exercise is a sin qua non of good health is evidenced by the Exercise is Medicine global initiative and the Healthy People 2020 physical activity goals for the American population ("Exercise is Medicine," 2008; "Healthy People 2020,"). Aerobic exercise such as walking, jogging, or cycling is the most common mode for exercise activity among clinical and general populations, and has demonstrated a wide array of health benefits; resistance exercise has shown to have physiological and psychological benefits independent of aerobic exercise (Ruiz et al., 2009). Exercise has been shown to be safe and effective across a broad range of health conditions and populations (Haskell, et al., 2009; Ruiz, et al., 2009), but a large percentage of the American population are not currently meeting physical activity guidelines set forth by public health officials (Haskell, et al., 2009). Furthermore, effective resistance exercise requires the use of proper biomechanics, making the benefits of resistance exercise less attainable for those without access to professional instruction or instructive materials.

In order to improve exercise adherence and compliance, many studies (Beauchamp, Carron, McCutcheon, & Harper, 2007; Cohen-Mansfield, Marx, Biddison, & Guralnik, 2004; Jette et al., 1998; van Stralen, Lechner, Mudde, de Vries, & Bolman, 2010) have focused on investigating individual exercise preferences or the determinants of exercise behavior. These studies are guided by the central tenet that by illuminating which factors surrounding the exercise experience make exercise activity more palatable to individuals, interventions can be developed that will improve adherence rates, subject recruitment and retention, and overall measures of
health. A study (Cohen-Mansfield, et al., 2004) of older adult exercise preferences identified several factors as being either important or very important when deciding to participate in an exercise program. Chief among these preferences are quality of instruction, type of exercise, advice of a physician, proximity of location, health evaluation and monitoring by a professional, and exercise evaluation by a professional. Furthermore, participants in this study expressed a desire to exercise alone at home. While this preference is supported by other studies (A. C. King et al., 2000), another possible explanation for this phenomenon is the demographics of group exercise classes. Group exercise classes tend to be populated by younger individuals (Burke, Carron, & Eys, 2005), and this fact may dissuade an older population from participating. This explanation is supported by a study (Beauchamp, et al., 2007) that concluded that preference for participation in group exercise is dependent upon the age make-up of the exercise class. Older adults, like younger adults, prefer to exercise in a group of their peers. This notion is supported by the Self Determination Theory (SDT) which theorizes behavior as partly dependent on social norms and the need for human contact (Alvers, 2010; Beauchamp, et al., 2007). What this information suggests is that interventions designed to promote exercise adherence should focus on creating exercise environments that are led by exercise professionals, supported by physicians, and populated by age-matched peers. While professionally led group exercise interventions are well represented in the literature with positive results (Dishman & Buckworth, 1996), noted barriers to such interventions are access to exercise facilities, transportation to the facility, and facility location (Mathews et al., 2010; Romero, 2005).

While logistical barriers are ever present in health care delivery, remote or home-based exercise interventions are commonly used to overcome these barriers. While home-based exercise interventions have been effective for improving physical activity, measures of quality of
life, and personal control beliefs regarding exercise, these are often self-reported measures (Ashworth, Chad, Harrison, Reeder, & Marshall, 2005). Furthermore, such interventions typically involve walking as the only mode of exercise, and the benefits of resistance exercise remain largely relegated to individuals who can participate in facility based, professionally instructed, programs (McTigue et al., 2009; Weinstock et al., 2011). The fallout from this approach to large scale exercise promotion interventions is two-fold: Large numbers of individuals do not receive the benefits of regular resistance exercise, and the importance of resistance exercise is not promoted on a large scale, and thus decreases public awareness.

The advancement of technology over the last several decades has provided creative methods for attempting to solve the problem of large scale resistance exercise interventions. Common methods include the use of VHS or DVD recorded demonstrations of proper exercise technique that can be mass produced and given to study participants (Tudor-Locke et al., 2000). Other studies (McTigue, et al., 2009; Slootmaker, Chinapaw, Schuit, Seidell, & Mechelen, 2009) have used internet communication, synchronous or asynchronous (McTigue, et al., 2009; Tudor-Locke, et al., 2000; Weinstock, et al., 2011), to provide instruction and participant follow-up. More recently, the field of telemedicine has provided a growing number of studies utilizing more advanced forms of technology for providing remotely delivered health services across a broad range of disciplines (Ekeland, Bowes, & Flottorp, 2010; van den Berg, Jw, & Tpm, 2007). While the field of telemedicine is new and growing, results from study reviews show that telemedicine is promising as an effective method for physical activity interventions, and could be crucial to the advancement of knowledge in the fields of exercise science and public health. Technology used for videoconferencing could potentially allow for successful provider-client interaction in a group exercise setting. By allowing exercise professionals to instruct,
demonstrate, observe and correct proper mechanics for executing resistance exercises, videoconferencing can potentially overcome the barriers to large scale resistance exercise while simultaneously meeting the requisites for effective training and culturally relevant exercise preferences.

Statement of the Problem

Despite the growth of telemedicine as an area of research, few studies to date have applied an interactive audio/video technology to the area of physical activity or exercise (Ekeland, et al., 2010; van den Berg, et al., 2007). Those telemedicine studies that have used exercise interventions are rehabilitative in nature, and therefore focus primarily on specific clinical outcomes or the efficacy of the technology (van den Berg, et al., 2007). A review of these studies (van den Berg, et al., 2007) concluded that the use of telemedicine in exercise is promising but effectiveness is inconclusive. The varied nature of study outcomes, technology, populations, and methods make generalizing efficacy difficult. Furthermore, a noted lack of formative assessments with regard to telemedicine and exercise means little or no evidenced based conclusions can be drawn regarding effectiveness. The use of interactive technologies for improving measures of health and physical activity may be deemed efficacious given that the equipment in question performed as designed and clinical outcomes were met, but, without data on how the technology is perceived or accepted by both participants and providers, it may not prove effective in practical use. To date, there are no publications utilizing a formative assessment process to help determine the effectiveness of a resistance exercise intervention conducted via videoconference.
Purpose of the Study

In light of the afore mentioned gap in the research literature regarding the use of formative assessments in telemedicine, interactive technologies in resistance exercise interventions, and videoconferencing for group exercise, new methods for understanding, promoting, and utilizing resistance exercise as a public health intervention remain understudied. Videoconferencing presents as a potentially useful method of interfacing with remote, culturally isolated, or resource limited populations that remain underrepresented in both exercise and public health research. Interactive technologies have been utilized in health care research in an effort to find cost effective measures for providing care to remote populations without the associated time and monetary cost associated with either provider or client travel (Ekeland, et al., 2010). While these studies have shown promise for the use of videoconferencing technologies in physical activity and exercise interventions (Ekeland, et al., 2010; van den Berg, et al., 2007), the use of any new or understudied technology with regard to exercise presents challenges that must be overcome before large scale interventions are initiated. First, the technology itself must be deemed efficacious in creating beneficial clinical or physiological health outcomes. Second, the technology must be deemed effective by establishing a high level of acceptance from users. Finally, user perceptions and feedback regarding the technology should be used to review, evaluate, and design future interventions to maximize cost effectiveness and the effectiveness of the intervention. Therefore, the purpose of this study was to develop an applicable formative assessment of resistance exercise conducted via videoconference using the Polycom telenetworking system. The study aimed to meet this objective by answering the following questions:
1. How do exercise adherence and compliance differ between participants of exercise conducted via videoconference from those exercising on their own at home?

2. Is resistance exercise instructed via videoconference more effective than home based interventions for improving muscular strength and endurance?

3. What are participants’ perceptions of the use of videoconferencing technology for resistance exercise training?

4. What limitations exist for conducting group exercise training with the Polycom system?

We hypothesized that 1) adherence and compliance to the resistance exercise intervention would be better in the teleconferencing group versus the home-based group, 2) exercise instructed via videoconference would be more effective for improving muscular strength and endurance, and 3) the Polycom networking system would have a high level of user acceptance.

Significance of the Study

The limited number of telemedicine studies that utilize exercise as an intervention, and the lack of formative assessments with regard to videoconferencing and resistive type exercise is significant in that large scale studies greatly depend on the effective use of technology. This pilot study sought to create a foundation for creating effective videoconferencing technologies in resistance exercise through the use of a formative assessment process. The development of such formative assessments adds to the current body of research by providing a framework for closing an identified research gap in and expanding the field of telemedicine and exercise.
Limitations and Assumptions of the Study

Videoconferencing provides the ability to interactively conduct exercise sessions between a central facility and a convenient remote location. Theoretically, this would provide the convenience of home-based, or near home, exercise programs with the quality and social benefits of facility-based group exercise. The nature of the participants used in this study, and the logistical constraints of this pilot study, made it necessary to assume the university campus met the requirement of a mutually convenient location for all videoconferencing participants.

Although this study was designed to gather real data about the effectiveness of resistance exercise conducted via videoconference, and assess user acceptance of the technology, there were two major limitations of the study. The first limitation is the extent to which the data collected from a population of students from a Midwestern university can be generalized to other populations in which videoconferencing technology may be useful. Secondly, the small sample size used in the study limit the power of statistical results and the acceptable frame of inference regarding the efficacy of the intervention.

Finally, a full discussion of limitations to the current study would not be complete without mention of the sociocultural and political factors that may influence the perceptions of technology, its usefulness, and its place in health care. While these factors lie beyond the scope of the data collected in this study, their importance to user acceptance of technology must be considered and are regarded as crucial to further investigations using exercise and technology.

Definition of Terms
Aerobic exercise- exercise involving large muscle groups with the intention of stressing aerobic energy systems in order to make specific health or performance improvements (Kamen, 2001).
Exercise- organized, planned, and structured activity with the goal of improving health parameters or athletic performance (Kamen, 2001).

Exercise is Medicine- A global interdisciplinary initiative designed to promote physical activity and exercise as pivotal to Public Health ("Exercise is Medicine," 2008)

Formative assessment- An assessment that is specifically designed to provide feedback from the user to help adapt, improve, and accelerate learning (Sadler, 1998).

Physical activity- any physical movement caused by skeletal muscles that requires energy expenditure (Caspersen, Powell, & Christenson, 1985).

Resistance exercise- exercise intended to improve local muscular endurance, muscular strength, and/or power (Kamen, 2001).

Self Determination Theory- A theory that humans are oriented toward healthy behavior so long as certain physical and psychological needs are met. These needs are categorized into the concepts of autonomy, competence and relatedness (Ryan & Deci, 2000).

Technology Acceptance Model- Developed in the 1985, the technology acceptance model (TAM) explores the predictor variables for user acceptance and future use of technology. The theory focuses on perceived usefulness and perceived ease of use of technologies to predict behavior intentions and level of adoption with regard to technology (Bagozzi, Davis, & Warshaw, 1992).

Telehealth- “The use of electronic information and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health, and health administration (Shaw, 2009).”
Telemedicine- “The use of telecommunications technology for medical diagnostic, monitoring, and therapeutic purposes when distance separates the users (Shaw, 2009).”

Telerehabilitation- “The use of electronic communication and information technologies to provide rehabilitation at a distance (Shaw, 2009).”
CHAPTER 2
REVIEW OF THE LITERATURE

Videoconferencing presents as a potentially useful method of interfacing with remote, culturally isolated, or resource limited populations that remain underrepresented in both exercise and public health research. Interactive technologies have been utilized in health care research in an effort to find cost effective measures for providing care to remote populations without the associated time and monetary cost associated with either provider or client travel. While these studies have shown promise for the use of videoconferencing technologies in physical activity and exercise interventions, the use of any new or understudied technology with regard to exercise presents challenges that must be overcome before large scale interventions are initiated. Therefore, further examination of these issues is warranted. This study sought to develop a formative assessment for evaluating the effectiveness of videoconferencing for resistance exercise interventions.

The related discussion in this chapter is organized into the following sections: (1) exercise as medicine, (2) resistance exercise, (3) exercise adherence and participation, (4) telemedicine, and (5) the need for formative assessments.

Resistance Exercise

A full discussion of the physiological response to resistance training is beyond the scope of this paper. However, certain responses to resistance training are particularly meaningful with regard to the general population as well as populations with chronic conditions. Resistance exercise has shown to be beneficial to improvements in physical functioning, bone density, glycemic control, protein metabolism and muscular strength and mass (Wolfe, 2006). Robert
Wolfe explains the importance of maintaining an adequate amount of lean muscle mass for survival during periods of inadequate nutritional intake or acute stress. Vital organs and tissues depend on amino acids in the blood to support function and viability (Wolfe, 2006). Since most of the amino acid surplus provided during nutritional intake is stored as muscle proteins, the breakdown of muscle protein in low-nutritional states creates blood amino acid levels that can support vital organs and tissues. Therefore, Wolfe concludes that maintaining and increasing muscle mass may allow individuals to safely endure extended periods of low nutritional intake such as during the treatment of cancer or other conditions marked by sarcopenia (Wolfe, 2006).

A recent prospective health study found a significant inverse relationship between muscular strength and cancer mortality in men (Ruiz, et al., 2009). This relationship remained significant even after adjustment for other confounders such as age, smoking, alcohol intake, health status or cardiorespiratory fitness.

The process of aging itself is associated with physiological decline including sarcopenia, reduced bone density, and frailty. In addition, older populations are more likely to suffer from chronic conditions such as metabolic disorders, diabetes, and heart disease. Resistance exercise has effectively been used in persons with type 2 diabetes to improve muscular strength, glycemic control, insulin sensitivity, and endothelial function (Cohen et al., 2008). There is suggestive evidence that the genesis of insulin resistance and other metabolic disorders may be more related to the metabolism of fatty acids within muscle than the amount of free fatty acids in the blood (Wolfe, 2006). Thus, improvements in muscle function and metabolism acquired through exercise are critical to the long-term survival of individuals predisposed to insulin resistance. Again, this supports the notion that independent of traditionally recognized measures of health, irregularities in muscle function and decreased strength may predispose individuals to chronic
conditions like metabolic syndrome, diabetes, osteoporosis, and CVD. Improvements in endothelial function may attenuate the progression and development of CVD. In a study by Cohen et al., improvements in endothelial function occurred after a long term resistance exercise intervention (Cohen, et al., 2008). However, as no control group was used during this study it is unclear whether the observed improvements were due to resistance training or secondary to lifestyle changes inherent to participation in an exercise trial such as dietary changes, improved glycemic control, and better self-monitoring (Cohen, et al., 2008).

Exercise Adherence and Participation

The physiological benefits of exercise, and its usefulness as primary, secondary, and tertiary prevention in chronic disease, are well established (Haskell, et al., 2009; Haskell, et al., 2007). Furthermore, resistive exercise used to improve muscular size and strength has been shown to be an important indicator of future mortality and morbidity (Ruiz, et al., 2009). The study conducted by Ruiz et al. (2009) indicated an inverse relationship between muscular strength and mortality from cancer and all-cause mortality in men. This relationship remained significant after adjustments for measures of aerobic fitness, alcohol intake, smoking habits, and other measures of healthy behaviors (Ruiz, et al., 2009). While this underscores the importance of and need for exercise interventions that employ the use of resistance exercises, it must be remembered that the health benefits gained through exercise can only be maintained through continued exercise behaviors.

Effective and safe resistance exercise training or therapy requires the use of proper body mechanics and technique. To ensure these requisites are met, proper supervision by qualified personnel is essential. For this reason, many training, rehabilitative, and therapy interventions
using resistance exercise are conducted at training facilities under the supervision of an exercise professional. While these programs are effective at improving health outcomes, the location of and transportation to such facilities are noted barriers to program use and adherence (Ashworth, et al., 2005; Mathews, et al., 2010; Romero, 2005). Furthermore, these logistical barriers coupled with the associated expense of operating, staffing, and maintaining training or rehabilitative facilities make resistance exercise interventions less effective at targeting populations that may benefit the most.

Current studies suggest that greater than 60% of American adults do not meet the recommended guidelines for physical activity (Haskell, et al., 2009; Haskell, et al., 2007). Explaining the factors associated with regular participation in physical activity or exercise remains a crucial focus for researchers in the fields of psychology, sociology, public health, and exercise science. By investigating factors that determine exercise behaviors, researchers are better able to design intervention strategies to improve exercise habits among various populations. These factors include personal attitudes and perceptions about exercise, self-efficacy and control beliefs, social norms, the environment in which exercise takes place, and preferences for exercise mode. The latter has garnered much attention based on the theory that interventions designed to fit individual or group preferences would increase exercise participation and long term adherence.

A study examining exercise preferences has found that over 70% of older adults rate quality of instruction, type of exercise, advice of a physician, proximity of location, health evaluation and monitoring by a professional, and exercise evaluation by a professional to be either important or very important for participating in an exercise program (Cohen-Mansfield, et al., 2004). Furthermore, an inverse relationship ($r= -0.116$) was found between age and a
preference for exercising in a group or class setting, and that older adults, given proper instruction, would be interested in exercising at home (Cohen-Mansfield, et al., 2004). This would suggest that older adults prefer to exercise alone and at home. The preferences of older adults noted by Cohen-Mansfield et al (2004) support an existing body of literature that indicate individual home-based exercise interventions are more preferable, and therefore promote better adherence, than group based exercise programs (Ashworth, et al., 2005; A. C. King, et al., 2000). Contrary to this line of thinking, Beauchamp et al (2007) proposed that the age related decline in preference for group exercise is less related to the age of the individual but rather the age make-up of the group itself. In a study of 947 individuals ranging in age from 30-91 years, exercise preferences were assessed across five age categories (30-39, 40-49, 50-59, 60-69, and 70+). Comparable to previous studies, a general increase in preference for exercising alone was noted with increases in age; however, significant group effects were noted when asking participants about group age preferences. A greater preference for exercising with groups of similar age was noted across all age groups (Beauchamp, et al., 2007). This suggests that older adults, comparable to younger adults who prefer group exercise, are not wholly opposed to exercise in a social setting. The expressed preference for exercising alone noted in the literature may be representative of demographic variables associated with group exercise. In fact, many studies investigating the determinants of exercise behaviors in various populations are guided by Self-Determination Theory (SDT), of which relatedness is a key factor for behavior. Relatedness addresses the influence of others and the environment on human behavior, and it pertains to the human need for social interaction. In a recent paper (Alvers, 2010) on community-based exercise programs for older adults, Alvers discusses the importance of a group format for improving exercise adherence in older adults. Comparable to Beauchamp et al (2007), Alvers
(2010) explains that the social interaction provided by group exercise may meet the psychological needs of a population often affected by depression and social isolation. Furthermore, in a population that may not wholly adopt or accept the concept of exercise as medicine due to generational differences, creating a social context for exercise may establish the behavior as an imperative better than conceptualizing it as prescribed behavior (Alvers, 2010).

Telemedicine

The relatively new field of Telemedicine attempts to bridge the gap between the efficacy of face-to-face care and an effective solution to remote clinical and public health interventions. Telemedicine refers to any use of information communication technology, or internet based interventions, in the area of health care, diagnosis and treatment, or social care that may serve health care professionals and clients with chronic disease or illness. Thus far, no consensus has been achieved as to the cost effectiveness, clinical effectiveness, client perceptions, or sustainability of telemedicine as an alternative to face-to-face care (Ekeland, et al., 2010). Several problems face researchers in developing quality studies that can be used to create evidenced based interventions in telemedicine. Telemedicine may present itself as a useful alternative for many disciplines, populations, and intervention designs, so current studies in telemedicine are widely varied in methodology, endpoints, and limitations. Therefore, finding quality studies with methodologies and evaluations of outcomes on which to base a review can be challenging.

A review of internet-based physical activity interventions concluded that there is indicative evidence to support the effectiveness of internet website based interventions over control interventions using informational tools or e-mail communication alone (van den Berg, et
al., 2007). One study used asynchronous web based instructional lessons and electronic messaging to provide lifestyle coaching to individuals with diabetes (McTigue, et al., 2009). Participants were provided written instructional material and pedometers and asked to log onto an internet site in through which dietary and physical activity coaching were provided. The study lasted one year with weekly lessons the first 16 weeks and 8 monthly sessions thereafter. Authors concluded that web-based instruction for lifestyle coaching is effective, but only 44% of participants regularly logged in for the first 16 weeks, and only 16% completed more than 20 sessions (McTigue, et al., 2009). In a similar study, individuals with diabetes were given instructional materials and pedometers to promote and assess physical activity, but synchronous coaching was implemented using videoconferencing (Weinstock, et al., 2011). Physical activity data were reported during daily videoconferencing sessions. The study found that the rate of decline in physical activity was lower in the videoconferencing group compared to a usual care control group, but no adherence or compliance data were assessed (Weinstock, et al., 2011). Van den Berg, et al. (2007) caution that the methodological limitations to the 10 studies they reviewed make generalized conclusions regarding internet-based physical activity interventions difficult. Participant drop-outs may be responsible for the low number of studies using an intent to treat analysis, and a number of the studies reviewed did not use objective measures for physical activity outcomes (van den Berg, et al., 2007). One study used videoconferencing to implement a resistance training program for older adults suffering from knee pain (Wong, Hui, & Woo, 2005). In a 12 week intervention, 20 adults over the age of 60 years performed once a week exercise sessions at one of two group exercise locations. Participants were assigned to a group exercise location based on the address of their residence. Exercise groups videoconferenced with physiotherapists at a local hospital for each exercise session. Authors
reported improvements in physical functioning as well as reductions in knee pain. Adherence rates in the videoconferencing groups was high (91%), and authors reported that 80% of participants agreed or strongly agreed that the videoconferencing system had positive qualities (Wong, et al., 2005). While Wong, et al. (2005) conclude that the use of videoconferencing for exercise is effective and has potential, the assessment of technology acceptance was not guided by a validated theoretical model, and the limitations of the videoconferencing system as perceived by both provider and user were not assessed. Even in light of such limitations, telemedicine remains a promising and potentially useful tool for reaching remote populations that may not be able to participate in other study designs.

In addition to promising usefulness in remote populations, telemedicine may be beneficial in promoting health awareness and education in populations with low health literacy. A review of nutrition and physical activity interventions in low income populations revealed that interactive and visual interventions may be more useful for education and awareness purposes due to the low levels of education and health literacy associated with low socioeconomic status (Chaudhary & Kreiger, 2007). Many of the interventions used interactive CD-ROMs, multimedia advertisements, adverts placed within culturally competent television programs, internet communication, and experiential learning such as cooking demonstrations and classes (Chaudhary & Kreiger, 2007).

The Need for Formative Assessments

Despite the growth of telemedicine as an area of research, few studies to date have applied an interactive audio/video technology to the area of physical activity or exercise (Ekeland, et al., 2010; van den Berg, et al., 2007; Weinstock, et al., 2011; Wong, et al., 2005).
Those telemedicine studies that have used exercise interventions are rehabilitative in nature, and therefore focus primarily on specific clinical outcomes or the efficacy of the technology (van den Berg, et al., 2007; Wong, et al., 2005). A review of these studies (van den Berg, et al., 2007) concluded that the use of telemedicine or telerehabilitation in physical activity or exercise is promising but effectiveness is inconclusive. The varied nature of study outcomes, technology, populations, and methods make generalizing efficacy difficult. Furthermore, a noted lack of formative assessments with regard to telemedicine and exercise means little or no evidenced based conclusions can be drawn regarding effectiveness (Ekeland, et al., 2010; van den Berg, et al., 2007; Wong, et al., 2005). The use of interactive technologies for improving measures of health and physical activity may be deemed efficacious given that the equipment in question performed as designed and clinical outcomes were met, but, without data on how the technology is perceived or accepted by both participants and providers, it may not prove effective in practical use. At this writing, no published studies currently exist utilizing a formative assessment process to help determine the effectiveness of a resistance exercise intervention conducted via videoconference.

In light of the afore mentioned gap in the research literature regarding the use of formative assessments in telemedicine, interactive technologies in resistance exercise interventions, and videoconferencing for group exercise, new methods for understanding, promoting, and utilizing resistance exercise as a public health intervention remain understudied. Videoconferencing presents as a potentially useful method of interfacing with remote, culturally isolated, or resource limited populations that remain underrepresented in both exercise and public health research. Interactive technologies have been utilized in health care research in an effort to find cost effective measures for providing care to remote populations without the
associated time and monetary cost associated with either provider or client travel (Ekeland, et al., 2010). While these studies have shown promise for the use of videoconferencing technologies in physical activity and exercise interventions (Ekeland, et al., 2010; van den Berg, et al., 2007), the use of any new or understudied technology with regard to exercise presents challenges that must be overcome before large scale interventions are initiated. First, the technology itself should be efficacious in creating beneficial clinical or physiological health outcomes. Second, the technology should be assessed as effective by establishing a high level of acceptance from users. Finally, user perceptions and feedback regarding the technology should be used to review, evaluate, and design future interventions to maximize cost effectiveness and the effectiveness of the intervention. Therefore, the purpose of this study was to develop an applicable formative assessment of resistance exercise conducted via videoconference using the Polycom telenetworking system.
CHAPTER 3
METHODOLOGY

This chapter describes the methods and data used to address the research questions presented in this study. Discussion in this chapter include: (1) restatement of the research questions answered by the study, (2) description of the site and participant selection process, (3) explanation of instruments and measures used for data collection, (4) discussion of study procedures, (5) description of data analysis used, and (6) assurances regarding the protection of human subjects.

Research Questions

The promising nature of telehealth makes the use of videoconferencing technology for Public Health exercise interventions appealing to both Public Health professionals and exercise scientists. The lack of formative assessments with regard to this technology makes the feasibility of large scale studies tenuous. This pilot study sought to create a formative assessment of the effectiveness and efficiency of a resistance exercise intervention conducted via videoconference by answering the following questions:

5. How do exercise adherence and compliance differ between participants of exercise conducted via videoconference from those exercising on their own at home?

6. Is resistance exercise instructed via videoconference more effective than home based interventions for improving muscular strength and endurance?

7. What are participants’ perceptions of the use of videoconferencing technology for resistance exercise training?

8. What limitations exist for conducting group exercise training with the Polycom system?
Site and Participant Selection

This study was conducted at Wichita State University (WSU) in Wichita, Kansas. Baseline and post-treatment measures were assessed in a laboratory setting. All videoconferencing was conducted within the same laboratory with the exception of a remote room, located in an adjacent building, in which the exercise instructor was located for videoconference. The selection of these sites for the study was chosen for three main reasons: (1) access to necessary equipment for study procedures, (2) time constraints regarding room availability, and (3) convenience of the location for participant use.

Since this study used the Polycom videoconferencing system, the sites selected for conducting each exercise session had to have a large screen television, an active Ethernet port available, and approximately 100 square feet of free space available for exercise. Furthermore, each room meeting the aforementioned requirements needed to be available for use at a convenient time for the duration of the study. Finally, the location for group exercise had to be a commonly convenient location for all participants in order to prevent location from being a limiting factor for exercise adherence. The need for location convenience was an influencing factor in participant selection as well as site selection.

Participants

Due to the nature of the research questions, time available for the study, and the logistical constraints of the study, convenience sampling was used. While convenience sampling limits the extent to which results can be generalized to the populations that may benefit from exercise conducted via videoconference, convenience sampling is useful for pilot studies on the feasibility of interventions for use in future research.
The participants of this study were undergraduate student volunteers at WSU. Seven participants, age ranging from 20 to 51 years (median age=21 years), were recruited from undergraduate courses in the Human Performance Studies Department of WSU. Each participant, subsequent to written and verbal consent, was randomly assigned to one of two treatment groups, a home-based (HB) group (n=3) or a videoconference (VC) group (n=4). Participant randomization was based on the last two digits of each student identification number and a random number sheet obtained electronically through a web site ("Stat trek," 2011). HB was made up of 2 females and 1 male ranging in age from 20 to 51 years (median age = 21), while VC was composed of 2 females and 2 males ranging in age from 20 to 41 years (median age=21).

Each participant was asked to fill out a brief questionnaire (appendix A) to assess exercise history. Overall years of experience ranged from zero to nine years with a combination of resistance and aerobic exercise being the most common type of training used.

Instruments and Measures

Discussion of the instruments and measures used during this pilot study include: (1) videoconferencing, (2) exercise interventions, (3) muscular strength and endurance testing, (4) adherence and compliance, and (5) acceptance of technology.

**Videoconferencing**

Videoconferencing during this study was conducted using the Polycom VeiwStation FX (Polycom, Pleasonton, CA, USA). The Polycom VeiwStation FX was chosen for use in this pilot study due to the availability of the technology and videoconferencing features that facilitate
its use in an exercise setting. The system enables the user to control camera functions from both the near and far (remote) locations. The “continuous presence” mode allows all sites involved in conferencing to be viewed at once on any site’s monitoring system. Each site used in this study was equipped with a Polycom ViewStation, a high definition television (HDTV), Polycom remote control, external microphone, and an active Ethernet port for communication between site locations. The remote location, used by exercise instructors during this study, was also equipped with a digital video disk recorder to facilitate the audio and visual recording of each exercise session. All device configurations, settings, and usage were in accordance with each device’s manufacturer instructions for proper set up, use, and care of the equipment.

**Exercise Interventions**

The HB and VC study groups were given the same resistance exercise program. The resistive type exercises were performed using elastic bands of various tensions. Thera-Band elastic bands of colors black, blue, and green were available for use by study participants. Elastic bands have safely and effectively been used as a cost effective method for improving muscular strength and muscular endurance in various populations (Colado & Triplett, 2008; Jette, et al., 1998). One band of each color (black, blue, and green) was given to each of the HB participants along with written instructions (appendix B) on which exercises to complete, how to execute each exercise movement with pictures demonstrating each movement, how to perform each exercise session, and how to evaluate and record the relative intensity of each session. The intensity of each session was assessed using a Borg rate of perceived exertion (RPE) scale ranging from 6 (very, very light exertion) to 20 (maximal exertion). In accordance with the study by Jette et al (1998), the goal for each exercise session was an RPE of 15 (hard) in order to
ensure an effective stimulus was applied during exercise. The use of RPE for evaluating intensity with regard to resistance training has been well studied, and high correlations between RPE and traditional methods for prescribing intensity for resistance exercise (Day, McGuigan, Brice, & Foster, 2004). For this study, participants were asked to evaluate the difficulty of each session immediately after the conclusion of each session. While this may cause each rating to be skewed by the relative difficulty, or lack thereof, at the end of each session (Day, et al., 2004), acquiring delayed responses was considered unlikely in the case of the VC group, so an immediate response protocol was used. HB participants verbalized understanding how and when to assess and record RPE for each session, and each was given written instructions to take home for reference. VC participants received verbal and written instructions at the conclusion of the first exercise session, and were provided only written instructions for each subsequent exercise session. Exercise logs (Appendix D) were provided to participants to record the length of each exercise session and the corresponding RPE.

Two different exercise programs were used during the three week intervention. The programs were labeled “Workout A” and “Workout B”. Participants were instructed to perform each program for alternating exercise sessions. For example, during weeks 1 and 3, “Workout A” would be performed on Monday and Wednesday, and “Workout B” would be performed on Friday; the schedule would be reversed during week 2.

Each exercise session included a five minute warm-up, approximately 30-40 minutes of strengthening, and a 5 minute cool-down. The strengthening portion of each session consisted of 1-2 repetitions of 10 exercises (appendix B). For each movement, participants were instructed to use a resistance that would allow them to complete no more than 10 repetitions with proper form. Participants were instructed to increase the resistance used when they could complete more than
10 repetitions comfortably with proper form. Participants were instructed that resistance could be increased by decreasing the length of the resistance band(s), using a band with higher tension, or by adding additional bands. Each individual in the HB group was given written and verbal instructions for each movement as well as demonstrations. Each individual in the HB group was able to verbally confirm and demonstrate understanding of each movement prior to starting the exercise intervention. Participants were allowed to contact researchers via e-mail if questions should arise during the intervention. VC participants were provided instructions and demonstrations during each exercise session to elucidate data on the use of the videoconferencing system.

**Muscular Strength and Endurance Testing**

In order to determine, in part, the effectiveness of using videoconferencing technologies for resistance exercise interventions, baseline and post-treatment measures of muscular strength and endurance were assessed. Muscular strength and endurance were assessed on every participant at baseline and post-treatment using an isokinetic dynamometer and a timed push up test.

The chest press movement was chosen as the ideal movement for determining global upper body strength as it employs the use of multiple muscles of the trunk, shoulder, and upper arm. The chest press has often been used successfully as a measure of upper body strength in multiple athletic and clinical populations (Hass, Collins, & Juncos, 2007; Miszko et al., 2003; Vossen, Kramer, Burke, & Vossen, 2000). Bilateral skeletal muscle strength and endurance during the seated chest press movement was assessed using an isokinetic dynamometer (BIODEX®; System 4 Pro, New York, NY, USA) with microprocessor that was calibrated for
torque and angular velocity according to manufacturer protocols. The chest press movement was simulated by modifying the elbow flexor/extensor protocols for the dynamometer. The elbow flexor/extensor attachment arm was used with the subject’s arm flexed 90 degrees and the shoulder horizontally flexed 90 degrees, with the scapula retracted, for the starting position of the chest press. Small adjustments to the start position were then made to allow for comfort depending on each individual’s anthropometry and range of motion. Similar modifications have been made in other studies using isokinetic dynamometry for a chest press movement (Meredith-Jones, Legge, & Jones, 2009). Limb position and a torque correction for limb weight are calibrated prior to each movement pattern. Limb and torso alignments and machine settings were recorded at the time of baseline and replicated for endpoint. Full range of movement within the constraints of the equipment was prescribed for each movement pattern in order to eliminate errors that could be caused by participants who failed to complete full repetitions. Standard instructions were issued with regard to both the technique and the maximal effort required during each test. The participants then practiced the movement patterns just prior to each trial. If smooth curves for torque are not obtained during practice, they are required to repeat these after a brief rest. Strength of the seated chest press movement were measured as the peak angular force (torque, ft∙lbf) generated during three maximal continuous repetitions at 60°.sec⁻¹ angular velocity. Following two minutes of rest, endurance was determined as the total angular work (ft∙lbf) achieved during the middle 16 of 20 consecutive maximal repetitions at 240°.sec⁻¹. A recovery period of two minutes was allowed between each of the two (ie. pressing strength and pressing endurance) maneuvers.

A one minute maximum repetition push up test was used to further assess each subject’s upper body muscular strength and endurance. A modification of the United States Army’s push
up protocol was used for the push up test (U.S. Department of the Army, 1992). Subject’s were instructed that they had one minute to complete the maximum number of push ups possible while maintaining proper form. Each individual was instructed to place hands at shoulder width with fingers facing forward. Males were instructed to perform each push up with hands and toes being the only points of contact while maintaining a flat back, and hips in line with the shoulders and ankles, creating a straight line between the subject’s shoulders and ankles. Females were instructed to use the same position as males with the exception that females performed each push up with the knees in contact with the ground instead of the toes. Each test began with participants in the high position with elbows extended. Time was started as soon as each participant began lowering his or her body for the first repetition. The low position was reached when the individual’s arm was flexed to at least 90 degrees, and a return to full elbow extension signified completion of one repetition. All participants received the same instructions on testing procedures and proper positioning. Each participant related understanding of the procedures verbally, and demonstrated proper push up form prior to the initiation of the test. All baseline and post-treatment push up tests were evaluated and graded by the same rater to avoid interrater disagreement given the low interrater reliability of push up tests using a 90 degree elbow flexion as the criterion for the low position for each correct repetition. The use of this criterion would allow field tests to be completed via videoconferencing; however, logistical constraints made a proof-of-concept test using videoconferencing equipment and a push up field test unfeasible. The push up test has been recognized as a useful field measurement of upper body strength and endurance with established construct validity and strong interrater reliability (Baumgartner, Oh, Chung, & Hales, 2002).
Adherence and Compliance

To appropriately determine the effectiveness and efficiency of the resistance exercise intervention, measures of exercise adherence and exercise compliance need to be assessed. Comparable with assessment methods used in a large home-based resistance exercise study (Jette, et al., 1998), adherence to exercise behavior was seen as synonymous with continued exercise participation. To assess exercise adherence, all participants were asked to log the days, times, and intensities of each exercise session completed. From this data, exercise adherence was determined by the number of exercise sessions completed divided by the total number of prescribed exercise sessions for the three week intervention.

While participation or adherence rates are important for describing general exercise behavior patterns, they do not provide accurate measures of compliance to a prescribed intensity or programming. Exercise compliance for both treatment groups was assessed based on the number of exercise sessions completed at the prescribed intensity. Each week in which an individual completed at least two of the three exercise sessions at the prescribed intensity would be summed and divided by the number of weeks included in the intervention period. For example, if an individual performed a majority of exercise sessions at the prescribed intensity in weeks 1 and 3, but failed to reach an appropriate intensity during week 2, then that individual’s overall compliance score would be 0.66 or 66% compliance. This method was used primarily for appropriate comparison measures between this pilot study and larger home-based resistance studies (Jette, et al., 1998) utilizing similar methodologies.
Acceptance of Technology

In order to meet the primary objective of this pilot study, elucidating participant perceptions and feedback regarding the technology was critical for the development of a formative assessment regarding videoconferencing technology used for resistance exercise. A 17 question technology response questionnaire was developed using the Technology Acceptance Model (TAM) as a theoretical guide, and can be referenced in appendix C. The TAM was developed in 1986 for studying computer usage in an age of ever advancing technologies. The TAM has been used in numerous fields to determine and predict user acceptance and future usage of various technologies with demonstrated validity and reliability (Chau, 1996).

Developed out of the Theory of Reasoned Action, the TAM posits that usage of technology is largely determined by the perceived ease of use (PEOU) and perceived usefulness (PU) of the technology, and that these constructs affect the attitudes and beliefs regarding technology (Chau, 1996; Davis, 1989). Therefore, these attitudes and beliefs mediate intentions for use and future behavior. Accordingly, the 17 question response questionnaire used in this study can be subdivided into questions pertaining to either PEOU or PU. 14 of the questions are seven point likart scale questions with the remaining three questions being open-ended in nature, and designed for participants to express particular likes and dislikes of the technology as well as identify problem areas not fully assessed with questions regarding PEOU and PU.

Procedures

Discussion of the procedures used in this pilot study include: (1) enrollment and familiarization, (2) baseline testing, (3) exercise intervention, and (4) final testing.
Enrollment and Familiarization

Upon enrollment into the study, participants completed a questionnaire (appendix A) about their current exercise habits. Following the completion of the questionnaire, participants’ height and weight were measured for correct calibration of the isokinetic dynamometer, and participants completed familiarization testing with regard to isokinetic measurement protocols. Each participant completed one familiarization testing session using the isokinetic dynamometer protocols previously described in a controlled laboratory setting. Baseline testing was then scheduled for the same time and location one week after completion of familiarization testing. Randomization of participants occurred after familiarization testing and prior to baseline assessments; however, participants were unaware of group assignments until baseline testing was completed to avoid group allocation from affecting baseline results.

Baseline Testing

For baseline testing, participants completed a three minute warm-up on an arm ergometer (Monark 881E Floor Model Training Ergometer) maintaining at least fifty revolutions per minute throughout the warm-up period. Subsequent to the warm-up period, participants were tested on the isokinetic dynamometer using the same protocols and equipment settings used in the familiarization session. Participants were allowed exactly 10 minutes following isokinetic testing in which to rest and recover before beginning the push up test. Each push up test was administered using the methods previously described after the 10 minute rest period. After the administration of the push up test, HB participants were given written (appendix B) and verbal instructions explaining the resistance exercise program, how to use the exercise logs, how to evaluate and record RPE for each exercise session, use of the resistance bands, proper form for
each exercise, and how to adjust resistance to achieve the desired intensity for each exercise. After obtaining verbal confirmation of understanding and witnessing a demonstration of correct form for each movement, each HB participant was given three resistance bands of varying tensions and allowed to start the three week exercise intervention. VC participants were instructed to meet in the laboratory location, as a group, at a previously agreed upon time, to start the exercise intervention.

**Exercise Intervention**

For the duration of the three week intervention, HB participants were allowed to contact researchers by e-mail if they had questions or needed to replace resistance bands. HB participants received periodic e-mail reminders on the use of exercise logs and to schedule final testing after completion of the three week intervention.

For the VC group, two separate rooms were used. The first room, which the VC group used for exercise was the laboratory setting used for familiarization, baseline and final testing. The second room was a remote room located in an adjacent building from which the exercise instructor would conduct each session. The VC group met every Monday and Wednesday at 2 p.m. and Friday at 12 p.m. in the laboratory to participate in the group exercise via videoconference. One session had to be rescheduled for a different time due to the remote instructor’s location being used for other purposes. At the beginning of each session, communication between the rooms was established and DVD recording initiated. Each session was conducted according to the intervention methods previously described except for the final two sessions. Each exercise session consisted of 1-2 sets of 10 exercises (7 upper body exercises and 3 lower body exercises) with approximately 30 seconds of rest between consecutive sets of the same exercise. Exercises were executed with a three second eccentric contraction and a two
second concentric contraction. During the final two sessions, an alternate instructor was brought in by researchers to try out the videoconferencing system, and to provide insights into the use of the technology from an experienced exercise instructor’s perspective.

**Final Testing**

Final testing procedures were identical to those used for both familiarization and baseline testing. All participants completed final testing between two and 14 days after their final exercise session. While the variation in time between intervention and final testing may affect testing results, participant availability for testing during this period was unreliable due to a school break being scheduled during this time period. HB participants returned completed exercise logs during final testing, and VC participants completed the technology response questionnaires (appendix C).

Statistical Analysis

Statistical analyses for this study were completed with the use of Statistical Packages for the Social Sciences (SPSS) version 17.0. Independent samples t-tests were used to compare mean differences between groups on measures of muscular strength and endurance, adherence and compliance to exercise, years of experience, age, and BMI. Dependent or paired samples t-tests were used to compare mean differences between baseline and post-intervention measures of Muscular strength and endurance. Pearson’s r analysis of correlation was used to assess correlations within dependent variables and correlations between dependent variable and potential confounders. Due to the limited sample size of the study, regression analyses were not
used to create models for describing potential mediators and moderators for the effectiveness of each treatment.

Protection of Human Subjects

Approval from the Wichita State University Institutional Review Board (IRB) for Research involving Human Subjects was obtained for the study design and consent form prior to the initiation of participant recruitment and data collection. Informed consent was explained verbally and in writing to all study participants. Informed consent was obtained from all study participants, and assurances were provided by the researcher that their responses or data would be reported as a group, or a representative of group data, and not identified by, or identifiable as pertaining to, a specific individual.
CHAPTER 4

RESULTS

The major findings for this study are presented as they pertain to the major study objectives and hypotheses. Discussion in this chapter includes, (1) a restatement of the study hypotheses, (2) participant characteristics at baseline, (3) post-intervention muscular strength and endurance, (4) adherence and compliance, (5) acceptance of technology, and (6) responses to videoconferencing for exercise.

Restatement of the Study Hypotheses

For future use in exercise interventions, the videoconferencing system must be deemed efficacious in creating beneficial clinical or physiological health outcomes. Second, the system must be deemed effective by establishing a high level of acceptance from users. Finally, user perceptions and feedback regarding the technology should be used to review, evaluate, and design future interventions to maximize cost effectiveness and the effectiveness of the intervention. Therefore, the purpose of this study was to develop an applicable formative assessment of resistance exercise conducted via videoconference using the Polycom telenetworking system. The study aimed to meet this objective by answering the following questions:

1. How do exercise adherence and compliance differ between participants of exercise conducted via videoconference from those exercising on their own at home?

2. Is resistance exercise instructed via videoconference more effective than home based interventions for improving muscular strength and endurance?

3. What are participants’ perceptions of the use of videoconferencing technology for resistance exercise training?
4. What limitations exist for conducting group exercise training with the Polycom system?

We hypothesized that 1) adherence and compliance to the resistance exercise intervention would be better in the teleconferencing group versus the home-based group, 2) exercise instructed via videoconference would be more effective for improving muscular strength and endurance, and 3) the Polycom networking system would have a high level of user acceptance.

Participant Characteristics at Baseline

SPSS version 17.0 was used to assess the descriptive statistical information for all participant characteristics at baseline. Participants ranged in age from 20 to 51 years ($M=27.86$, $SD=12.73$) with a median age of 21 years. Participants’ BMI ranged from 19.68 kg/m$^2$ to 37.65 kg/m$^2$ ($M=24.55$, $SD=6.08$). Participants’ experience with exercise varied between no experience and nine years ($M=4.5$, $SD=3.48$). Two individuals reported primarily engaging in aerobic exercise activities; one individual primarily engaged in resistance exercise; three individuals expressed regular participation in both aerobic and resistance exercise, and one individual had no experience with regular exercise. The peak torque and total work values for each arm were averaged for both pressing and pulling movements to create one value each for pressing strength, pulling strength, pressing endurance, and pulling endurance of the trunk and shoulder girdle muscles. The mean for peak torque on the chest press movement was 100.79 ft lbs ($SD=33.59$) while pressing and 76.54 ft lbs ($SD=21.94$) while pulling. Mean total work during the chest press movement was 830.82 ft lbs ($SD=439.6$) while pressing and 672.4 ft lbs ($SD=267.32$) while pulling. The number of correctly performed push-ups completed during baseline assessment ranged from zero to 84 ($M=35.86$, $SD=25.01$) with a median value of 34. A
summary of baseline descriptive analysis can be found in Table 4.1. After randomization of HB and VC groups, an independent samples t-test was conducted to assess differences between the two groups on mean age, BMI, push-ups completed, years of experience, and isokinetic measures of peak torque and total work for the chest press movement. Results of the t-test showed no significant differences, \( p < 0.05 \), between the HB and VC groups on these measures at baseline.

### TABLE 4.1

**SUMMARY OF PARTICIPANT CHARACTERISTICS AT BASELINE**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Range</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>7</td>
<td>31</td>
<td>20</td>
<td>51</td>
<td>27.86</td>
<td>12.73</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>7</td>
<td>17.97</td>
<td>19.68</td>
<td>37.65</td>
<td>24.5451</td>
<td>6.08</td>
</tr>
<tr>
<td>Baseline Push-ups</td>
<td>7</td>
<td>84</td>
<td>0</td>
<td>84</td>
<td>35.86</td>
<td>25.01</td>
</tr>
<tr>
<td>Years of Experience</td>
<td>7</td>
<td>9.0</td>
<td>0.0</td>
<td>9.0</td>
<td>4.50</td>
<td>3.48</td>
</tr>
<tr>
<td>Peak Torque Pressing (ft(\cdot)lb)</td>
<td>7</td>
<td>92.95</td>
<td>60.05</td>
<td>153</td>
<td>100.79</td>
<td>33.59</td>
</tr>
<tr>
<td>Peak Torque Pulling (ft(\cdot)lb)</td>
<td>7</td>
<td>60.6</td>
<td>48.9</td>
<td>109.5</td>
<td>76.54</td>
<td>21.94</td>
</tr>
<tr>
<td>Total Work Pressing (ft(\cdot)lbs)</td>
<td>7</td>
<td>1168.25</td>
<td>247.7</td>
<td>1415.95</td>
<td>830.82</td>
<td>439.6</td>
</tr>
<tr>
<td>Total Work Pulling (ft(\cdot)lbs)</td>
<td>7</td>
<td>690.2</td>
<td>358.4</td>
<td>1048.6</td>
<td>672.4</td>
<td>267.32</td>
</tr>
</tbody>
</table>

The results of a Pearson correlation showed a strong correlation between peak pressing torque and peak pulling torque, \( r(7) = 0.98, p < 0.01 \); total work while pressing, \( r(7) = 0.85, p = 0.016 \); and total work while pulling, \( r(7) = 0.92, p < 0.01 \). Peak torque while pulling was
strongly correlated to total work while pressing, $r(7)=0.91$, $p<0.01$, and total work while pulling, $r(7)=0.92$, $p<0.01$. Total work while pressing was strongly correlated to total work while pulling, $r(7)=0.97$, $p<0.01$. Push-ups completed at baseline were not significantly, $p<0.05$, correlated with isokinetic measures of strength and endurance during the chest press.

Post-Intervention Muscular Strength and Endurance

To assess the effectiveness of each treatment on the strength and endurance of the muscles of the trunk and shoulder girdle and to test the study hypothesis that exercise instructed via videoconference would be more effective for improving muscular strength and endurance, an independent samples t-test was used to compare mean measures of strength and endurance between the HB and VC groups. Additionally, a dependent samples t-test was used to assess changes in muscular strength and endurance after the three week resistance exercise intervention (figures 4.1 and 4.2).

![Figure 4.1 The mean number of push-ups completed at baseline and after a three week resistance exercise intervention for both HB and VC groups.](image)
Figure 4.8 Peak torques for both pressing and pulling from a seated chest press position at baseline and after a three week resistance exercise intervention for VC and HB groups.

Results from the independent samples t-test revealed no significant difference, \( p>0.05 \), in post intervention measures on muscular strength and endurance between the VC and HB groups.

The dependent samples t-test conducted to test the effectiveness of HB and VC groups’ resistance training showed significant improvements in the VC groups’ push-ups, \( t(3)=3.66, p=0.04 \), with a mean difference of 1.75 push-ups; peak torque while pressing, \( t(3)=4.60, p=0.02 \), with a mean difference of 8.51 ft∙lbs; and peak torque while pulling, \( t(3)=3.26, p=0.047 \), with a mean difference of 10.86 ft∙lbs. No significant differences, \( p>0.05 \), were found between baseline and post intervention measures of muscular strength and endurance in the HB group.

Adherence and Compliance

To help assess the effectiveness of resistance exercise conducted via videoconference as a potential public health intervention, and to test the study hypothesis that adherence and
compliance to the resistance exercise intervention would be better in the teleconferencing group versus the home-based group, participant adherence and compliance to the exercise regimen were evaluated. All participants returned a completed exercise log including when specific workouts were completed, the duration of each exercise session, and the RPE for each session. Adherence in the HB group ranged from 0.66 to 1.1 (M=0.85, SD=0.23). A value of 1.0 represents the completion of all nine prescribed exercise sessions. One individual from the home group completed 10 sessions within the three week time period. Adherence in the VC group ranged from 0.55 to 0.77 (M=0.66, SD=0.13). An independent samples t-test showed no significant difference, \( p=0.23 \), in adherence between HB and VC groups.

To assess participant compliance to the exercise prescription, the number of weeks in which a participant completed two workouts at the prescribed intensity was divided by the number of weeks in the intervention. Compliance in the HB group ranged from 0 to 1.0 (M=0.55, SD=0.51). One individual in the home group spent 1.5hrs on each workout according to their exercise log, and this was associated with much higher reported RPEs than other HB participants. Compliance in the VC group ranged from 0 to 0.66 (M=0.41, SD=0.32). An independent samples t-test showed no significant difference, \( p=0.67 \), in compliance between the HB and VC groups.

Acceptance of Technology

The VC group was asked to respond to a questionnaire designed to assess their attitudes, beliefs and perceptions regarding the use of the videoconferencing system for a resistance exercise intervention and test the third study hypothesis that the videoconferencing system would have a high level of user acceptance. Guided by the TAM, the questionnaire was broken down
into four sections. One group of questions was designed to assess perceived ease of use (PEOU) with regard to the technology, another set of questions assessed perceived usefulness (PU), a third set of questions assessed participant perceptions of the idea of using the technology (IOT) for resistance exercise, and a final set of questions assessed participant intentions for future use (INTENT).

A seven point Likert scale, with a score of seven representing the highest level of usefulness, ease of use, and intentions, was used to assess each set of questions. All VC group participants and one guest exercise instructor completed the questionnaire. The mean value for PEOU was 6.15 (SD=0.86), PU had a mean of 5.55 (SD=0.6); mean IOT was 5.95 (SD=0.91); mean INTENT was 4.15 (SD=1.5). A Pearson correlation test revealed a strong correlation, \( r(7)=0.95, p=0.012 \), between PEOU and IOT.

Responses to Videoconferencing for Exercise

In an effort to bring richness to the quantitative assessment of user perceptions for the use of videoconferencing technology with resistance exercise, and to meet the primary study objective of creating a formative assessment, three open-ended questions were added to the technology acceptance questionnaire. These questions were designed to solicit feedback from participants regarding their experience with the videoconferencing system, and provide valuable information for the use of videoconference in exercise in future studies or interventions. One question asked participants to compare their experience with videoconferencing to other common uses of technology in exercise. A second question was used to garner feedback on limitations of the equipment, and how participants think the technology can be improved. A final question was implemented to recognize the positive aspects of the technology.
In response to the question, “When comparing your experience with exercise conducted via the Polycom videoconferencing system and exercising with the aid of instructional DVDs or web-based videos, which would you prefer to use? Why?” participants said:

“I would probably prefer the Polycom videoconferencing because knowing that I’m performing live for the fitness trainer makes me work harder. I also like how the trainer was able to offer positive criticism and corrections when I was performing a move the wrong way or could see that I was struggling. Having a set time to work out was also beneficial for me to stay on a set workout track.”

“Polycom allows for feedback making it a better choice. However, sessions with one on one attention would need to be readily available to the consumer. The instructional DVDs can be used whenever the consumer feels like it is necessary.”

“I would use the Polycom system because it provides instant feedback and is more personal than preprogrammed media.”

“Polycom”

“I would hands down prefer the Polycom videoconferencing system. The system allows both parties (instructor and exerciser) to have a more interactive relationship. I strongly believe that this may be the next step to fitness instruction.”

In response to the question, “What changes could be made to the Polycom system to make it more likely to be used for exercise, or to improve its use in an exercise setting?” participants said:

“I would suggest having the workout of the day recorded and available to those who can’t make the workouts on certain days at the specified times. I think I would have been
able to make up the times that I didn’t make it to the set time at a later time. Also, making sure that the Polycom screens weren’t blurry.”

“I believe the system would have to be more affordable for the consumer. Possibly just using good webcams over the internet would be a more likely approach.”

“I would say that what is holding it back is the availability and cost. If I wanted to use this as way to exercise (sic) I would need to get a cable to connect my laptop to my tv (sic) and a webcam/mic to pick up sound and video.”

“Another training to montor (sic) our technique”

“a. If the instructor was provided with a personal mic for better sound effects for the exercisers
b. Motion sensor camera on the instructor
c. Heart monitors for the exercisers
d. If possible setting the system in a studio where mirrors are provided for the exercisers (for body position observations)
e. A crisper view of both parties would be highly advised”

In response to the question, “What did you like about the Polycom system used for exercise training?” participants said:

“I liked knowing the trainer I was working with and being able to get feedback from him.
I also liked how he brought in another outside trainer to get a workout of a different style. It was also nice to have a workout class-like setting. It made me feel more accountable to show up and workout.”
“The system allows for comfort in your own home but needs a lot of technical work first.”

“It was convient (sic), personal, and can adapt or change depending on what I want to workout (sic) and how I want to work out. It can eliminate the plateau (sic) effect resulting from continually doing the same exercise.”

“It was more interactive the video based”

“The idea is genius! I love the concept behind it, as well as allowing fitness professionals to reach a large audience within one session (it’s all about making a difference). I believe that this is a great way to help participants achieve a healthier lifestyle.”

No thematic coding was done to the qualitative data, so it has been presented in raw form. The presented responses make up data that can be used to gain richer insights into technology and research design improvements that may improve outcome measures in future studies.
CHAPTER 5
DISCUSSION

A full discussion of the results of this study as they pertain to the primary study objectives and research questions is presented in this chapter. Discussion in this chapter includes: (1) the effectiveness of muscular strength and endurance training conducted via videoconference, (2) discussion of participant compliance and adherence, (3) acceptance of videoconferencing as a medium for exercise training, (4) limitations of the technology, (5) limitations of the study, (6) theoretical implications, practical applications, and future study, and (7) conclusions.

Effectiveness of Muscular Strength and Endurance Training Conducted Via Videoconference

The results from baseline testing provide evidence that both the VC and HB groups were similar in measures of muscular strength and endurance. Furthermore, the high correlation between isokinetic measurements for both peak torque and total work provides support for the validity of these measures. The lack of significant correlation between the push-up test and isokinetic strength and endurance measures has been reported in other studies (Baumgartner, et al., 2002). Baumgartner et al (2002) explain that some of the lack in correlation between push-up tests may be due to the modified position used for females. The modified position, in which the push-up is executed with the knees in contact with the ground, creates a change in the relative resistance load, and this inconsistency may account for the lack of correlation between the push up and isokinetic measures of peak torque and total work during a chest press movement. In addition to group the similarities in measures of muscular strength and endurance, each group was statistically similar in age, BMI, and years of exercise experience. None of these potential...
confounders were significantly correlated with either the push-up test or isokinetic measures at baseline and post-intervention, and, therefore, their influence on participants’ response to resistance training should be considered minimal.

The significant improvement in the VC group in number of push-ups completed, peak torque during the chest press, and peak torque while pulling provide support for the use of videoconferencing as an effective tool for exercise interventions. While the HB group did not experience these significant improvements after the three week intervention, the improvement in the VC group was not enough to create a significant difference between the two groups. The improvements noted in the VC group could be explained by a number of factors. First, the speed at which each exercise was executed was instructor led, so the potential for inconsistencies with regard to achieving the prescribed tempo was attenuated. The effect of tempo control was potentially twofold. Participants were forced to work at slower speeds that were more specific to the testing speed of 30⁰/sec, and which allow for greater muscular forces to be applied (Enoka, 1996). Also, the slower execution speed increases the duration of eccentric contraction which can lead to a more effective stimulus for improvements in muscular strength (Enoka, 1996).

Secondly, the mean level of exercise experience in the HB group was greater than that of the VC group. Although this difference was not statistically significant, it should be noted that as an individuals’ level of experience with resistance training increases, a concomitant increase in training stimulus is needed to allow for further improvements in strength (Peterson, Rhea, & Alvar, 2005). The program used in this study was not intended for use by individuals with extensive experience with resistance training, and this could account for the lack of improvements seen in the home based group.
The muscular strength improvements noted in the VC group support previous telehealth and physical activity studies that concluded telehealth to be a promising and effective method for improvements in physical activity and measures of physical performance (Ekeland, et al., 2010). While unsupervised home-based resistance exercise programs have shown to be effective (Jette et al., 1999; Jette, et al., 1998), the measures of strength and muscular endurance in these studies are often functionally based due to the populations being studied. The results from this study demonstrate the effectiveness of and potential for the use of videoconferencing as a medium for resistance exercise through the use of both functional measures of upper body strength as well as laboratory measures.

Adherence and Compliance

From a Public Health perspective, the purpose of regular physical activity or exercise is the attenuation of health risks and the improvement of overall health. With regard to Public Health exercise initiatives, the crux of the problem stems from the fact that in order to achieve and maintain the health benefits of exercise, a continued adherence to exercise behaviors must be present. Given this rationale, any effective exercise intervention must not only demonstrate effectiveness for achieving objective measures of health, but it must foster an uptake of and adherence to exercise behavior. Since one of this study’s primary objectives was to assess the effectiveness of videoconferencing as a medium for resistance exercise interventions, participant patterns of exercise adherence and compliance provide crucial data for drawing conclusions in regards to the study’s aims.

The results of studies comparing adherence or participation rates to either home-based or group exercise programs are mixed. While a number of studies suggest that exercise adherence
is greater in home-based interventions ((Ashworth, et al., 2005; Abby C. King, Haskell, Taylor, Kraemer, & DeBusk, 1991; Perri, Martin, Leermakers, Sears, & Notelovitz, 1997), other studies have shown or predict greater adherence in supervised group settings (Alvers, 2010; Cox, Burke, Gorely, Beilin, & Puddey, 2003; Wong, et al., 2005). Comparable to the mixed results from previous studies, the results of this study show no significant differences in exercise adherence between the VC and HB groups. While the data does not support the hypothesis of greater exercise adherence in the VC group, it must be viewed in light of the major assumption of this study and the length of the study intervention. Videoconferencing provides the ability to interactively conduct exercise sessions between a central facility and a convenient remote location. Theoretically, this would provide the convenience of home-based, or near home, exercise programs with the quality and social benefits of facility-based group exercise. Wong, et al. (2005) reported greater adherence for group exercise conducted via videoconference (91%) than the home-based group (78%) which supports the theoretical approach used in this study. The nature of the participants used in this study, and the logistical constraints of this pilot study, made it necessary to assume the university campus met the requirement of a mutually convenient location for all VC group members. Should the location of the university, and travel associated with this location, have created an inconvenience for VC participants, then adherence could be affected.

Measures of exercise adherence are vitally important for understanding exercise participation rates, but compliance to exercise prescriptions are a sin qua non of effective exercise behaviors. From the medical model adopted by the EIM global initiative, a dose-response relationship exists between exercise and the associated health benefits ("Exercise is Medicine," 2008; Sallis, 2009). Assessing compliance within an exercise program ensures that
participants are receiving the intended physical stimulus. The results from the compliance data in this study showed that there were no significant mean differences between the VC and HB groups, however, there was a trend for higher compliance in the HB group. The HB group, in general, reported higher rates of perceived exertion for each exercise session than the VC group. Interestingly, this runs counterintuitive to the results garnered from the muscular strength and endurance tests, because one would expect that a greater compliance to exercise prescription would create better results on objective measures of performance. One possible explanation for these results is the nature of self-reported subjective measures. Overall, participant measures of adherence and compliance are much lower than those reported in the study by Jette et al (1998). Jette et al reported adherence rates of 90% and a compliance rate of 78% in their home-based study of older adults using similar resistance training methods. The large difference in both participant adherence and compliance between this study and the one conducted by Jette et al (1998) could be due in part to the differences in study population and the duration of the intervention. The study by Jette et al (1998) evaluated compliance in 14 two week segments spanning a total of 26 weeks of intervention.

Acceptance of Videoconferencing as a Medium for Exercise Training

Guided by the TAM, this study aimed to assess participant acceptance of the use of videoconferencing technology as a medium for exercise training by investigating the Perceived Ease of Use and Perceived Usefulness of the Polycom Viewstation system. The Polycom Viewstation received high scores on questions pertaining to Ease of Use. Overall participants responded that it was “slightly likely” to “extremely likely” that the Polycom Viewstation would be easy to use. Responses regarding the usefulness of the Polycom Viewstation for exercise
training ranged from a neutral response of “neither” useful nor non-useful to “extremely useful”. What can be interpreted from these responses is that the mean responses for Perceived Ease of Use and Perceived Usefulness are significantly higher than the neutral response, and support the retention of the hypothesis that participants are accepting of the videoconferencing technology. Interestingly, no significant correlation between Ease of Use and Usefulness was found in the present study. According to the theoretical constructs of the TAM, a correlation between these two factors would be expected; however, this relationship may not be evident given the small sample size of the present study.

While no current published studies exist applying the TAM to videoconferencing in exercise, Wong, et al. (2005) reported high levels of user acceptance in their study using videoconferencing and exercise in older adults. Studies using the TAM with videoconferencing technology have been done with comparable results (Gibson & O'Donnell, 2009; Tao, Ramsey, & Watson, 2011). One study (Gibson & O'Donnell, 2009) on the use of multi-site videoconferencing in telehealth found comparable scores for Perceived Ease of Use and Perceived Usefulness on a five point Likert scale. Additionally, researchers found a significant positive correlation between both Ease of Use and Usefulness to measures of Social Connection. The use of technologies that provide an experience that is closely related to the experience of face-to-face communication improves measures of acceptance. Responses to open-ended questions revealed a similar pattern in the appeal of Social Connection: “It was more interactive the video based”; “The system allows both parties (instructor and exerciser) to have a more interactive relationship.”; “…it provides instant feedback and is more personal than preprogramed media.” Results from the present study are significant in that they aim to close an identified gap in telehealth and telemedicine studies. Few, if any, published studies investigating
the effectiveness of telehealth technologies for improving physical activity or exercise have used user perceptions as an outcome measure. The current pilot study allows researchers to gain a deeper understanding of the potential effectiveness of videoconferencing technology prior the initiation of larger more costly community-based studies. While these data provide evidence to support the use of videoconference for exercise interventions, user acceptance only partially meets the primary study objective of creating a formative assessment of the technology.

Limitations of the Technology

The use of the Polycom Viewstation for exercise training appears to be easy to use and perceived as useful toward improving resistance exercise outcomes and resistance exercise effectiveness; however, a complete formative assessment of the technology includes a discussion of the limitations to be overcome before larger and more complex study designs are initiated. These limitations, as perceived by both exercise instructors and participants, center on the logistical constraints of the equipment necessary to make videoconferencing possible, the audio and visual limitations of the Polycom Viewstation, and the limitations on group size.

While the Polycom Viewstation set-up has the potential to be a cost effective measure for providing effective resistance exercise interventions to large numbers of remote populations, the requirements for videoconference may prove to be a limiting factor in the size of the population it can effectively reach. Each room that contains a Viewstation must be equipped with a monitor of sufficient size for all participants to be able to easily and clearly visualize and mimic complex biomechanical movements. The size of the monitor would be dependent on the size of the group at each location, so, while smaller monitors are more cost-effective, the population that can be effectively exercised at a location decreases. Furthermore, each site must be wired to
accommodate a network connection through the use of an Ethernet cable, since the Polycom Viewstation lacks Wi-Fi capabilities. These limitations were mirrored in the questionnaire responses of participants when they stated, “I believe the system would have to be more affordable for the consumer. Possibly just using good webcams over the internet would be a more likely approach,” and “I would say that what is holding it back is the availability and cost. If I wanted to use this as way to exercise (sic) I would need to get a cable to connect my laptop to my tv (sic) and a webcam/mic to pick up sound and video.” These limitations place constraints on what locations can feasibly be used to conduct exercise training. This, as was the case in the current study, can lead to using room environments that may not be appropriate for accommodating group exercise, and the exercise environment can diminish the effectiveness of an exercise program (Alvers, 2010; Beauchamp, et al., 2007).

The limitations of the audio and visual capabilities of the Polycom Viewstation became apparent during the first week of the exercise intervention. Depending on the particular conferencing unit being used, on-screen images were often out of focus and blurry: “...a crisper view of both parties would be highly advised,” and “…making sure that the Polycom screens weren’t blurry” were among the improvements study participants’ suggested for the system. From an instructors’ perspective, the use of a remote control to move the camera around the group of participants during exercise was beneficial for instruction, but cumbersome and slightly distracting. No practical solutions to this limitation exist, or at least currently available for public use, but this limitation should be mentioned as it may constrain what types of exercise interventions are feasible over videoconference.

By far the most problematic complication arising from the use of the videoconferencing system was the sensitivity of the microphone to background noise. Since the Polycom system
was designed for videoconferencing at conversational volumes in locations suited to these ends, the external microphone for the Polycom system was very sensitive to sound and could not differentiate background noises. This limited the effectiveness of verbal communication between instructor and participants due to the extensive background noise and poor acoustics of the laboratory setting. The resultant feedback effect in the laboratory location could only be mitigated by reducing the volume of the monitor to such a degree that the instructor was barely audible throughout each exercise session. It would not be feasible to effectively conference with audio functions enabled in a traditional exercise setting where loud background noises are commonplace.

In light of the mentioned limitations to the videoconferencing system, the technology still presents itself as an effective and accepted tool for remote exercise instruction provided certain criteria are met. First, each room must be equipped with all necessary materials and network connection. Secondly, each room should have limited background noise interference and quality acoustics to prevent a feedback effect. Lastly, the exercise group should be limited in size to reduce the amount of time exercise instructors spend using the camera remote control. Size of the exercise group will greatly depend on the size of the location used for exercise and the position of the camera in relation to this space. While the current limitations of the videoconferencing system may appear to be great, they provide data for improvements and considerations when designing future interventions.

Limitations of the Study

Although this study was designed to gather real data about the effectiveness of resistance exercise conducted via videoconference, and assess user acceptance of the technology, there
were two major limitations of the study. The first limitation is the extent to which the data collected from a population of students from a Midwestern university can be generalized to other populations in which videoconferencing technology may be useful. Secondly, the small sample size and short intervention used in the study limit the power of statistical results and the acceptable frame of inference regarding the efficacy of the intervention.

Data collected in this study are representative of the effectiveness of resistance exercise conducted via videoconference with respect to a convenience sample of college students from a Midwestern university. While this sample population limits the extent to what can be inferred about the use of videoconferencing for resistance exercise in populations characterized by a disparity in health outcomes, access to exercise facilities, and limited knowledge of the benefits of resistance exercise, this pilot study provides proof-of-concept data that can be utilized as a foundation for further study.

Data regarding the effectiveness of the resistance exercise intervention are limited by the small sample size and short duration of the intervention. The likelihood that results would differ given a broader population sample and longer intervention should not be ignored; however, trends noted in regard to measures of muscular strength, adherence, and compliance were comparable with the significant findings of studies using similar methods for assessing these measures in home-based and group exercise.

Finally, a full discussion of limitations to the current study would not be complete without mention of the sociocultural and political factors that may influence the perceptions of technology, its usefulness, and its place in health care. While these factors lie beyond the scope of the data collected in this study, their importance to user acceptance of technology must be considered and are regarded as crucial to further investigations using exercise and technology. A
noted limitation to the TAM for assessing and predicting user acceptance of technology is the lack of inclusion of sociocultural, political, and other external variables into the model construct (Chau, 1996). Newer, more complex models for assessing technology acceptance are being validated and may prove useful in future studies on videoconferencing as a medium for exercise interventions.

Study Significance and Suggestions for Future Research

The limited number of telemedicine and telehealth studies that utilize exercise as an intervention, and the lack of formative assessments with regard to videoconferencing and resistance exercise is significant in that large scale studies using resistance exercise and public health initiatives such as Exercise is Medicine greatly depend on the effective use of technology. The data gathered in this pilot study can serve as a foundation for effective videoconferencing technologies in resistance exercise through the use of a formative assessment process. Results from this study add to the current body of research by providing a framework for closing an identified research gap in and expanding the field of telemedicine and exercise.

Videoconferencing has shown to be an effective medium for the instruction of resistance training based on the improvements in muscular strength found in the VC group. Furthermore, the lack of comparable strength improvements in the HB group indicates that the use of videoconferencing may provide for more effective training given the interactive nature of the exercise sessions. This data supports the theoretical basis for the use of videoconferencing in exercise, which is to provide the efficacy of face-to-face professional instruction with the effectiveness of home-based or community-based exercise initiatives for reaching broad underrepresented populations. In order for a new technology, or a new use for older technology,
to remain effective in real world application it needs to be perceived as both easy to use and useful. Results from this study on acceptance of the use of videoconferencing for exercise are high and comparable to previous data gathered on videoconferencing in telehealth and telemedicine. This evidence provides support for the use of videoconferencing technologies in larger and more complex study designs.

Follow up studies should focus on five critical areas: (1) using various populations with demonstrated health disparities, (2) using more complex study designs for network conferencing, (3) improving the technology, (4) validity and reliability testing for conducting physical function tests via videoconference, and (5) use extensions of the TAM to refine the formative assessment process.

Given the preliminary data in this pilot study, further study into the effectiveness of videoconferencing with various populations is warranted. Ideal populations for study would be those statistically most likely to be affected by chronic disease, disparities in health outcomes, or those populations that remain underrepresented in research due to their remote location. Low SES is correlated with an increased risk for chronic illness and poorer health outcomes (Baquet & Commiskey, 2000; Chaudhary & Kreiger, 2007; Chu et al., 1998; Goel et al., 2003). Baquet and Commiskey (2000) found that visual and interactive interventions for promoting physical activity and nutrition in lower income populations were most effective. Authors suggested that the visual interaction may attenuate any potential language barriers, and visual media may be more effective since low SES is often associated with low health literacy. The use of videoconferencing is well suited to meet the suggestions for physical activity interventions presented by Baquet and Commiskey (2000).
The logistical constraints of this pilot study prevented testing the limitations of videoconferencing networking capabilities with regard to exercise. Future studies should focus on using multi-site conferencing. Multi-site community-based conferencing would eliminate the limiting assumption of a mutually convenient location used in this study. Furthermore, solutions now exist that allow multi-site conferencing between systems like Polycom Viewstations and personal computers (Polycom® PVX). Such technologies would be useful in giving individuals the option to exercise at home or with a group via videoconference.

As with any new technology, intervention, or study population, a formative assessment should be included in the study design. Many factors are involved in how a population of potential users may perceive the new technology, and this could prove disastrous to a Public Health initiative that fails to consider such issues. The use of formative assessments like extensions of the TAM can give researchers a richer perspective on the variables that may be affecting the effectiveness of a particular intervention.

Finally, validating physical function tests conducted via videoconference could provide cost effective and time effective methods for health and fitness evaluations. Validating testing methods that can be performed remotely would be crucial to the advancement of knowledge in the fields of Exercise Science, Public Health, Telehealth and Telemedicine.

Conclusion

Using videoconferencing technology to improve outcome measures of muscular strength and endurance in remotely located populations appears to have some benefit when compared to traditional home-based exercise interventions. Additionally, the high levels of acceptance inferred from participant responses make videoconferencing an exercise tool that is likely to be
used by the populations that may benefit the most from its use. Group-based resistance exercise conducted via videoconference did not show any evidence of being superior to home-based exercise on measures of exercise adherence and compliance, but this may be due to the site selected for videoconferencing in this pilot study. The demonstrated effectiveness, user acceptance, and rich feedback garnered from participant responses provides strong preliminary support for future formative studies investigating the use of interactive technologies with exercise in remote populations.
BIBLIOGRAPHY


APPENDICES
APPENDIX A

INITIAL ENROLLMENT QUESTIONNAIRE

Study Questionnaire

ID#__________

Do you currently participate in regular exercise?

If so, how many days per week do you exercise?

What type(s) of exercise(s) do you do?

About how long is each exercise session?

Do you exercise at home or in a facility?

Do you currently use a personal trainer, or have you used a personal trainer in the past?

How long have you been exercising regularly?

Are you happy with your current level of exercise? Why or why not?

Describe your ideal exercise program (where, how much time, what types of exercise, etc.).
APPENDIX A (continued)

Would you prefer to exercise at home or in a fitness facility? Why or why not?

What makes an exercise program easy to stick with? What makes it difficult?
APPENDIX B

INSTRUCTIONAL MATERIALS FOR THE RESISTANCE EXERCISE PROGRAM

Perform one of the following workouts three days per week with approximately 48 hrs in between each workout (example: Monday, Wednesday, and Friday). In week 1, perform **workout A** on Monday and Friday, and **workout B** on Wednesday. In week 2, perform **workout B** on Monday and Friday, and **workout A** on Wednesday. For week 3, repeat week 1.

<table>
<thead>
<tr>
<th>Workout A</th>
<th>Workout B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm up with 5 minutes of walking (can be done in place) and light stretching</td>
<td>Warm up with 5 minutes of walking (can be done in place) and light stretching</td>
</tr>
<tr>
<td><strong>Push up</strong> 1 set of 75% Max repetitions (based on baseline test)</td>
<td><strong>Push up</strong> 2 set of 75% Max repetitions (based on baseline test)</td>
</tr>
<tr>
<td><strong>Chest press</strong> using chair 2 sets of 10-12 repetitions</td>
<td><strong>Chest fly</strong> using chair 2 sets of 10-12 repetitions</td>
</tr>
<tr>
<td><strong>Seated row</strong> 10-12 repetitions</td>
<td><strong>Upright row</strong> 10-12 repetitions</td>
</tr>
<tr>
<td><strong>Band above head and pull down to chest</strong> 10-12 repetitions</td>
<td><strong>Shoulder front raise</strong> 10-12 repetitions</td>
</tr>
<tr>
<td><strong>Reverse fly</strong> 10-12 repetitions</td>
<td><strong>Lateral raise</strong> 10-12 repetitions</td>
</tr>
<tr>
<td><strong>Tricep extension from seated fly position</strong> 10-12 repetitions</td>
<td><strong>Tricep pushdown</strong> 10-12 repetitions</td>
</tr>
<tr>
<td><strong>Bicep curl</strong> 10-12 repetitions</td>
<td><strong>Bicep curl</strong> 10-12 repetitions</td>
</tr>
<tr>
<td><strong>Squat</strong> 2 sets of 10-12 repetitions</td>
<td><strong>Lunge step (with or without band)</strong> 20-24 steps</td>
</tr>
<tr>
<td><strong>Standing leg abduction</strong> 10-12 repetitions</td>
<td><strong>Standing knee extension (with or without band)</strong> 10-12 repetitions</td>
</tr>
<tr>
<td><strong>Hip flexion</strong> 10-12 repetitions</td>
<td><strong>Standing knee flexion</strong> 10-12 repetitions</td>
</tr>
<tr>
<td>5-10 minutes of stretching</td>
<td>5-10 minutes of stretching</td>
</tr>
</tbody>
</table>

Attached is a basic instruction guide for most of the above exercises. Please reference the images and instructions as a reminder throughout this three week program.
Using Rate of Perceived Exertion (RPE) as a measure of intensity, complete all exercises with enough resistance to allow for an RPE of 15 for each session (see RPE info sheet for instructions on how to use RPE). When you can complete 10 repetitions of an exercise comfortably with good form, add resistance by adding a resistance band, changing to a more difficult band, or beginning the exercise with hands closer to the center of the band.

Make sure to conclude each session with stretching to maintain and improve range of motion. Use www.sportsinjuryclinic.net as a resource with images. Hold each position at the point of mild discomfort, but not pain, for 20-30 seconds. Concentrate on areas of the body that were just exercised or are feeling “tight”.
APPENDIX C

TECHNOLOGY ACCEPTANCE QUESTIONNAIRE

Please fill out the following. Your comments will help us to design further improvements so your comments are very important. Thank you in advance for your time.

Have you ever used a video-conferencing system before?:  1. Yes  2. No
How many hours a week do you go on the internet or use internet-based services?
What activity do you do the most:
   Surf the web for personal reasons
   Surf the web for educational/professional reasons
   eMail
   Other _________________________________________________

Circle the response that closest fits your opinion for statements 1-10:
1= Extremely Unlikely
2= Quite Unlikely
3= Slightly Unlikely
4= Neither
5= Slightly Likely
6= Quite Likely
7= Extremely Likely

1. I would find using the Polycom system for exercise training easy. 1 2 3 4 5 6 7
2. Using the Polycom system would improve my exercise performance. 1 2 3 4 5 6 7
3. I intend to use the Polycom system for exercise whenever available. 1 2 3 4 5 6 7
4. The Polycom system would be easy for me to use. 1 2 3 4 5 6 7
5. Using the Polycom system would enhance my effectiveness during Exercise. 1 2 3 4 5 6 7
6. I would find it simple to use the Polycom system. 1 2 3 4 5 6 7
7. I intend to use Polycom for exercise frequently when available. 1 2 3 4 5 6 7
8. Using Polycom would increase my productivity in during exercise. 1 2 3 4 5 6 7
9. It would be easy for me to become skillful at using Polycom. 1 2 3 4 5 6 7
10. I would find Polycom useful in an exercise setting. 1 2 3 4 5 6 7
11. Using the Polycom system for exercise training is a(n) _____ idea.
   Extremely good
   Quite good
   Slightly good
   Neither
   Slightly bad
   Quite bad
   Extremely bad
12. I ____ the idea of using the Polycom system for exercise training.
APPENDIX C (continued)

Strongly Like
Like
Slightly Like
Neither
Slightly Dislike
Dislike
Strongly Dislike

13. Using Polycom is a __________ idea
   Extremely Foolish
   Quite Foolish
   Slightly Foolish
   Neither
   Slightly Good
   Quite Good
   Extremely Good

14. Using Polycom would be _____
   Extremely Foolish
   Quite Foolish
   Slightly Foolish
   Neither
   Slightly Good
   Quite Good
   Extremely Good

15. When comparing your experience with exercise conducted via the Polycom videoconferencing system and exercising with the aid of instructional DVDs or web-based videos, which would you prefer to use? Why?

16. What changes could be made to the Polycom system to make it more likely to be used for exercise, or to improve its use in an exercise setting?

17. What did you like about the Polycom system used for exercise training?