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EFFECT OF INCORPORATING THE FITBIT FITNESS TRACKING TECHNOLOGY INTO A PRESCRIBED EXERCISE INTERVENTION PROGRAM TO IMPROVE LONG-TERM FUNCTION IN OBESE INDIVIDUALS ONE YEAR FOLLOWING TOTAL KNEE ARTHROPLASTY.

A Dissertation

presented in partial fulfillment of requirements

for the degree of Doctorate of Philosophy

in the Department of Health, Exercise Science and Recreation Management

The University of Mississippi

By

Webb A Smith

Chair

Dr. Mark Loftin

August, 2014

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ABSTRACT

Obesity is associated with numerous negative effects on health and QOL. Obese individuals are significantly more likely to have a TKA compared to normal weight individuals. In addition, obese individuals appear to have limited long term physical function which negatively impacts their ability to complete activities of daily living and QOL. We hypothesized that obese patients have additional barriers and deficits that would benefit from a tailored general fitness program once recovery from knee replacement should have occurred. Informed consent was obtained in compliance with IRB policies. Thirty four obese (36.9±4.8 kg/m2) TKA patients completed an 8 week home based exercise program with the guidance of an exercise physiologist. In addition, 17 participants were given additional motivational input from a Fitbit fitness tracker (Fitbit). An assessment measuring body size and shape, strength, walking endurance, knee function, and QOL was completed pre and post exercise program. One-way ANOVA comparing the adherence rates between groups was performed. Since adherence rates were not different (80.1±10.6 vs. 78.3±12.0, p=0.68) indicating the Fitbit did not have an effect, groups were collapsed and the effects of the exercise intervention were evaluated with a one-way ANOVA comparing the functional outcomes and QOL measurements pre and post intervention. Our results indicate that many patients had baseline deficits in knee extensor strength (38.2%), walk performance (50.0%), and self-reported physical function limitations (52.9%). Following an 8 week home based exercise program, significant improvements were noted in distance on the 6 minute walk (321.3±74.0 m vs 379.6±85.7m, p<0.01) and peak knee

extension strength (54.1±16.0 kg vs 65.3±15.7, p<0.01). Non-significant improvements were noted in self-reported knee function (19.9±13.4 vs 15.3±9.8, p=0.13) and physical function (35.8±10.4 vs 38.7±9.2, p=0.27). This study provides preliminary evidence that an 8 week home based exercise program in obese individuals one year post TKA is feasible and effective in improving strength and walk performance. The results of this study also indicate that a home based exercise program may improve patient perceptions of knee function and QOL. However, the FitBit was not a significant motivational factor to comply with a prescribed exercise program.

LIST OF ABBREVIATIONS

1. TKA= Total knee arthroplasty
2. QOL= Quality of Life
3. WOMAC= Western Ontario and McMaster Universities Osteoarthritis Index
4. ACSM = American College of Sports Medicine
5. SF-36= SF-36 Health Survey Version 2.0
6. 6MW= six minute walk test
7. OA=Osteoarthritis
8. PCS= Physical Components Scale of SF-36 Health Survey Version 2.0
9. MCS= Mental Components Scale of SF-36 Health Survey Version 2.0
10. PFnorm= Normalized physical function subscale scores of SF-36 Health Survey V2.0
11. REnorm= Normalized role emotional subscale scores of SF-36 Health Survey V2.0
12. RPnorm= Normalized role physical subscale scores of SF-36 Health Survey V 2.0
13. SFnorm= Normalized social function subscale scores of SF-36 Health Survey V2.0
14. GHnorm= Normalized general health subscale scores of SF-36 Health Survey V2.0
15. MHnorm= Normalized mental health subscale scores of SF-36 Health Survey V2.0
16. VTnorm= Normalized vitality subscale scores of SF-36 Health Survey V2.0
17. BPnorm= Normalized bodily pain subscale scores of SF-36 Health Survey V2.0
18. BMI= body mass index
19. 6MW= Six minute walk

20. PAQ= physical activity questionnaire

21. NHANES= National Health and Nutrition Examination Survey

22. BPM=Beats per minute

23. mmHg= millimeters of Mercury

24. Kg= Kilograms

25. Cm= centimeters

26. Mm= millimeters

27. M= Meters

28. CDC= Center for Disease Control

29. UTHSC= University of Tennessee Health Science Center

30. RPE= Rating of perceived exertion

31. IRB= Institutional Review Board

32. ANOVA= Analysis of Variance

33. SD= Standard Deviation

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Obesity is a complex medical state associated with a number of health-related conditions deleterious to the musculoskeletal system (Anandacoomarasamy, Fransen, & March, 2009; Anandacoomarasamy et al., 2012). From a biomechanical perspective, excess weight directly and indirectly creates abnormal stress on joints, particularly at the knee, which hastens the deterioration of the protective soft tissues in the joint structures (Abramson, Attur, & Yazici, 2006; Powell, Teichtahl, Wluka, & Cicuttini, 2005). Thus, obesity is a strong risk factor for development of OA (Centers for Disease & Prevention, 2011; Murphy & Helmick, 2012; Stürmer, Günther, & Brenner, 2000) and obese individuals have a substantially higher rate than non-obese individuals of total knee arthroplasty (TKA) (Bourne, Mukhi, Zhu, Keresteci, & Marin, 2007; De Guia, Zhu, Keresteci, & Shi, 2006; Liu et al., 2007; Wendelboe et al., 2003; Wright et al., 2010).

Although the associations between obesity and OA and obesity and incidence of TKA are reasonably well described, the implications of obesity on TKA rehabilitation and long-term functional recovery are not sufficiently understood. All patients, regardless of body weight, appear to experience decreased pain and improved function following TKA (Unver, Karatosun, Bakirhan, & Gunal, 2009). However, there is some evidence recounting worse long-term outcomes among obese patients. Obese individuals have higher reported need for additional surgical revision to adjust or repair the TKA, and although functional abilities improve following TKA, outcomes are significantly poorer when compared to normal weight patients (Foran et al.,

2004; Singh, O'Byrne, Harmsen, & Lewallen, 2010). Morbidly obese patients are over five times more likely than normal weight patients to experience complications and device failure within five years of TKA (Dewan et al., 2009). Physical inactivity has also been reported to have similar negative effects following joint replacement. Inactive patients have been reported to have higher surgical revision rates and loosening of the joint, and lower function scores, than those who are physically active (Gschwend, Frei, Morscher, Nigg, & J., 2000; Kilgus, Dorey, Finerman, & Amstutz, 1991).

It has commonly been assumed by medical professionals and reported by patients that obesity and physical inactivity were secondary to the OA and the accompanying pain and physical limitations. More recently, it has been suggested that obesity and physical inactivity should be treated as separate medical issues since they do not appear to improve with the restored function and reduced pain following TKA (Heisel, Silva, Rosa, & Schmalzried, 2005; Unver et al., 2009). Most studies indicate that TKA does not result in decreased body weight. In fact, it has been frequently reported that body weight often increases after TKA (Aderinto, 2005; Heisel et al., 2005; Unver et al., 2009; Woodruff & Stone, 2001; Zeni & Snyder-Mackler, 2010). Most patients report the ability to return to regular activities such as walking, hiking, and swimming, with some patients even returning to sports like tennis and jogging (Foran et al., 2004; Jones, Cox, Jhangri, & Suarez-Almazor, 2012; Loughead et al., 2008). Despite the ability to return to these activities, it appears that poor exercise habits that preceded surgery are likely to return following the initial recovery period, which may result in long-term functional abilities that are significantly compromised (Bradbury, Borton, Spoo, & Cross, 1998). Based on the limited data available, it appears that obesity and physical inactivity, which are major

contributors to the development and progression of OA, remain after TKA. Thus, functional recovery, such as general mobility, gait mechanics, walking endurance, ability to walk stairs, freedom from pain, and quality of life, may not be as thorough and lasting as expected.

The role of exercise therapy and intervention has received relatively little attention with regard to the long term outcomes following a TKA. Exercise interventions, including both aerobic and strength training, have been shown to improve aerobic fitness, mobility, coordination, and body composition; increase muscle mass and bone density; and reduce depression and anxiety in many clinical populations (Chodzko-Zajko et al 2009; Barry & Eathorne, 1994; Butler, Davis, Lewis, Nelson, & Strauss, 1998), all of which are relevant for obese patients after a TKA. However, few exercise interventions have been conducted in TKA patients. The few pre-operative and early post-operative studies, including an exercise intervention focusing on rehabilitation of the injured area, have shown that increasing strength is predictive of better function one year after surgery (Beaupre, Lier, Davies, & Johnston, 2004; Mizner, Petterson, Stevens, Axe, & Snyder-Mackler, 2005; Topp, Swank, Quesada, Nyland, & Malkani, 2009). In one of the only exercise interventions in patients more than one year from TKA, LaStayo and colleagues conducted a pilot study using a 12 week strength training program designed to improve muscle strength in the quadriceps and reported significant increases in strength and mobility (LaStayo et al., 2009). These preliminary data offer promise that exercise interventions can improve the long term function and outcomes from TKA.

Any potential exercise intervention in obese TKA patients must balance improving physical fitness levels and minimizing wear on the prosthesis. Although there have been few studies evaluating the biomechanical stress that common activities place on the knee joint, post

joint replacement exercise recommendations are available based on a survey of 54 members of Hip and Knee Society who provided their expert opinion on common sporting activities. Activities that were recommended consisted of exercises such as stationary cycling, swimming, walking, golf, low impact aerobics, weight machines, and dancing (Healy, Lorio, & Lemos, 2000). In addition to minimizing wear on the joint, consideration has to be given to motivation to become physically active. OA and obese TKA patients are routinely advised to become more physically active and lose weight before surgery. However, reports indicate that only about one third of patients are successful at increasing physical activity and ultimately reducing body weight (Borland & Jennings, 2011). Howarth et al assessed barriers to weight loss in obese patients with knee OA and while 29% reported pain as major barrier, nearly 90% reported lack of motivation to be the largest barrier to weight loss (Howarth, Inman, Lingard, McCaskie, & Gerrand, 2010). For an exercise intervention to be successful, these barriers must be carefully considered in the exercise program.

The primary outcomes of this project will be to assess functional measures pre- and post- a home based exercise intervention in obese knee replacement patients with comparison of additional benefits from the Fitbit fitness tracker. We hypothesize that obese patients have additional barriers and deficits that would benefit from a tailored general fitness program at the 1 year follow-up visit when post-surgical rehabilitation is long completed and full healing should have occurred.

SPECIFIC AIMS:

Specific Aim 1:

To describe physical function and quality of life in obese patients one year after TKA.

Specific Aim 2:

To investigate the between and within group effects on physical function and QOL of Incorporating an eight week home based exercise program with and without FitBit tracking technology in obese patients one year after TKA.

The following null hypotheses will be tested:

H02a: There will be no significant difference in body weight between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

H02b: There will be no significant difference in waist to hip ratio between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

H02c: There will be no significant difference in body composition between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

H02d: There will be no significant difference in knee range of motion between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

H02e: There will be no significant difference in resting vital signs (heart rate, respirations, and blood pressure) between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

H02f: There will be no significant difference in distance walked during the six minute walk test between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

H02g: There will be no significant difference in WOMAC knee function scores between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

H02h: There will be no significant difference in QOL (PCS, MCS, and subscales of SF 36) between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

H02i: There will be no significant difference in knee extension strength between and within groups from pre to post intervention in those in the exercise only and FitBit plus exercise group.

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CHAPTER II

LITERATURE REVIEW

Osteoarthritis (OA) is a the most common joint disease affecting over 27 million adults in the United States (Van Manen, Nace et al., 2012). The steady and rapid increases in the incidence and prevalence over the last 20 years have made OA a serious public health concern (Suri, Morgenroth et al., 2012). The significant impact OA has on the patients' health and physical function is evident as OA is one of the leading causes of long term disability (McNeil and Binette, 2001; Arden and Nevitt, 2006). This has led to much work to understand OA and the impact on the health of those with living with the disease.

OA is degenerative joint diseases which can affect both the soft tissue and bony structures of the joint. OA can affect any joint however the hip, knee and hand are the most common. OA of the knee is particularly concerning due to the frequency it occurs and the impact on mobility. Estimates of lifetime risk for developing symptomatic knee OA report that 40 % of males and 47% of females will be impacted by OA (Murphy, Schwartz et al., 2008). Not surprisingly, knee OA is the leading cause of walking related disability (Felson, Lawrence et al. 2000). OA is clearly a burden on many adults in the United States as well as the medical system.

OA diagnosis is based on a combination of clinical assessment and radiographic evidence of joint deterioration. OA is commonly characterized by clinical report of pain, and stiffness in the joint. These symptoms often progress limiting physical activity and ultimately function. Radiographic evidence is characterized using one several grading systems. The Kellgren-Lawerence grading system of OA being the most widely used to assess knee OA

(Kallman, Wigley et al., 1989; Spector, Hart et al., 1993). The Kellgren-Lawerence grading system of OA focuses on the amount of joint space created by soft tissue deterioration and the eventual narrowing of sub-chondral bone (Kellegren and Lawrence, 1957).

Risk factors for Osteoarthritis

Much attention has been focused toward disease prevention which led to the identification of several risk factors for the development and progression of OA. These factors have been commonly grouped as systemic which impact the whole body and indirectly the joint or be more localized factors which directly impact the joint. More practically from a clinical and treatment perspective, risk factors can be grouped into non-modifiable and modifiable factors. Non-modifiable risk factors generally include age, sex, hormonal status, ethnicity, and genetics. Modifiable risk factors of developing OA which are generally reported include nutrition, muscle strength, and obesity.

Non modifiable risk factors

Age is one of the strongest risk factors for development of OA (Dougados, Gueguen et al., 1992; Lawrence, Felson et al., 2008; Blagojevic, Jinks et al., 2010). The prevalence of OA increases substantially after the age of 45 years old with over 20% reporting OA (Blagojevic, Jinks et al., 2010). The prevalence of OA increases to nearly 40% in those over 65 years old (Dillon, Rasch et al., 2006). The impact age has on the progression of OA is unclear since OA appears to be stable for long periods in some patients and progresses quickly in others (Lievense, Bierma-Zeinstra et al., 2002; Belo, Berger et al., 2007).

In addition to age, it is clear that genetics have significant role in the development of OA. On a population or cohort level, studies have consistently shown the influence of

heritability explains nearly 50% of the variation in vulnerability to OA (Spector, Cicuttini et al., 1996; MacGregor, Antoniades et al., 2000; Valdes and Spector, 2009). Despite the consistency and quality of population level findings, individual level genetic research has been challenging and the results varied. While genome wide association studies have identified some points of interest including nearly 30 genes across 6 pathways affecting nearly 40 identified cellular functions (Loughlin, 2005; Valdes and Spector, 2009; Valdes and Spector, 2010). The lack of a clear consensus and identification of a specific gene has led to the conclusion that multiple genes are likely involvement and are modified by environment factors and polymorphisms across multiple genes. Although population studies indicate a genetic influence, individual genetic identification and screening appear to be a long way off.

Gender is commonly reported as non-modifiable risk factors for developing OA (Lawrence, Felson et al., 2008). However, there is some disagreement in the literature with regard to the individual contributions and interactions between age, gender, and hormonal status. None the less, women over the age of 50 years old experience OA at significantly higher incidence and prevalence rates compared to males (Dillon, Rasch et al., 2006). This is likely mediated by changes in sex hormone levels following menopause although current evidence is inconsistent (Sowers, Hochberg et al., 1996; Wluka, Cicuttini et al., 2000). However, studies comparing post-menopausal women on supplemental estrogen with those not receiving supplementation showed those supplementing have lower prevalence of OA (Wluka, Cicuttini et al., 2000; Wluka, Davis et al., 2001; Carbone, Nevitt et al., 2004). Based on these findings, it appears that hormonal status is likely confounding the gender findings.

Ethnicity also appears to affect both the rates at which OA occurs as well as the progression of the disease. African Americans have similar but slightly higher reported symptomatic knee OA but were considerable more likely to have evidence of more severe knee OA than Caucasians (Jordan, Helmick et al., 2007). Caucasians and Mexican Americans have nearly identical rates of Knee OA (Dillon, Rasch et al., 2006). In addition, Chinese and African American women have a significantly higher likelihood of having symptomatic OA of the knee compared to Caucasian women (Zhang, Xu et al., 2001; Lawrence, Felson et al., 2008). The effects of ethnicity on the progression of OA are somewhat unclear however it is clear that African Americans have evidence of more severe disease suggesting different, possible accelerated, progression compared to Caucasians (Braga, Renner et al., 2009).

Non-modifiable risk factors of development and progression of OA are useful in the determination of those most at risk for developing OA and may inform medical decision making and recommendation for radical treatment. However, these risk factors are of little use in terms of preventing OA and managing the progression of OA. On the other hand, modifiable risk factors of developing OA such as obesity, nutrition, and muscle strength may be useful treatment targets.

Modifiable risk factors

Obesity itself is a complex medical condition which affects more than 78 million adults in the United States (Flegal, Carroll et al., 2010). Obesity is characterized the accumulation of excess body fat to the point where negative effects on health are observed. Obesity is a major public health concern with a cost estimated at 200 billion dollars annually (Institute of Medicine, 2012). Obesity is associated with the development of heart disease, type 2 diabetes,

obstructive sleep apnea, cancer, as well as OA (Haslam and James, 2005). The growing body of literature supporting the impact obesity has directly on an individual's health has recently led the American Medical Association to recognize obesity as a disease (American Medical Association, 2013). With obesity rates steadily increasing for decades, this distinction paved the way for greater recognition of the harmful effects of obesity and more aggressive treatment and medical support for obese patients.

Obesity has been shown to negatively impact the musculoskeletal system (Anandacoomarasamy, Fransen et al., 2009; Anandacoomarasamy, Leibman et al., 2012). Not surprisingly, obesity is a strong risk factor for development of OA (Stürmer, Günther et al., 2000; Centers for Disease and Prevention, 2011; Murphy and Helmick, 2012). In a longitudinal study of twins, Cicuttini et al found for each kilogram increase in body weight the risk of developing knee OA increased by 13% (Cicuttini, Baker et al., 1996). This increased risk of OA is partially explained by the excessive and abnormal stress patterns in the joint which directly and indirectly lead to deterioration of the protective soft tissues in the joint structures (Powell, Teichtahl et al., 2005; Abramson, Attur et al., 2006). OA involves the degeneration of the joints specifically through chronic cartilage damage, sub chondral bone remodeling, and inflammation in the synovial membranes. Not surprisingly, this is compounded in obese individuals as excess body weight and body fat add undue pressure to the orthopedic structures of the body particularly the lower extremities.

In addition to increased pressure on the joints, obesity also appears to have additional effects that increase the risk of OA. Some evidence suggesting an increased risk of OA in a non-load bearing joints such as the hand (Yusuf, Nelissen et al., 2010). This increased risk has been

used to build a case for the impact the metabolic effects of obesity on risk and progression of OA. Close examination has produced inconsistent results and no conclusive mechanisms. Although metabolic disease is clearly associated with obesity it remains unclear how much impact this has on the development of OA.

Dietary intake has an obvious relationship with regard to the development of obesity and has suggested as a potential risk factor that can influence the risk of developing OA and the progression of the disease. Longitudinal studies have shown that those with chronic dietary insufficiencies are at risk for OA. Some evidence to suggest individuals with low Vitamin D intake are at an increased risk of developing OA and have greater progression of OA (McAlindon, Felson et al., 1996; Lane, Gore et al., 1999). This conclusion appears consistent with previous work showing the importance of Vitamin D levels with regard to bone health (Parfitt, Gallagher et al., 1982; Gallagher and Sai, 2010; Institute of Medicine, 2012; Turner, Anderson et al., 2012). In addition to Vitamin D, the effects of Vitamin C and Vitamin E have on OA have been discussed in recent literature. The research on Vitamin C and Vitamin E has been based largely based around their antioxidant properties. Data from the Framingham study investigating nutrient intake and longitudinal development of OA is suggestive of a protective effect against progression of OA in those with higher levels of Vitamin C and Vitamin E (McAlindon, Jacques et al., 1996). However, studies providing supplementation with antioxidant compounds including Vitamin E have shown no effect on symptoms or structure related to OA (Brand, Snaddon et al., 2001; Wluka, Stuckey et al., 2002). This data is clearly not yet robust but based on the limited information available nutrient intake may have some impact on the development and progression of knee OA.

Muscle strength is another potentially modifiable risk factor that has been reported in development and progression of OA. Muscle weakness has long been assumed to be the result of pain and disuse following development OA. However, several studies suggest muscle weakness as an independent risk factor for developing knee OA especially in women (O'Reilly, Jones et al., 1998; Slemenda, Heilman et al., 1998; Brandt, Heilman et al., 1999). In addition, pain and disability scores from knee OA are significantly higher in those with muscle weakness (O'Reilly, Jones et al., 1998). These results are supported by evidence that decreased peak quadriceps strength leads to increase joint and ligament loading (Shelburne, Torry et al., 2006). The increased forces in the joint are largely the result of a decreased joint stability (Brand, 1989). The reported increased joint loading has been implicated in acute injury and subsequent damage to the tissues in the joint. Although, the direct link between muscle weakness and injury is difficult to quantify due to unpredictable nature of injury. The assumptions that a relationship between muscle weakness and injury are not unsubstantiated. Acute injuries and possible structural changes to the knee have been shown to greatly increase the risk of developing OA (Felson, Zhang et al., 1995; Cooper, Snow et al., 2000; Gelber, Hochberg et al., 2000). Muscle weakness is further compounded in this population by the higher force requirements associated with increased body mass.

Medical management and treatment of Osteoarthritis

There is currently no cure for OA so medical management has been focused on symptom management of the affected joint, and prevention and control of disease progression. Primary treatment generally includes pain management, weight loss and surgical intervention to replace degenerative tissue with a prosthetic joint. This is especially true in obese individuals

which have a substantially higher rate than non-obese individuals of total knee arthroplasty (TKA) (Wendelboe, Hegmann et al., 2003; De Guia, Zhu et al., 2006; Bourne, Mukhi et al., 2007; Liu, Balkwill et al., 2007; Wright, Katz et al., 2010).

Total knee arthroplasty outcomes

Although the associations between obesity and OA and obesity and incidence of TKA are reasonably well described, the implications of obesity on TKA rehabilitation and long-term functional recovery are not sufficiently understood. TKA procedures have been improved and have substantially better outcomes than seen as recently as 15 years ago. This is due to improved materials as well as improved surgical procedures. All patients, regardless of body weight, appear to experience decreased pain and improved function following TKA (Unver, Karatosun et al., 2009). However, there is some evidence recounting worse long-term outcomes among obese patients. Obese individuals have higher reported need for additional surgical revision to adjust or repair the TKA, and although functional abilities improve following TKA, outcomes are significantly poorer when compared to normal weight patients (Foran, Mont et al., 2004; Singh, O'Byrne et al., 2010). Morbidly obese patients are over five times more likely than normal weight patients to experience complications and device failure within five years of TKA (Dewan, Bertolusso et al., 2009). Physical inactivity has also been reported to have similar negative effects following joint replacement. Inactive patients have been reported to have higher surgical revision rates and loosening of the joint, and lower function scores, than those who are physically active (Kilgus, Dorey et al., 1991; Gschwend, Frei et al., 2000). Despite all these improvements, obese patients are still a concern for the orthopedic community and the management of OA.

It has commonly been assumed by medical professionals and reported by patients that obesity and physical inactivity were secondary to the OA and the accompanying pain and physical limitations. More recently, it has been suggested that obesity and physical inactivity should be treated as separate medical issues since they do not appear to improve with the restored function and reduced pain following TKA (Heisel, Silva et al., 2005; Unver, Karatosun et al., 2009). Most studies indicate that TKA does not result in decreased body weight. In fact, it has been frequently reported that body weight often increases after TKA (Woodruff and Stone, 2001; Aderinto, 2005; Heisel, Silva et al., 2005; Unver, Karatosun et al., 2009; Zeni and Snyder-Mackler, 2010). Most patients report the ability to return to regular activities such as walking, hiking, and swimming, with some patients even returning to sports like tennis and jogging (Foran, Mont et al., 2004; Loughead, Malhan et al., 2008; Jones, Cox et al., 2012). Despite the ability to return to these activities, it appears that poor exercise habits that preceded surgery are likely to return following the initial recovery period, which may result in long-term functional abilities that are significantly compromised (Bradbury, Borton et al., 1998). Based on the limited data available, it appears that obesity and physical inactivity, which are major contributors to the development and progression of OA, remain after TKA. Thus, functional recovery, such as general mobility, gait mechanics, walking endurance, ability to walk stairs, freedom from pain, and quality of life, may not be as thorough and lasting as could be expected.

The role of exercise therapy and intervention has received relatively little attention with regard to the long term outcomes following a TKA. Exercise interventions, including both aerobic and strength training, have been shown to improve aerobic fitness, mobility,

coordination, and body composition; increase muscle mass and bone density; and reduce depression and anxiety in many clinical populations (Barry and Eathorne, 1994; Butler, Davis et al., 1998), all of which are relevant for obese patients after a TKA. However, few exercise interventions have been conducted in TKA patients. The few pre-operative and early post-operative studies, including an exercise intervention focusing on rehabilitation of the injured area, have shown that increasing strength is predictive of better function one year after surgery (Beaupre, Lier et al., 2004; Mizner, Petterson et al., 2005; Topp, Swank et al., 2009). In one of the only exercise interventions in patients more than one year from TKA, LaStayo and colleagues conducted a pilot study using a 12 week strength training program designed to improve muscle strength in the quadriceps and reported significant increases in strength and mobility (LaStayo, Meier et al., 2009). These preliminary data offer promise that exercise interventions can improve the long term function and outcomes from TKA.

Any potential exercise intervention in obese TKA patients must balance improving physical fitness levels and minimizing wear on the prosthesis. Although there have been few studies evaluating the biomechanical stress that common activities place on the knee joint, post joint replacement exercise recommendations are available based on a survey of 54 members of Hip and Knee Society who provided their expert opinion on common sporting activities. Activities that were recommended consisted of exercises such as stationary cycling, swimming, walking, golf, low impact aerobics, weight machines, and dancing (Healy, Lorio et al., 2000). In addition to minimizing wear on the joint, consideration has to be given to motivation to become physically active. OA and obese TKA patients are routinely advised to become more physically active and lose weight before surgery. However, reports indicate that only about one

third of patients are successful at increasing physical activity and ultimately reducing body weight (Borland and Jennings, 2011). Howarth et al assessed barriers to weight loss in obese patients with knee OA and while 29% reported pain as major barrier, nearly 90% reported lack of motivation to be the largest barrier to weight loss (Howarth, Inman et al., 2010). For an exercise intervention to be successful, these barriers must be carefully considered in the exercise program.

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CHAPTER III

MANUSCRIPT 1

PHYSICAL FUNCTION AND ACTIVITY IN OBESE PATIENTS ONE YEAR AFTER TOTAL KNEE ARTHOPLASTY

INTRODUCTION

Obesity is associated with a number of health-related conditions detrimental to general health and specifically the musculoskeletal system (Anandacoomarasamy, Fransen, & March, 2009; Anandacoomarasamy et al., 2012). Obese individuals have excess body weight which directly and indirectly stresses the joints, particularly at the knee, abnormally which increases the deterioration of the protective soft tissues in the joint structures (Abramson, Attur, & Yazici, 2006; Powell, Teichtahl, Wluka, & Cicuttini, 2005). Thus, obesity is a strong risk factor for development of OA (Centers for Disease & Prevention, 2011; Murphy & Helmick, 2012; Stürmer, Günther, & Brenner, 2000) and obese individuals have a substantially higher rate than non-obese individuals of total knee arthroplasty (TKA) (Bourne, Mukhi, Zhu, Keresteci, & Marin, 2007; De Guia, Zhu, Keresteci, & Shi, 2006; Liu et al., 2007; Wendelboe et al., 2003; Wright et al., 2010).

Although the associations between obesity and OA and obesity and incidence of TKA are reasonably well described, the implications of obesity on TKA rehabilitation and long-term functional recovery are not sufficiently understood. All patients, regardless of body weight, appear to experience decreased pain and improved function following TKA (Unver, Karatosun, Bakirhan, & Gunal, 2009). However, there is some evidence recounting worse long-term outcomes among obese patients. Morbidly obese patients are over five times more likely than normal weight patients to experience complications and device failure within five years of TKA

(Dewan et al., 2009). Obese individuals have higher reported need for additional surgical revision to adjust or repair the TKA, and although functional abilities improve following TKA, outcomes are significantly poorer when compared to normal weight patients (Foran et al., 2004; Singh, O'Byrne, Harmsen, & Lewallen, 2010). Functional abilities i.e. completion of activities of daily living and exercise capacity are not well researched after the initial rehabilitation programs are completed; leaving the long-term durability of these initial rehabilitation programs in question.

The impact of obesity is compounded by low levels of physical activity. Physical inactivity has been reported to have similar negative effects following joint replacement. Inactive patients have been reported to have higher surgical revision rates and loosening of the joint, and lower function scores, than those who are physically active (Gschwend, Frei, Morscher, Nigg, & J., 2000; Kilgus, Dorey, Finerman, & Amstutz, 1991). It has commonly been assumed by medical professionals and reported by patients that obesity and physical inactivity were secondary to the OA and the accompanying pain and physical limitations. More recently, it has been suggested that obesity and physical inactivity should be thought of as separate medical issues since they do not appear to improve with the restored function and reduced pain following TKA (Heisel, Silva, Rosa, & Schmalzried, 2005; Unver et al., 2009). Most studies indicate that TKA does not result in decreased body weight. In fact, it has been frequently reported that body weight often increases after TKA (Aderinto, 2005; Heisel et al., 2005; Unver et al., 2009; Woodruff & Stone, 2001; Zeni & Snyder-Mackler, 2010).

Most clinical evaluations indicate patients report the ability to return to regular activities such as walking, hiking, and swimming, with some patients even returning to sports like tennis and jogging (Foran et al., 2004; Jones, Cox, Jhangri, & Suarez-Almazor, 2012; Loughead et al., 2008). Despite the ability to return to these activities, it appears that poor exercise habits that preceded surgery are likely to return following the initial recovery period, which may result in long-term functional abilities that are significantly compromised (Bradbury, Borton, Spoo, & Cross, 1998). Based on the limited data available, it appears that obesity and physical inactivity, which are major contributors to the development and progression of OA, remain after TKA. Thus, functional recovery, such as general mobility, gait mechanics, walking endurance, ability to walk stairs, freedom from pain, and quality of life, may not be as thorough and lasting as could be expected.

This purpose of this investigation was to evaluate physical function, physical activity levels, and quality of life in obese patients one year following a total knee arthroplasty.

MATERIALS AND METHODS

Participants

Thirty four obese patients who were 10 to 18 months post total knee arthroplasty volunteered to complete surveys and participate in a functional assessment. Patients were required to have medical clearance to participant in exercise testing. Patients were identified and recruited from surgical follow up clinics at Campbell Clinic Orthopaedics. Prior to consent each participant was prescreened by phone for physical activity level and health status by a research nurse. Participants were informed of all procedures, potential risks, and benefits associated with the study with procedures approved by the University of Tennessee Health Science Center Institutional Review Board for Human Subjects research. Eligibility was verified with health and medical history and physical activity survey to verify eligibility during the initial visit. All participants signed an informed consent prior to enrollment on the study.

Anthropometrics

Height and weight were collected without shoes using a digital clinic scales and a wall mounted stadiometer. Body composition was measured using standardized skinfold measures developed by Jackson and Pollock and described in detail by the American College of Sports Medicine (Jackson & Pollock, 1985; American College of Sports Medicine, 2010). Skinfolds were measured with Lange skinfold caliper (Beta Technology, Santa Cruz, CA, 95060) recorded at the

chest, abdomen and thigh in males and triceps, suprailiac crest, and thigh in females. Sum of skinfolds measured were used to calculate percentage body fat using two stage predictive equations by first calculating body density and then body fat percentage (Jackson & Pollock, 1985; American College of Sports Medicine, 2010). BMI was calculated by dividing kilograms of body weight by height in meters squared. Waist and hip circumference was measured using a Gullick II tape measure at the narrowest point between the umbilicus and the xiphoid process and the widest point between umbilicus and the knee, respectively.

Physical Function

Heart rate, blood pressure, and respirations were measured following a five minute quiet seated rest period. Walk endurance was measured using the 6MW, which consists of continuous walking at a self-selected walk pace in accordance with the American Thoracic Society guidelines (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002). During the 6MW, participants were encouraged to walk as quickly as possible for six minutes on the designated walk path. Participants could stop and rest as needed during the test, however the test timer did not stop. Distance walked in six minutes will be recorded. Predicted walk distances were based on previously published predictive equations based on healthy adults (Enright & Sherrill, 1998).

Passive and active range of motion at the knee was measured by a licensed physical therapist using a goniometer. Participants were instructed to flex and extend the knee as far as possible and results were recorded at the terminal range in degrees. Knee extension strength was measured using a handheld dynamometer. The participants were seated with the knee

positioned at 60 degrees and the dynamometer was placed 20 centimeter below the tibial tuberosity. The participant was instructed to extend their lower leg against the dynamometer as hard as possible. Three trials were performed on each leg with one minute rest between. Predicted strength values were based on previously published gender based normative ranges in healthy adults (Andrews, Thomas, & Bohannon, 1996).

Self-Reported Knee Function and Health Related Quality of Life

The Western Ontario and McMaster University Osteoarthritis Index (WOMAC) used to survey to assess pain, function, and quality of life in patients with OA of the knee (Quintana et al., 2006). WOMAC scoring yields one composite (0 to 96) and 3 subscales: pain (0 to 20), stiffness (0-8), and physical function (0-68). Responses to each question range from zero indicating none to four indicating severe. Higher scores on the composite or subscales indicate worse pain, stiffness, or function. The composite and subscales have been shown valid (Spearman correlations from 0.63 to 0.67) and reliable (Cronbach's alphas from 0.86 to 0.95) (Bullens, van Loon, de Waal Malefijt, Laan, & Veth, 2001; Dunbar, Robertsson, Ryd, & Lidgren, 2001).

Health related quality of life was assessed using the Medical Outcomes Study short form 36 version 2 (Ware, 2004; Ware, Snow, Kosinski, & Gandek, 1993). The SF36 is a commonly used questionnaire used to assess health related quality of life. The survey is generic health survey which has been used in many populations including obese and osteoarthritis populations (Bohannon & DePasquale, 2010; Ware, 2000). Scores were calculated for eight health domains (mental health, role physical, physical function, vitality, social function, bodily pain, role

emotional, and general health), the physical component survey (PCS) and mental component survey (MCS). Survey responses were summed to generate raw scores in each subscale and health domain and used to create general population norm-based scoring (t scores with a population mean of 50 and a standard deviation of 10 using previously prescribed methodology (Ware, 2004; Ware, 2000; Ware et al., 1993). Scores were considered poor if the normalized scores (T-Scores) were less than 37 which correspond to the lowest 10^{th} percentile of the general population. Scores were considered to be average or better if the normalized scores (T-Scores) were greater than 48 which correspond to the >40th percentile of the general population.

Physical Activity Levels

Physical activity was assessed using the Nation Health and Nutrition Examination Survey (NHANES) Physical Activity Questionnaire (PAQ) version 2009 (Available at http://www.cdc.gov/nchs/nhanes/nhanes2009-2010/PAQ_F.htm). The survey consists of questions about daily, leisure time, and sedentary activities. Each value was carefully reviewed with each participant to ensure accuracy. Minutes per week spent doing vigorous or moderate physical activity was calculated from responses to daily (work) and leisure time activities. Sedentary time was collected and reported in hours per day. Screen time was evaluated separately as television and computer time. Responses were less than one hour, one hour, two hours, three hours, four hours, and five hours or more.

All testing was completed by the same clinical exercise physiologist, with the exception of lower extremity range of motion and the WOMAC index which were completed by a licensed physical therapist.

Data Analysis

All data reduction, processing, and analysis for this project were generated using SAS software, version 9.2 of the SAS system for Windows (SAS Institute, Cary, NC, USA). The outcomes of this project are primarily descriptive as such statistical analysis consisted of calculating means and standard deviations for each measure. Reference ranges were constructed from population based normative equations and references where available.

RESULTS

Patient Characteristics

Patient characteristics can be found in *Table 1.1.* Patients included in this project were comprised of 24 females and 10 males. Average age was 65.0 ±9.5 years old (mean± standard deviation). Participants had a normal resting heart rate (77.1±7.4 bpm), borderline hypertensive systolic blood pressure (132.1±8.8 mmHg) and pre-hypertensive diastolic blood pressure (82.0±4.1 mmHg). Two participants (5.9%) were current smokers. All had medical clearance and none were currently receiving medical treatment for an acute medical issue.

Anthropometrics

Patient anthropometrics can be found in *Table 1.1.* Participants were 164.1±9.9 cm tall, and weighted 99.7±17.5 kg which corresponds to an average BMI of 36.9±4.8 kg/m^2. All patients had a BMI over 30 kg/m^2 indicating obesity. Mean sum of skinfolds were 133.4±18.7 mm which corresponds to a body fat percentage of 41.3±5.2%. Males in our study had slightly lower body fat (34.8±3.6% vs 44.0±2.8%), BMI (36.1±4.3 30 kg/m^2 vs. 37.3±5.1 kg/m^2), skinfolds (121.4±19.4 mm vs 138.4±16.3mm) and higher waist to hip ratios (0.97±0.06 vs 0.88±0.06) compared to females in our study.

Knee Range of Motion

Active knee extension ranged from 8 degrees of hyperextension to 15 degrees lacking full extension. The average active knee extension was 2.1±4.5 degrees on the left and 2.5±5.2 degrees on the right. Active knee extension limb difference was 4.2±3.7 degrees with a range of 0 to 14 degrees. Active knee flexion ranged from 84 degrees to 140 degrees. The average active knee flexion was 119.2±10.6 degrees on the left and 120.6±11.4 degrees on the right. Active knee extension limb difference was 8.8±7.0 degrees with a range of 0 to 31 degrees.

Table 1.1. Patient characteristics

	Total (N=34) N (%)	**Male (n=10) N (%)**	**Females (n=24) N (%)**
Smoker	2 (5.9)	0 (0)	2 (5.9)
Bilateral TKA	10 (29.4)	2 (5.9)	8 (23.5)
	Mean±SD	**Mean±SD**	**Mean±SD**
Age (yrs)	65.0±9.5	62.7±8.9	66.0±9.8
Height (cm)	164.1±9.9	174.3±10.5	159.8±5.8
Weight (kg)	99.7±17.5	110.8±22.2	95.1±13.1
BMI (kg/m^2)	36.9±4.8	36.1±4.2	37.3±5.0
Bodyfat (%)	*	34.8±3.6	43.9±2.8
Skinfolds (mm)	133.4±18.7	131.6±16.9	138.4±16.3
Waist to hip	0.91±0.07	0.96±0.06	0.88±0.06

*Calculations of body fat percentage are gender specific.

Knee Extensor Strength

Knee extension strength ranged from 8.7 kg to 43.0 kg. The average knee extension strength was 23.8±7.0 kg on the left and 25.4±8.1 kg on the right. Knee extension strength difference was 3.3±2.9 kg with a range of 0.2 to 11.2 kg. Percent of predicted strength based on gender based normative data were 81.1±20.9%. Thirteen patients (38.2%) failed to reach 75% of their predicted knee extension strength values.

Walk Performance

Total distance walked during six minutes ranged from 152.0 meters to 471.2 meters. The average distance walked during six minutes was 321.3±74.0 meters. Percent of predicted walk distance based on gender based prediction equation were 75.3±18.1%. Seventeen patients (50.0%) failed to reach 75% of their predicted walk distance during the six minute walk test. Average peak heart rate during the six minute walk was 107.1±12.2 bpm. Average peak rating of perceived exertion was 10.7±2.9 on the Borg scale.

Self-Reported Knee Function

WOMAC scores can be found in Table 1.2. WOMAC composite scores were 19.9±13.4 points out of a possible 96 points with a minimum of 3 and maximum of 51. The function subscale scores were 14.4±10.4 points out of a possible 68 points with a minimum of 1 and maximum of 38. Pain subscale scores were 3.1±2.5 points out of a possible 20 point with a minimum of 0 and a maximum of 9. Stiffness subscale scores were 2.4±1.4 points out of a possible 8 points with a minimum of 0 and a maximum of 6 points.

Table 1.2 Knee Related Quality of Life

	Mean ± SD	Range
WOMAC		
Composite Score (0-96)	19.9±13.4	3.0; 51.0
Function (0-68)	14.4±10.4	1.0; 38.0
Pain (0-20)	3.1±2.5	0.0; 9.0
Stiffness (0-8)	2.4±1.4	0.0; 6.0

Self-Reported Health Related Quality of Life

Self-Reported Health Related Quality of Life scores can be found in Table 1.3. Participants had a mean of 39.5±9.2 on the Physical Component Scale (PCS). Normative scores on the Physical functioning sub-scale were 35.8±10.4. Twelve patients (35.3%) scored poorly on the PCS scale indicating their scores were in the lowest 10^{th} percentile of general population. In addition, eighteen patients (52.9%) scored poorly on the physical function sub-scale indicating their scores were in the lowest 10^{th} percentile of general population. While only five patients (14.7%) scored average or better (≥40^{th} percentile) indicating normal physical performance on the PCS. In addition, only four (11.8%) scored average or better (≥40^{th} percentile) indicating normal physical performance on the physical function subscale. Role physical sub-scale (41.4±11.9) and bodily pain subscales (44.9±9.7) were slightly below the normative values. Participants had a mean slightly above the predicted normal (54.5±9.7) on the Mental Component Scale (MCS). Social functioning, mental health, and general health sub scales were all with the normative ranges (49.1+9.7, 52.1±10.5, and 49.9±8.1, respectively).

Table 1.3 Health Related Quality of Life

	Mean ± SD	RANGE	<10th Percentile n (%)	≥40th Percentile n (%)
PCS	39.5±9.2	20.1; 54.1	12 (35.3)	4 (11.8)
MCS	54.5±9.2	20.4; 66.2	2 (5.9)	32 (94.1)
MHnorm	52.1±10.5	21.8; 64.1	2 (5.9)	24 (70.6)
PFnorm	35.8±10.4	19.2; 54.9	18 (52.9)	5 (14.7)
REnorm	47.1±13.1	9.2; 55.9	8 (23.5)	5 (14.7)
RPnorm	41.4±11.9	20.1; 56.6	11 (32.3)	10 (29.4)
SFnorm	49.1±9.7	13.2; 56.8	4 (11.8)	22 (64.7)
VTnorm	50.8±6.9	36.5; 67.7	2 (5.9)	17 (50.0)
GHnorm	49.9±8.1	31.5; 63.9	2 (5.9)	19 (55.9)
BPnorm	44.9±9.7	19.9; 55.4	5 (14.7)	19 (55.9)

Physical Activity Levels

No patients reported completing any vigorous physical activity during daily or leisure time activities in the past 30 days. Patients on average reported completing 16.3+27.3 minutes of moderate intensity physical activity per week with twenty three patients (67.8%) reporting no physical activity in the past 30 days. Patients reported 10.0±2.8 hours per day of sedentary time. Ten patients (29.4%) reported more than five hours per day of television watching while thirteen patients (38.1%) report one hour or less of computer use per day.

DISCUSSION

The management of knee osteoarthritis and its debilitating symptoms has advanced significantly in recent decades (Dieppe & Brandt, 2003; Foran et al., 2004; Van Manen, Nace, & Mont, 2012). These advancements necessitate the evaluation of the long term outcomes after total knee replacement. This is particularly important in the growing number of obese patients receiving TKA. Our findings indicate that patients have physical limitations and low levels of physical activity that persist after recovery from TKA. Furthermore, patients reported limitations are confirmed with objective assessment of physical performance.

This investigation is one of the first to evaluate obese patients to describe physical function both objectively and subjectively one year after TKA. The recovery from TKA has been reasonably well described up to about 6 months post operation. This period is marked by rapid recovery from surgery, restoration of independence, and significant improvements from pre-surgery functional and quality of life. After six months, the recovery is less well documented and based on limited data available appears to slow. Our results indicate that obese TKA patients remain well below age predicted references on the six minute walk distance, and leg extensor strength one year after surgery.

Although the data in obese patients with one year of follow up are sparse, our results appear consistent with previous studies in normal weight patients showing around 20% deficit in knees extensor strength in those 6 to 33 months post TKA as compared to healthy controls

(Berman, Bosacco, & Israelite, 1991; Berth, Urbach, & Awiszus, 2002). Our patients on average achieved approximately 81% of gender predicted strength values. However, over one third (38.2%) of our patients were not able to achieve 75% of their gender based reference strength values. Although this is far from a majority, this is a clinically concerning subset of participants who are at particular risk due to excess body weight whose physical function may be limited by muscle weakness. These are particularly concerning because knee extensor strength has been reported to be a significant predictor of long term satisfaction with TKA (Mizner, Petterson, Stevens, Axe, & Snyder-Mackler, 2005).

Six minute walk distances were also well below age and gender predicted values in our population. Half of the patients in our study were not able to walk at least 75% of their predicted distance based on gender and body size. Although not completely analogous our results are in agreement with Yoshida et al noted significantly decreased walk distance in a group of normal to overweight patients at three months and one year after TKA (Yoshida, Mizner, Ramsey, & Snyder-Mackler, 2008). Surprisingly, the six minute walk distances in our patients were notably lower than many other reported walk distances in normal to overweight but not obese patient populations (Kennedy, Stratford, Riddle, Hanna, & Gollish, 2008; Yoshida et al., 2008).

In addition, our results indicate that patients report impairments in physical function on both the SF36 and WOMAC scales. This is similar to previously published studies where patients self-reported physical performance limitations as long as two years after TKA (Foran et al., 2004; Walsh, Woodhouse, Thomas, & Finch, 1998). While no absolute or clinical cutoffs for

exist for the WOMAC scale, our patients still report mild to moderate functional limitation, pain and stiffness in their knees which is similar to previous reports and indicates incomplete recovery from TKA (Bourne, Chesworth, Davis, Mahomed, & Charron, 2010). The more global assessment of health related quality of life (SF36) which showed that a majority of our patients report poor physical function. Interestingly despite the physical limitations that remain after TKA, patients in our study report similar vitality, general health, and mental health compared to the general population. These findings are similar to previous reports which indicate patients report physical limitation but are otherwise on par with the general population (Loughead et al., 2008).

Physical activity has been a commonly reported risk factor for development and progression of knee OA. Low preoperative levels of physical activity are well documented and commonly assumed are result of preoperative pain. Our results agree with previous reports that physical activity levels remain low after TKA and recovery (Heisel et al., 2005; Unver et al., 2009). None of patients in our study reached the ACSM and CDC guidelines of 150 minutes of physical activity per week (Whaley, 2006). Nearly 70% of our patients reported no physical activity in the past 30 days. In addition to very low amounts of physical activity, our patients reported high levels of sedentary behavior which is an extremely concerning pattern. The large amounts of sedentary behavior and lack of physical activity further exacerbates the physical performance limitation and deconditioning following TKA.

This research project is not without limitation which must be considered when interpreting the results. First this is a cross sectional study and does not afford the opportunity to evaluate the pre-operative body habitus, functional abilities or quality of life of the patient. In addition, we were not able to evaluate the surgical techniques employed, complications during surgery, or post-operative therapy programs which could influence the outcomes at one year. Secondly, this was a convenient sample which was recruited from orthopedic surgery follow up clinic. Although, the patients were pretty typical of those routinely seen in the clinic it is possible that selection bias exists which could influence the outcomes.

Future research including longitudinal evaluate of obese patients is needed to determine if pre-operative factors are predictive of long term functional outcomes with special attention to the role excess body weight may play. In addition, the number of obese patients receiving TKA has increased dramatically in the past decade. More careful evaluation of the post-operative rehabilitation programs is needed with specific emphasis on how effectively the current programs address functional recovery in obese patients. In addition, interventions focused on improving the long term functional abilities in obese individuals appear warranted based on our results.

This cross sectional evaluation of obese individuals one year post TKA provides evidence that while quality of life and patient satisfaction with the TKA may be improved; it is despite significant performance and functional limitations which are apparent in both direct assessment and patient responses. Furthermore, obese patients may have physical performance limitations which remain well after patients have been released from post-

operative rehabilitation. These limitations may be exacerbated by increased body weight and decreased physical activity. The combination of residual strength and conditioning deficits after TKA, low levels of physical activity, and increased physiological and biomechanical pressure from excess body weight make these patients particularly vulnerable.

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APPENDICES

APPENDIX A

INFORMED CONSENT

APPENDIX A: INFORMED CONSENT

THE UNIVERSITY of TENNESSEE HEALTH SCIENCE CENTER

Main Consent Form

TITLE: Feasibility and effect of incorporating the Fitbit fitness tracking technology into a prescribed exercise intervention program to improve long-term function in obese individuals one year following total knee arthroplasty

PRINCIPAL INVESTIGATORS:

Webb A. Smith, MS, PhC
122 Robison Hall
University of Memphis
Memphis, TN 38152

James G. Gurney, PhD
228 Robison Hall
University of Memphis
Memphis, TN 38125

Audrey Zucker-Levin, PhD, PT, MBA
617, 930 Madison Avenue
Memphis, TN 38163

CO-INVESTIGATOR(S):

William M. Milhalko, MD, PhD
956 Court St.
E226 Coleman College of Medicine Building
Memphis, TN, 38163

John Williams, PhD
330 Engineering Technology Building
University of Memphis
Memphis, TN 38152

1. INTRODUCTION:

You are being given the opportunity to participate in this research study. The purpose of this consent form is to help you decide if you want to be in the research study. This consent form may contain words that you do not understand. Please ask the study doctor or the study staff to explain any words or information that you do not clearly understand. We encourage you to talk with your family and friends before you decide to take part in this research study. Please tell the study doctor or study staff if you are taking part in another research study.

The purpose of this study is:

- To evaluate whether or not it is possible to use the FitBit Fitness tracker in a 16-week home-based exercise training program.
- To evaluate whether or not inclusion of the FitBit Fitness tracker is more beneficial than an exercise program by itself.

THE UNIVERSITY of TENNESSEE HEALTH SCIENCE CENTER
IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

The Fitbit fitness tracker is a small device (about the size of an AA battery) that can be worn as a bracelet, or clipped to a necklace, waistline or other clothing. The device tracks steps taken, number of stairs climbed and calories burned. This information will show you how much activity you have done and encourage you to reach your activity goals. The device can provide information on your android and iPhone with programs which are free to download, the Fitbit website (www.fitbit.com), and the screen on the device. The Fitbit is battery powered and requires 1 to 2 hours of charging every 5 to 7 days either by docking to a computer through the USB plug provided or an adapter for standard wall outlet use.

The information from this study may help develop a training program to help improve physical fitness in overweight patients after having a knee replacement.

60 subjects will be participating in this study.

The study will take place in the physical therapy clinics at Campbell's Clinic Orthopaedics-Memphis (1211 Union Avenue, Suite 500, Memphis, TN 38104) and Germantown (1400 South Germantown Road, Germantown, TN 38138) locations.

Your participation in this study will last 17 weeks.

2. PROCEDURES TO BE FOLLOWED:

Week 1: First testing session in the physical therapy clinic at Campbell's Clinic Orthopaedics (either Germantown or Memphis).

The first testing session will take about 60 minutes to complete.

- You will be asked to complete surveys about your health and medical history and your normal amount of physical activity.
- After you complete these surveys, we will assess your body size and shape by measuring your height, weight, and waist and hip size.
- We will also measure your body fat percentage with skinfold measurement. This is completed by measuring the thickness of the skin in three locations (males: chest, stomach, and leg; females: back of the upper arm, hip and leg)
- Your heart rate, blood pressure, and breathing rate will also be measured after you quietly rest in a chair for five minutes.
- A physical therapist will measure your knee flexibility and function.
    - Knee flexibility will be measured by having you straighten and bend your knee several times while we measure how far you are able to move.
    - Knee function will be measured with a survey which asks about knee pain, stiffness, and difficulty doing daily activities like getting in a car or putting on socks.
- Your knee strength will be measured by having you push your lower leg against a padded scale as hard as you can three times.

THE UNIVERSITY of TENNESSEE HEALTH SCIENCE CENTER
IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

- We will also measure how well you walk with two tests.
  - First we will have you walk on a carpet which measures where your feet land when you walk. You will be asked to walk about 20 feet on the carpet three times with time to rest in between.
  - The second test will measure how far you can walk in six minutes. During this test you will walk as fast as you feel comfortable in a hallway. You can stop and rest during the test if needed.
- Your quality of life will be measured with a survey which asks you questions about your health, difficulty with activities you do each day, and how you feel.
- After these tests are completed, you will be given an exercise training program to do at home and exercise diary to record your workouts.
  - You will be shown how to do each of the exercises and how to do the program with common items you can find in your home.
  - You will also be given the contact information for a study team member that you can call if you have difficulty completing the exercise program.
- You will be randomly assigned (like the flip of a coin) to receive the Fitbit fitness tracker and exercise program or only the exercise program. You have a 1 in 2 chance of receiving the Fitbit fitness tracker. Both groups are receiving experimental treatment. It is not known whether the experimental treatment is as good as, better than, or worse than the standard treatment. The investigator will not be the person who decides which treatment you receive. A computer program that gives random numbers will be used to decide which treatment you receive.
  - If you are randomly assigned to get the Fitbit fitness tracker, we will set the Fitbit fitness tracker up for you and show you how to use the device.

Weeks 1 through 16: Exercise program in your home.

- During your first visit you will be shown how to do all the exercises and how to record your progress.
- The exercise program will consist of walking, cycling or other joint-friendly (low impact) activity. In addition, you will be given 8 to 10 exercises that you can complete on 2 to 3 days per week.
  - Exercise examples: standing from a chair, standing from the floor, sit ups, leg lifts, and modified push-ups.
  - All exercises will be discussed and you will have time to ask questions and attempt the exercises. If you cannot do or are uncomfortable with one of the exercises a different exercise will be provided.
- Initially, the exercise program will take about 30 minutes three days per week and increase to about 45 to 60 minutes five days per week. The exercise can be split to fit your schedule.
- You will be asked to record each of your workouts in the workout diary provided including what you did, and your comments about what you like or dislike about the program.

THE UNIVERSITY of TENNESSEE HEALTH SCIENCE CENTER
IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

- You will receive weekly phone calls from a study team member to discuss your workouts, progress, and make any changes to the workouts.
- If you received the Fitbit Fitness tracker, you will be asked to wear the device every day. You will have to charge the device once every 5 to 7 days. You will be asked for your thoughts about the device during the weekly phone call with the study team member.

Week 9: Second testing session in the physical therapy clinic at Campbell's Clinic Orthopaedics (either Germantown or Memphis).
This testing session will take 45 to 60 minutes to complete.

- We will assess your body size and shape by measuring your height, weight, and waist and hip size.
- We will also measure your body fat percentage with skinfold measurement. This is completed by measuring the thickness of the skin in three locations (males: chest, stomach, and leg; females: back of the upper arm, hip and leg)
- Your heart rate, blood pressure, and breathing rate will also be measured after you quietly rest in a chair for five minutes.
- A physical therapist will measure your knee flexibility and function.
  - Knee flexibility will be measured by having you straighten and bend your knee several times while we measure how far you are able to move.
  - Knee function will be measured with a survey which asks about knee pain, stiffness, and difficulty doing daily activities like getting in a car or putting on socks.
- Your knee strength will be measured by having you push your lower leg against a padded scale as hard as you can three times.
- We will also measure how well you walk with two tests.
  - First we will have you walk on a carpet which measures where your feet land. You will walk about 20 feet on this carpet three times with time to rest in between.
  - The second test will measure how far you can walk in six minutes. During this test you will walk as fast as you feel comfortable in a hallway. You can stop and rest during the test if needed.
- Your quality of life will be measured with a survey which asks you questions about your health, difficulty with activities you do each day, and how you feel.
- After these tests are completed, your exercise program will be updated and reviewed with you.
  - You will be shown how to do each of the exercises and how to do the program with common items you can find in your home.

IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

Week 17: Third testing session in the physical therapy clinic at Campbell's Clinic Orthopaedics (either Germantown or Memphis).

This testing session will take 45 to 60 minutes to complete.

- We will assess your body size and shape by measuring your height, weight, and waist and hip size.
- We will also measure your body fat percentage with skinfold measurement. This is completed by measuring the thickness of the skin in three locations (males: chest, stomach, and leg; females: back of the upper arm, hip and leg).
- Your heart rate, blood pressure, and breathing rate will also be measured after you quietly rest in a chair for five minutes.
- A physical therapist will measure your knee flexibility and function.
  - Knee flexibility will be measured by having you straighten and bend your knee several times while we measure how far you are able to move.
  - Knee function will be measured with a survey which asks about knee pain, stiffness, and difficulty doing daily activities like getting in a car or putting on socks.
- Your knee strength will be measured by having you push your lower leg against a padded scale as hard as you can three times.

- We will also measure how well you walk with two tests.
  - First we will have you walk on a carpet which measures where your feet land when you walk. You will be asked to walk about 20 feet on the carpet three times with time to rest in between.
  - The second test will measure how far you can walk in six minutes. During this test you will walk as fast as you feel comfortable in a hallway. You can stop and rest during the test if needed.
- Your quality of life will be measured with a survey which asks you questions about your health, difficulty with activities you do each day, and how you feel.
- After these tests are completed, we will discuss your thoughts about the program and any suggestions you have about the device or exercise program.

The week 1, week 9 and week 17 tests will provide information about the effectiveness of the exercise program and the Fitbit fitness tracker to improve your ability to complete activities of daily living, walking ability, and general fitness. All of these tests are being done for research purposes. None of these procedures will be done if you decide not to participate in this research study.

IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

3. RISKS ASSOCIATED WITH PARTICIPATION:

There is the potential risk of loss of confidentiality. Every effort will be made to keep your information confidential; however, this cannot be guaranteed. Some of the surveys may ask you questions that make you feel uncomfortable or cause troublesome feelings or emotions. You may refuse to answer any of the questions and you may take a break at any time during the study.

As a result of your participation in this study, you are at risk for the following side effects. You should discuss these with the study doctor and your regular health care provider if you choose.

Rare (1-5 out of 100)

- Potential mild muscle soreness and knee pain due to the exercise during the exercise testing or program.
- Potential for trips and falling while exercising.
- Potential uncomfortable and troublesome feelings and emotions when answering study questions.

Common (21-50 out of 100)

- Temporary fatigue and shortness of breath due to the exercise during the exercise testing or program.

You may discuss these with a study team member and your regular health care provider if you choose.

The research may involve risks to you which are currently unforeseeable. You will be told about any new information that might change your decision to be in this study. You may be asked to sign a new consent form if this occurs.

4. BENEFITS ASSOCIATED WITH PARTICIPATION:

Participation in this study may improve your knee function and result in weight loss which may increase your ability to do daily activities however this cannot be promised. There may be a potential benefit to future knee replacement patients from your participation. The information gained from this study may help understand how exercise and rehabilitation programs can improve knee function and physical fitness in overweight subjects who have a knee replacement.

5. ALTERNATIVES TO PARTICIPATION:

You will not receive the tailored home based exercise program designed for this study however; you can discuss beginning an exercise program with your doctor. The Fitbit Fitness tracking devices are commercially available and can be purchased from retailers locally or via internet.

IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

You will receive medical treatment for your knee whether or not you participate in the study.

You will not have to undergo any of the procedures described if you do not take part in this study.

6. CONFIDENTIALITY:

All your paper research records will be stored in locked file cabinets and will be accessible only to research personnel. All your electronic research records will be computer password protected and accessible only to research personnel.

Information about your participation in this study or the results of procedures performed in this study will not be placed in your medical record; as such, this information will not be made available to your employer or insurer.

You will not be identified in any presentations or publications based on the results of this research study.

Authorization to Use and Disclose Information for Research Purposes
Under federal privacy regulations, you have the right to decide who can review and copy your personal health information (called "protected health information" or PHI). PHI collected in this study may include information such as:

- Past and present medical records
- Records about your study visits
- Records about phone calls made as part of this research
- Research records

By signing this consent form, you are giving your permission for the study doctor and the study staff at the University of Tennessee to get your PHI from your doctor and/or facilities where you have received health care. They may also share your PHI with:

- The Institutional Review Board (IRB) at the University of Tennessee Health Science Center
- The University of Memphis
- Campbell Clinic Orthopaedics

Your PHI will only be used and/or given to others:

- to do the research,
- to study the results, and
- to see if the research was done right.

Your PHI will be used until the study is completed.

IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

You may withdraw or take away your permission to use and disclose your PHI at any time. You do this by sending written notice to the study doctor. If you withdraw your permission, you may not be able to stay in the study.

When you withdraw your permission, no new PHI will be gathered after that date. However, information that has already been gathered may still be used and given to others. The federal regulations allow you to review or copy your PHI that is used in this study.
However, in order to complete the research, your access to this PHI may be temporarily suspended while the research is in progress. Once the study is over, your right to review and copy your PHI will be reinstated.

7. COMPENSATION AND TREATMENT FOR INJURY:

You are not waiving any legal rights or releasing the University of Tennessee or its agents from liability for negligence. In the event of physical injury resulting from research procedures, the University of Tennessee does not have funds budgeted for compensation for medical treatment. Therefore, the University of Tennessee does not provide for treatment or reimbursement for such injuries.

If you are injured or get sick as a result of being in this study, a study team member will provide acute medical treatment and will provide you with a subsequent referral to appropriate health care facilities.

If you are injured or get sick as a result of being in this study, you and/or your insurance will be billed for the costs associated with this medical treatment.

No compensation will be available to you for any extra expenses that you may have as the result of research related physical injuries, such as additional hospital bills, lost wages, travel expenses, etc.

No compensation will be available to you for any non-physical injuries that you may have as a result of research participation, such as legal problems, problems with your finances or job, or damage to your reputation.

8. QUESTIONS:

Contact Audrey Zucker-Levin, PhD, PT at 901.448.5888 if you have questions about your participation in this study or if you have questions, concerns, or complaints about the research.

If you feel you have had a research-related injury, contact Audrey Zucker-Levin, PhD, PT at 901.830.6954. This is a cell phone number accessible 24 hours per day, 7 days per week.

IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

You may contact Terrence F. Ackerman, Ph.D., UTHSC IRB Chairman, at 901-448-4824 or visit the IRB website at http://www.uthsc.edu/research/research_compliance/IRB/participant_complaint.php if you have any questions about your rights as a research subject or if you have questions, concerns, or complaints about the research.

9. PAYMENT FOR PARTICIPATION:

You will receive a total of $100 in gift cards to Wal-Mart or Target for participating in this study. You will receive a $50 gift card at the completion of the week 9 and week 17 assessments

.

10. COSTS OF PARTICIPATION:

There are no costs to you for participating in this study.

11. VOLUNTARY PARTICIPATION AND WITHDRAWAL:

Your participation in this research study is voluntary. You may decide not to participate or you may leave the study at any time. Your decision will not result in any penalty or loss of benefits to which you are entitled.

Deciding to not take part in this research study will not change your regular medical care in any way. If you decide to stop taking part in this research study, you should tell your study doctor, and any information that you have already provided will be kept in a confidential manner.

Your participation in this research study may be stopped by the study doctor without your consent for any of the following reasons:

- We are unable to contact you for 4 successive weeks during the intervention.
- If you do not show up for visits; or
- If you do not follow the study doctor's instructions

IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

12. CONSENT OF SUBJECT:

You have read or have had read to you a description of the research study as outlined above. The investigator or his/her representative has explained the study to you and has answered all the questions you have at this time. You knowingly and freely choose to participate in the study. A copy of this consent form will be given to you for your records.

_____	_____	_____
Signature of Research Subject (18 years +)	**Date**	**Time**

_____

Printed Name of Adult Research Subject

_____	_____	_____
Signature of Person Obtaining Consent	**Date**	**Time**

_____

Printed Name of Person Obtaining Consent

In my judgment, the subject has voluntarily and knowingly given informed consent and possesses the legal capacity to give informed consent to participate in this research study.

_____	_____	_____
Signature of Investigator	**Date**	**Time**

THE UNIVERSITY of TENNESSEE HEALTH SCIENCE CENTER
IRB NUMBER: 13-02822-XP UM
IRB APPROVAL DATE: 12/10/2013
IRB EXPIRATION DATE: 10/30/2014

APPENDIX B

APPROVAL LETTERS

APPENDIX B: APPROVAL LETTERS

THE UNIVERSITY OF TENNESSEE
Health Science Center

June 11, 2014

WEBB A SMITH
UTHSC - COAHS - Physical Therapy

Institutional Review Board 910 Madison Avenue, Suite 600
Memphis, TN 38163
Tel: (901) 448-4824

Re: 13-02822-XP UM
Study Title: Feasibility and effect of incorporating the Fitbit fitness tracking technology into a prescribed exercise intervention program to improve long-term function in obese individuals one year following total knee arthroplasty

Dear Mr. SMITH:

The Administrative Section of the UTHSC Institutional Review Board (IRB) reviewed your application for
revision of your previously approved project, referenced above.

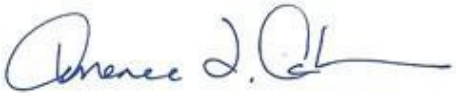
The IRB determined that your application is eligible for **expedited** review under 45 CFR 46.110(b)(2). The attached revisions were approved as complying with proper consideration of the rights and welfare of human subjects and the regulatory requirements for the protection of human subjects. Approval does not alter the expiration date of this project, which is October 30, 2014.

In the event that subjects are to be recruited using solicitation materials, such as brochures, posters, web- based advertisements, etc., these materials must receive prior approval of the IRB. Any revisions in the approved application must also be submitted to and approved by the IRB prior to implementation. In addition, you are responsible for reporting any unanticipated serious adverse events or other problems involving risks to subjects or others in the manner required by the local IRB policy.

Finally, **re-approval** of your project is required by the IRB in accord with the conditions specified above. You may not continue the research study beyond the time or other limits specified unless you obtain prior written approval of the IRB.

Sincerely,

Signature applied by Donna L Stallings on 06/11/2014 01:26:04 PM CDT



Signature applied by Terrence F Ackerman on 06/11/2014 01:26:33 PM CDT

Donna Stallings, CIM
IRB Administrator
UTHSC IRB

Terrence F. Ackerman, Ph.D.
Chairman
UTHSC IRB

Attachment: Revisions

Webb Smith
Re: 13-02822-XP UM
June 11, 2014

1. The study application was updated to version 1.6 to (a) add Tyler Ward as research support staff

From: Beverly Jacobik (bjacobik) **On Behalf Of** Institutional Review Board
Sent: Friday, March 14, 2014 12:56 PM
To: James G Gurney (jggurney); Lisa Jane Krull (ljkrull)
Subject: IRB Approval 3036

Hello,

The University of Memphis Institutional Review Board, FWA00006815, has reviewed and approved your submission in accordance with all applicable statuses and regulations as well as ethical principles.

PI NAME: James Gurney
CO-PI: William M. Milhalko, John Williams
PROJECT TITLE: Feasibility and effect of incorporating the Fitbit fitness tracking technology into a prescribed exercise intervention program to improve long-term function in obese individuals one year following total knee arthroplasty
FACULTY ADVISOR NAME (if applicable): N/A

IRB ID: #3036
APPROVAL DATE: 3/5/2014
EXPIRATION DATE: 10/30/2014
LEVEL OF REVIEW: Expedited Modification

RISK LEVEL DETERMINATION: No more than minimal

Please Note: Modifications do not extend the expiration of the original approval

Approval of this project is given with the following obligations:

1. If this IRB approval has an expiration date, an approved renewal must be in effect to continue the project prior to that date. If approval is not obtained, the human consent form(s) and recruiting material(s) are no longer valid and any research activities involving human subjects must stop.

2. When the project is finished or terminated, a completion form must be completed and sent to the board.

3. No change may be made in the approved protocol without prior board approval, whether the approved protocol was reviewed at the Exempt, Exedited or Full Board level.

4. Exempt approval are considered to have no expiration date and no further review is necessary unless the protocol needs modification.

Approval of this project is given with the following special obligations:

Thank you,

Ronnie Priest, PhD

Institutional Review Board Chair

The University of Memphis.

Note: Review outcomes will be communicated to the email address on file. This email should be considered an official communication from the UM IRB. Consent Forms are no longer being stamped as well. Please contact the IRB at IRB@memphis.edu if a letter on IRB letterhead is required.

From: irb@olemiss.edu [mailto:irb@olemiss.edu]
Sent: Monday, May 19, 2014 1:29 PM
To: Webb Smith (wasmith1); Mark Loftin
Cc: JOHN C GARNER
Subject: IRB Exempt Approval of 14x-248

Mr. Smith:

This is to inform you that your application to conduct research with human participants, "Effect of incorporating the Fitbit fitness tracking technology into a prescribed exercise intervention program to improve long-term function in obese individuals one year following total knee arthroplasty" (Protocol #14x-248), has been approved as Exempt under 45 CFR 46.101(b)(#4).

Please remember that all of The University of Mississippi's human participant research activities, regardless of whether the research is subject to federal regulations, must be guided by the ethical principles in The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research.

It is especially important for you to keep these points in mind:

- You must protect the rights and welfare of human research participants.
- Any changes to your approved protocol must be reviewed and approved before initiating those changes.
- You must report promptly to the IRB any injuries or other unanticipated problems involving risks to participants or others.

If you have any questions, please feel free to contact the IRB at irb@olemiss.edu.

Jennifer Caldwell, PhD

Senior Research Compliance Specialist, Research Integrity and Compliance

The University of Mississippi

212 Barr

University, MS 38677-1848

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+1-662-915-5006

irb@olemiss.edu | www.olemiss.edu

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APPENDIX C

HEALTH AND MEDICAL HISTORY

APPENDIX C: HEALTH AND MEDICAL HISTORY

FedEx Institute of Technology: Knee Rehabilitation Project Protocol

Study ID: _____ Tester Initials: _____ Page 1 of 1

Appendix A: Health and medical history

Name: _____ Date of Birth: _____

Address: _____

City: _____ ____ State: ____ Zip: _____

Phone: _____ Email: _____

Preferred Contact Method: Phone or Email

Best time (s) to contact you by phone:

1) _____

2) _____

3) _____

Health and Medical History**:**

1) Has a physician ever told you that you have a heart condition? **Yes or No**

2) Do you have pains in your chest or heart? **Yes or No**

3) Have you lost consciousness or fell as a result of dizziness? **Yes or No**

4) Do you currently smoke? **Yes or No**

If yes: how many years? _____; how many packs per day? ____

5) Have you ever been a regular smoker? **Yes or No**

If yes: When did you quit? _____; years _____; packs per day? ____

6) Do you have high blood pressure? **Yes or No**

7) Do you have diabetes or high blood sugar? **Yes or No**

8) Do you have a bone or joint condition that could be aggravated by exercise? **Yes or No**

9) Is there any reason not mentioned here why you should not exercise? **Yes or No**

10) Have you talked to your doctor about participating in an exercise program? **Yes or No**

11) Do you have any other medical or physical limitations that would prevent you from participating in an exercise program? **Yes or No**

If yes, please specify:

_____

_____

12) Are you currently taking any medications?

If yes, please list the medication and the reason for prescription:

_____

_____

Comments:

_____

_____

Completed by: _____ Date:_____

IRB NUMBER: 13-02822-XP UM IRB APPROVAL DATE: 12/10/2013

APPENDIX D

PHYSICAL ACTIVITY

APPENDIX D: PHYSICAL ACTIVITY: PAQ (NHANES)

PAQ.605 Next I am going to ask you about the time you spend doing different types of physical activity in a typical week.

Think first about the time you spend doing work. Think of work as the things that you to do such as paid or unpaid work, household chores, and yard work.

Does your work involve **vigorous**-intensity activity that causes **large increases** in breathing or heart rate like carrying or lifting heavy loads, digging or construction work for **at least 10 minutes continuously**?
YES 1
NO..... 2 (PAQ.620)
REFUSED 7 (PAQ.620)
DON'T KNOW 9 (PAQ.620)

PAQ.610 In a typical week, on how many days do you do vigorous-intensity activities as part of your work?

PROBE IF NEEDED: Vigorous-intensity activity causes large increases in breathing or heart rate and is done for at **least 10 minutes continuously**.

INTERVIEWER: REMEMBER, WE ARE ONLY ASKING ABOUT WORK AND CHORES IN THIS QUESTION.
HARD EDIT: 1-7.
ERROR MESSAGE: THE NUMBER OF DAYS SHOULD BE BETWEEN 1 AND 7.

|___|___|
ENTER NUMBER OF DAYS
REFUSED 77 (PAQ.620)
DON'T KNOW 99 (PAQ.620)

PAQ.615 How much time do you spend doing vigorous-intensity activities at work on a typical day?
Q/U
PROBE IF NEEDED: Think about a typical day when {you do/he does/she does} vigorous-intensity activities during {your/his/her} work.

PROBE IF NEEDED: Vigorous-intensity activity causes large increases in breathing or heart rate and is done for at least 10 minutes continuously.

INTERVIEWER: REMEMBER, WE ARE ONLY ASKING ABOUT WORK AND CHORES.

SOFT EDIT: >4 HOURS.
ERROR MESSAGE: INTERVIEWER, YOU HAVE RECORDED THAT THE SP SPENDS MORE THAN 4 HOURS DOING VIGOROUS-INTENSITY ACTIVITIES AT WORK ON A TYPICAL DAY. PLEASE CONFIRM WITH SP THAT OVER 4 HOURS IS CORRECT.
HARD EDIT: >24 HOURS.
HARD EDIT: <10 MINUTES.
ERROR MESSAGE: THE TIME SHOULD BE 10 MINUTES OR MORE, BUT LESS THAN 24 HOURS.

|___|___|___|
ENTER NUMBER OF MINUTES OR HOURS

REFUSED 777 (PAQ.620)
DON'T KNOW 999 (PAQ.620)
ENTER UNIT
MINUTES 1
HOURS 2

PAQ.620 Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking or carrying light loads for at least 10 minutes continuously?
YES 1
NO..... 2 (PAQ.635)
REFUSED 7 (PAQ.635)
DON'T KNOW 9 (PAQ.635)

PAQ.625 In a typical week, on how many days do you do moderate-intensity activities as part of your work?

PROBE IF NEEDED: Moderate-intensity activity causes small increases in breathing or heart rate and is done for at least 10 minutes continuously.
INTERVIEWER: REMEMBER, WE ARE ONLY ASKING ABOUT WORK AND CHORES.
HARD EDIT: 1-7.
ERROR MESSAGE: THE NUMBER OF DAYS SHOULD BE BETWEEN 1 AND 7.

|___|___|
ENTER NUMBER OF DAYS
REFUSED 77 (PAQ.635)
DON'T KNOW 99 (PAQ.635)

PAQ.630 How much time do you spend doing moderate-intensity activities at work on a typical day?
Q/U
PROBE IF NEEDED: Think about a typical day when {you do/he does/she does} moderate-intensity activities during {your/his/her} work.

PROBE IF NEEDED: Moderate-intensity activity causes small increases in breathing or heart rate and is done for at least 10 minutes continuously.

INTERVIEWER: REMEMBER, WE ARE ONLY ASKING ABOUT WORK AND CHORES.
SOFT EDIT: >4 HOURS.
ERROR MESSAGE: INTERVIEWER, YOU HAVE RECORDED THAT THE SP SPENDS MORE THAN 4 HOURS DOING MODERATE-INTENSITY ACTIVITIES AT WORK ON A TYPICAL DAY. PLEASE CONFIRM WITH SP THAT OVER 4 HOURS IS CORRECT.
HARD EDIT: >24 HOURS.
HARD EDIT: <10 MINUTES.
ERROR MESSAGE: THE TIME SHOULD BE 10 MINUTES OR MORE, BUT LESS THAN 24 HOURS.

|___|___|___|
ENTER NUMBER OF MINUTES OR HOURS
REFUSED 777 (PAQ.635)
DON'T KNOW 999 (PAQ.635)
ENTER UNIT
MINUTES 1
HOURS 2
REFUSED 7
DON'T KNOW 9

PAQ.635 The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to school.

In a typical week do you walk or use a bicycle for at least 10 minutes continuously to get to and from places?
YES 1
NO..... 2 (PAQ.650)
REFUSED 7 (PAQ.650)
DON'T KNOW 9 (PAQ.650)

PAQ.640 In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?
HARD EDIT: 1-7.
ERROR MESSAGE: THE NUMBER OF DAYS SHOULD BE BETWEEN 1 AND 7.

|___|___|
ENTER NUMBER OF DAYS
REFUSED ..... 77(PAQ.650)
DON'T KNOW ..... 99(PAQ.650)

PAQ.645 How much time do you spend walking or bicycling for travel on a typical day? Q/U

PROBE IF NEEDED: Think about a typical day when {you walk or bicycle/SP walks or bicycles} for travel.
SOFT EDIT: >4 HOURS.

ERROR MESSAGE: INTERVIEWER, YOU HAVE RECORDED THAT THE SP SPENDS MORE THAN 4 HOURS WALKING OR BICYCLING TO GET TO AND FROM PLACES ON A TYPICAL DAY. PLEASE CONFIRM WITH SP THAT OVER 4 HOURS IS CORRECT.
HARD EDIT: >24 HOURS.
HARD EDIT: <10 MINUTES.
ERROR MESSAGE: THE TIME SHOULD BE 10 MINUTES OR MORE, BUT LESS THAN 24 HOURS.

|___|___|___|
ENTER NUMBER OF MINUTES OR HOURS

REFUSED 777 (PAQ.650)
DON'T KNOW 999 (PAQ.650)
ENTER UNIT
MINUTES 1
HOURS 2
REFUSED 7
DON'T KNOW 9

PAQ.650 The next questions exclude the work and transportation activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities.

In a typical week do you do any vigorous-intensity sports, fitness, or recreational activities that cause large increases in breathing or heart rate like running or basketball for at least 10 minutes continuously?
YES 1
NO..... 2 (PAQ.665)
REFUSED 7 (PAQ.665)
DON'T KNOW 9 (PAQ.665)

PAQ.655 In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational activities?

PROBE IF NEEDED: Vigorous-intensity activity causes large increases in breathing or heart rate and is done for at least 10 minutes continuously.
HARD EDIT: 1-7.

ERROR MESSAGE: THE NUMBER OF DAYS SHOULD BE BETWEEN 1 AND 7.

|___|___|
ENTER NUMBER OF DAYS
REFUSED 77 (PAQ.665)

PAQ.660 Q/U How much time do you spend doing vigorous–intensity sports, fitness or recreational activities on a typical day?

PROBE IF NEEDED: Think about a typical day when {you do/SP does} vigorous-intensity sports, fitness or recreational activities.

SOFT EDIT: >4 HOURS.
ERROR MESSAGE: INTERVIEWER, YOU HAVE RECORDED THAT THE SP SPENDS MORE THAN 4 HOURS DOING VIGOROUS-INTENSITY RECREATIONAL ACTIVITIES ON A TYPICAL DAY. PLEASE CONFIRM WITH SP THAT OVER 4 HOURS IS CORRECT.
HARD EDIT: >24 HOURS.
HARD EDIT: <10 MINUTES.
ERROR MESSAGE: THE TIME SHOULD BE 10 MINUTES OR MORE, BUT LESS THAN 24 HOURS.

|___|___|___|
ENTER NUMBER OF MINUTES OR HOURS
REFUSED 777 (PAQ.665)
DON'T KNOW 999 (PAQ.665)
ENTER UNIT
MINUTES 1
HOURS 2
REFUSED 7
DON'T KNOW 9

PAQ.665 In a typical week do you do any moderate-intensity sports, fitness, or recreational activities that cause a small increase in breathing or heart rate such as brisk walking, bicycling, swimming, or golf for at least 10 minutes continuously?
YES 1
NO..... 2 (PAQ.680)
REFUSED 7 (PAQ.680)
DON'T KNOW 9 (PAQ.680)

PAQ.670 In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational activities?

PROBE IF NEEDED: Moderate-intensity sports, fitness or recreational activities cause small increases in breathing or heart rate and is done for at least 10 minutes continuously.

HARD EDIT: 1-7.
ERROR MESSAGE: THE NUMBER OF DAYS SHOULD BE BETWEEN 1 AND 7.

|___|___|
ENTER NUMBER OF DAYS
REFUSED 77 (PAQ.680)
DON'T KNOW 99 (PAQ.680)

PAQ.675 Q/U How much time do you spend doing moderate-intensity sports, fitness or recreational activities on a typical day?

PROBE IF NEEDED: Think about a typical day when {you do/SP does} moderate-intensity sports, fitness or recreational activities.

PROBE IF NEEDED: Moderate-intensity sports, fitness or recreational activities cause small increases in breathing or heart rate and is done for at least 10 minutes continuously.

SOFT EDIT: >4 HOURS.
ERROR MESSAGE: INTERVIEWER, YOU HAVE RECORDED THAT THE SP SPENDS MORE THAN 4 HOURS DOING MODERATE-INTENSITY RECREATIONAL ACTIVITIES ON A TYPICAL DAY. PLEASE CONFIRM WITH SP THAT OVER 4 HOURS IS CORRECT.
HARD EDIT: >24 HOURS.
HARD EDIT: <10 MINUTES.
ERROR MESSAGE: THE TIME SHOULD BE 10 MINUTES OR MORE, BUT LESS THAN 24 HOURS.

|___|___|___|
ENTER NUMBER OF MINUTES OR HOURS
REFUSED 777 (PAQ.680)
DON'T KNOW 999 (PAQ.680)
ENTER UNIT
MINUTES 1
HOURS 2
REFUSED 7
DON'T KNOW 9

PAQ.680 Q/U The following question is about sitting at work, at home, getting to and from places, or with friends, including time spent sitting at a desk, traveling in a car or bus, reading, playing cards, watching television, or using a computer. Do not include time spent sleeping. How much time do you usually spend sitting on a typical day?
|___|___|___|
ENTER NUMBER OF MINUTES OR HOURS
REFUSED ..... 777 (BOX 2)
DON'T KNOW ..... 999 (BOX 2)
ENTER UNIT

MINUTES 1
HOURS 2
REFUSED 7
DON'T KNOW 9
SOFT EDIT: 18 HOURS OR MORE AND LESS THAN 8 HOURS.
ERROR MESSAGE: PLEASE VERIFY TIMES OF 18 HOURS OR MORE OR LESS THAN 8 HOURS.
HARD EDIT: 24 HOURS OR MORE.
ERROR MESSAGE: THE TIME SHOULD BE LESS THAN 24 HOURS.

PAQ.710 Now I will ask you first about TV watching and then about computer use.
Over the past 30 days, on average how many hours per day did you sit and watch TV or videos? Would you say . . .
less than 1 hour,..... 0
1 hour, ... 1
2 hours, ... 2
3 hours, ... 3
4 hours, ... 4
5 hours or more, or 5
{You do/SP does} not watch TV or videos..... 8
REFUSED 77
DON'T KNOW 99

PAQ.715 Over the past 30 days, on average how many hours per day did you use a computer or play computer games outside of work or school? Include Playstation, Nintendo DS, or other portable video games. Would you say . . .
less than 1 hour,..... 0
1 hour, ... 1
2 hours, ... 2
3 hours, ... 3
4 hours, ... 4
5 hours or more, or 5
You do not use a computer outside of work or school 8
REFUSED 77
DON'T KNOW 99
HELP SCREEN:

APPENDIX E

DATA COLLECTION FORM

APPENDIX E: DATA COLLECTION FORM

Assessment Date: _____ Study ID: _____ DOB: _____

Name: _____ Assessment: **T0 T1 T2**

1) <u>Anthropometrics</u>

Height: _____cm Waist: _____ cm _____cm

Weight: _____kg Hip: _____ cm _____cm

BMI: _____kg/m^2 Waist-to-hip Ratio: _____

Skinfold:		Trial 1	Trial 2
For males:	Chest	____	____
	Abdomen	____	____
	Thigh	____	____
For Females:	Triceps	____	____
	Suprailiac	____	____
	Thigh	____	____

2) <u>Vital Signs:</u>

Heart rate:	____bpm	_____bpm
Respirations:	____breaths per minute	_____breaths per minute
Blood pressure:	_____SBP	_____DBP
	_____SBP	_____DBP
	_____SBP	_____DBP

3) <u>Knee Range of Motion</u>

<u>Knee Flexion</u>		Trial 1	Trial 2
Active:	Left	_____°	_____°
	Right	_____°	_____°
Passive:	Left	_____°	_____°
	Right	_____°	_____°
<u>Knee Extension</u>			
Active:	Left	_____°	_____°
	Right	_____°	_____°
Passive:	Left	_____°	_____°
	Right	_____°	_____°

4) <u>Knee Extension Strength</u>

	Trial 1	Trial 2
Left	_____ lbs	_____lbs
Right	_____ lbs	_____lbs

5) <u>Gait Testing:</u>		Trial 1	Trial 2	Trial 3
Step length:	Left	_____cm	_____cm	_____cm
	Right	_____cm	_____cm	_____cm
Step width:	Left	_____cm	_____cm	_____cm
	Right	_____cm	_____cm	_____cm
Swing time:	Left	_____sec	_____ sec	_____ sec
	Right	_____ sec	_____ sec	_____ sec
Stance time:	Left	_____sec	_____ sec	_____ sec
	Right	_____ sec	_____ sec	_____ sec

DS time:	Left	_____sec	_____ sec	_____ sec
	Right	_____ sec	_____ sec	_____ sec
SW/ST:	Left	_____%	_____ %	_____ %
	Right	_____ %	_____ %	_____ %

6) **<u>Six minute walk test:</u>**

	HR	**RPE**
Pre-test:		
2 min:		
4 min:		
6 min:		
Recovery:		

Total walk distance: _____ meters

7) **WOMAC Survey completed:** □
8) **SF 36 Survey completed:** □

Comments:

_____
_____
_____
_____
_____
_____

Tester Signature: _____ Date: _____

Assisted By: _____ Date: _____

WOMAC OSTEOARTHRITIS INDEX

1. The following questions concern the amount of pain you are currently experiencing in your knees. For each situation, please enter the amount of pain you have experienced in the past 48 hours.

		None	mild	moderate	severe	extreme
A. Walking on a flat surface	A.	☐	☐	☐	☐	☐
B. Going up or down stairs	B.	☐	☐	☐	☐	☐
C. At night while in bed	C.	☐	☐	☐	☐	☐
D. Sitting or lying	D.	☐	☐	☐	☐	☐
E. Standing upright	E.	☐	☐	☐	☐	☐

2. Please describe the level of pain you have experienced in the past 48 hours for each one of your knees.

		None	mild	moderate	severe	extreme
A. Right knee	A.	☐	☐	☐	☐	☐
B. Left knee	B.	☐	☐	☐	☐	☐

3. How severe is your stiffness after first awakening in the morning?

None	mild	moderate	severe	extreme
☐	☐	☐	☐	☐

4. How severe is your stiffness after sitting, lying, or resting later in the day?

None	mild	moderate	severe	extreme
☐	☐	☐	☐	☐

5. The following questions concern your physical function. By this we mean your ability to move around and to look after yourself. For each of the following activities, please indicate the degree of difficulty you have experienced in the last 48 hours, in your knees.

What degree of difficulty do you have with:

		None	mild	moderate	severe	extreme
A. Descending (going down) stairs	A.	☐	☐	☐	☐	☐
B. Ascending (going up) stairs	B.	☐	☐	☐	☐	☐
C. Rising from sitting	C.	☐	☐	☐	☐	☐
D. Standing	D.	☐	☐	☐	☐	☐
E. Bending to floor	E.	☐	☐	☐	☐	☐
F. Walking on a flat surface	F.	☐	☐	☐	☐	☐
G. Getting in/out of car	G.	☐	☐	☐	☐	☐
H. Going shopping	H.	☐	☐	☐	☐	☐
I. Putting on socks/stockings	I.	☐	☐	☐	☐	☐
J. Rising from bed	J.	☐	☐	☐	☐	☐
K. Taking off socks/stockings	K.	☐	☐	☐	☐	☐
L. Lying in bed	L.	☐	☐	☐	☐	☐
M. Getting in/out of bath	M.	☐	☐	☐	☐	☐
N. Sitting	N.	☐	☐	☐	☐	☐
O. Getting on/off toile	O.	☐	☐	☐	☐	☐
P. Heavy domestic duties (mowing the lawn, lifting heavy grocery bags)	P.	☐	☐	☐	☐	☐
Q. Light domestic duties (such as tidying a room, dusting, cooking)	Q.	☐	☐	☐	☐	☐

The SF-36v2™ Health Survey

Instructions for Completing the Questionnaire

Please answer every question. Some questions may look like others, but each one is different. Please take the time to read and answer each question carefully by filling in the bubble that best represents your response.

EXAMPLE

This is for your review. Do not answer this question. The questionnaire begins with the section ***Your Health in General*** below.

For each question you will be asked to fill in a bubble in each line:

1. **How strongly do you agree or disagree with each of the following statements?**

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
a) I enjoy listening to music.	○	●	○	○	○
b) I enjoy reading magazines.	●	○	○	○	○

Please begin answering the questions now.

Your Health in General

1. **In general, would you say your health is:**

Excellent	Very good	Good	Fair	Poor	
○1	○2	○3	○4	○5	GH01

2. **Compared to one year ago, how would you rate your health in general now?**

Much better now than one year ago	Somewhat better now than one year ago	About the same as one year ago	Somewhat worse now than one year ago	Much worse now than one year ago	
○1	○2	○3	○4	○5	HT

Please turn the page and continue.

3. **The following questions are about activities you might do during a typical day. Does <u>your health now limit you</u> in these activities? If so, how much?**

	Yes, limited a lot	Yes, limited a little	No, not limited at all	
a) **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	O_1	O_2	O_3	PF01
b) **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	O_1	O_2	O_3	PF02
c) Lifting or carrying groceries	O_1	O_2	O_3	PF03
d) Climbing **several** flights of stairs	O_1	O_2	O_3	PF04
e) Climbing **one** flight of stairs	O_1	O_2	O_3	PF05
f) Bending, kneeling, or stooping	O_1	O_2	O_3	PF06
g) Walking **more than a mile**	O_1	O_2	O_3	PF07
h) Walking **several hundred yards**	O_1	O_2	O_3	PF08
i) Walking **one hundred yards**	O_1	O_2	O_3	PF09
j) Bathing or dressing yourself	O_1	O_2	O_3	PF10

4. **During the <u>past 4 weeks</u>, how much of the time have you had any of the following problems with your work or other regular daily activities <u>as a result of your physical health</u>?**

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a) Cut down on the **amount of time** you spent on work or other activities	O_1	O_2	O_3	O_4	O_5	RP01
b) **Accomplished less** than you would like	O_1	O_2	O_3	O_4	O_5	RP02
c) Were limited in the **kind** of work or other activities	O_1	O_2	O_3	O_4	O_5	RP03
d) Had **difficulty** performing the work or other activities (for example, it took extra effort)	O_1	O_2	O_3	O_4	O_5	RP04

5. **During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?**

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a) Cut down on the **amount of time** you spent on work or other activities	O_1	O_2	O_3	O_4	O_5	RE01
b) **Accomplished less** than you would like	O_1	O_2	O_3	O_4	O_5	RE02
c) Did work or other activities **less carefully than usual**	O_1	O_2	O_3	O_4	O_5	RE03

6. **During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?**

Not at all	Slightly	Moderately	Quite a bit	Extremely	
O_1	O_2	O_3	O_4	O_5	SF01

7. **How much bodily pain have you had during the past 4 weeks?**

None	Very mild	Mild	Moderate	Severe	Very severe	
O_1	O_2	O_3	O_4	O_5	O_6	BP01

8. **During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?**

Not at all	A little bit	Moderately	Quite a bit	Extremely	
O_1	O_2	O_3	O_4	O_5	BP02

9. **These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...**

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a) did you feel full of life?	O_1	O_2	O_3	O_4	O_5	VT01
b) have you been very nervous?	O_1	O_2	O_3	O_4	O_5	MH01
c) have you felt so down in the dumps that nothing could cheer you up?	O_1	O_2	O_3	O_4	O_5	MH02
d) have you felt calm and peaceful?	O_1	O_2	O_3	O_4	O_5	MH03
e) did you have a lot of energy?	O_1	O_2	O_3	O_4	O_5	VT02
f) have you felt downhearted and depressed?	O_1	O_2	O_3	O_4	O_5	MH04
g) did you feel worn out?	O_1	O_2	O_3	O_4	O_5	VT03
h) have you been happy?	O_1	O_2	O_3	O_4	O_5	MH05
i) did you feel tired?	O_1	O_2	O_3	O_4	O_5	VT04

10. **During the <u>past 4 weeks</u>, how much of the time has your <u>physical health or emotional problems</u> interfered with your social activities (like visiting friends, relatives, etc.)?**

All of the time	Most of the time	Some of the time	A little of the time	None of the time	
O_1	O_2	O_3	O_4	O_5	SF02

11. **How TRUE or FALSE is <u>each</u> of the following statements for you?**

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false	
a) I seem to get sick a little easier than other people	O_1	O_2	O_3	O_4	O_5	GH02
b) I am as healthy as anybody I know	O_1	O_2	O_3	O_4	O_5	GH03
c) I expect my health to get worse	O_1	O_2	O_3	O_4	O_5	GH04
d) My health is excellent	O_1	O_2	O_3	O_4	O_5	GH05

CHAPTER IV

MANUSCRIPT 2

EFFECT OF INCORPORATING THE FITBIT FITNESS TRACKING TECHNOLOGY INTO A PRESCRIBED EXERCISE INTERVENTION PROGRAM TO IMPROVE LONG-TERM FUNCTION IN OBESE INDIVIDUALS ONE YEAR FOLLOWING TOTAL KNEE ARTHROPLASTY.

INTRODUCTION

OA is a serious joint disease affecting over 27 million adults in the United States (Van Manen, Nace, & Mont, 2012). Incidence and prevalence have steadily increased over the last 20 years making OA a serious public health concern (Suri, Morgenroth, & Hunter, 2012). Both the severity of the disease and the number living with OA makes it one of the leading causes of long term disability (Arden & Nevitt, 2006; McNeil & Binette, 2001). Clinical care of OA has met the increased demands with improved care and management which in those with severe debilitating disease now routinely includes TKA.

Based on the limited data available, it appears that obesity and physical inactivity, which are major contributors to the development and progression of OA, remain after TKA. Most patients report the ability to return to regular activities such as walking, hiking, and swimming, with some patients even returning to sports like tennis and jogging (Foran et al., 2004; Jones, Cox, Jhangri, & Suarez-Almazor, 2012; Loughead et al., 2008). Despite the ability to return to these activities, it appears that poor exercise habits that preceded surgery are likely to return following the initial recovery period (Bradbury, Borton, Spoo, & Cross, 1998). Most studies indicate that TKA does not result in decreased body weight but in fact body weight often increases after TKA (Aderinto, 2005; Heisel, Silva, Rosa, & Schmalzried, 2005; Unver, Karatosun, Bakirhan, & Gunal, 2009; Woodruff & Stone, 2001; Zeni & Snyder-Mackler, 2010).

The persistence of these risk factors and unhealthy habits may result in long-term functional abilities that are significantly compromised. Thus, functional recovery, such as general mobility, gait mechanics, walking endurance, ability to walk stairs, freedom from pain, and quality of life, may not be as thorough and lasting as could be expected. It has commonly been assumed by medical professionals and reported by patients that obesity and physical inactivity were a result of OA and the common symptoms of pain and physical limitation. More recently, it has been suggested that obesity and physical inactivity should be treated as separate medical issues since they do not appear to improve with the restored function and reduced pain following TKA (Heisel et al., 2005; Unver et al., 2009).

The role of exercise therapy and intervention has received relatively little attention outside of short duration and injury specific post-operative rehabilitation. Exercise interventions, including both aerobic and strength training, have been shown to improve aerobic fitness, mobility, coordination, and body composition; increase muscle mass and bone density; and reduce depression and anxiety in many clinical populations (Chodzko-Zajko, et al. 2009; Barry & Eathorne, 1994; Butler, Davis, Lewis, Nelson, & Strauss, 1998), all of which are relevant for obese patients after a TKA. However, few exercise interventions have been conducted in TKA patients.

Pre-operative and early post-operative studies including exercise intervention, focusing on rehabilitation of the injured area, have shown that leg strength and improving leg strength was predictive of better function one year after surgery (Beaupre, Lier, Davies, & Johnston, 2004; Mizner, Petterson, Stevens, Axe, & Snyder-Mackler, 2005; Topp, Swank, Quesada,

Nyland, & Malkani, 2009). In one of the only exercise interventions in patients more than one year from TKA, LaStayo and colleagues conducted a pilot study using a 12 week supervised strength training program designed to improve muscle strength in the quadriceps and reported significant increases in strength and mobility (LaStayo et al., 2009). These preliminary data offer promise that exercise interventions can improve the long term function and outcomes from TKA.

Any potential exercise intervention in obese TKA patients must balance improving physical fitness levels and minimizing wear on the prosthesis. Although there have been few studies evaluating the biomechanical stress that common activities place on the knee joint, post joint replacement exercise recommendations are available based on a survey of 54 members of Hip and Knee Society who provided their expert opinion on common sporting activities. Activities that were recommended consisted of exercises such as stationary cycling, swimming, walking, golf, low impact aerobics, weight machines, and dancing (Healy, Iorio, & Lemos, 2000). In addition to minimizing wear on the joint, consideration has to be given to motivation to become physically active. OA and obese TKA patients are routinely advised to become more physically active and lose weight before surgery. However, reports indicate that only about one third of patients are successful at increasing physical activity and ultimately reducing body weight (Borland & Jennings, 2011). Howarth et al assessed barriers to weight loss in obese patients with knee OA and while 29% reported pain as major barrier, nearly 90% reported lack of motivation to be the largest barrier to weight loss (Howarth, Inman, Lingard, McCaskie, & Gerrand, 2010). For an exercise intervention to be successful, these barriers must be carefully considered in the exercise program.

We hypothesize that obese patients have additional barriers and deficits that would benefit from a tailored general fitness program at the 1 year follow-up visit when post-surgical rehabilitation is long completed and full healing should have occurred. The primary outcomes of this project were to assess functional measures pre- and post- an 8 week home based exercise intervention in obese knee replacement patients with comparison of additional benefits from the Fitbit fitness tracker.

MATERIALS AND METHODS

Participants

Thirty four obese patients who were 10 to 18 months post total knee arthroplasty volunteered to complete surveys and participate in a functional assessment. Patients were required to have medical clearance to participant in exercise testing. Patients were identified and recruited from surgical follow up clinics at Campbell Clinic Orthopaedics. Prior to consent each participant was prescreened by phone for physical activity level and health status by a research nurse. Participants were informed of all procedures, potential risks, and benefits associated with the study with procedures approved by the University of Tennessee Health Science Center Institutional Review Board for Human Subjects research. Eligibility was verified with health and medical history and physical activity survey to verify eligibility during the initial visit. All participants signed an informed consent prior to enrollment on the study.

Research Design

Following signing the informed consent, 34 participants were randomly assigned using a dual random number matrix to one of two intervention groups. Each intervention group received an 8 week tailored home-based exercise program based on the American College of Sports Medicine (ACSM) guidelines for exercise prescription (American College of Sports, 2013). In addition to the tailored exercise program, participants in one of the intervention arms

received a Fitbit fitness tracker. The Fitbit fitness tracker, in theory, provided additional motivation via feedback on amount of exercise completed and progress towards goals. Participants in both intervention arms were assessed at baseline and follow up after the 8 week intervention.

Anthropometrics

Height and weight were collected without shoes using a digital clinic scales and a wall mounted stadiometer. Body composition was measured using standardized skinfold measures developed by Jackson and Pollock and described in detail by the American College of Sports Medicine (Jackson & Pollock, 1985; American College of Sports Medicine, 2010). Skinfolds were measured with Lange skinfold caliper (Beta Technology, Santa Cruz, CA, 95060) recorded at the chest, abdomen and thigh in males and triceps, suprailiac crest, and thigh in females. Sum of skinfolds measured were used to calculated percentage body fat using two stage predictive equations by first calculating body density and then body fat percentage (Jackson & Pollock, 1985; American College of Sports Medicine, 2010). Body mass index (BMI) was calculated by dividing kilograms of body weight by height in meters squared. Waist and hip circumference was measured using a Gullick II tape measure at the narrowest point between the umbilicus and the xiphoid process and the widest point between umbilicus and the knee, respectively.

Physical Function

Heart rate, blood pressure, and respirations were measured following a five minute quiet seated rest period. Walk endurance was measured using the six minute walk (6MW), which consists of continuous walking at a self-selected walk pace in accordance with the

American Thoracic Society guidelines (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002). During the 6MW, participants were encouraged to walk as quickly as possible for six minutes on the designated walk path. Participants could stop and rest as needed during the test, however the test timer did not stop. Distance walked in six minutes was recorded. Predicted walk distances were based on previously published predictive equations based on healthy adults (Enright & Sherrill, 1998).

Passive and active range of motion at the knee was measured by a licensed physical therapist using a goniometer. Participants were instructed to flex and extend the knee as far as possible and results were recorded at the terminal range in degrees. Knee extension strength was measured using a handheld dynamometer. The participants were seated with the knee positioned at 60 degrees and the dynamometer was placed 20 centimeter below the tibial tuberosity. The participant was instructed to extend their lower leg against the dynamometer as hard as possible. Three trials were performed on each leg with one minute rest between. Predicted strength values were based on previously published gender based normative ranges in healthy adults (Andrews, Thomas, & Bohannon, 1996).

Self-Reported Knee Function and Health Related Quality of Life

The Western Ontario and McMaster University Osteoarthritis Index (WOMAC) used to survey to assess pain, function, and quality of life in patients with OA of the knee (Quintana et al., 2006). WOMAC scoring yields one composite (0 to 96) and 3 subscales: pain (0 to 20), stiffness (0-8), and physical function (0-68). Responses to each question range from zero indicating none to four indicating severe. Higher scores on the composite or subscales indicate

worse pain, stiffness, or function. The composite and subscales have been shown valid (Spearman correlations from 0.63 to 0.67) and reliable (Cronbach's alphas from 0.86 to 0.95) (Bullens, van Loon, de Waal Malefijt, Laan, & Veth, 2001; Dunbar, Robertsson, Ryd, & Lidgren, 2001).

Health related quality of life was assessed using the Medical Outcomes Study short form 36 version 2 (SF36) (Ware, 2004; Ware, Snow, Kosinski, & Gandek, 1993). The SF36 is a commonly used questionnaire used to assess health related quality of life. The survey is a generic health survey which has been used in many populations including obese and osteoarthritis populations (Bohannon & DePasquale, 2010; Ware, 2000). Scores were calculated for eight health domains (mental health, role physical, physical function, vitality, social function, bodily pain, role emotional, and general health), the physical component survey (PCS) and mental component survey (MCS). Survey responses were summed to generate raw scores in each subscale and health domain and used to create general population norm-based scoring (t scores with a population mean of 50 and a standard deviation of 10) using previously prescribed methodology (Ware, 2004; Ware, 2000; J. E. Ware et al., 1993). Scores were considered poor if the normalized scores (T-Scores) were less than 37 which corresponds to the lowest 10^{th} percentile of the general population. Scores were considered to be average or better if the normalized scores (T-Scores) were greater than 48 which correspond to the >40th percentile of the general population.

All testing was completed by the same clinical exercise physiologist, with the exception of lower extremity range of motion and the WOMAC index which were completed by a licensed physical therapist.

Intervention (independent Variable)

All participants in the study received an 8 week home based exercise program based on guidelines for exercise prescription from the American College of Sports Medicine (ACSM) (American College of Sports, 2013). The program included tailored resistance and aerobic training program designed to be completed at home with no supervision and minimal required equipment. The program was tailored with weekly phone calls from the study exercise physiologist. The weekly phone calls were used to monitor compliance, assess the patient's progress, and to modify the exercise prescription as needed.

The resistance training program consisted of 8 to 10 exercises. Each exercise was done for one set of 12 to 15 repetitions on two non-successive days per week. The program was progressed over the phone by increasing the difficulty of the selected exercises and by increasing the volume of resistance training prescribed (number of sets and/or number of days per week) in a systematic manner. The loading on the joint was minimized in accordance with the recommendations from the Knee Society survey (Healy et al., 2000). The resistance training program was tailored for each individual based on the baseline functional assessment and progression will be adjust as needed based on patient feedback from weekly phone calls.

The aerobic training program consisted of the patient's choice and availability of equipment of walking, cycling, or other low impact options recommended by the Knee Society

Survey (Healy et al., 2000). Aerobic training began with three days per week for 20 minutes (or two 10 minute sessions) at a low intensity walk (or alternative activity with equivalent intensity). The aerobic program was increased over the phone by progressively increasing duration to a maximum of 60 minutes, increasing intensity to a maximum of power walking (or alternative activity with equivalent intensity), and increasing number of sessions per week to a maximum of 5 days per week as tolerated. The aerobic training program was tailored for each individual based on the baseline functional assessment and progression was adjust as needed based on patient feedback from weekly phone calls.

All participants received a demonstration of each exercise and an introduction to the forms and logs in the program at the end of the baseline functional assessment. During this education session, handouts were provided that included a visual depiction and written explanation of the prescribed exercise. In addition to the educational handouts, workout logs were provided so that the patient may record and track their workouts and provide comments. The workout logs were used as a reference during the weekly phone calls and to record compliance to the exercise program. Workout logs were collected at the follow up functional assessment to measure compliance.

Each participant assigned to the Fitbit study arm received additional motivational input via a commercially available Fitbit wireless fitness tracker for use during the study. The Fitbit wireless fitness tracker is a small device (about the size of an AA battery) that can be worn as a bracelet (Fitbit Flex), or clipped to a necklace, waistline or other clothing (Fitbit One). The device tracks steps taken, number of stairs climbed and estimates caloric expenditure. The

device provides information in two (or three) ways. The device is fully supported by both android and iPhone applications which are freely downloadable, by logging on to the Dashboard feature on the Fitbit website (www.fitbit.com), and through the device's visual display (Fitbit One). The device is battery powered and requires 1 to 2 hours of charging every 5 to 7 days either by docking to a computer through the USB plug provided or an adapter for standard wall outlet use. A Fitbit account was established for each participant using a study identification number, gender, height and weight. The patients received login information and assistance with the set up and configuration of the Fitbit device during the baseline functional assessment. A study team member was available during the study to help them trouble shoot any issues. Participants were reminded to charge the device during the weekly phone calls.

Data Analysis

As the study was primarily designed to assess feasibility and proof of principle, the sample size of 17 individuals in each arm was based on practical significance (primarily funding, timing, and other resource limitations) but not statistical significance of anticipated differences. However with 17 participants per group (34 total), the trial had 80% power to detect a 10% difference in adherence with the exercise program as a result of inclusion of the Fitbit fitness tracker at the 0.05 significance level. This a priori analysis was conducted using G*Power 3.1.7 (Dusseldorf, Germany) using a fixed effects, one-way ANOVA. Effect size was set as 0.5 which reflects an adherence improvement of 10% (60 vs 70%) based on previously reported adherence rates (Linke, Gallo, & Norman, 2011), and number of groups was two.

The first analytical step was evaluation of the impact Fitbit fitness tracker had on adherence to the exercise program. This was done with a one-way ANOVA comparing the adherence rates between the exercise only group and exercise plus Fitbit fitness tracker group. Since adherence rates were not different indicating the Fitbit fitness tracker did not have an effect, groups were collapsed and the effect of the exercise intervention were evaluated. This was done with a one-way ANOVA comparing the functional outcomes and quality of life measurements pre and post intervention. Statistical significance was set with $\alpha = 0.05$. All data reduction, processing, and analysis for this project were generated using SAS software, version 9.2 of the SAS system for Windows (SAS Institute, Cary, NC, USA).

RESULTS

Participants

Baseline testing was completed on 34 patients (24 females; 10 males) who were randomly assigned to exercise only group or exercise and Fitbit group. There were no statistically significant differences between groups at baseline (Table 2.1). Of the 34 patients randomized, twenty nine patients completed the follow up assessment leaving 13 participants in the exercise and Fitbit group and 16 participants in the exercise only group. Of the five patients who did not return for follow up testing, three were females, none were smokers, and one received bilateral TKA. Of the 4 participants who dropped from the Fitbit group, one patient had unrelated orthopedic surgery (shoulder), one patient lost their home and relocated (tornado) and two patients started new jobs (travel). The one withdrawal from the exercise only group lost interest.

Overall compliance with the prescribed exercise sessions was not different between Fitbit and exercise group and exercise only group (80.1±10.6 vs. 78.3±12.0; $F(1, 27)= 0.17$, $p=0.68$). Since there was no difference in compliance, treatment groups were collapse and results of the intervention will be presented. However, treatment and intervention effects were evaluated and there were no significant differences in training response between the Fitbit and exercise group and exercise only group.

Table 2.1. Baseline group characteristics

	Total (N=34) N (%)	**Fitbit & Exercise (n=17) N (%)**	**Exercise Only (n=17) N (%)**	**P Value**
Males	10 (29.4)	5 (14.7)	5 (14.7)	-
Smoker	2 (5.9)	2 (5.9)	0 (0)	0.15
Bilateral TKA	10 (29.4)	6 (17.6)	4 (11.8)	0.56
	Mean±SD	**Mean±SD**	**Mean±SD**	
Age (yrs)	65.0±9.5	63.6±11.4	66.4±7.3	0.40
Height (cm)	164.1±9.9	165.8±8.5	162.3±11.1	0.30
Weight (kg)	99.7±17.5	103.6±17.4	95.8±17.2	0.20
BMI (kg/m^2)	36.9±4.8	37.5±4.2	36.4±5.4	0.50
Skinfolds (mm)	133.4±18.7	131.6±16.9	135.3±20.8	0.58
Waist to hip	0.91±0.07	0.91±0.06	0.90±0.08	0.58
HR (bpm)	77.1±7.4	76.8±6.7	77.5±8.3	0.77
SBP (mmHg)	132.1±8.8	130.4±7.9	133.9±9.4	0.25
DBP (mmHg)	82.0±4.1	80.8±3.7	83.2±4.2	0.10

Vitals and anthropometrics

Heart rate, respirations, and systolic blood pressure measures did not change significantly following 8 weeks of home based exercise (Table 2.2). The exercise program did result in a statistically significant decrease in diastolic blood pressure (82.0±4.1 vs 79.3±4.1; F (1, 62)= 6.68, p=0.01). Although patients did lose an average of 2.6kg of bodyweight during the 8 week home based exercise program this reduction did not reach statistical significance (F (1, 62)= 0.34, p=0.56). Sum of skinfolds improved by 10 % (133.4±18.7 vs 120.0±20.1; F (1, 61)=7.53, p= 0.01) which reached statistical significance.

Knee Range of Motion and Extensor Strength

Active knee extension values were just below full extension and while improvements of nearly one degree were observed on each leg (0.9 degrees left and 1.2 degrees on the right; respectively) from baseline evaluations these did not reach statistical significance. Active knee flexion values improved similarly with one to two degrees of increased flexion observed on each leg (1.3 degrees left and 2.1 degrees on the right; respectively) from baseline evaluations these did not reach statistical significance.

Knee extensor strength showed notable improvements following 8 weeks of home based exercise. The average of peak knee extension strength on each leg improved significantly from 54.1±16.0 kg to 65.3±15.7 ($F(1, 61)= 7.68$, $p<0.01$). Similar independent improvements were noted for right and left leg (table 2.2). Percent change calculations strength demonstrated an average increase of 23.7 % on the left leg and 17.9% on the right leg.

Six Minute Test Walk Performance

Total distance walked during six minutes increased from 321.3±74.0 meters to 379.6±85.7 meters which was statistically significant ($F(1, 61)= 8.41$, $p<0.01$). The average distance walked during six minutes improved by 58.3 meters (percent change of 18.1%) which is clinically significant improvement in walk distance. In addition, average peak heart rate and rating of perceived exertion during the six minute walk remained unchanged (-2.5 bpm and -0.5 on the Borg scale).

Table 2.2. Effect of 8 week home based exercise program on physical performance

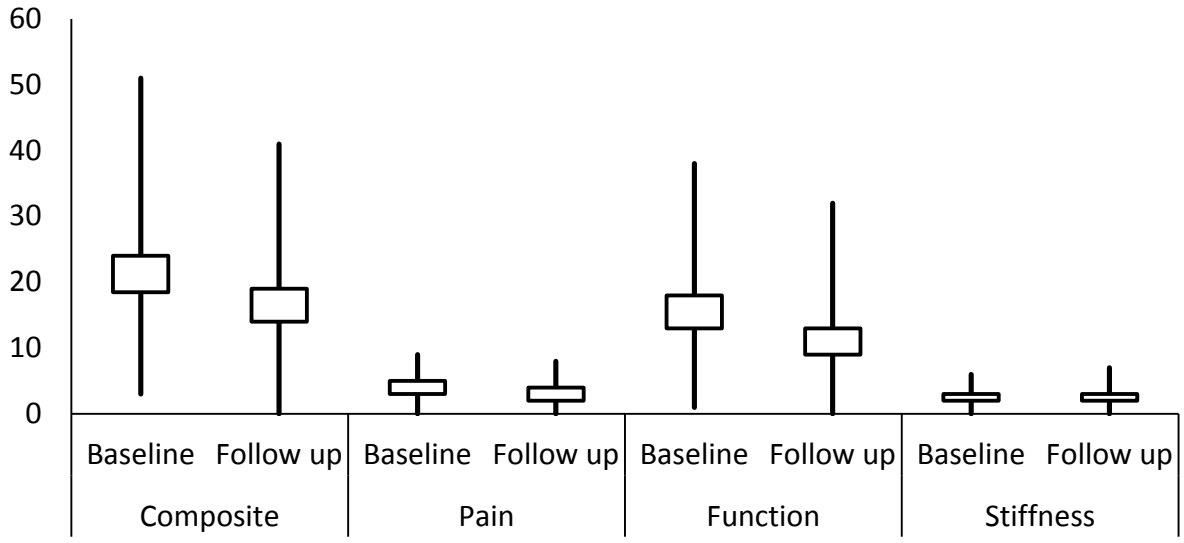
	Baseline Mean ± SD	Follow-Up Mean ± SD	Change Δ (%)	P Value
Resting Vitals				
HR (bpm)	77.1±7.4	75.7±5.3	-1.4 (-1.8)	0.39
Respirations (RR)	18.7±1.3	20.8±1.4	2.1 (11.2)	0.30
SBP (mmHg)	132.1±8.8	129.2±9.2	-2.9 (-2.2)	0.21
DBP (mmHg)	82.0±4.1	79.3±4.1	-2.7 (-3.3)	0.01*
Anthropometrics				
Body Weight (kg)	99.7±17.5	97.1±18.1	-2.6 (-2.6)	0.56
BMI (kg/m^2)	36.9±4.8	36.1±4.9	-0.8 (-2.2)	0.50
Sum of Skinfolds (mm)	133.4±18.7	120±20.1	-13.4 (-10.0)	0.01*
Waist to Hip	0.91±0.07	0.89±0.08	-0.02 (-2.2)	0.51
Active Knee Range of Motion (degrees)				
Extension				
Left (degrees)	2.1±4.5	1.2±4.0	-0.9 (-42.9)	0.43
Right (degrees)	2.5±5.2	1.3±4.7	-1.2 (-48)	0.35
Imbalance (degrees)	4.2±3.7	3.6±3.7	-0.6 (-14.3)	0.53
Flexion				
Left (degrees)	119.2±10.6	120.5±12.0	1.3 (1.1)	0.66
Right (degrees)	120.6±11.4	122.7±11.4	2.1 (1.74)	0.46
Imbalance (degrees)	8.8±7.0	8.5±6.5	-0.3 (-3.4)	0.84
Knee Extensor Strength				
Left (kg)	23.8±7.0	29.4±7.0	12.4 (23.7)	<0.01*
Right (kg)	25.4±8.1	30.0±8.5	10.0 (17.9)	0.03*
Average (kg)	24.6±7.3	29.7±7.1	-0.3 (-3.4)	<0.01*
Six Minute Walk				
Peak HR (bpm)	107.1±12.2	104.6±11.4	-2.5 (-2.3)	0.41
Peak RPE	10.7±2.9	10.2±2.7	-0.5 (-4.7)	0.53
Distance (m)	321.3±74.0	379.6±85.7	58.3 (18.1)	<0.01*

*p<0.05

Self-Reported Knee Function

WOMAC composite scores improved from 19.9±13.4 points out of a possible 96 points at baseline to 15.3±9.8 points after 8 weeks of home based exercise (Figure 2.1). These improvements were not statistically significant but there was a trend towards significance (F (1, 61)= 2.35; p=0.13). In addition, knee function subscale scores improved from 14.4±10.4 points out of a possible 68 points at baseline to 10.2±7.4 points after 8 weeks of home based exercise. These improvements again were not statistically significant but there was a trend towards significance (F (1, 61)= 3.12; p=0.08).

Figure 2.1: Self-Reported Knee Function (WOMAC)



Self-Reported Health Related Quality of Life

Small non-significant increases in the pre post mean scores on the MCS (F (1, 61)= 0.84, p=0.36) and PCS (F (1, 61)= 1.26, p=0.27) were noted (Table 2.3; Figure 2.2). In addition to these mean improvements, the number of patients classified as poor (<10th percentile) on the PCS decreased from 12 patients to 8 patients and on the MCS decreased from 2 patients to 1 patients.

Figure 2.2: Health Related Quality of Life (SF-36): Mental and Physical Summary Scales

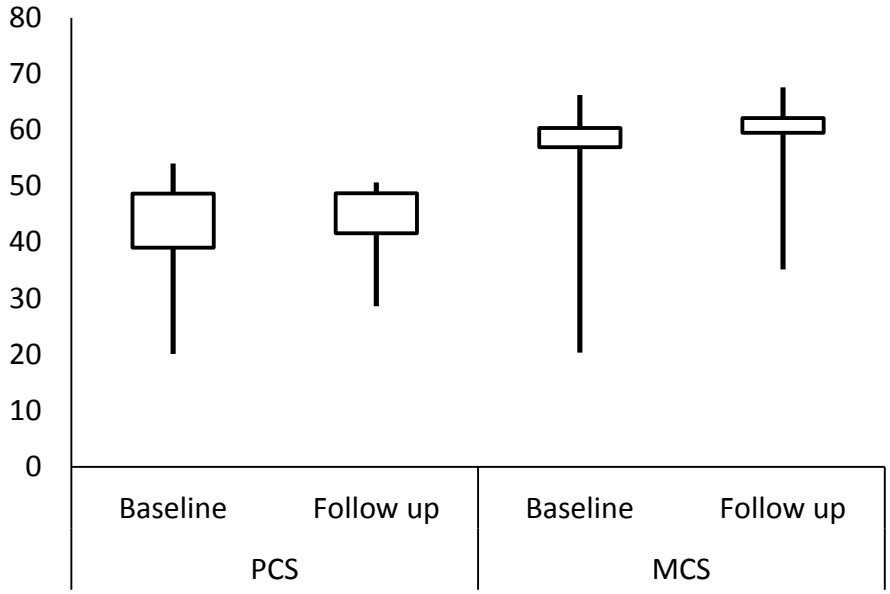


Figure 2.3: Health Related Quality of Life (SF-36): Mental Sub-Scales

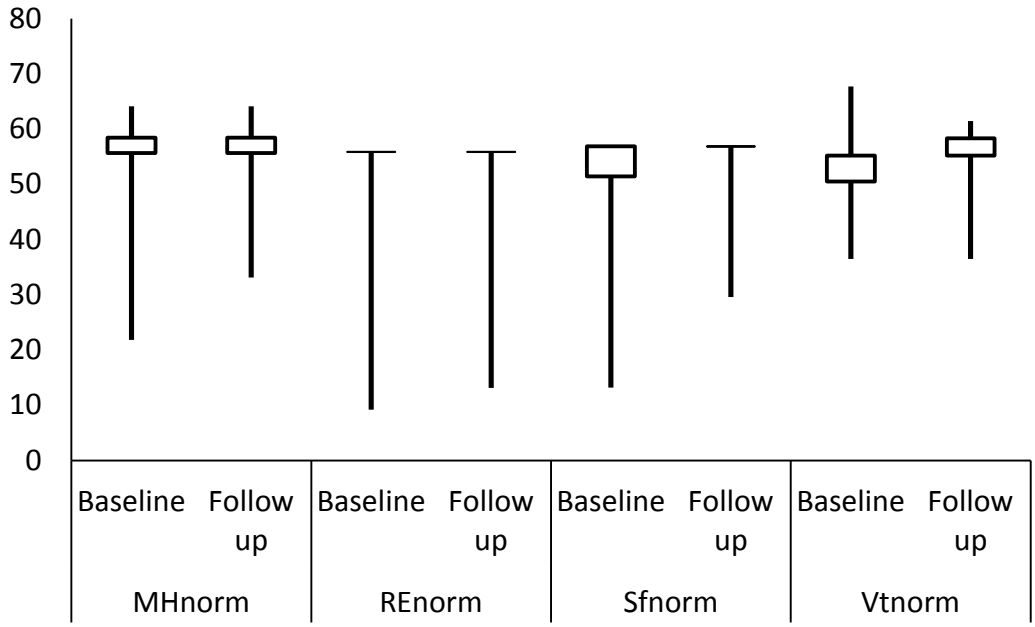
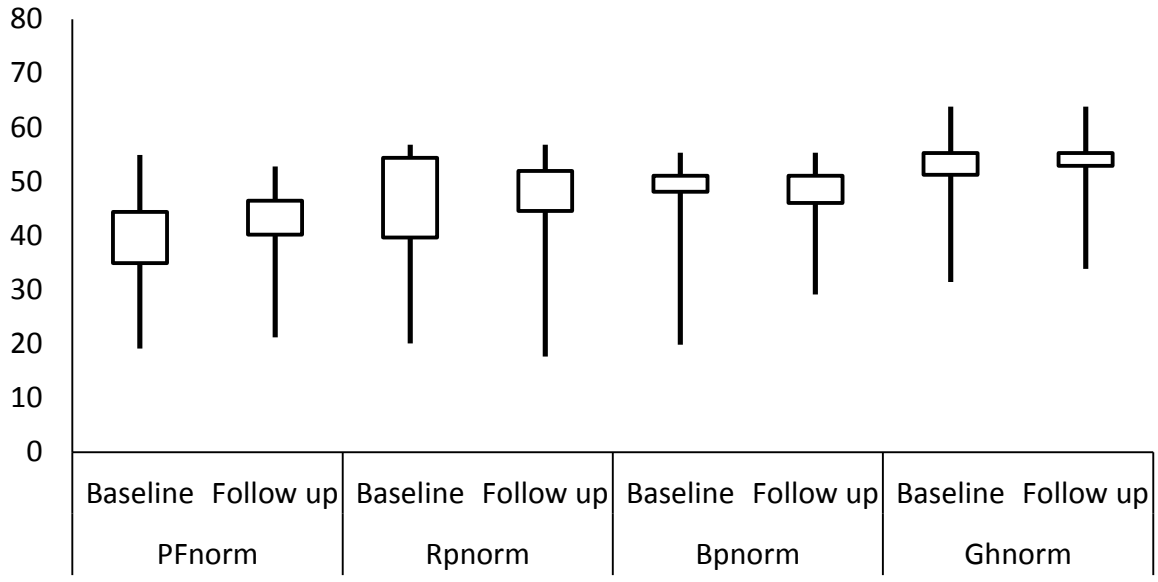


Figure 2.4: Health Related Quality of Life (SF-36): Physical Sub-Scales



There were no substantive changes in pre post mean scores on the mental sub-scales of the SF36 (Figure 2.3). Individually, the number of patients classified as poor (<10th percentile) on the REnorm subscale decreased from 8 patients to 3 patients (Table 2.3). The physical subscales also didn't reveal any statistically significant changes from baseline to follow up. However, GHnorm did have improvements which approach a statistically significant trend (F (1, 61)= 1.99, p=0.16). In addition, several patients improved on the PFnorm (6 patients) and RPnorm (7 patients) subscales saw enough to move out of the lowest 10 percentile (Table2.3).

Table 2.3. Changes in Health Related Quality of Life

	Baseline		Follow up	
	Mean±SD	<10th Percentile n (%)	Mean±SD	<10th Percentile n (%)
PCS	39.5±9.2	12 (35.3)	41.8±7.2	8 (23.5)
MCS	54.5±9.2	2 (5.9)	56.6±7.7	1 (2.9)
MHnorm	52.1±10.5	2 (5.9)	55.0±7.4	1(2.9)
PFnorm	35.8±10.4	18 (52.9)	38.7±9.2	12 (35.2)
REnorm	47.1±13.1	8 (23.5)	48.6±11.0	3 (8.8)
RPnorm	41.4±11.9	11 (32.3)	44.3±10.4	4 (11.8)
SFnorm	49.1±9.7	4 (11.8)	51.8±7.6	2 (5.9)
VTnorm	50.8±6.9	2 (5.9)	52.6±7.1	2 (5.9)
GHnorm	49.9±8.1	2 (5.9)	52.6±6.8	2 (5.9)
BPnorm	44.9±9.7	5 (14.7)	46.1±7.7	4 (11.8)

Patient Feedback Regarding Fitness Tracker

The Fitbit fitness tracker failed to increase overall compliance with the exercise program. During the informal interview regarding the device, two clear groups emerged. One group (8 patients) reported a positive impact of the device. This group enjoyed the feedback

about their activity levels and interested in the technology. This group took advantage of the website, email reports, and the smart phone applications. The second group (5 patients) were either indifferent or negatively viewed the device. The most common reason for not liking the device was they did not think the information was useful. In general, this group did not utilize the smart phone applications or the websites. This group reported forgetting to wear the device frequently.

DISCUSSION

The management of knee osteoarthritis and its debilitating symptoms has advanced significantly in recent decades (Dieppe & Brandt, 2003; Foran et al., 2004; Van Manen et al., 2012). These advancements necessitate the evaluation of the long term outcomes after total knee replacement. This is particularly important in the growing number of obese patients receiving TKA. Previous work has shown that obese patients are at greater risk of TKA and have worse outcomes after TKA. The results of this project showed that a home based exercise program in obese TKA patients can improve knee extensor strength and walking distance. The results of this study also indicate that an 8 week home based exercise program may improve patient perceptions of knee function and health related quality of life. However, the FitBit fitness tracking was not a significant motivational factor to comply with a prescribed exercise program.

This study is the first to demonstrate that an 8 week home based exercise program is feasible and effective in improving strength and walk performance. Several studies have documented knee extensor strength weakness in TKA patients and most reports suggest a deficit of approximately 20% in patients who range from 1 to 10 years post TKA (Berman, Bosacco, & Israelite, 1991; Berth, Urbach, & Awiszus, 2002; Huang, Cheng, Lee, & Lee, 1996). These strength deficits have been very clearly implicated in decreased performance limitations (i.e walking and general mobility) (Finch, Walsh, Thomas, & Woodhouse, 1998; Noble et al.,

2005). In our study patients who completed the 8 week home based exercise program noted statistically significant improves in knee extensor strength of approximately 20% and consistent with previous showing the relationship between strength and mobility saw significant increases in walk endurance.

Our results are similar to results reported by LaStayo et al who had patients do 12 weeks of supervised resistance training in a rehabilitation clinic and noted similar improvements in strength and mobility (LaStayo et al., 2009). Our results are particularly exciting as the program was minimally invasive in that it required only 30 to 45 minutes three days per week for most patients and did not require any travel or specialized equipment. The program was done with minimal supervision and feedback. This was accomplished with detail materials and handouts and a single demonstration of the exercises making this a very cost effective program to administer from a clinic.

Patients in general reported the program was enjoyable and quite easy to follow. Administration was not a significant burden on the study staff or the patients. This is supported by the exceptionally high reported compliance rates reported (nearly 80%). Previous reports on self-reported compliance rate for home based exercise programs to be in the 50 to 60% (Linke et al., 2011). Patients reported the program was easily assimilated into their daily routines and this helped them stick with the program.

Although the FitBit Fitness Tracker technology did not significantly improve reported compliance with prescribed exercise sessions, patient feedback provided interesting insight which could help optimize the use of similar technology in future research. The anecdotal

reports from patients who received the FitBit Fitness Tracker Technology indicated that many participants were really engaged by the device and found it motivational. This group tended to already be engaged in technology (i.e. computer, and/or smart phone users) while those who did not favorably review the device tended to be less engaged with technology in general. While the fitness tracking technology is not of interest to everyone, screening to identify those who are engaged in technology may improve the results and utility these tools with respect to motivation and exercise programming.

The improvements noted in health and knee related quality of life were not statistically significant. The improvements observed, especially in those with the poorest function, are encouraging and warrant further evaluation. Patient satisfaction after TKA is largely based on patient perception (Bourne, Chesworth, Davis, Mahomed, & Charron, 2010). Failure to meet post-operative performance expectations and low one year WOMAC scores are among the strongest predictors of patient dissatisfaction with TKA (Bourne et al., 2010). Our home based exercise program results in substantial albeit statistically insignificant improvements of nearly 25% in composite scores on the WOMAC. Future research is needed to evaluate the long term impact these improvements might have on a patient's long term satisfaction.

These results must be interpreted with in the context of our limitations. One such limitation is the lack of a true control group. Our study demonstrated improvement from pre to post exercise with no effect from our treatment group. We do not believe that these improvements are related to recovery from TKA nor that patients would have improved without intervention. This is supported by the normal time course of recovery illustrated by the

active medical follow up which results in medical release at 12 months. In addition, previous research does not support the idea that patient spontaneously improve after TKA and indicates that the deficits in normal weight individuals receiving TKA persists for many years after surgery (Berman, Bosacco, & Israelite, 1991; Berth, Urbach, & Awiszus, 2002; Huang, Cheng, Lee, & Lee, 1996, Finch, Walsh, Thomas, & Woodhouse, 1998; Noble et al., 2005). Secondly, this was a convenient sample which was recruited from orthopedic surgery follow up clinic. Although, the patients were pretty typical of those routinely seen in the clinic it is possible that selection bias exists which could influence the outcomes. In addition, small sample size limited ability to determine statistical significance and may mask significant effects which may be present if adequately powered. Additionaly, patients were recruited one year after TKA which did not afford the opportunity to evaluate the pre-operative body habitus, functional abilities or quality of life of the patient. In addition, we were not able to evaluate the surgical techniques employed, complications during surgery, or post-operative therapy programs which could influence the outcomes at one year. Finally our results are promising with regard to physical function and quality of life however the intervention was relative short duration leaving the long-term durability and impact on patient's health in question.

Future research involving longitudinal evaluation of obese patients beginning pre TKA is needed to determine if pre-operative factors are predictive of long term functional outcomes with special attention to the role excess body weight may play. In addition, the number of obese patients receiving TKA has increase dramatically in the past decade. More careful evaluation of the post-operative rehabilitation programs is needed. Specifically, the effectiveness of rehabilitation programs to restore and manage physical function long term in

obese patients receiving TKA. Future more comprehensive randomized clinical trials utilizing longer duration home based exercise intervention focused on improving the long term functional abilities in obese individuals appear warranted based on our results.

Obese patients receiving a TKA for debilitation OA have physical performance limitations which remain well after patients have been released from post-operative rehabilitation. These limitations may be exacerbated by increased body weight and decreased physical activity. The combination of residual strength and conditioning deficits after TKA, low levels of physical activity, and increased physiological and biomechanical pressure from excess body weight make these patients particularly vulnerable. This study provides preliminary evidence that an eight week home based exercise program in obese individuals one year post TKA is feasible and effective in improving strength and walk performance. The results of this study also indicate that an 8 week home based exercise program may improve patient perceptions of knee function and health related quality of life. However, the FitBit fitness tracking was not a significant motivational factor to comply with a prescribed exercise program.

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APPENDICES

APPENDIX F

EXERCISE HANDOUTS

APPENDIX F: EXERCISE HANDOUTS

Personal exercise program

Knee Replacement Exercise program

For questions contact:
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Email: wasmith1@memphis.edu

Provided by Webb Smith
Provided for Sample Exercise Booklet for IRB Application


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Stand.

Walk for a minimum of 10 minutes at a comfortable pace.


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Sitting with your arms crossed.

Stand up and then sit down slowly on a chair. If this is easy, use a lower chair. If this is difficult, use a higher chair.

Repeat 12 times.


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Stand facing a wall with your arms straight and hands on the wall.

Do push-ups against the wall keeping your body in a straight line.

Repeat 12 times.


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Stand in front of a 6 to 12 inch step. Step up onto the step and down SLOWLY. If this is easy, use a higher step, if this is difficult, us a lower step

Step up 12 times with one leg leading and then repeat with the other leg leading.

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Sit on the floor, lean back and support yourself with your arms. Now, lift one knee towards your shoulder with the other leg straight on the floor alternating legs like pedaling a bicycle.

Repeat 12 times on each leg.

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Lying on your back with knees bent.

Pull pelvic floor muscles up and in. Hold approx. 5 secs.

Repeat 12 times.

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Lie face down, arms by your side.

Lift your upper trunk off the floor and pull your shoulder blades together. Look down at the floor while doing the exercise.

Repeat 12 times.

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Lying on your back with your fingers just behind your ears and elbows out.

Tighten your stomach muscles and lift your head and shoulders off the floor.

Repeat 12 times.

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Stand or sit holding your hands on your chest. You will be doing this with out weights to begin so ignore the weights in the picture.

Briskly lift both arms from your chest straight up and bring back down.

Repeat 12 times.

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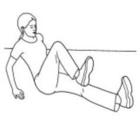

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CURRICULUM VITAE

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ACADEMIC DEGREES:

PhD		University of Mississippi, Oxford, Mississippi (Health & Kinesiology; Concentration: Exercise Physiology); *In Progress (PhD Candidate)*: Expected completion August 2014.
M.S.	2007	University of Memphis, Memphis, Tennessee (Health and Sport Science; Concentration: Exercise Physiology)
B.S.	2005	University of Memphis, Memphis, Tennessee (Health and Human Performance)

PROFESSIONAL APPOINTMENTS:

2013-Present	Project Director, School of Public Health, University of Memphis, Memphis, TN
2010-2013	Senior Clinical Exercise Specialist, Department of Epidemiology and Cancer Control, St. Jude Children's Research Hospital, Memphis, Tennessee
2007-2010	Clinical Exercise Specialist, Department of Epidemiology and Cancer Control, St. Jude Children's Research Hospital, Memphis, Tennessee
2004-2007	Graduate Research Assistant, Department of Health and Sport Sciences, University of Memphis, Memphis, Tennessee
2004	Undergraduate Research Assistant, Department of Health and Sport Sciences, University of Memphis, Memphis, Tennessee
2002-2005	Certified Personal Trainer, Bartlett Recreation Center, Bartlett, Tennessee

PROFESSIONAL SOCIETY MEMBERSHIPS:

American Physiological Society (APS)

American Thoracic Society (ATS)

American College of Sports Medicine (ACSM)

National Strength and Conditioning Association (NSCA)

Clinical Exercise Physiology Association (CEPA)

HONORS AND AWARDS:

Melvin A. Humphreys Award for Student research. Curriculum and Research Council of the Department of Health and Sport Sciences and University of Memphis' Honor Program, Memphis, Tennessee

Sigma Tau Health Science Student Scholarship, University of Memphis, Memphis, Tennessee

Award Winner, 18th Annual Student Research Forum, University of Memphis, Memphis, Tennessee

Dean's List 2002, University of Memphis, Memphis, Tennessee

Graduated *Cum Laude*, University of Memphis, Memphis, Tennessee

Employee Spotlight February 2013, St. Jude Children's Research Hospital, Memphis, TN

CERTIFICATION/LICENSURE:

ACSM Certified Clinical Exercise Specialist®

NSCA – Certified Strength and Conditioning Specialist® (CSCS)

NSCA – Certified Personal Trainer (NSCA-CPT)

American Heart Association (AHA) – CPR, AED, First Aid

COMMITTEES/ WORKING GROUPS:

Childhood obesity working group. A Multi-disciplinary collaboration with nursing research, endocrinology, nutrition, oncology, and cancer control. St. Jude Children's Research Hospital. 2012-2013.

Cardiopulmonary working group. Discuss cardiopulmonary concept and research proposals in the St. Jude Lifetime Cohort. St. Jude Children's Research Hospital. 2010- 2013.

RESEARCH INTERESTS:

Obesity control and prevention in children and adolescents

Impact of health behaviors on physical fitness and health

Exercise interventions for health and physical function

Physical activity and function in children with chronic disease

Physical function and physiology in children with chronic disease

Physiological adaptations to exercise

CURRENT RESEARCH:

Feasibility and effect of incorporating the Fitbit fitness tracking technology into a prescribed exercise intervention program to improve long-term function in obese individuals one year following total knee arthroplasty; FedEx Institute of Technology; Project Director.

RECENT RESEARCH:

Establishment of a Lifetime Cohort of Adults Surviving Childhood Cancer (SJLIFE); Study Staff

Aerobic and Strengthening Exercise for Acute Leukemia (XRCISL); Study Coordinator

Motor Proficiency and Physical Activity in Adult Survivors of Childhood ALL (MTRPAL); R01 CA132901-04 NCI, Institutional Co-Investigator

Vibration Intervention for Bone Enhancement in Childhood Cancer Survivors (VIBE); R21HD059292-02 NIH/NICHD, Gabrielle's Angel Foundation, Study Coordinator

Resistance and Aerobic Exercise for Subclinical Anthracycline Cardiomyopathy (CARHAB); Study Staff

The Effects of Ankle Foot Orthoses on Gait Efficiency in Children with Acute Lymphoblastic Leukemia and Foot Drop (GAIT09); Study Staff

Physical Activity to Modify Sequelae and Quality of Life in Childhood Acute Lymphoblastic Leukemia (PAQOL); R01 CA129384-04 NIH/NCI, Study Staff

The Relationship between Retained Platinum and Cardiac Risk Factors, Sensory and/or Motor Neuropathy, Vestibular and/or Auditory Function and Renal Function among SJLIFE Participants Treated with Cis-platinum or Carboplatinum (SJLA4); Co-Investigator

Pulmonary Function after Surgical Treatment of Pulmonary Metastases from Osteosarcoma (XPD10-118); Co-Investigator

A Phase II Trial of Limited Surgery and Proton Therapy for Craniopharyngioma and Observation for Craniopharyngioma after Radical Resection (RT2CR); Study Staff

Brain Integrity in Survivors of Hodgkin Lymphoma Treated with Thoracic Radiation (BRIGHT); Study Staff

GRANT SUPPORT:

Gatorade Sports Science Institute Student Grant, 2006.
$2,500.00. *Effect of Carnitine and Aerobic Exercise on Exercise Performance and Muscle Carnitine.*

NSCA Foundation GNC Nutrition Grant, 2006.
$2,500.00. *Effect of Glycine Propionyl-L-Carnitine and Aerobic Exercise on Exercise Performance Related Variables***.**

NSCA Foundation Undergraduate Research Grant, 2005
$1,500.00. *Alterations in biomarkers of oxidative stress and skeletal muscle injury following acute anaerobic exercise.*

PUBLICATIONS:

Thesis

Effect of glycine propionyl-L-Carnitine and aerobic exercise on exercise performance related variables. May 2007.

Original Articles

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2. Bloomer RJ, Falvo MJ, Schilling BK, **Smith WA**. Prior exercise and antioxidant supplementation: Effect on oxidative stress and muscle injury. *J Int Soc Sports Nutr*, 4 (9): Epub Oct 3, 2007.

3. Bloomer RJ, Creasy AK, **Smith WA**. Physical work-induced oxidative stress is exacerbated in young cigarette smokers. *Nicotine Tob Res*, 9(2): 205-211, 2007.

4. Bloomer RJ, Solis A, Fisher-Wellman K, **Smith WA**. Postprandial oxidative stress is exacerbated in cigarette smokers. *Brit J Nutr*, 2007 Oct 10; 1-6.

5. Bloomer RJ, **Smith WA**, Fisher-Wellman K. Glycine propionyl-L-carnitine increases plasma nitrate/nitrite in resistance trained men. *J Int Soc Sports Nutr*, 4(22): Epub Dec 3, 2007.

6. Falvo MJ, Schilling BK, Bloomer RJ, **Smith WA**, Creasy AK. Efficacy of prior eccentric exercise in attenuating impaired exercise performance after muscle injury in resistance trained men. *J Strength Cond Res*, 21(4): 1053-1060.

7. Falvo MJ, Schilling BK, Bloomer RJ, **Smith WA**. Repeated bout effect is absent in resistance trained men: An electromyographic analysis. *J Electomyogr Kines*, 19 (6): e529-535, 2009.

8. **Smith WA**, Fry AC, Tschume LC, Bloomer RJ. Effect of glycine propionyl-L-carnitine on aerobic and anaerobic exercise performance. *Int J Sport Nutr Exerc Metab*, 18: 19-36, 2008.

9. Bloomer RJ, Solis AD, Fisher-Wellman KH, **Smith WA**. Postprandial oxidative stress is exacerbated in cigarette smokers. *Brit J Nutr*, 99: 1055-1060, 2008.

10. Bloomer RJ, **Smith WA**. Oxidative stress in response to aerobic and anaerobic power testing: Influence of exercise training and dietary carnitine supplementation. *Res Sports Med*, 17: 1-16, 2009.

11. Bloomer RJ, Tschume LC, **Smith WA**. Glycine propionyl-L-carnitine modulates lipid peroxidation and nitric oxide in human subjects*. Int J Vitam Nutr Res*, 79: 131-141, 2009.

12. Bloomer RJ, **Smith WA**, Fisher-Wellman K. Oxidative stress in response to forearm ischemia-reperfusion with and without carnitine administration. *Int J Vitam Nutr Res*, 80: 12-23, 2010.

13. **Smith, WA**, Nolan VG, Robison LL, Hudson MM, and Ness KK. Physical activity among cancer survivors and those with no history of cancer--- a report from the National Health and Nutrition Examination Survey 2003-2006. *Am J Transl Res*, 3(4): 342–350. 2011.

14. Ness KK, Jones KE, **Smith WA**, Spunt SL, Wilson CL, Armstrong GA, Srivastava DK, Robison LL, Hudson MM, Gurney JG. Chemotherapy-related neuropathic symptoms and functional impairment in adult survivors of extracranial tumors of childhood: Results from the St. Jude Lifetime Cohort Study. *Arch Phys Med Rehabil,* 94 (8): 1451-1457. 2013.

15. Ness KK, Krull KR, Jones KE, Mulrooney DA, Armstrong GT, Green DM, Chemaitilly W, **Smith WA**, Wilson CL, Sklar CA, Shelton K, Srivastava DK, Ali S, Robison LL, Hudson MM. Physiologic frailty as a sign of accelerated aging among adult survivors of childhood cancer: A report from the St. Jude Lifetime Cohort Study. *J Clin Oncol,* 31: 4496-4503. 2013.

16. **Smith WA**, Ness KK, Joshi V, Hudson MM, Robison LL, Green DM. Exercise training in childhood cancer survivors with subclinical cardiomyopathy who were treated with anthracyclines. *Pediatr Blood Cancer, 61 (5): 942-945. 2013.*

17. **Smith WA**, Li Z, Loftin M, Carlyle BE, Hudson MM, Robison LL, Ness KK. Measured vs self-reported physical function in adult survivors of childhood cancer. *Med Sci Sport Exer*, 46 (2): 211-218. 2014.

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20. **Smith WA**, Li C, Nottage K, Hudson MM, Lanctot J, Green D, Nolan V, Laver J, Robison LL, Ness KK. Dietary intake and metabolic syndrome in adult survivors of childhood cancer. *Cancer*, in press.

21. Huang TT, Li Z, **Smith WA**, Hudson MM, Ness KK. The six-minute walk as a measure of functional capacity in adult survivors of childhood acute lymphoblastic leukemia. *Leukemia,* submitted and under review.

Abstracts and Presentations

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2. **Smith WA**, Fry AC, Bloomer RJ, Schilling BK, Moore CA, Falvo MJ, Weiss LW. A Comparison of the Memphis Squat Test and Wingate Anaerobic Test. National Strength and Conditioning Association Annual Meeting 2005.

3. **Smith WA**, Falvo MJ, Creasy AK, Leatherwood C, Schilling BK, Bloomer RJ. Correlation between visual analog scale and pressure algometry measures in assessing skeletal muscle soreness. American College of Sports Medicine Annual Meeting 2006.

4. Creasy AK, **Smith WA**, McMahan RA, Bloomer RJ. Cigarette Smoking Exacerbates Exercise-Induced Oxidative Stress in Young Healthy Men and Women. American College of Sports Medicine Annual Meeting 2006.

5. Bloomer RJ, Falvo MJ, Fry AC, Schilling BK, **Smith WA**, Moore CA. Anaerobic Exercise Does Not Result in Oxidative Stress or Skeletal Muscle Injury in Trained Men. American College of Sports Medicine Annual Meeting 2006.

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8. **Smith WA**, Falvo MJ, Schilling BK, Creasy AK, Leatherwood C, Bloomer RJ. Effect of Antioxidant Therapy and Prior Eccentric Exercise on Markers of Muscle Injury in Resistance Trained Men. National Strength and Conditioning Association Annual Meeting 2006.

9. **Smith WA**, Creasy AK, Upchurch JH, Bloomer RJ. Lipid Peroxidation Following Aerobic and Anaerobic Power Testing. National Strength and Conditioning Association Annual Meeting 2006.

10. Falvo MJ, Schilling BK, Bloomer RJ, Leatherwood C, **Smith WA**, Creasy AK. Time course of recovery from multi-joint eccentric exercise intended to induce skeletal muscle injury. National Strength and Conditioning Association Annual Meeting 2006.

11. **Smith WA**, Hudson MM, Ness KK. Physical Activity in Cancer Survivors versus Controls with No History of Cancer from the National Health and Nutrition Survey (NHANES) 2003-2004. International conference on long term complications of treatment of children and adolescents for cancer 2008.

12. Ness KK, **Smith WA**, Hudson MM, Robison LL. Balance in childhood cancer survivors who were treated with platinum: A pilot study. American Physical Therapy Association Combined Sections Meeting, SanDiego, CA, 2010.

13. **Smith WA**, Carlyle BE, Huang S, Ness KK. Measured Versus Self-Reported Physical Function in Adult Survivors of Childhood Cancer. American College of Sports Medicine Annual Meeting 2010.

14. Huang TT, **Smith WA**, J Roberts, MM Hudson, KK Ness. Assessment of Exercise Capacity in Adult Survivors of

Childhood Acute Lymphoblastic Leukemia Using Six Minutes Walk Test. APTA Combined Sections Meeting 2011.

15. Ness KK, Green DM, Gurney JG, Bass JK, **Smith WA,** Huang TT, Robison LL, Hudson MM. Balance impairment in adult survivors of childhood cancer treated with platinum. 43rd Congress of International Society of Paediatric Oncology, Auckland, NZ, 2011.

16. **Smith WA**, Carlyle BE, Huang S, Ness KK. Measured Versus Self-Reported Physical Function in Adult Survivors of Childhood Cancer. Pediatric Oncology Rehabilitation Conference 2012.

17. Chemiatilly W, Hudson M, Huang S, **Smith WA**, Srivastava DK, Barnes N, Pui CH, Kun LE, Sklar CA, Robison LL, Ness KK The Relationship Between Low Insulin-like Growth Factor-1 (IGF-1) Levels, Exercise Capacity, Muscle Strength and Vitality in Adult Survivors of Childhood Acute Lymphoblastic Leukemia (ALL) Treated with Cranial Radiotherapy (CRT). Endocrine Society Annual 2012.

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19. **Smith WA**, Li C, Nottage K, Lanctot J, Hudson M, Green D, Nolan V, Laver J, Gurney J, Robison L, Ness KK. Dietary intake and metabolic syndrome in adult survivors of childhood cancer. 12th International conference on long term complications of treatment of children and adolescents for cancer 2012.

20. **Smith WA**, Li C, Nottage K, Lanctot J, Hudson M, Green D, Nolan V, Laver J, Gurney J, Robison L, Ness KK. Dietary intake and metabolic syndrome in adult survivors of childhood cancer. J Clin Oncol 30, 2012 (suppl; abstr 9526).

21. Ness KK, Armstrong GT, Gurney JG, Srivastava DK, Wilson CL, **Smith WA**, Robison LL, Hudson MM, Krull KK. Physiologic fragility in adult survivors of childhood cancer: a report from the St. Jude Lifetime Cohort Study, 44th Congress of the International Society of Paediatric Oncology, London, UK. 2012.

22. **Smith WA**, Ness KK, Joshi VM, Robison LL, Hudson MM, Green DM. Exercise training in childhood cancer survivors with subclinical cardiomyopathy. Experiment Biology 2013. Boston MA.

23. **Smith WA**, Hudson MM, Pui CH, Lanctot JQ, Howell CR, Karlage R, Robison LL, Ness KK. Association between physical activity level and cardiorespiratory fitness in adult survivors of childhood Acute Lymphoblastic Leukemia. 13th International conference on long term complications of treatment of children and adolescents for cancer 2013.

24. Ness KK, Huang S, **Smith WA**, Pui CH, Lanctot JQ, Howell CR, Karlage R, Shelton KC, Robison LL, Hudson MM. Global fitness in adult survivors of childhood acute lymphoblastic leukemia (ALL). 2013 ASCO annual meeting. Memphis, TN.

25. Ness KK, Armstrong GT, Gurney JG, Jones KE, Wilson CL, **Smith WA**, Green DM, Robison LL, Hudson MM. Physiologic frailty as a marker of early aging and mortality among survivors of childhood cancer: A report from the St. Jude Lifetime Cohort Study. 13th International conference on long term complications of treatment of children and adolescents for cancer 2013. Memphis, TN.

26. Lanctot JQ, Hudson MM, **Smith WA**, Brinkman TM, Shelton KC, Robison LL, Ness KK. Comparison of health behaviors between childhood acute lymphoblastic leukemia survivors and healthy controls. 13th International conference on long term complications of treatment of children and adolescents for cancer 2013. Memphis, TN.

27. **Smith WA**, Klein JC, Osinubi O, Helmer DA, Ndirangu D, Falvo MJ. Cardiopulmonary exercise testing in deployed veterans with respiratory symptoms and airborne hazards exposure concerns. American Thoracic Society 2014. San Diego, CA.

28. Falvo MJ, Osinubi O, Klein JC, Patrick-Deluca LA, **Smith WA**, Helmer DA. Late prevalence of pulmonary function abnormalities in Iraq/Afghanistan veterans. American Thoracic Society 2014. San Diego, CA.

29. Chen Y, Klein JC, Ndirangu D, **Smith WA**, Falvo MJ. Deployment length and its correlation with spirometric variables in deployed veterans. Experimental Biology 2014. San Diego, CA.

30. **Smith WA**, Klein JC, Ndirangu, Chen Y, Falvo MJ. Exercise tolerance in Gulf War veterans and relationship to deployment exposures. Experimental Biology 2014. San Diego, CA.

Teaching and Mentorship:

Community Education

Staying healthy with diet and exercise. Bartlett Recreation Center, Bartlett, TN. 2007

Exercise and cancer survivorship. St. Jude Children's Research Hospital Survivor Day 2008, Memphis, TN.

Physical fitness and function in childhood cancer survivors. St. Jude Children's Research Hospital Survivor Day 2012, Memphis, TN.

Measuring your physical fitness and function: Human Performance Lab. St. Jude Children's Research Hospital Survivor Day 2012, Memphis, TN.

Guest Lectures and Invited Scientific Presentations

SJLIFE Functional Assessment: Exactly what are these guys doing? SJLIFE investigator and clinician workshop, 2009

SJLIFE Functional Assessment: what tests are being done and what do they mean clinically? SJLIFE investigator and clinician workshop. 2010.

Human performance research in childhood cancer survivorship. University of Tennessee Health Science Center, Spring 2010.

Function and fitness in childhood brain tumor survivors. Pediatric Rehabilitation Conference. St. Jude Children's Research Hospital, Memphis, TN. March 2012.

RT2CR: Physical Performance Measures. Radiation Oncology Clinical Rounds. St. Jude Children's Research Hospital, November 2012.

Cancer Prevention and Control. The School of Public Health, University of Memphis. Memphis, TN, April 2013.

Approaches to exercise in chronic childhood conditions, Clinical rounds, St. Jude Children's Research Hospital, May 2013.

Teaching and Clinical Training Workshops

EXSS 4000: Exercise testing techniques and interpretation lab. Instructor. University of Memphis, Summer 2006.

Human performance lab testing techniques. St. Jude Children's Research Hospital, Memphis, TN. Fall 2007.

Balance testing techniques in patients with vestibular damage from platinum based chemotherapy agents. St. Jude Children's Research Hospital, Memphis, TN. Spring 2008.

Strength and mobility assessment in patients with osteosarcoma treated with amputation. St. Jude Children's Research Hospital, Memphis, TN. Spring 2008.

Motor proficiency assessment in adult survivors of childhood acute lymphoblastic leukemia. St. Jude Children's Research Hospital, Memphis, TN. Spring 2009.

Multicenter exercise intervention in children undergoing treatment for acute lymphoblastic leukemia (XRCISL). St. Jude Children's Research Hospital, Memphis, TN. Spring 2008.

Exercise intervention in children undergoing treatment for acute lymphoblastic leukemia (XRCISL). Vanderbilt University, Nashville, TN. Summer 2009.

Exercise and function testing for a Phase II Trial of Limited Surgery, Proton Therapy and Observation for Craniopharyngioma after Radical Resection (RT2CR). St. Jude Children's Research Hospital, Memphis, TN. Spring 2011.

Exercise and function testing to evaluate Brain Integrity in Survivors of Hodgkin Lymphoma Treated with Thoracic Radiation (BRIGHT). St. Jude Children's Research Hospital, Memphis, TN. Spring 2012.

Exercise testing risk stratification of childhood cancer survivors for exercise testing. St. Jude Children's Research Hospital, Memphis, TN. Spring 2012

Vascular flow testing. St. Jude Children's Research Hospital, Memphis, TN. Spring 2013

Cardiopulmonary exercise testing orientation: Introduce new equipment and measurements to clinical and research staff. St. Jude Children's Research Hospital, Memphis, TN. Spring 2011.

Review of standard operating procedures in the Human Performance Lab at St. Jude Children's Research Hospital. Quarterly from May 2007 to September 2013.

Vascular flow assessment. Department of Cardiology. LeBonheur and University of Tennessee Health Science Center Cardiology. April 2013 and May 2013.

Student Advising

Students: Adam Pignon, Laura Barclay, April Batts, Laura Ashbridge, Leah Andrews
Project description: Research project and thesis for professional Doctorate of Physical Therapy
Thesis Title: Fitness in adolescents with hematological disorders
Graduated: DPT, University of Tennessee, 2010
Advising Role: Site and project supervisor

Students: Kathryn Barry, Ashleigh Bingham, Katie Freeman, Kristyn Gumz, Jessica Welker
Project description: Research project and thesis for professional Doctorate of Physical Therapy
Thesis Title: The effects of ankle foot orthoses on gait efficiency in children with chemotherapy induced motor neuropathy
Graduated: DPT, University of Tennessee, 2010
Advising Role: Site and project supervisor

Student: Brent Carlyle
Internship description: Pediatric Oncology Education Program (www.stjude.org/POE)
Project title: Measured versus self-reported physical function in adult survivors of childhood cancer
Graduated: MD, University of Buffalo; Medical School 2011
Advising role: Site and project supervisor

Student: Rachel Allgood
Internship description: Pediatric Oncology Education Program (www.stjude.org/POE)
Graduated: BS, University of Iowa 2010
Advising role: Clinical supervisor

Student: Jenell Roberts
Internship description: Undergraduate exercise science internship
Project title: Six minute walk test as a measure of peak oxygen consumption in adult survivors of childhood acute lymphoblastic leukemia survivors
Graduated: BS, Slippery Rock University 2010
Advising role: Project supervisor and clinical internship director

Student: Katie McGonigle
Internship description: Undergraduate exercise science internship
Project title: Effects of isokinetic knee extension and plantar flexion in peak torque to body weight on mobility among adult survivors of childhood acute lymphoblastic leukemia
Graduated: BS, Slippery Rock University 2011
Advising role: Project supervisor and clinical internship director

Student: Darcy Grandstaff
Internship description: Undergraduate exercise science internship
Project title: Orthostatic Intolerance in Childhood Cancer Survivors
Graduated: BS, Slippery Rock University 2012
Advising role: Project supervisor and clinical internship director

Student: Madison Carpenter
Internship description: Undergraduate exercise science internship
Graduated: BS, University of Memphis, In progress
Advising role: Clinical internship director

Student: Sarah Benedetti
Internship description: Post-graduate exercise science and clinical internship
Graduated: BS, University of Memphis, 2011
Advising role: Clinical internship director

Student: Lan Tran
Internship description: Rhodes academic internship program
Graduated: BS, Rhodes College 2013
Advising role: Clinical internship director
Student: Matthew Krull

Internship description: Undergraduate clinical internship
Graduated: BS, University of Memphis, In Progress
Advising role: Clinical internship director

Student: Carly Shatten
Internship description: Pediatric Oncology Education Program (www.stjude.org/POE)
Project title: Causes of postural instability in the long-term, adult survivor of pediatric cancer
Graduated: MS, University of North Carolina
Advising role: Project supervisor and clinical internship director

Student: Greg Cantrell
Internship description: Graduate exercise science internship
Project title: Role of cancer treatment and balance
Graduated: MS, University of Memphis 2013
Advising role: Project and clinical internship director

Student: Rachel Vernon
Internship description: Undergraduate clinical internship
Project title: Skeletal muscle and chemotherapy: a systematic review of literature
Graduated: BS, University of Tennessee, In progress
Advising role: Project and clinical internship director

Student: Innocence Harvey
Internship description: Pediatric Oncology Education Program (www.stjude.org/POE)
Project title: Physical function in adult survivors of Hodgkin's lymphoma
Graduated: MS, University of Memphis, 2013; PhD, University of Tennessee Health Science Center, In progress.
Advising role: Project supervisor and clinical internship director

Student: Katie Simon
Internship description: Clinical exercise science internship
Project title: Standardized exercise intervention in obese childhood cancer survivors
Graduated: MS, University of Northern Colorado, Rocky Mountain Cancer Center, In Progress
Advising role: Project and clinical internship director

Student: Sarah Boop
Internship description: Graduate clinical internship
Project title: Physical function in adult survivors of pediatric brain tumors
Graduated: BA, University of Tennessee, 2012; MD, University of Tennessee Health Science Center, In progress
Advising role: Project supervisor and clinical internship director

REFERENCES:

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