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Older adults are at a higher risk of falls due to physiological and psychological factors associated with natural aging. Relative to balance, a recent meta-analysis showed that an external focus of attention results in enhanced learning of balance tasks compared to an internal focus. However, only a couple studies have incorporated attentional focus as part of their multi-session balance training program. This observation set the foundation for the NIH funded clinical trial at UNCG titled “Merging attentional focus and balance training to reduce fall risk in older adults”. The clinical trial was a balance intervention program that assessed motor ability and patient reported outcomes throughout 12-weeks of training (2 sessions per week), and for 8 weeks following the training program to test for retention. The potential extended retention (>6 months) of patient-reported outcomes is outside the scope of the clinical trial, but it is the focus of this thesis. It was hypothesized that elevations in the patient reported outcomes observed at the last assessment timepoint (week 20 and differentiated by attentional focus group) would remain elevated relative at their extended retention timepoint.

Participants who completed the clinical trial (N=54) were asked to re-enroll in this study, of which a total of 33 participants (82.39 (6.25) years; 164.91 (9.72) cm; 63.84 (17.32) kg; M=7, F=26) elected to participate. This included those who were originally assigned to the external focus group (n=19; 87.88 (6.15) years; 164.91 (7.74) cm; 61.92 (17.99) kg; M=3, F=16) or to the internal focus group (n=14; 82.62 (6.61) years; 163.99 (11.81) cm; 64.02 (17.23) kg; M=4, F=10). All participants enrolled in this study completed

the same patient-reported outcomes as assessed during the original 20-week clinical trial [(Activities-Specific Balance Confidence Scale short version (ABC-6), Short Form 36 (SF-36), and the Tampa Scale for Kinesiophobia (TSK)] so that extended retention can be examined. The new data and data from the final timepoint in the clinical trial (week 20) were combined to examine the extent to which patient-reported outcomes were retained over an extended period of time (>6 months). We used a repeated measures ANCOVA for each metric of interest, with timepoint (week 20 vs. extended retention) as the within subjects variable and training group assignment (external focus vs. internal focus) as the between-subjects variable. The covariate of time since completing the study (in weeks) was included in the model. Cohen's *d* was also calculated between groups at week 20 and again at the extended retention timepoint to compare group-related effect size differences.

The ABC-6 and TSK showed no group × time interaction, nor a group or time main effect (all $p>.05$). For the SF-36, seven of the eight dimensions had non-significant interaction or main effects. Only physical role exhibited an interaction, $F(1,28)=5.301$, $p=.029$, $n_p^2<.159$, which was driven by unusual, by valid, responses from the external focus group reporting an increase in physical limitations in the extended retention test. For the effect size data, a medium effect between groups was reported at the 20-week and extended retention timepoints for the ABC-6 and the SF-36 physical functioning dimension, suggesting that some group-level differences that existed after the clinical trial persisted at the extended retention timepoint. Collectively, these data show that some patient-reported outcomes can be retained long after an attentionally focused balance training intervention.

LONG-TERM RETENTION OF PATIENT-REPORTED OUTCOMES AFTER A 12-WEEK ATTENTIONAL FOCUS BALANCE TRAINING PROGRAM

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CHAPTER I

INTRODUCTION

Older adults are at a higher risk of falls due to physiological and psychological factors associated with natural aging (Razmara et al., 2018; Tiedemann et al., 2005). Falls are the leading cause of fatal and non-fatal injuries among adults ages 65 and older (Bergen et al., 2016; Verma et al., 2016). The vast majority of falls occur from balance and gait tasks during activities of daily living. Thus, it is important to improve older adults' ability to perform activities of daily living (ADLs), also termed functional mobility, in order to reduce fall risk. Functional mobility encompasses the ability to complete tasks such as walking, clearing curbsides, controlling side-to-side movements, sitting down, unsupported sitting, reaching, and picking up items from the ground.

Traditional balance training programs have adopted a multifactorial approach that may include static and dynamic balance training, strength training, cardiovascular training, and/or flexibility exercises (Bhasin et al., 2018; Campbell & Robertson, 2007; Der Ananian et al., 2017; H.-C. Lee et al., 2013). While these programs have shown positive effects, they have been moderate at best. One missing aspect of most balance training programs is the inclusion of psychological factors, despite its potential benefit.

For example, the dichotomy between an external and internal focus of attention has been well studied in motor tasks and it has been repeatedly shown that an external focus of attention can enhance motor control and learning (Wulf, 2013). Relative to balance, a recent meta-analysis showed that an external focus of attention results in enhanced learning of balance tasks compared to an internal focus (Kim et al., 2017). However, only a couple studies have incorporated attentional focus as part of their multi-session balance training program (Diekfuss et al., 2019; Landers et al., 2016). This observation set the foundation for the NIH funded clinical trial at UNCG titled “Merging attentional focus and balance training to reduce fall risk in older adults”.

The UNCG clinical trial has enrolled N=54 participants to date, with a goal of enrolling N=90 by the end of 2021. Participants were randomly assigned to one of the experimental groups (external focus or internal focus) or the control group. The experimental groups completed a balance training program that consisted of 20-minute sessions of personalized balance training on a wobble-board twice a week throughout the 12-weeks. Both experimental groups completed motor ability tests and patient-reported outcome assessments at weeks 0, 6, 12, 13, 16, and 20. The latter three testing timepoints were to test for retention up to 8-weeks after the training. The control group completed the same tests/assessments at the same timepoints, but did not receive any balance training. Preliminary data shows that the external focus of attention is having a positive effect on some motor ability and patient-reported outcomes for up to 8-week after the training. The potential extended retention (>6 months) of these effects is outside the scope of the clinical trial, but it is the focus of this thesis. The motor ability testing included in the clinical trial requires in-person visits, so we have elected to omit them from this thesis due to in-person restrictions from COVID-19. However, the patient reported outcomes can safely be done without in-person visits and they will be the focus of this thesis.

The purpose of this study was to examine the extent to which patient reported outcomes were retained over an extended period of time following a 12-week attentional focus balance training program. Participants from the UNCG clinical trial were recruited to enroll in this follow-up study and asked to complete the same patient-reported outcomes used in the original study. The new data and data from the original study were combined to examine the extent to which patient-reported outcomes were retained over an extended period of time (>6 months). It was hypothesized that elevations in the patient reported outcomes observed at the 8-week retention test (relative to baseline and differentiated by attentional focus group) would remain elevated in the extended (>6 month) retention test.

CHAPTER II

REVIEW OF THE LITERATURE

What is Balance?

Balance and postural control are commonly used synonymously in human movement research to describe the ability to maintain upright stance. From a mechanical (physics) perspective, balance defines an object when the sum of the loads upon it equal zero, aligned with Newton's first law that states that an object will not change its motion unless a force is acted upon it. In human movement research, balance has been described as the dynamics of body posture to prevent falling (i.e., to maintain upright stance) (Winter et al., 1998). To maintain upright stance, the center of mass (COM)—defined as the location of the mathematical average of the body's mass—must remain within the base of support (BOS)—defined as the boundary of the body parts in touch with the ground. As a person moves, the COM is displaced, and they become more unstable as the COM nears the BOS. A fall occurs if the COM goes outside of the BOS, so a corrective action is required to maintain stability as the COM nears the BOS boundary (Pollock et al., 1999). As humans age, the ability to exhibit corrective balance actions becomes more challenging—especially after 65 years of age—due to a decline in muscle strength, reaction time, visual acuity, and related factors (Ambrose et al., 2013; Bergland, 2012; Rubenstein, 2006).

Static vs. Dynamic Balance

Balance can be dichotomously separated in to static or dynamic tasks. Static balance refers to a task in which the person is not changing their BOS. This is commonly assessed via a quiet standing task in which the person stands as still as possible while on a force plate (Panzer et al., 1995; Winter et al., 1998, 2003), but can also be extended to measuring postural control while sitting (Deffeyes et al., 2009; van Dieën et al., 2010). A common clinical test—the sit-to-stand assessment—combines the two tasks (Cheng et al., 1998). In these examples, the BOS is unchanged, but the person must still control their COM within the BOS during the task.

Alternatively, tasks that require the person to alter their BOS are termed dynamic balance. An example of this is human gait, in which the COM is propelled outside the BOS, but the BOS is repositioned by taking a step, allowing for balance (and upright stance) to be maintained. It is due to this observation that walking has been called a series of controlled falls. Dynamic balance tasks index the ability of someone to transfer their COM outside of a moving BOS, a characteristic of many ADLs. Thus, dynamic balance is also commonly referred to the ability to exhibit functional mobility (Shubert et al., 2006).

Role of Balance in Activities of Daily Life (ADLs)

ADLs are fundamental skills that fulfill everyday basic needs such as, eating, grooming/personal hygiene, dress, and restroom needs (Mlinac & Feng, 2016). ADLs serve types of function: (1) basic ADLs are involved in general activities, and (2) instrumental

ADLs are involved in more complex activities. Performance on ADLs is important to measure a person's functional independence. Lower ADL performance has been correlated with a poorer quality of life. Thus, measuring ADL performance is an effective way to track if one is functional dependent and/or needs additional assistance.

Cognitive impairments may lead to challenges in a person's daily life and can result in loss of autonomy (Katz et al., 1976). Age-related cognitive deficits can cause a decline in the overall ability to perform ADLs and this may result in falls or other injuries that can occur during basic daily activities. Declines in executive functioning can lead to a decline in physical functioning. Age-related diseases may affect a person's overall cognitive and physical functioning that may lead to challenges with completing the ADLs. In the rehabilitation setting ADLs are accessed frequently to determine the overall functional independence of the patient (Fauth et al., 2013). Static and dynamic balance can be included in the rehabilitation setting to strength the coordination and balance of the patient. Static balance focuses on "quiet standing" that involves little to no movement; this will help access if the individual is able to maintain balance while remaining in a stationary position, often without a secondary task (Winter et al., 2003). Dynamic balance can measure how one can maintain balance while moving. ADLs are used to promote effective mobility that can indicate whether the patient is functionally independent (Mlinac &Feng, 2016).

Balance is a critical component to many ADLs, including walking, clearing curbsides, controlling side to side movements, sitting down, sitting down unsupported, reaching, retrieving an object from floor (bending down), and turning around (Runge et al

, 2000). It is important to note that the aging process, diseases, and lack of physical activity could implement a decline of overall functioning of balance that may lead to an increase in fall risk. To decrease these declines, previous research found that the combination of balance and strength training led to the lowest fall risk relative to a structured exercise group and a no exercise control group (Lord et al., 2010).

Changes in Balance across the Lifespan

Balance is a part of everyday functioning across the lifespan. During youth, the average child enjoys recreational activities or even sports; during those activities balance is important and assists with lowering risk of sustaining a fall. Developing safe balance can be represented over a lifespan and known to benefit health-related daily activities. Balance control encompasses static and dynamic tasks. Moreover, balance performance can be divided into four types: (1) static steady state, (2) dynamic steady state, (3) proactive balance, and (4) reactive balance. Static steady state balance refers to maintaining a steady position while standing or sitting. During dynamic steady state, the individual is maintaining balance while walking at a constant speed. Proactive balance refers to the prediction of postural disturbances while performing any balance task. Lastly, reactive balance occurs when unpredicted postural disturbances occur during postural performance (Mackey & Robinovitch, 2005).

Balance performance in children are premature and still developing due to their neurophysiological structures compared to adults (Kiss et al., 2018). Maturation in age increases the sensory feedback processing, peaking in young adulthood. Throughout the lifespan, balance evolves and can be characterized across various age groups. In children ages 6-12, the integration of sensory feedback is still developing. In young adulthood (ages 20-24), this group has matured and developed neurophysiological structures to assist in postural control. In the upper 60s, the individuals overall cognitive control declines as age-related changes occur and this will cause a shift toward a decline in balance performance (Woollacott & Shumway-Cook, 1990). The overall development of balance is beneficial to all age groups across the lifespan and can decrease the risk of falling injuries in the aging population.

Geriatric research is vital to the continuation of functionality of the independence and quality of life. Balance control gradually becomes challenging with aging, which has a result of increased falls in older adults (Lord & Sturnieks, 2005). Balance training is a clinical rehabilitation tool that can help increase functionality of one’s life, in the consideration of their overall health. Research shows older adults have an increase in falls, which is associated with age and the gradual decline of functionality of balance and other limiting factors.

Measurements of Balance

Subjective Measurements

Subjective measures are included in self-report outcomes and recall questionnaires. Subjective measures also encompass assessments where the clinician or researcher is making a judgement about the person’s movement ability. It is important to incorporate subjective measures in overall bases of balance to focus on the subject’s needs and their level of functional mobility (Cameron et al., 2013). This section will highlight some of the more commonly used subjective measurements of balance.

The Star Excursion Balance Test (SEBT) was developed as an efficient and inexpensive test of static balance to screen for injury risk (Earl, 2001; Olmstead, 2002). It was initially designed with eight reach directions that extend out at 45 degrees, with three trials in each of eight directions and participants moving in a clockwise direction. Participants start with right stance leg in the center grid and after completion, there is a 5-minute rest, followed by a set of trials with left stance. The SEBT instructions to the participant are to make light touch on the ground with the most distal part of the reaching leg and return to dual stance without affecting the overall balance. For example, when reaching in the lateral and posterolateral directions, participants much reach behind the stance leg to complete the task. Participants much maintain their balance with one leg while maximally reaching in the different direction with the opposite leg. The modified SEBT (mSEBT) test was simplified to three directions: anterior (ANT), posterolateral (PL), and posteromedial (PM) (Shaffer et al., 2013). This test measures dynamic and static postural control, muscular strength, and range of motion (ROM) measurements.

The Y-balance test is an instrumented version of the mSEBT that is commercially available (Move2Perform, Evansville, IL) (Bulow et al., 2019). It has become a frequently administered test due to its simplicity and reliability. The YBT requires participants to balance on one leg and move the other leg as far as possible in three separate directions: anterior, posterolateral, and posteromedial. The YBT has shown to have strong correlation with knee flexor and hip abductor strength. This test can be used in the clinical setting to access balance control programs that contribute to fall prevention. In a recent studies, lower limb muscle strength of the older adult group was assessed using the YBT test (A. Lee et al., 2016). This test has also been used to measure balance in individuals with chronic ankle instability (CAI) (Ko et al., 2019).

The Balance Error Scoring System (BESS) was developed to be a simple and practical tool to subjectively assess balance (Reimann et al., 1999). The test is used frequently in clinical and field-based settings due to the low cost, simple instructions, and easy scoring methods. The basis of the test is to count the number of deviations (i.e., errors) a person makes when attempting to maintain balance in one of six starting positions. The starting position for all six conditions is to stand upright with eyes closed and hands placed on hips. The six conditions encompass three different BOS (single-leg stance, feet together, and tandem stance) on two different surfaces (firm and foam), each lasting for 20 seconds. An error is counted if one of the following occurs: (1) hands lifted off iliac crest, (2) opening eyes, (3) a step, stumble, or fall, (4) moving hip into greater than 30 degrees, (5) lifting forefoot or heel, or (6) remaining out of test position greater than 5 secs. Each committed error is given 1 point, and the maximum allowable number of points for each position is 10 (Finnoff et al., 2009). The subject's total BESS score is the sum of the individual stance position scores. There are 6 BESS positions, so the maximum possible total BESS score is 60. This test has been shown to have adequate-to-excellent reliability and validity (Bell et al., 2011; Finnoff et al., 2009; Susco et al., n.d.; Valovich McLeod et al., 2004). However, some questions have been raised about the appropriateness of the reliability of the BESS due to its subjective nature (Buckley et al., 2016; Murray et al., 2019; Rochefort et al., 2017). Normative data have been developed for this test that can be used for comparison purposes (Hansen et al., 2016; Iverson et al., 2008; Iverson & Koehle, 2013). This test is commonly used in populations with a suspected concussion (Furman et al., 2013; Guskiewicz et al., 2001), but it has also been used with other clinical populations, such as patients with ankle instability (Docherty et al., 2006), as well as in military populations (Haran et al., 2016).

The Functional Gait Assessment (FGA) is a standardized test for assessing postural stability during walking tasks (Wrisley et al., 2004). The FGA is a modified version of the Dynamic Gait Index (DGI), which includes an 8-item index to assess gait during walking tasks. The FGA was created to improve the reliability and reduce the ceiling effect. This test is a 10-item test that makes up out of 7/8 of the DGI tasks and the addition of three new tasks. The scoring scale ranges from 0-3 on each item, with a 0 indicating severe impairment and 3 indicating normal ambulation. Thus, a higher score is indicative of more functional gait. The FGA has been shown to have 100% sensitivity and 76% specificity with respect to classifying community dwelling older adults with a fall within 6 months (Wrisley & Kumar, 2010). The interrater has been shown to be excellent (ICC=.93) (Walker et al., 2007). The FGA has been used with a variety of populations, including patients with Parkinson’s, spinal cord injury, stroke, and vestibular disorders

The Community Balance and Mobility (CB&M) Scale is similar to the FGA in that it also assesses dynamic balance in activities of daily living (Howe et al., 2006). The CB&M Scale includes the assessment of several challenging tasks and may alleviate the ceiling effects observed in commonly used gait and balance assessments. The population that the test was initially created for is the traumatic brain injury (TBI) community (Howe et al., 2006). However it has also been used with other clinical populations, such as stroke survivors (Knorr et al., 2010), patients with cerebral palsy (Brien et al., 2011), and older adults (Liu-Ambrose et al., 2006). During the CB&M test, there are 12 challenging tasks that are performed with 6 tasks on both sides. The scoring ranges from 0-5, with 0 indicating complete inability to perform the task and 5 indicating the most successful completion of the item possible.

The Berg Balance Scale (BBS) was developed to measure balance among older people with balance impairment by assessing performance on functional tasks (Berg et al., 1992). The BBS is considered a valid instrument that is used for evaluating the effectiveness in interventions for quantitative description of clinical practice (Conradsson et al., 2007). The assessment uses 14 static and dynamic tasks of varying difficulty. The scoring of this test is 0-4 on each task, with a 0 indicating the inability to complete the task and a 4 indicating the ability to complete the task with ease. A maximum score of 56 indicates functional balance, whereas cutoff scores of 45 (Berg, 1992), 51 and 42 (Shumway-Cook et al., 2000), and 47 (Viveiro et al., 2019) have been shown to indicate elevated fall risk in older adults.

Objective Measurements

Objective measurements differ from subjective measurements by typically using sensors interfaced with computers to monitor/measure human movement. Historically, objective measurements were confined to the laboratory due to the necessary computation power and sensitivity of the sensors. However, advancements in the past decade has made portable objective measurements a possibility in human movement research. This section outlines some of the laboratory and field-based objective measurements commonly used to assess human balance.

Force plates contain sensors that can track the Center of Pressure (COP)—defined as the location of the average pressure point of the body parts in contact with the ground. When standing still on two feet, the COP typically hovers around the middle of the BOS. However, since it is impossible for humans to stand perfectly still, the COP is constantly moving. It is the temporal and spatial characteristics of COP movement that are commonly of interest, as they provide a quantifiable way to measure postural control. Common metrics derived from the COP movement are path length (i.e., total distance travelled by the COP), geometric area covered by the COP movement, variability of COP movement (i.e., range, standard deviation), and velocity/acceleration of the COP. Moreover, time-to-boundary metrics quantify the relationship between the COP and BOS (Riccio, 1993; (Slobounov et al., 1997; Wade & Newell, 1972), which has been used to examine postural control in a variety of populations (Van Wegen et al., 2002; DiLiberto et al., 2021; Haddad et al., 2006; Hertel & Olmsted-Kramer, 2007). The force plate measures CoP movement over time in a horizontal plane defined by two directions—anterior-posterior (AP) and medial-lateral (ML)—allowing researchers and clinicians to see how balance control evolves over time. While this technology was traditionally bound to a laboratory, portable options have been developed in recent years. This includes the BTrackS portable force plate (Balance Tracking System, San Diego, CA), which has been shown to be valid (O'Connor et al., 2016) and reliable (D. J. Goble et al., 2018), and for which normative data for people ages 5-100 years old have been published (D. J. Goble & Baweja, 2018). BTrackS has been shown to have clinical utility in populations with a concussion (D. J. Goble et al., n.d.) and with older adults (D. Goble et al., 2017).

Inertial measurement units (IMUs) commonly include sensors such as an accelerometer, gyroscope, and magnetometer to monitor kinematics and kinetics in a variety of contexts (Ahmad et al., 2013). IMUs have been extensively used in human gait and balance research in recent years (Ghislieri et al., 2019; Gordt et al., 2018), including with clinical populations (Cinnera, n.d.; Hubble et al., 2015). Traditional metrics such as gait velocity, stride time, and range of motion can be derived from the IMU sensors, which can be standalone devices or embedded in a smartphone (Pfau & Weller, 2017). One example of a smartphone app that uses IMUs to collect data is the Accwalker app, which captures the information of the lower extremity during a stepping-in-place task to probe dynamic balance control (Rhea et al., 2017, 2018) . This app was originally developed to study military personnel who experienced head trauma due to blasts, but has since been expanded to study dynamic balance in clinical populations such as those with a concussion (Kuznetsov et al., 2017), chronic ankle instability (Sugimoto et al., 2017), and older adults with an elevated fall risk (Stout et al., 2019). A stepping-in-place task is used for neuromotor testing and a smartphone with the Accwalker app is placed on the participants thigh to record the data. The use of smartphone apps to monitor human health is increasing and, while there is potential for apps to be used as a self-managed balance intervention, there is also the concern about the content and credibility of health apps overall (BinDhim & Trevena, 2015). One way to bridge this gap is to include theory-based rationale in smartphone app design, such as adopting the behavioral change technique framework (Rhea et al., 2018).

Patient Reported Outcomes

Patient reported outcomes include direct subjective assessments by the patient of the basis of their overall health, which can include symptoms, functional capacity, well-being, health-related quality of life, perceptions about treatment, quality of care, impressions of how distractions affect function, the ability to comply with recommendations, and descriptions of difficulties imposed on personal and family life (McColl et al., 2003; Rothman et al., 2007). Patient reports can provide insight to health status, how challenging a task is, and how it impacted them. Incorporating only objective measurements may miss the patient’s perception that could be identified through subjective reports (Deshpande, 2011). In human movement studies, three commonly used patient reported outcomes are the Activities-Specific Balance Confidence Scale (ABC-6), Short Form 36 (SF36), and the Tampa Scale for Kinesiophobia (TSK). Each of these are further described below.

ABC

The ABC is a self-report measure of balance confidence while performing activities without losing balance or experiencing a sense of unsteadiness (Powell et al., 1995). The ABC is a 16-item self-reported measure in which patients rate their confidence ranging from 0-100; zero represents no confidence and a score of 100 represents complete confidence. Peretz and colleagues created a shorter 6-item version of the ABC is known as the ABC-6 to be more time efficient during assessments (Peretz et al., 2006). The overall score is calculated by adding the items scores and then dividing by the total number of items. The survey is geared towards the older community dwelling population for balanced confidence levels and it has been shown to have excellent reliability (Powell et al., 1995) and validity (Hatch et al., 2003). It has also been used to assess persons with Parkinson's disease (Maki & McIlroy, 2006), stroke (Botner, 2005), TBI (Inness et al., 2011), and vestibular disorders (Legters et al., 2005). For older adult fall risk, scores less than 67 indicates a risk of falling (Lajoie & Gallagher, 2004).

SF-36

The SF-36 is a 36-item patient reported health questionnaire, that includes eight scaled scores which are the weighted sums of the questions in their section (Ware & Sherbourne, 1992). Each of the eight scaled scores (i.e., dimensions) are directly transformed into a 0-100 scale, with a lower score indicating a lower rating on that dimension. The eight scaled scores consist of**:** (1) vitality, (2) physical functioning, (3) bodily pain, (4) general health perceptions, (5) physical role functioning, (6) emotional role functioning, (7) social role functioning, and (8) mental health. The standard form of the instrument asks participants to reply to questions according to how they have felt over a specified duration of time. The test questions are in a Likert-type scale, some with a few points and others with five or more points. Sample items include “How much bodily pain have you had during the past 4 weeks”, and “How much of the time during the past 4 weeks have you felt so down in the dumps nothing could cheer you up?” The SF-36 has been widely used and has excellent psychological factors in the clinical setting. This assessment is beneficial in the healthcare to provide insightful measures of those individuals that are being clinically accessed (Brazier et al., 1992). The benefits of the SF-36 questionnaire are the accessibility in the community setting or primary care setting. In community-dwelling older adults, subjective measurements such as the SF-36 self-rating tool have been used to assess the overall well-being in study participants (Montross et al., 2006).

TSK

The Tampa Scale for Kinesiophobia (TSK) is a self-reported survey that measures fear of movement, and how it relates to injury or re-injury (Miller, Kori, & Todd, 1991). The scale is based on the model of fear avoidance and fear of work-related activities. The survey has 17 items, with scoring from 1 (strongly disagree) to 4 (strongly agree) relative to the fear of injury from each presented task. The total score is the sum from the 17 questions that will range from 17 (no kinesiophobia) to 68 (high-level fear of pain with movement). The TSK was originally developed for those with lower back pain (LBP). In LBP patients, the resulting inactivity may lead to a deterioration of physical and mental health, and decreased muscle strength. In this theoretical model, pain catastrophizing influences fear of (re)injury, which in turn enhances avoidance behavior, in the long run resulting in disuse, depression, and disability (Vlaeyen et al., 1999). In recent studies, there was a positive correlation between kinesiophobia and the risk of falling (Erden & Güner, 2018). The TSK can also help determine the risks that correlate with quality of life in older adults. The fear of pain and reinjury is prevalent in aging adults and has negative effects on health expectancies (Jo et al., 2019). Falls are prevalent in the older community and the fear of falling again can raise awareness of a decline in balance/postural control. Meanwhile, the promotion of quality of life is important for overall well-being in older adults. Recognizing the psychological factors that are involved in kinesiophobia will allow clinical preventative measures to be accessed.

Enhancing Balance

The majority of training programs designed to enhance balance focus on static and dynamic tasks, strength training, cardiovascular training, and/or flexibility exercises (Der Ananian et al., 2017). Strength training is used in balance training studies due to the current research showing that increased strength can reduce fall risk (Lord et al., 2008). Cardiovascular training commonly includes walking or light aerobic exercises, and flexibility exercises are included to enhance range of motion. These modes of exercises can be prescribed in various intensities (high, moderate, or low), depending on the participant's characteristics. Furthermore, some training programs use a multifactorial intervention that incorporates several aspects training. The literature shows that both single and multifactorial interventions are effective in reducing falls to an at-risk community population. Multifactorial fall prevention has been shown to reduce fall risk and improve functional performance (Bhasin et al., 2018; Campbell & Robertson, 2007; Der Ananian et al., 2017; H.-C. Lee et al., 2013). Older adults at high risk for falls could benefit most from a multifactorial intervention to maintain physical functioning for ADLs.

While some fall prevention programs have shown a moderate improvement in balance control, there is still room for improvement. One area that is not commonly included in balance training programs are psychological skills. For example, instructing participants where to focus their attention when completing a motor skill is well known to enhance motor control and learning (Wulf, 2013). However, the attentional focus framework has only been used in a couple of multisession balance training programs (Landers et al., 2016; Wulf, 2013). The next section outlines the role of attentional focus in motor skills, followed by its application to balance tasks.

Attentional Focus in Motor Skills

Attentional focus in motor learning can be dichotomized into an internal focus and an external focus (Wulf & Weigelt, 1997). An internal focus refers to focusing on a body part during the movement, which induces conscious control and is thought to cause individuals to constrain their motor system by interfering with automatic control processes. In contrast, an external focus refers to focusing on something outside of the body that is related to the movement and it is thought to promote a more automatic mode of control by utilizing unconscious, fast, and reflexive control processes (Wulf &Weigelt, 1997; Wulf et al., 2013). Several converging lines of research show and an EF leads to enhanced motor performance and retention, including studies on skills related to balance (Landers et al., 2005), golf (Wulf & Su, 2007), volleyball (Wulf et al., 2002), soccer (Wulf et al., 2002), football (Zachry, 2005), basketball (Zachry et al., 2005), dart throwing (Emanuel et al., 2008), juggling (Zentgraf & Munzert, 2009), and playing piano (Duke et al., 2011). Studies have shown an association of external focus instructions and various measures of automaticity, including demonstrations of reduced attentional-capacity demands (Wulf, 2001; Wulf, 2013). The benefits of an external focus of attention for motor learning and performance had reportedly been a phenomenon in movement effectiveness. For example, in a systematic review of attentional focus in weightlifting tasks, an EF was found enhance movement effectiveness due to a higher peak force, greater speed, longer endurance, and more automatic fluid movements (Neumann, 2019).

Attentional Focus in Balance Tasks

An EF has been shown to enhance balance performance relative to IF in a several review papers (Park et al., 2015). Park and colleagues (2015) analyzed 18 articles that are related to attentional focus and balance control. The majority of the articles showed an EF had the most effective outcome during the intervention. The authors made the following observations. First, effects of attentional focus may be related to the difficulty of the balance task. Studies showed that when the task was easier (e.g., static standing), standing on a solid surface) for young adults, the effect of attentional focus disappeared. Second, when the skill level of a performer is high for specific motor skills, the effect of attentional focus may decrease. Third, postural adjustment of top-level performers (balance acrobats) was most effective when no instruction was given while they performed a balance task. This shows that in the case of experts, attentional focus instruction decreases automotive motor control of their balance. The systematic review and meta-analysis provided by Kim et al. (2017) provides further quantitative evidence showing that EF enhances the acquisition, retention, and transfer of balance skills.

The nearly all of the studies included in the aforementioned review papers, as well as more recent work (Becker & Hung, 2020; Rhea et al., 2019), has used a single training session study design to measure within-day effects on balance control from attentional focus cues. While these studies were important to establish the theoretical models and proof-of-concept for using an EF to enhance balance control, the next logical step is to extend this line of research into a multi-day training study design. To date, only two papers have made this leap (Landers et al., 2016). The Landers study focused on individuals with Parkinson's disease and included four groups (three underwent attentional focus strategies and one control). The overall findings suggest that attentional focus instructions did not improve balance impairment in participants with Parkinson's disease (Landers et al., 2016), raising questions about this paradigm's application as a clinical intervention. To study a shorter, more focused intervention, Diekfuss et al. (2019) had young, healthy adults complete seven consecutive days of training using a dynamic balance board with EF or IF instructions. The results showed EF can enhance balance control relative to IF (Diekfuss et al., 2019).

In the aforementioned studies, all examined motor ability as a function of attentional focus conditions. In order to transition this line of research to clinical practice, incorporating patient reported outcomes would provide a more well-rounded view of the balance intervention's efficacy. This observation, in addition to the scientific foundation from the previous balance studies, laid the foundation for the UNCG clinical trial on balance training.

UNCG Clinical Trial

A gap identified in the previous section is the use of attentional focus in a multi-session balance training program for older adults who are at an increased risk of falling, along with the inclusion of patient-reported outcomes. To address this gap, the NIH-funded clinical trial at UNCG titled “Merging attentional focus and balance training to reduce fall risk in older adults” was developed to deliver a 12-week balance training intervention with 8-weeks of follow-up assessments to test to retention. A total of 90 participants will be enrolled, with N=30 in the external focus training group, N=30 in the internal focus training group, and N=30 in the control group. Participants aged 65-90 years old who have fallen at last once in the past year are eligible to enroll. The total number of participants who have completed the study to date is N=54. All participants resided in an older adult living facility and their group assignment in the study was based on where they lived and the time of their enrollment. This design was adopted to ensure that participants in the same living facility participating in the study at the same time were not in different groups, minimizing contamination between our experimental groups. Of the N=54, 31 were assigned to the external focus (EF) group and 23 were assigned to the internal focus (IF) group.

All participants in this study complete motor ability tests and patient reported outcome surveys prior to the study (week 0) and at weeks 6, 12, 13, 16, and 20. The assessments at weeks 6 and 12 are to test to training effects and the assessments at weeks 13, 16, and 20 are to test for retention. The motor ability tests include a the BTrackS static balance test, Functional Gait Assessment (FGA), Timed Up and Go (TUG), and the Berg Balance Scale (BBS). The patient-reported outcomes include the Activities-Specific Balance Confidence Scale (ABC-6), Short Form 36 (SF36), and the Tampa Scale for Kinesiophobia (TSK).

The experimental groups (external and internal focus training groups) complete 20 minutes of balance training using wobble boards, twice per week for 12 weeks. The external focus (EF) group was instructed to "focus on keeping the board parallel to the floor", while the internal focus (IF) group was cued to "focus on keeping your feet parallel to the floor". Patient-reported outcome data for the N=54 participants who have completed the study thus far were used as preliminary data in the development of this proposal and are presented below. Only the data for the EF and IF groups are included, as there is not yet a critical mass of controls to be included in the analysis.

Preliminary Data for Patient Reported Outcomes

Figure 1 shows the ABC-6 data. At week 0, both experimental groups exhibited nearly the same values at week 0 and increased similarly at weeks 6 and 12, indicating an elevated confidence in balance control due to the training program. However, the EF group declined slightly in the retention testing through week 20, whereas the IF group continued to increase.

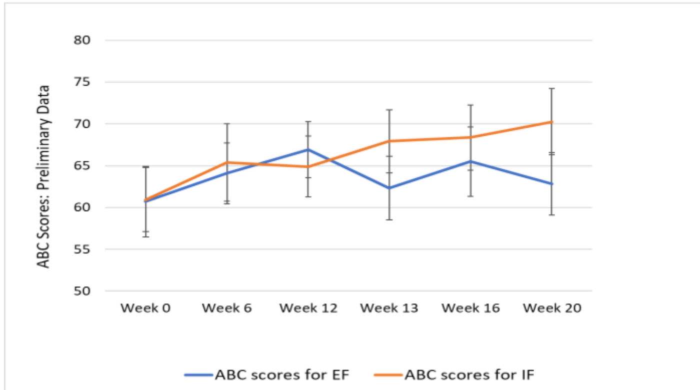

Figure 1. ABC-6 scores for the EF and IF groups across all 20 weeks of the clinical trial.

Figure 2 shows the SF-36 data across the eight dimensions. Physical function (Figure 2A) shows a group difference at week 0 that remain unchanged across the training and retention periods. Body pain (Figure 2B) began at different levels in week 0, but ended up at similar levels in week 20. Physical role (Figure 3B) shown a training effect in the IF group at week 12, but no difference if the group was observed by week 20. General health (Figure 2D) remained stable for the EF group, but declined during training for the IF group before stabilizing in week 20. Vitality showed an increase during training for both groups, but then declined during retention (Figure 2E) Social functioning (Figure 2F) and emotional role (Figure 2H) showed relatively little change across the study. Mental health (Figure 2H) increased in both groups across the training, with IF exhibiting a retained elevation of mental health at week 20.

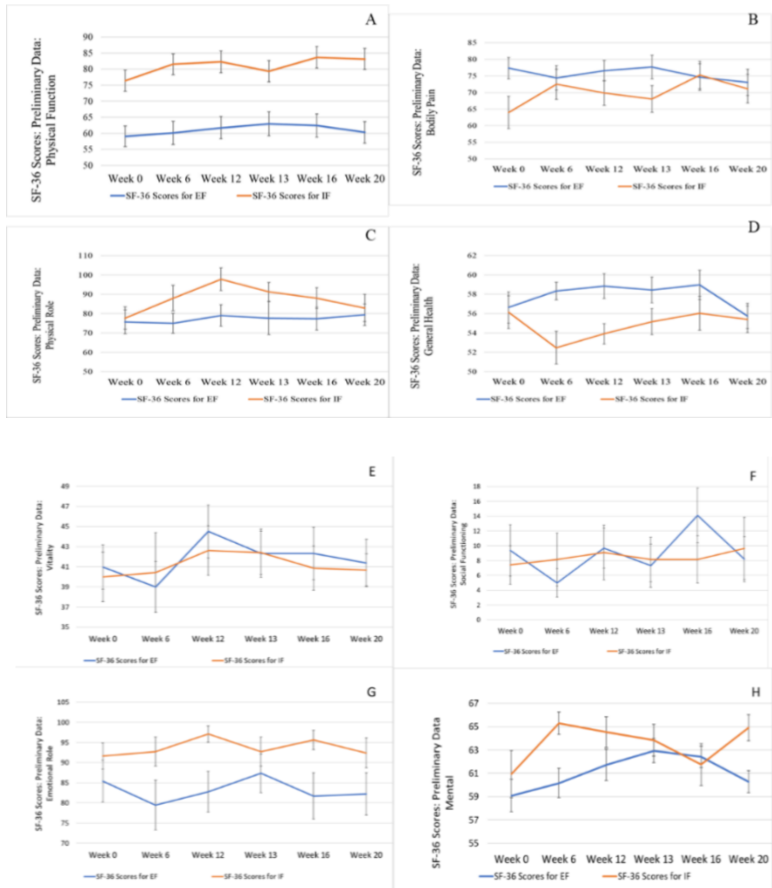

Figure 2. The eight dimensions of the SF-36 across all 20 weeks of the clinical trial.

Figure 3 shows the TSK data. The graph demonstrates that the EF group experienced a lower amount of fear within the training intervention relative to the IF group, which was retained through week 20.

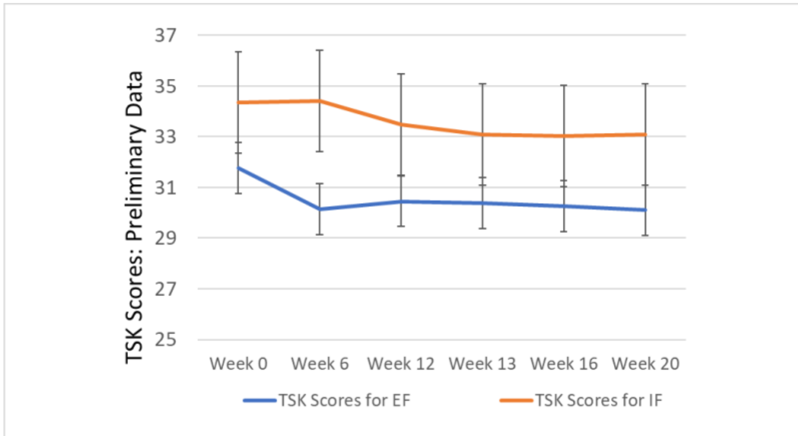

Figure 3. The TSK across all 20 weeks of the clinical trial.

CHAPTER III

METHODS

Participants

We recruited 54 individuals who previously completed our NIH clinical trial. The older adults must have met the following criteria to be in the original study: 65-90 years old, at least one fall in the past 12 months, medical clearance from their physician to participate, the ability to independently walk for 10 minutes consecutively, not score in the "impaired" range on the Mini-Mental State Exam, no diagnosis of a neurological disorder, no visual impairment of 20/70 or worse, a body mass index <30, and no acute medical problems, including musculoskeletal based impairments that lead to pain or discomfort. Demographic data of these 54 participants are presented in Table 1. The sex, age, height, and weight characteristics of participants assigned to each group are presented in Table 2.

Table 1. Demographic Characteristics of Sample

	n **= 54**	
	n	(%)
Sex		
Male	17	31.5
Female	37	68.5
Ethnicity		
Non-Hispanic White	51	94.4
African American	1	1.9
Latino	0	0
East Asian or Asian American	0	0
South Asian or Indian American	0	0
Middle Eastern	1	1.9
Native American or Alaskan Native	0	0
Other	0	0
Declined to answer	1	1.9
Highest Level of Education		0
Did not attend school	0	0
Grade School (through) 8th Grade	0	0
Graduated from High School or received GED	3	5.6
Received Associates Degree	5	9.3
Bachelors Degree	27	50.0
Completed Graduate or Professional School	18	33.3
Declined to answer	1	1.9
Average Household Income (during last 3 year before retirement)		
$0 – 24,999	1	1.9
$25,000 – 49,999	8	14.8
$50,000 – 74,999	8	14.8
$75,000 – 99,999	8	14.8
$100,000 – 124,999	5	9.3
$125,000 – 149,999	2	3.7
$150,000 – 174,999	2	3.7
$175,000 – 199,999	0	0
$200,000 and up	6	11.1
Declined to answer	14	25.9

Note. Data are reported as n and percent of total sample.

Table 2. Characteristics of Intervention Groups								
		External Focus (*n* =31)			Internal Focus (*n* =23)			*p*
Sex	Male (*n*)	8			9			
	Female (*n*)	23			14			
Age (years)		80.71	±	6.03	80.7	±	6.39	0.993
Height (cm)		165	±	10.5	164.94	±	12.07	0.984
Weight (kg)		67.97	±	13.16	69.87	±	16.82	0.644
Note. Values are reported as mean ± SD.								

Experimental Design/Procedure

Following approval from the UNCG IRB, the 54 participants from a previous NIH balance project were contacted via phone or email about our follow-up study. If interested, the participant received information about the study and was asked to be a part of the research. If so, they were given the option to complete the study form electronically (via Qualtrics) or on paper. If the electronic option was selected, they provided their email address and a window of time they are available to complete the study forms. If the paper option is selected, the forms were mailed in a sealed envelope which included a pre-stamped and pre- addressed envelope they returned to the PI. The informed consent form was not deemed important to the IRB due to contactless and questionnaire format. The study forms included a detailed health and physical activity history, updated fall profile, and the ABC-6 (Appendix A), SF-36 (Appendix B), and the TSK (Appendix C).

Statistical Analyses

The primary question of interest is the extent to which patient-reported outcomes are retained over an extended period of time (>6 months). However, that information is contextual relative to the change in the patient reported outcomes over the duration of the original study. Thus, we included week 20 (end of retention) with our new data time point (extended retention) to address our research question. We used a repeated measures ANCOVA for each metric of interest, with time (week 20, and extended retention) as the within subjects variable training group (external or internal focus) as the between-subjects variable. The covariate of time since completing the study was included in the model. If a time by group interaction is observed, a follow-up Bonferroni corrected paired-samples t-tests will be used to explore the differences across groups and time points.

CHAPTER IV

MANUSCRIPT

Introduction

Falls are the leading cause of fatal and non-fatal injuries among adults ages 65 and older (Bergen et al., 2016; Verma et al., 2016). Older adults are at a higher risk of falls due to physiological and psychological factors associated with natural aging (Razmara et al., 2018; Tiedemann et al., 2005). Balance control—which changes across the lifespan—is important to prevent falling and avoiding injury. A fall will occur when the individual's center of mass (COM) goes outside of the base of support (BOS) (Winter et al., 1998) and training programs have been utilized to enhance older adults control of balance to reduce fall risk (Pizzigalli et al., 2016; Beling et al., 2009).

As humans age, the ability to exhibit corrective balance actions becomes more challenging—especially after 65 years of age—due to a decline in muscle strength, reaction time, visual acuity, and related factors (Ambrose et al., 2013; Bergland, 2012; Rubenstein, 2006). What is less understood is the contribution of psychological aspects to fall-risk. Despite the potential benefit of balance training attentional focus balance training, only a couple studies have incorporated attentional focus as part of their multi-session balance training program (Diekfuss et al., 2019; Landers et al., 2016). This observation set the foundation for the NIH funded clinical trial at UNCG titled "Merging attentional focus and balance training to reduce fall risk in older adults", examining the extent to which a 12-

week attentional focus balance training intervention may enhance balance and reduce fall-risk.

Attentional focus balance training demonstrates improvements in the external group opposing to the internal group (Kim et al., 2017; Park et al., 2015). The dichotomy between an external and internal focus of attention has been well studied in motor tasks and it has been repeatedly shown that an external focus of attention can enhance motor control and learning (Wulf & Weigelt, 1997; Wulf et al., 2001, 2003; Wulf, 2013; Wulf & Lewthwaite, 2016). Relative to balance, a recent meta-analysis showed that an external focus of attention results in enhanced learning of balance tasks compared to an internal focus (Kim et al., 2017).

Patient-reported outcomes can be impacted by the participant's self-perception of health and quality of life. The Activities of Balance Confidence (ABC) Scale is geared towards community dwelling adults. The shorter version (ABC-6) has been used to assess persons with Parkinson's disease (Maki & McIlroy, 2006), stroke (Botner, 2005), TBI (Inness et al., 2011), and vestibular disorders (Legters et al., 2005). For older adult fall risk, scores less than 67 indicates a risk of falling (Lajoie & Gallagher, 2004; Landers et al., 2016). While confidence is a fall-risk factor, fear of pain due to movement—termed kinesiophobia—has also connected to fear of falling or reinjury (Erden & Güner, 2018). The Tampa Scale for Kinesiophobia (TSK) was originally developed for persons with back pain (Miller et al., 1991), but has since been used in broader populations Lundberg et al., 2009). Older adults mostly report falls that involve activities of daily living (ADLs), for which the TSK is a viable tool to assess kinesiophobia in such movements. The TSK total score is the sum from the 17 questions that range from 17 (no kinesiophobia) to 68 (high-level fear of pain with movement). Lastly, the SF-36 is a 36-item patient reported health questionnaire that includes eight scaled scores, which are the weighted sums of the questions in their section (Ware & Sherbourne, 1992). Each of the eight scaled scores (i.e., dimensions) are directly transformed into a 0-100 scale, with a lower score indicating a lower rating on that dimension. The eight scaled scores consist of**:** (1) physical functioning, (2) physical role, (3) bodily pain, (4) general health perceptions, (5) vitality, (6) emotional role functioning, (7) mental health, and (8) social functioning. The SF-36 has been widely used and has been shown to be an excellent psychological assessment a variety of settings. This assessment is beneficial in healthcare to provide insightful measures of those individuals that are being clinically accessed (Brazier et al., 1992). Fall risk older adults commonly report scores that are impacted by recent injuries and low scores on the 36-Short Form health survey (SF-36) are related to low self-efficacy. Low scores indicate increased risk of falling and ability to perform ADLs (Ware et al., 1999).

The purpose of this study was to examine the extent to which patient reported outcomes were retained over an extended period of time following a 12-week attentional focus balance training program. The potential extended retention (>6 months) of patient-reported outcomes is outside the scope of the original clinical trial, but it is the focus of this study. Participants from the UNCG clinical trial were recruited to enroll in this follow-up study and asked to complete the same patient-reported outcomes used in the original study. The new data and data from the original study were combined to examine the extent to which patient-reported outcomes were retained over an extended period of time (>6 months). It was hypothesized that elevations in the patient reported outcomes observed at the 8-week retention test (relative to baseline and differentiated by attentional focus group) would remain elevated in the extended (>6 month) retention test.

Methods

Participants

All participants who completed the UNCG NIH clinical trial (N=54) were contacted and asked if they would like to enroll in the current study. Of the original participants, 33 participants (82.39 ±6.25 years; M=7, F=26) agreed to re-enroll and complete the extended retention study. Demographic data of these 33 participants are presented in Table 3 The sex, age, height, and weight characteristics of participants assigned to each group are presented in Table 4.

Table 3 Demographic Characteristics of Re-Enrolled Sample

	***n* = 33**	
	n	(%)
Sex		
Male	7	21.2
Female	26	78.8
Ethnicity		0.0
Non-Hispanic White	33	100.0
African American	0	0.0
Latino	0	0.0
East Asian or Asian American	0	0.0
South Asian or Indian American	0	0.0
Middle Eastern	0	0.0
Native American or Alaskan Native	0	0.0
Other	0	0.0
Declined to answer	0	0.0
Highest Level of Education		0.0
Did not attend school	0	0.0
Grade School (through) 8th Grade	0	0.0
Graduated from High School or received GED	3	9.1
Received Associates Degree	1	3.0
Bachelors Degree	19	57.6
Completed Graduate or Professional School	10	30.3
Declined to answer	0	0.0
Average Household Income (during last 3 year before retirement)		0.0
$0 – 24,999	1	3.0
$25,000 – 49,999	6	18.2
$50,000 – 74,999	6	18.2
$75,000 – 99,999	4	12.1
$100,000 – 124,999	2	6.1
$125,000 – 149,999	0	0.0
$150,000 – 174,999	2	6.1
$175,000 – 199,999	0	0.0
$200,000 and up	4	12.1
Declined to answer	8	24.2

Note. Data are reported as n and percent of total sample.

Table 4 Characteristics of Re-Enrolled Intervention Groups

		External Focus (*n* =19)			Internal Focus (*n* =14)		
Sex	Male (*n*)	3			4		
	Female (*n*)	16			10		
Age (years)		87.88	±	6.15	82.4	±	6.44
Height (cm)		164.91	±	7.738	163.99	±	11.39
Weight (kg)		61.92	±	17.985	66.43	±	18.64

Note. Values are reported as mean ± SD.

Experimental Design/Procedure

Following approval from the UNCG IRB, 54 participants were contacted via phone or email about re-enrolling in this study. A total of N=33 participants were interested. They received information about the study and was asked to be a part of the research. Participants were given the option to complete the study form electronically (via Qualtrics) or on paper. If the electronic option was selected, they provided their email address and a window of time they were available to complete the study forms. If the paper option is selected, the forms were mailed in a sealed envelope, which included a pre-stamped and pre-addressed envelope they returned to the research team. The informed consent form was not deemed necessary to the IRB due to contactless and questionnaire format. The study forms included a detailed health and physical activity history, updated fall profile, and the ABC-6 (Appendix A), SF-36 (Appendix B), and the TSK (Appendix C).

Statistical Analyses

The primary question of interest is the extent to which patient-reported outcomes are retained over an extended period of time (>6 months). However, that information is contextual relative to the change in the patient reported outcomes over the duration of the original study. Thus, we included week 20 (end of retention) with our new data time point (extended retention) to address our research question. We used a repeated measures ANCOVA with 2 time points (20 week vs. extended retention) as the within subjects variable and training group [(external focus (EF) or internal focus (IF)] as the between-subjects variable. The covariate of time (in weeks) since completing the study was included in the model. Additionally, Cohen's *d* was used to examine effect size differences between the groups at week 20 and at extended.

Results

The time between when participants completed the clinical trial and enrolled in this extended retention study was not different between groups (EF=84.2±24.8 weeks; IF=88.2±24.2 weeks), $t(31)=.455$, $p=.652$. However, given the variance in the time since study completion within each group, this variable was used as a covariate in the analyses. Means and standard errors for the ABC (Figure 4), TSK (Figure 5) and SF36 (Figure 6) are presented below.

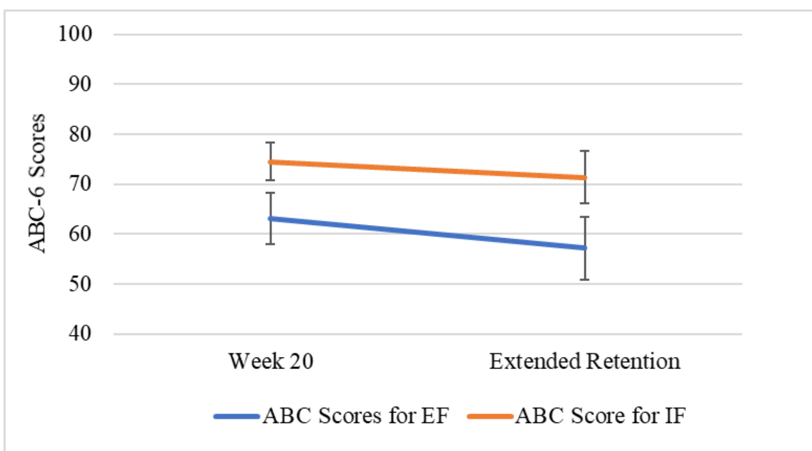

Figure 4. ABC-6 scores for the EF and IF groups at week 20 and extended retention.

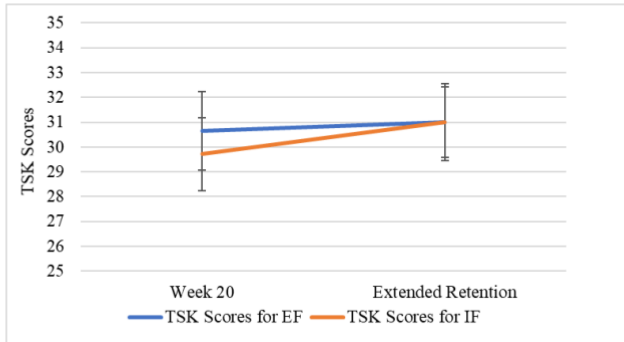

Figure 5: TSK scores for EF and IF at week 20 and extended retention.

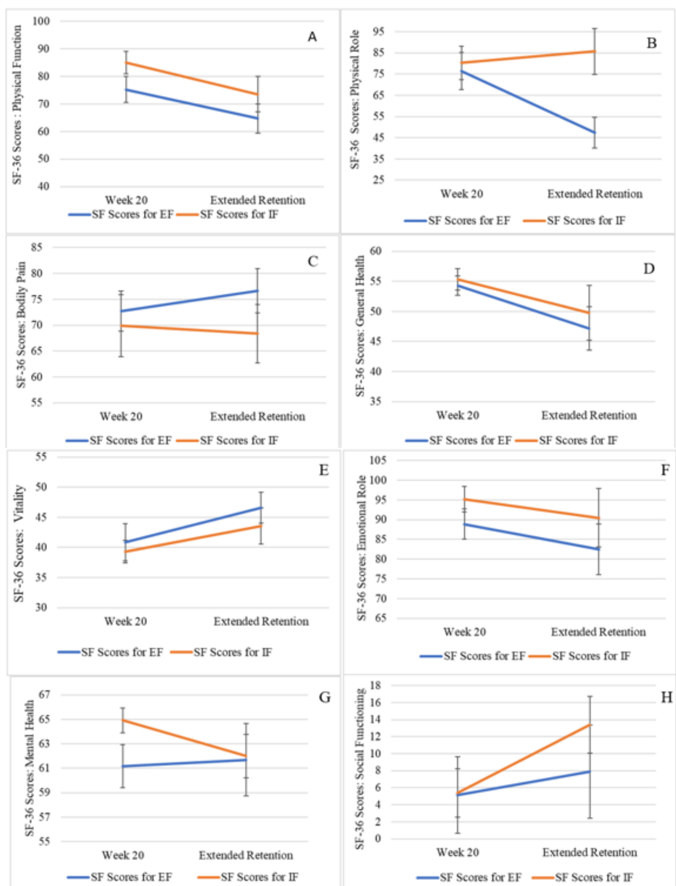

Figure 6: All eight dimensions SF-36 scores for EF and IF at week 20 and extended retention.

The *F*-statistics for the group × time interaction and main effects are presented in Table 5. The findings indicate a significant group × time interaction for SF-36 Physical Role, $F(1,28)=5.301$, $p=.029$, $n_p^2<.159$. No other significant interactions or main effects were observed.

Table 5 F-statistics for the interaction and main effects for each dependent variable with covariate of time since study completion included in the model.

Dependent Variable	Group × time interaction	Group main effect	Time main effect
ABC-6	$F(1,29)=0.012$, $p=.913$, $n_p^2<.001$	$F(1,29)=2.840$, $p=.103$, $n_p^2=.089$	$F(1,29)=0.760$, $p=.390$, $n_p^2=.026$
TSK	$F(1,28)=0.007$, $p=.933$, $n_p^2<.001$	$F(1,28)=0.240$, $p=.628$, $n_p^2=.009$	$F(1,28)=0.066$, $p=.799$, $n_p^2=.002$
SF-36 Physical Functioning	$F(1,29)<0.001$, $p=.983$, $n_p^2<.001$	$F(1,29)=1.979$, $p=.170$, $n_p^2=.064$	$F(1,29)<0.001$, $p=.996$, $n_p^2<.001$
SF-36 Physical Role	$F(1,28)=5.301$, $p=.029$, $n_p^2<.159$	$F(1,28)=4.737$, $p=.038$, $n_p^2=.145$	$F(1,28)=3.669$, $p=.066$, $n_p^2=.116$
SF-36 Body Pain	$F(1,27)=0.178$, $p=.676$, $n_p^2<.007$	$F(1,27)=0.670$, $p=.420$, $n_p^2=.024$	$F(1,27)<0.001$, $p=.991$, $n_p^2<.001$
SF-36 General Health	$F(1,27)=0.548$, $p=.466$, $n_p^2<.020$	$F(1,27)=0.668$, $p=.421$, $n_p^2=.024$	$F(1,27)=2.95$, $p=.100$, $n_p^2<.097$
SF-36 Vitality	$F(1,28)=0.200$, $p=.658$, $n_p^2<.007$	$F(1,28)=0.696$, $p=.411$, $n_p^2=.024$	$F(1,28)=.061$, $p=.806$, $n_p^2=.002$
SF-36 Emotional Role	$F(1,29)=0.158$, $p=.694$, $n_p^2=.005$	$F(1,29)=1.522$, $p=.227$, $n_p^2=.050$	$F(1,29)=1.898$, $p=.179$, $n_p^2=.061$
SF-36 Mental Health	$F(1,27)=0.432$, $p=.517$, $n_p^2<.016$	$F(1,27)=1.391$, $p=.249$, $n_p^2=.049$	$F(1,27)=0.110$, $p=.743$, $n_p^2<.004$
SF-36 Social Functioning	$F(1,28)=1.104$, $p=.302$, $n_p^2<.038$	$F(1,28)=0.868$, $p=.359$, $n_p^2=.030$	$F(1,28)=2.505$, $p=.125$, $n_p^2=.082$

We also ran Cohen's *d* due to the small sample size of this study. The effect sizes for between group comparisons are in Table 6. In week 20 and at extended retention, the ABC-6 showed a medium effect size. SF-Physical Functioning showed a medium effect in week 20, with a slight decrease at extended retention. SF-Physical Role demonstrated an extreme large effect size at extended retention, but was driven by unusual, but valid, responses. SF-Mental Health showed a large effect size in week 20.

Table 6 Effect sizes (Cohen's d) between groups		
	Week 20	Extended retention
ABC-6	0.61	0.60
TSK	0.16	0.00
SF-36 Physical Functioning	0.55	0.38
SF-36 Physical Role	0.12	0.99
SF-36 Body Pain	0.14	0.41
SF-36 General Health	0.17	0.16
SF-36 Vitality	0.16	0.27
SF-36 Emotional Role	0.44	0.29
SF-36 Mental Health	0.70	0.03
SF-36 Social Functioning	0.01	0.32

Discussion

The purpose of this study was to examine the extent to which patient-reported outcomes are retained over an extended period of time following a 12-week attentional focus balance training program. The new data and data from the final timepoint in the clinical trial (week 20) were combined to examine the extent to which patient-reported outcomes were retained over an extended period of time (>6 months). It was hypothesized that elevations in the patient reported outcomes observed at the last assessment timepoint (week 20 and differentiated by attentional focus group) would remain elevated relative at their extended retention timepoint. Our hypotheses were generally not supported, as the ABC-6, TSK, and seven out of eight SF-36 variables did not show a significant group × time interaction nor a group or time main effect.

The ABC-6 provides a measurement of confidence in completing certain balance tasks that are challenging activities within daily living (Peretz et al., 2006). There are 3 levels of physical functioning in relation to older adults. High functioning individuals score

>80, moderate functioning is 50-80, and low functioning is anything <50. The sub-scores that are in the low functioning groups completing the ABC-6 represent a decline of balance confidence, which is associated with fall-risk and how impactful balance confidence correlates with rate of falling (Myers et al., 1998). In the new data of this thesis, we measured the ABC-6 during extending retention period; in Figure 4 it demonstrates the scores between groups and time-points. This approach of extending retention can help provide more insight on retention after a balance study. In the findings, ABC-6 was non-significant in the group × time interaction and main effects. However, due to small sample size we ran Cohen's *d* (Table 2.2) to analyze the effect size and the findings indicate a medium effect between groups in week 20 and at extended retention. This effect size at both timepoints was driven by the IF group consistently scoring higher on the ABC-6 relative to the EF group, which is the opposite of the hypothesis of the original study. With previous work showing that EF facilitates better balance (Kim et al., 2017), it was expected that the EF group would exhibit higher ABC-6 scores in the 20 week retention test of the original study and that group difference would be observed in our extended retention timepoint. The finding that the EF group scored ~10 points lower than the IF group at both timepoints warrants further investigation into why this group difference was consistently shown. The finding that a decline in SF-36 for both groups was observed from week 20 to extended retention is to be expected, as the participants were no longer participating in a twice/week balance training program. However, it should be noted that the scores for both groups were within the moderate functioning range at both timepoints, suggesting that the long duration since completing the balance training program did not cause them to drop

into low functioning status.

In a recent study, there was a positive correlation between kinesiophobia and the risk of falling (Erden & Güner, 2018). The TSK can also help determine the risks that correlate with quality of life in older adults (Milenkovic et al., 2015). The fear of pain and reinjury is prevalent in aging adults and has negative effects on health expectancies (Jo et al., 2019). Falls are prevalent in the older community and the fear of falling again can raise awareness of a decline in balance/postural control. Meanwhile, the promotion of quality of life is important for overall well-being in older adults. Recognizing the psychological factors that are involved in kinesiophobia will allow clinical preventative measures to be accessed. In the follow-up extended retention study, we accessed TSK in relation to fall risk and the lower scores relating to fear of falling or reinjury. In Figure 5, it demonstrates the scores between groups and time point and the EF and IF result in similar scores at extended retention. The F-statistics (Table 5) findings indicated that the TSK showed no group by time interaction nor time effect. Since our sample size was small, we also examined group differences with Cohen's *d* (Table 6) for effect sizes. The TSK has a small-to-nonexistant effect size between the groups, suggesting that the EF and IF groups exhibited similar kinesiophobia at week 20 and extended retention.

In the SF-36, recent literature indicates that low scores indicate low self-efficacy in relation to falls, and with low self-efficacy indicates increased risk of falling in those individuals (Ozcan et al., 2005; Suzuki et al., 2002). Inversely, higher scores on the SF-36 indicate healthy individuals with low risk of falling (Brazier et al., 1992). The two groups (EF vs IF) and the time (week 20 and extended retention) were analyzed over the scores received in each of the eight dimensions of the SF-36. Figure 6 shows the SF-36 data across the eight dimensions. Physical function (Figure 6A) at week 20 through extended retention period remains unchanged. Physical role (Figure 6B) showed a decline in the EF group week 20 to the extended retention, but for the IF group it demonstrated a slight increase in scores over the extended retention period. Body pain (Figure 6C) began at different levels in week 20 and diverged in the extended retention, with EF increasing. General health (Figure 6D) remained in a constant rate of decline for both groups. Vitality (Figure 6E) showed an increase during the extended retention from week 20 for both groups. Emotional role (Figure 6F) showed a constant decline downwards at extended retention. Mental health (Figure 6G) began at different points, but the two groups both declined to similar levels at extended retention. Social functioning (Figure 6H) demonstrated an upward increase from week 20 to extended retention, with IF increasing at a greater rate. Seven of the eight dimensions had non-significant interaction or main effects. Only physical role exhibited an interaction, $F(1,28)=5.301$, $p=.029$, $n_p^2<.159$, which was driven by unusual, by valid, responses from the external focus group reporting an increase in physical limitations in the extended retention test. Collectively, the inferential statistics and effect size comparisons showed relatively little group differences from week 20 to extended retention.

There were a few limitations of this study. First, this is all self-reported data from the re-enrolled participants from the previous study. In being self-reported, the copies had to be 100% contactless due to COVID-19, with the survey packets mailed back to the sender and some participants left certain questions blank. In the previous study, the onsite researchers ensured that the participants had all their questions answered and no blanks in the response. However, in this study the patient reported outcomes were completed in the comfort of their home, which did not afford double checking of complete responses. Another limitation was the amount comprehension of a certain questions. If the participant did not quite understand what was being asked, they did not ask a researcher to clarify (even though they were provided a phone number to call in this situation). Lastly, the small sample size makes it difficult to generalize our results to the broader population.

In conclusion, patient-reported outcomes can provide useful information from the participants perspective. This will allow participants to reflect on their overall changes in physical, mental, social, and overall well-being aspects after completing a balance training program. Measuring extended retention can contribute to long-term benefits after completing any program. The data showed that the external focus group reported an increase in physical limitations in the extended retention test. For the effect size data, a medium effect between groups was reported at the 20-week and extended retention timepoints for the ABC-6 and the SF-36 physical functioning dimension, suggesting that some group-level differences that existed after the clinical trial persisted at the extended retention timepoint. Collectively, these data show that some patient-reported outcomes can be retained long after an attentionally focused balance training intervention.

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APPENDIX A

ABC-6 FORM

The Short Activities-specific Balance Confidence (ABC-6) Scale

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

0% 10 20 30 40 50 60 70 80 90 100%
no confidence completely confident

"How confident are you that you will not lose your balance or become unsteady when you…

1. …stand on your tiptoes and reach for something above your head? ____%
2. …stand on a chair and reach for something? ____%
3. …are bumped into by people as you walk through the mall?____%
4. … step onto or off an escalator while you are holding onto a railing? ____%
5. … step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? ____%
6. …walk outside on icy sidewalks? ____%

* Peretz, C., Herman, T., Hausdorff, J.M., Giladi, N., 2006. Assessing fear of falling: can a short version of the Activities-specific Balance Confidence scale be useful? Mov. Disord. 21, 2101–2105.

APPENDIX B

SF-36 FORM

SF-36 QUESTIONNAIRE

Name:___________________ **Ref. Dr:**__________________ **Date:** _______

ID#: ______________ **Age:** _______ **Gender: M / F**

Please answer the 36 questions of the **Health Survey** completely, honestly, and without interruptions.

GENERAL HEALTH:
In general, would you say your health is:
◯ Excellent ◯ Very Good ◯ Good ◯ Fair ◯ Poor

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
◯ Somewhat worse now than one year ago
◯ Much worse than one year ago

LIMITATIONS OF ACTIVITIES:
The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.
◯ Yes, Limited a lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf
◯ Yes, Limited a Lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Lifting or carrying groceries
◯ Yes, Limited a Lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Climbing several flights of stairs
◯ Yes, Limited a Lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Climbing one flight of stairs
◯ Yes, Limited a Lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Bending, kneeling, or stooping
◯ Yes, Limited a Lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Walking more than a mile
◯ Yes, Limited a Lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Walking several blocks
◯ Yes, Limited a Lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Walking one block
◯ Yes, Limited a Lot ◯ Yes, Limited a Little ◯ No, Not Limited at all

Bathing or dressing yourself
◯Yes, Limited a Lot ◯Yes, Limited a Little ◯No, Not Limited at all

PHYSICAL HEALTH PROBLEMS:
During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

Cut down the amount of time you spent on work or other activities
◯Yes ◯No

Accomplished less than you would like
◯Yes ◯No

Were limited in the kind of work or other activities
◯Yes ◯No

Had difficulty performing the work or other activities (for example, it took extra effort)
◯Yes ◯No

EMOTIONAL HEALTH PROBLEMS:
During the past 4 weeks, 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)?

Cut down the amount of time you spent on work or other activities
◯Yes ◯No

Accomplished less than you would like
◯Yes ◯No

Didn't do work or other activities as carefully as usual
◯Yes ◯No

SOCIAL ACTIVITIES:
Emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

◯Not at all ◯Slightly ◯Moderately ◯Severe ◯Very Severe

PAIN:
How much bodily pain have you had during the past 4 weeks?

◯None ◯Very Mild ◯Mild ◯Moderate ◯Severe ◯Very Severe

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

ENERGY AND EMOTIONS:
These questions are about how you feel and how things have been with you during the last 4 weeks. For each question, please give the answer that comes closest to the way you have been feeling.

Did you feel full of pep?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you been a very nervous person?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you felt so down in the dumps that nothing could cheer you up?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you felt calm and peaceful?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Did you have a lot of energy?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you felt downhearted and blue?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Did you feel worn out?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you been a happy person?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Did you feel tired?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

SOCIAL ACTIVITIES:
During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

- All of the time
- Most of the time
- Some of the time
- A little bit of the time
- None of the Time

GENERAL HEALTH:
How true or false is each of the following statements for you?

I seem to get sick a little easier than other people
○Definitely true ○Mostly true ○Don't know ○Mostly false ○Definitely false

I am as healthy as anybody I know
○Definitely true ○Mostly true ○Don't know ○Mostly false ○Definitely false

I expect my health to get worse
○Definitely true ○Mostly true ○Don't know ○Mostly false ○Definitely false

My health is excellent
○Definitely true ○Mostly true ○Don't know ○Mostly false ○Definitely false

APPENDIX C

TSK FORM

Tampa Scale for Kinesiophobia

(Miller , Kori and Todd 1991)

1 = strongly disagree
2 = disagree
3 = agree
4 = strongly agree

1. I'm afraid that I might injury myself if I exercise	1	2	3	4
2. If I were to try to overcome it, my pain would increase	1	2	3	4
3. My body is telling me I have something dangerously wrong	1	2	3	4
4. My pain would probably be relieved if I were to exercise	1	2	3	4
5. People aren't taking my medical condition seriously enough	1	2	3	4
6. My accident has put my body at risk for the rest of my life	1	2	3	4
7. Pain always means I have injured my body	1	2	3	4
8. Just because something aggravates my pain does not mean it is dangerous	1	2	3	4
9. I am afraid that I might injure myself accidentally	1	2	3	4
10. Simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening	1	2	3	4
11. I wouldn't have this much pain if there weren't something potentially dangerous going on in my body	1	2	3	4
12. Although my condition is painful, I would be better off if I were physically active	1	2	3	4
13. Pain lets me know when to stop exercising so that I don't injure myself	1	2	3	4
14. It's really not safe for a person with a condition like mine to be physically active	1	2	3	4
15. I can't do all the things normal people do because it's too easy for me to get injured	1	2	3	4
16. Even though something is causing me a lot of pain, I don't think it's actually dangerous	1	2	3	4
17. No one should have to exercise when he/she is in pain	1	2	3	4

Scoring Information
Tampa Scale for Kinesiophobia
(Miller et al 1991)

A total score is calculated after inversion of the individual scores of items 4, 8, 12 and 16.

APPENDIX D

TABLE 1 APPENDIX

Table A1. F-statistics for the interaction and main effects for each dependent variable.

Dependent Variable	Group × time interaction	Group main effect	Time main effect
ABC-6	F (1,30)=0.023, p =.879, n_p^2=.001	F (1,30)=2.982, p =.094, n_p^2=.090	F (1,30)=1.136, p =.295, n_p^2=.036
TSK	F (1,29)=0.008, p =.930, n_p^2<.001	F (1,29)=0.201, p =.657, n_p^2=.007	F (1,29)=1.618, p =.213, n_p^2=.053
SF-36 Physical Functioning	F (1,30)=0.006, p =.939, n_p^2<.001	F (1,30)=2.104, p =0.157, n_p^2=.066	F (1,30)=8.313, p =.007, n_p^2=.217
SF-36 Physical Role	F (1,29)=5.283, p =.029, n_p^2<.154	F (1,29)=4.858, p =.036, n_p^2=.143	F (1,29)=2.707, p =.111, n_p^2=.085
SF-36 Body Pain	F (1,28)=0.187, p =.669, n_p^2<.007	F (1,28)=0.549, p =.465, n_p^2=.019	F (1,28)=0.001, p =.976, n_p^2<.001
SF-36 General Health	F (1,28)=0.223, p =.640, n_p^2<.008	F (1,28)=0.427, p =.519, n_p^2=.015	F (1,28)=6.175, p =.019, n_p^2<.181
SF-36 Vitality	F (1,29)=0.198, p =.660, n_p^2<.007	F (1,29)=0.742, p =.396, n_p^2=.025	F (1,29)=4.787, p =.037, n_p^2=.142
SF-36 Emotional Role	F (1,30)=0.071, p =.791, n_p^2=.002	F (1,30)=1.508, p =.229, n_p^2=.048	F (1,30)=1.512, p =.228, n_p^2=.048
SF-36 Mental Health	F (1,28)=0.422, p =.521, n_p^2<.015	F (1,28)=1.458, p =.237, n_p^2=.050	F (1,28)=0.422, p =.521, n_p^2<.015
SF-36 Social Functioning	F (1,29)=0.997, p =.326, n_p^2<.033	F (1,29)=0.911, p =.348, n_p^2=.030	F (1,29)=1.439, p =.240, n_p^2=.047