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Assessing the risk of falling in adults one-year after total hip arthroplasty

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Abstract

The purpose of this study was to examine falls prevalence, falls risk factors and knowledge of falls in individuals who have undergone a total hip arthroplasty. There were 135 patients examined at their one-year follow-up appointment for total hip arthroplasty. Our primary outcome, falls prevalence and falls circumstances, found a falls prevalence of 21.5% with identical circumstances to that of average community-dwelling older adults. Female sex, number of prescription medications and multiple joint replacements were found to be significantly associated with the occurrence of falls in the previous year. The Falls Risk for Older People in a Community Setting Questionnaire found an overall mild falls risk classification among participants. However, participants had lower scores on the Timed-Up-and-Go test, the Step Test, and 30-Second Chair Stand Test compared to normative values in community-dwelling older adults. These results indicated physical deficits that can be associated with an increased risk of falling.

Keywords: Total hip arthroplasty, falls, osteoarthritis, older adults

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List of Abbreviations

ABC: Activities-specific Balance Confidence Scale
ADL: Activities of Daily Living
BMI: Body Mass Index
CAD: Canadian Dollars
CI: Confidence Interval
CRR: Corrected Response Rate
DA: Direct Anterior
DL: Direct Lateral
DTCcog: Cognitive dual-task cost
DTCgait: Gait dual-task cost
FROP-Com: Falls Risk for Older People in a Community Setting
HHS: Harris Hip Score
iADL: Instrumental Activities of Daily Living
ICC: Intraclass Correlation Coefficient
LCFN: Lateral Cutaneous Femoral Nerve
MCS: Mental Composite Score
MDC: Minimal Detectable Change
MoCA: Montreal Cognitive Assessment
OA: Osteoarthritis
PCS: Physical Composite Score
POD: Post-Operative Day
ProFaNE: The Prevention of Falls Network Europe Working Group
QoL: Quality of Life
ROM: Range of Motion
SF-12: Short-Form 12 Survey
TFL: Tensor Fascia Latae
TUG: Timed Up-and-Go Test
THA: Total Hip Arthroplasty
TKA: Total Knee Arthroplasty
WOMAC: Western Ontario and McMaster Osteoarthritis Index
30CST: 30-Second Chair Stand Test

Chapter 1: Literature Review

1.1 Introduction

Falls in older adults are a significant public health problem, as such many countries have focused efforts on the development of fall prevention and fall screening strategies.[1] There are many known risk factors for falls that must be considered when screening for falls. Osteoarthritis, a painful, degenerative joint disease, has been identified as an important risk factor for falls in older adults and results in several physical deficits that can contribute to falls.[2,3] Total joint replacement procedures, such as total hip arthroplasty (THA) and total knee arthroplasty (TKA), are often used to treat severe osteoarthritis of the hip and knee, respectively. Both THA and TKA are effective treatments resulting in substantial improvement in function and quality of life (QoL), as well as pain reduction.[4,5]

Despite the effectiveness of both THA and TKA in alleviating the pain associated with osteoarthritis, there has been limited research examining if these interventions diminish the risk of falling in this population, as the majority of surgeries are performed in older adults. Previous research has shown that undergoing a TKA procedure results in functional deficits that would be predicted to increase the risk of falling, including impaired lower extremity proprioception and reduced lower extremity strength.[6,7] Functional deficits in balance, lower extremity strength and gait are also present after THA and would be expected to increase falls risk.[8] In 2014, Matsumoto et al.[7] was able to demonstrate that falls risk was increased in people after TKA as a result of knee pain and reduced range of motion (ROM). Despite this evidence of a potentially increased falls risk in older adults having undergone TKA, there is limited research documenting falls risk in older adults following THA. As older adults constitute the majority of people undergoing THA, it is important to assess falls risk among this population.

1.2 Anatomy of the Hip

The hip joint is a multi-axial ball and socket joint designed for stability and weight-bearing. The joint is a synovial articulation between the rounded head of the femur and the acetabulum of the pelvis. It is one of the most stable articular structures in the human body and can withstand forces of up to seven times bodyweight.[9] A wide range of motion occurs at the hip joint,

including: flexion, extension, abduction, adduction, internal and external rotation as well as circumduction.[10]

The acetabulum is formed by the three components of the pelvis: the ischium, ilium and pubis. The rim of the acetabulum is raised slightly by a fibrocartilaginous collar known as the acetabular labrum, which assists in deepening the socket to prevent joint dislocation. The acetabular labrum is C-shaped, being bridged inferiorly by the transverse acetabular ligament with the center free for the acetabular fossa – the depression is occupied by the ligament of the head of the femur. The acetabulum articulates with the head of the femur, which is completely covered in hyaline cartilage except for the fovea through which the ligamentum teres runs. This ligament carries a small branch of the obturator artery and assists in blood supply to the head of the femur.[10] The hip joint is covered by a strong, thick fibrous membrane. The membrane is then surrounded by the illiofemoral, ischiofemoral and pubofemoral ligaments that help stabilize the joint.

Twenty-one muscles act on the hip joint, dynamically reinforcing joint stability and providing joint mobility.[11] The muscles are grouped according to their role in mobility as flexors, adductors, extensors, external rotators and abductors.[9] These muscles and their function at the hip joint are presented in Table 1.1.

Table 1.1 List of muscles that act at the hip joint, classified by motor function.

Muscle Groups		
Hip Flexors Pectineus Iliacus Psoas Sartorius Rectus Femoris	*Hip Extensors* Adductor Magnus Gluteus Maximus Gluteus Maximus Biceps Femoris Semitendenosous Semimembranosous	*Hip Adbuctors* Piriformis Glutues Medius Glutues Minimus Tensor Fascia Latae (TFL)
Hip Adductors Adductor Brevis Adductor Longus Gacilis Adductor Magnus	*Hip External Rotators* Obturator Internus Gemellus Superior Gemellus Inferior Quadratus Femoris Piriformis	

1.3 Osteoarthritis of the Hip

Osteoarthritis (OA) is a chronic, degenerative joint disease that commonly affects the weight-bearing joints of the lower extremity; specifically, the hip and knee. As a result of OA, a joint undergoes several changes including weakened ligaments, severe joint space narrowing, the formation of osteophytes on the femoral or acetabular regions, damage to the articular cartilage and subchondral sclerosis.[5] The primary symptoms of OA are joint stiffness, loss of function, reduced range of motion and pain.[2,12,13]

The origin of pain associated with OA is still not well understood. The most prominent theory is that pain is a consequence of bone-on-bone interaction that occurs with the loss of articular cartilage on both joint surfaces and the development of inflammation in the joint membrane.[14] Pain in the inguinal region is often the most prominent symptom of hip OA, though it can also be present in the buttocks or thigh.[15] Individuals presenting with OA usually report having a gradual onset of pain that is exacerbated by activity and relieved with rest.[4,12] The severity of pain experienced with OA of the hip typically worsens with disease progression and adversely impacts QoL.[5]

1.3.1 Risk Factors for the Development of OA

OA is classified as either primary or secondary. Primary OA is idiopathic, while secondary OA has both systemic and localized factors which often result from bone or joint abnormalities that cause destruction of the articular cartilage. Primary OA is believed to be related to biomechanical factors that affect the application of forces to a joint, as well as physiological factors, such as an abundance of estrogen that may slow the progression of disease.[4,16–18] The combination of biomechanical and physiological factors causes a wear-and-tear effect that renders joints incapable of withstanding normal forces over time.[4,17] Secondary OA is believed to be a consequence of internal or external injury with several factors likely contributing to the development of this condition, including: increased body mass index (BMI), genetics, occupational hazards, previous injury and systemic diseases (e.g., hypothyroidism).[5]

The incidence of OA rises with increasing age due to age-related changes that affect the integrity of the joint, such as the degradation of the articular cartilage and sarcopenia.[8,19–21] Birtwhistle et

al.[22] noted an increasing prevalence of OA from 1.6% among Canadians aged 30 – 39 years to 35% among those 80 years and older. OA is more common in females,[16,20] which is speculated to be a consequence of hormonal differences, yet there has been limited evidence to support these claims.[16] There is, however, increasing evidence of a genetic component in the development of OA, such that family history may play a role in disease susceptibility.[23] Spector et al.[24] determined OA is common between sets of female twins, however, these findings have not directly demonstrated heritability of OA. Obesity is another factor that is associated with increased risk of developing OA. Jiang et al.[25] found an 11% increase in the risk of developing hip OA for every 5-point increase in BMI beyond 24.9, which was defined as normal weight.

Prolonged periods of repetitive tasks, such as squatting or climbing stairs, and heavy physical workloads have also been shown to increase the risk of developing OA.[4,26] Previous injury resulting from falls, or traffic accidents, as well as participation in impact sports are risk factors that have been shown to quadruple the risk for development of hip OA. [5] The likelihood of developing this condition is further exacerbated by developmental deformities or systemic diseases, and the accompanying altered joint positioning and biomechanics. Developmental deformities include Legg-Calve-Perthes disease and acetabular dysplasia, while systemic diseases such as hypothyroidism have also been linked to the development of secondary OA.[4] While there has been limited research indicating that joint malalignment leads to the development of OA, there are strong indications that anatomical variants in joint positioning play a role in disease progression.[27]

1.3.2 Epidemiology of OA

Currently, approximately 250 million people suffer from OA globally.[28] Given the aging population, the incidence of this disease and its economic impact is expected to rise in coming years.[5,20] In Canada, an estimated 10% of the population, roughly 3.5 million people, suffer from OA.[13] MacDonald et al.[13] found the prevalence of hip OA ranged from 10.1% to 15.0% and was a significant cause of morbidity among Canadian older adults, those age 65 and older, however, it was less common than knee OA.[13,29] Additionally, it is predicted that by 2031 there will be a 64% increase in the total proportion of Canadian adults, at least 20 years of age, presenting with OA.

A significant portion of annual medical expenditure in Canada is associated with OA, accounting for several billion dollars, through both direct and indirect costs.[19,30] The direct cost associated with OA in Canada is estimated to be approximately $2,300 annually per case, with a cumulative cost of $2.9 billion.[30,31] The economic impact associated with OA is only expected to rise in coming years, with a projected $4.3 billion increase on top of the current $2.9 billion by the year 2031.[31] The majority of hospital costs associated with the disease result from joint replacement surgery.[19] Additionally, a significant portion of the indirect cost associated with OA is attributed to lost days of work.[19] Cumulatively, OA contributes a substantial economic burden, that affects a significant portion of the population..[31]

1.3.3 Diagnosis of OA

The average age of diagnosis of hip OA in Canada is approximately 50 years of age.[13] Hip OA is generally not difficult to diagnose, however, there are numerous conditions that present with similar symptoms that must also be ruled out, such as lumbar spine pathology, hip bursitis or tendonitits.[4,21] Diagnosis generally occurs through a thorough review of the patient's medical history, physical examination and radiographic evidence.[4,21]

Practitioners will diagnose OA after first reviewing the patient's past medical history and reviewing patient symptoms. A thorough evaluation of hip range of motion (ROM) and gait is conducted along with hip-specific testing to assess for joint pathology and correlation to patient symptoms. Pain associated with OA of the hip is most frequently noted in the anterior or lateral thigh and inguinal region, however, it may also present elsewhere as referred pain; specifically, pain that extends down to the level of the knee. Generally, if an individual presents with moderate to severe hip pain for which OA is a possible differential diagnosis, radiography will be performed to confirm OA. Hip pain needs to be differentiated from other potential diagnoses, such as spine pathology, using patient history and physical examination to determine potential causes of pain before reaching a definitive diagnosis using radiography.[4] Radiographs are the most widely employed diagnostic tool in identifying OA and is used to determine the cause and source of pain in ruling out a diagnosis other than hip OA.[32] Radiographic images are examined for the presence of joint space narrowing, osteophytes and subchondral sclerosis. These

structural changes, if present, will often be graded using a standardized classification system to indicate the severity of OA and guide treatment.[4]

The Kellgren-Lawrence scale, first described in 1957, is the most well-known and frequently used radiographic assessment tool in the clinical diagnosis of OA. The classification system ranges on a 5-point scale (grades 0 to 4) representing the increasing severity of OA with 0 representing no pathology and 4 being representative of severe OA.[33] The scale shows a gradual increase in the radiographic appearance of signs of OA with each grade, commencing with formation of osteophytes and culminating in the deformation of bony ends (Table 1).[17,33,34]

Table 1.2 The Kellgren-Lawrence Scale.[34]

Grade	**Description**
0	No pathological features
1	Doubtful narrowing of joint space and possible osteophytic lipping
2	Definite osteophytes and possible narrowing of joint space
3	Moderate multiple osteophytes, definite narrowing of joint space, and possible deformity of bony ends (femoral head and acetabulum)
4	Large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bony ends (femoral head and acetabulum)

An individual is considered to have symptomatic OA if there is radiographic evidence of OA in a given joint with subjective report of frequent pain in the same joint.[35] Kim et al.[12] found that the majority of older adults reporting frequent hip pain in the inguinal region did not have radiographic evidence of hip OA. Similarly, those with radiographic hip OA did not have complaints of frequent hip pain. This study used frequent pain in the inguinal region as the gold standard in detecting hip OA, as the combination of clinical exam with radiography has shown a specificity of 90.5% and a sensitivity of 36.7%.[12] These findings demonstrate that the relationship between pain and radiographic changes are controversial, however, pain in the inguinal region has been shown to be the best predictor of OA of the hip.[12,16,22]

The structural and anatomical changes that occur with aging make hip OA a major concern for Canadian older adults. Individuals who present with greater pain often display more pronounced signs of OA than those without pain.[12] Upon the presence of pain, radiography is used to confirm presence of hip OA. However, individuals presenting with inguinal pain may not have radiographic evidence of hip OA, but rather display with some other diagnosis, such as lumbar spine pathology. Additionally, those without pain may display radiographic changes indicative of hip OA.[12]

1.3.4 Treatment of OA

While the damage caused by OA is irreversible and disease progression cannot be slowed, several treatment options exist for providing pain management. The majority of interventions involve lifestyle adjustments, such as exercise and weight reduction, in conjunction with pharmacological therapies. All treatment options share a common goal of improving joint function and reducing pain. Despite such treatment options, which may relieve pain for individuals in the early stages of the disease, severe OA of the hip with significant pain may require surgical intervention, specifically total hip arthroplasty.[4]

1.4 Total Hip Arthroplasty

Total hip arthroplasty (THA) is an orthopaedic procedure involving the surgical excision of the head and proximal neck of the femur, as well as the subchondral bone and acetabular cartilage of the pelvis and replacing them with artificial prostheses. Greater than 1 million THA procedures are performed worldwide each year.[5] Currently, more than 24,000 procedures are performed annually in Canada.[36] THA is indicated in hip joints with end stage deterioration with deformity, severe pain and reduced ROM, though surgery may be elected before this point. Hip OA is the necessitating factor in greater than 70% of all THA procedures, with the remaining 30% performed for conditions such as avascular osteonecrosis, hip fractures, and rheumatoid arthritis.[37] THA is one of the most successful orthopaedic surgical procedures, with at least 90% of patients reporting satisfaction with the surgery.[38,39] Patients typically experience significant reductions in pain and improved quality of life following surgery, with the greatest improvements occurring in the first six months post-operatively.[40]

1.4.1 Approaches to Surgery

THA has been performed successfully using many differing surgical techniques. The most common approaches to surgery are the posterior, lateral and anterior approaches as well as variations of these techniques that allow adequate access to the hip joint.[41,42] Despite the overall success of THA in improving patient QoL and restoring joint function, there is still much debate regarding which surgical approach is superior.[43] Each THA surgical approach presents with its own unique advantages and disadvantages based on the anatomy of the hip as well as surgical landmarks and incisions, however, in long term outcomes there has been no evidence to support one surgical approach over another.[36,44,46] The selection of surgical technique often depends on the preference of the surgeon and their level of expertise.[36] At University Hospital, London Health Sciences Centre in London, Ontario there are two commonly used approaches to surgery: the direct lateral (DL) approach and the direct anterior (DA) approach.

1.4.1.1 Direct Lateral Approach

The DL approach to THA surgery is the most popular approach among Canadian surgeons, with approximately 60% utilizing the technique.[36] The current technique was introduced in 1982 by Hardinge, and hence, is referred to as the Hardinge approach.[41] The DL approach involves the splitting of the abductor muscles to gain adequate exposure to the femoral head and acetabulum. The major limitation of the DL approach is subsequent abductor weakness which has been speculated to delay recovery and cause greater post-operative complications.[41] The impaired abductor function associated with this approach is believed to be greater than that of the DA approach, however, similar functional levels are achieved around 3 months post-operatively.[8,36,45]

1.4.1.2 Direct Anterior Approach

The variation of this technique used at our institution involves an incision to the fascia overlying the tensor fascia latae (TFL) in order to create an opening between the sartorius and TFL muscles to gain adequate hip joint exposure.[36] This technique has been advocated as a muscle sparing approach avoiding the splitting of the abductor muscles and allowing for faster recovery in the short-term; yet it is the preferred approach of only 10% of Canadian surgeons.[36,46] There are several reported benefits to using the DA approach that include earlier functional recovery,

greater patient-reported functional improvements, and minimized soft tissue damage.[36] However, a recent review by Meermans et al.[46] found equivalence in surgical approaches. This review also found better results for gait in the initial post-operative period, however, there was negligible difference at one-year after surgery.[46]

1.4.2 Complications after THA

Regardless of the overall effectiveness of any surgery, there is always the potential for complications to occur. Major post-operative complications following THA include, but are not limited to: dislocation, fracture, abductor insufficiency, nerve injury, and chronic gait disturbances.[47] Post-operative dislocation is a complication of THA that occurs in a small proportion of cases, ranging from 1% to 2.7% of procedures in some studies.[36,48] Dislocation is dependent on several factors including surgical approach and implant design.[8,41,49] Similarly, nerve injuries resultant from THA surgery are also approach-dependent. Injury to the lateral cutaneous femoral nerve (LCFN) is a potential complication of surgery via the DA approach and occurs in anywhere from 2% to 81% of individuals.[44,50–52] The LCFN supplies sensation to the anterior and lateral thigh and surgically-induced damage to this nerve will present as reduced sensation and numbness. Importantly, damage to the LCFN typically resolves in most patients within two years of surgery.[8,44]

Surgeons must be cautious to avoid damaging the superior gluteal nerve when using the DL approach.[53] The superior gluteal nerve is responsible for innervating the hip abductors and has been shown to sustain injury more frequently by the DL approach than any other. However, complications to the superior gluteal nerve generally occur in less than 10% of cases.[36,53] Injury to this nerve prevents recovery of the anterior aspect of the gluteus medius in patients, and can often result in impairments in hip abductor function. Abductor insufficiency causes inefficient gait mechanics and altered balance in patients.[36,41] Strengthening of the abductors is important to recovery following THA and is often a focus of rehabilitative efforts post-operatively.[8]

1.4.3 Rehabilitation After THA

It is standard for patients undergoing THA to receive rehabilitation after surgery.[54] Protocols focus on pain reduction, improvements in joint function, restoration of muscular strength and flexibility in muscles that produce movement at the hip joint.[55] Activity restrictions may be imposed on patients in the early post-operative period, but are generally dependent on the surgical approach. Restrictions often include the avoidance of extremes of external rotation, internal rotation past neutral, and flexion beyond 90 degrees.[8,56] These precautions are in place to prevent prosthesis dislocation and are usually maintained for a minimum of 4 weeks after surgery.[56] However, there is an increasing body of evidence supporting no hip precautions after THA, as it may actually increase recovery time with no true effect on post-operative complications.[57]

While activity restrictions have been well-defined for THA, there is no standard rehabilitation protocol post-surgery. The rehabilitative measures employed during physiotherapy treatments are often dependent on several factors, including surgical approach, as well as institutional preference.[8,56,58] At our institution, patients typically begin rehabilitation on post-operative day 2 with therapeutic exercise, including muscle strengthening, along with active and assisted ROM techniques for the hip and knee joints. These exercises continue for the first 2 weeks after surgery, beyond which progressive strengthening exercises are often implemented.[8,55,58]

Hip abductor strengthening is an integral part of any post-operative rehabilitation program for THA, especially for patients in which the DL approach has been employed. Despite rehabilitative protocols employed after THA, patients often exhibit deficits in lower extremity strength, balance, and gait that may persist months to years after surgery.[8,58–64] Sicard-Rosenbaum et al.[61] demonstrated that individuals after THA had significant deficits in lower extremity strength in their operative compared to the non-operative side at two years post-operatively. These deficits may persist as long as 10 years after surgery.[65]

Deficits in lower extremity strength can contribute to impairments in balance following THA.[62] Nallegowda et al.[63] showed significantly altered dynamic balance in patients after THA compared to age and sex-matched healthy controls. Additionally, Belaid et al.[64] found that

patients showed asymmetric weight-bearing after surgery, with the healthy leg carrying more of the load than the operated leg. These results suggest that compensation strategies after THA, relative to normal functioning, exist well beyond the 8-week early post-operative phase. These deficits may be the result of lingering deficits of OA that pre-date surgical intervention in addition to new features related to the surgery.[55,66,67]

Appropriate rehabilitative measures following THA is crucial for the restoration of joint function and muscle strength. The necessity of restrictions has become questionable given the increasing body of evidence supporting no contraindications following surgery.[57] THA a very successful surgery, however, there is still the potential for complications post-operatively such as impaired balance.[63,64] Previous research has noted deficits in these areas has the potential to contribute to the likelihood of adverse events such as a fall.[68–70]

1.5 Falls

Falls are a prevalent public health concern as one in three adults over the age of 65 fall each year and greater than half of these individuals will experience recurrent falls.[68,71,72] Age-associated decrease in balance function begins after the age of 50 in the absence of pathology or injury.[73] These changes are the beginning of progressive changes that are associated with an increased risk of falling in individuals beyond 50 years of age. Approximately 10% of falls in older adults, defined as 65 years of age or older, will result in a serious injury such as a fracture, head trauma, and death.[68] Falls are also the single greatest cause of accidental death among older adults each year.[74] Individuals who experience a fall often have a reduced quality of life as the fall affects them both physically and psychologically, especially through a fear of falling.[6] THA has not previously been shown to contribute to falls risk as there is a lack of existing research in this area. However, this surgery has been shown to result in several functional deficits that have frequently been linked to falls. Given Canada's aging population and the increasing number of THA procedures performed annually, an understanding of falls and falls prevention becomes even more important for this population.

1.5.1 Defining Falls

The Prevention of Falls Network Europe Consensus (ProFaNE) defines a fall as "an unexpected

event in which a participant comes to rest on the ground, floor or lower level."[1,75]. In the falls literature there are several limitations related to the definition of the fall outcome, specifically the definition used by researchers is frequently absent or the definition is tailored to the needs of the study, limiting comparability across studies.[76] Additionally, falls not perceived as the result of an accident, such as those that occur as a result of a cardiac event or external force, have frequently are excluded from counts of fall occurrences.[75,77] It is important for older adults documenting their own falls to understand the working definition of fall for accurate collection of adverse events.[75] If falls are interpreted differently between patient and practitioner it may result in failure to report near falls or non-injurious falls that serve as valuable warning signs for fall screening and prevention.[76] Encouraging the use of a universal falls definition would ensure improved understanding of what constitutes a fall and allow for greater comparability across studies.

1.5.2 Prevalence and Economic Burden of Falls

In Canada between 2003 and 2008, the occurrence of fall-related deaths in adults 65 years of age and older increased by 65%, accounting for almost 3000 deaths in 2008.[78] Falls are the most prevalent cause of accidental deaths and the fifth leading cause of death in older adults behind stroke, cardiovascular disease, cancer and pulmonary disorders.[79] Falls are more prevalent amongst older women, having almost twice the risk of falling compared to men.[78,80,81] However, this trend reverses beyond 85 years of age at which point males have a greater likelihood of falling.[78,82]

Falls are often classified as injurious or non-injurious. Approximately 5 to 10% of falls result in serious injury, such as fractures or head trauma, while 30 to 50% result in minor injuries, such as bruises or lacerations.[68] The Public Health Agency of Canada[78] found that the prevalence of fall-related injuries among older adults from 2005 to 2008 increased by 43%. The impact of injuries sustained as a result of falling makes allocating healthcare resources a difficult task.[83] Zecevic et al.[84] reported the cost for a person in hospital who fell and sustained a serious injury at $44,203 (CAD), whereas an inpatient who had not fallen carried a cost of $13,507 (CAD). The greater expenditure for injurious falls resulted from an increased length of hospital stay in the group that fell.[84] The cumulative cost of injurious falls in Canada was stated at greater than $2 billion (CAD) in 2004 and it is expected to rise with the increasing age of the population.[78,82]

1.5.3 Risk Factors for Falls in Older Adults

There are many factors that have been identified with an increased risk of falling in older adults and are usually categorized as personal (intrinsic) factors or environmental (extrinsic) factors.[85,86] Personal factors include aspects of the person such as age, balance, lower extremity strength, or cognition;[87] whereas environmental risk factors are those external to an individual, such as floor surfaces and lighting conditions of the dwelling or outdoors.[88,89] Falls are multifactorial, resulting from the interaction between personal and environmental risk factors.[88,90,91] An increase in the number of risk factors constitutes a linear increase in the likelihood of a fall.[68]

Falls risk has been shown to increase dramatically with age, primarily due to declines in function and mobility.[82,88] Changes in physiology are a normal occurrence of the aging process, however, an effect of deconditioning, in addition to these age-related declines, may result in greater deficits in physical function. Deconditioning can induce impairments in lower extremity strength and balance which causes abnormal gait patterns; thus increasing falls risk.[88,70,69] Changes in an individual's gait have been described as one of the most important factors in predicting falls risk and are second only to environmental factors as the most commonly cited cause of falling.[70,92] Typically, individuals with a slower gait velocity or those exhibiting compensatory walking strategies are at a greater risk of falling.[92,93] Older adults demonstrating significant deviation in the mediolateral direction during ambulation have been shown to be at an increased risk for multiple falls.[94]

Additional age-related declines that increase falls risk include: impaired cognition[81,90,91], postural hypotension[81,90], depression[6,91]**,** and sensory disorders that affect vision, proprioception or vestibular sense[81,95]. Chronic diseases and comorbid conditions also increase falls risk as individuals age.[81,89,96] The risk of falling increases as the number of chronic conditions increase, with specific conditions, such as hypertension or arthritis, being directly linked to an increased occurrence of falls.[96] Prescription medications, often used in the treatment of chronic diseases, also have the potential to increase falls risk.[81,91,97] Medications that have been linked to an increased falls risk include: antipsychotics, antidepressants, hypnotics, sedatives, narcotics and polypharmacy.[68,79,81,98]

Environmental risk factors for falls include elements of housing design, such as poor lighting conditions, uneven or slippery floor surfaces, slip and trip hazards, lack of railings and unstable furniture.[77] Older adults who have fallen will often attribute their fall to their immediate surroundings in or around their home. Given that falls are multifactorial, it is difficult to pinpoint in-home modifications in isolation that will assist in fall prevention.[99] Environmental factors must not be neglected in assessing an individual's falls risk, as accidental falls occur as a result of an individual performing tasks while interacting with their environment.[70] Falls related to environmental risk factors usually occur with a preceding increase in intrinsic risk.[70]

1.5.4 Fear of Falling

Fear of falling is a term encompassing the psychological factors of balance confidence, anxiety related to having a fall, and self-efficacy.[100] These terms relate to the individual's self-perceived ability to be ambulatory and complete tasks of daily living without falling. Fear of falling is related with the incidence of falls and is predictive of future falls.[81,101] Similar to falls, fear of falling is a significant health problem that may be as, or more debilitating, than the actual experience of a fall.[102] Individuals will self-restrict activities out of the fear, which can lead to social isolation and a loss of independence due to deconditioning. These factors create a downward spiral that further increases an individual's falls risk and subsequently decreases quality of life.[103,104]

A fear of falling is a common consequence of injurious and non-injurious falls, but also exists in 12% to 65% older adults with no history of falls.[104–106] Several factors have been found to increase the likelihood of older adults developing a fear of falling. A recent review by Denkinger et al.[107] found impaired balance, functional status, female gender, and the use of a walking aid to be predictors of a fear of falling. The authors noted that individuals already at a greater risk for falling, due to factors such as muscle weakness and balance impairments, were shown to possess the greatest fear of falling.[108,107]

1.5.5 Falls in Older Adults with OA and After THA

OA as a risk factor for falls in older adults is believed to stem from muscle weakness, altered weight-bearing and gait abnormalities present with the condition. Older adults with self-reported hip OA have a 30% increased risk of falling and carrying a relative risk of 1.30 (95% CI 1.20 to 1.50).[109,110] Comparatively, those who had radiographic evidence of OA had a reduced risk of falls in the first year after physician diagnosis, carrying a relative risk of only 0.7 (95% CI 0.50 to 0.95).[110] Given these findings, it appears that self-reported hip pain is a greater predictor of falls risk than the structural changes associated with OA of the hip.[109,110] This is likely a result of disuse atrophy that occurs in addition to the altered weight-bearing strategies adopted by individuals experiencing the pain prevalent with hip OA.[111] Disuse atrophy and self-restriction of activities may further result in important functional deficits and abnormalities that may predispose an individual to a fall.[2]

Arnold and Faulkner[112] found an annual falls prevalence of 45% among community-dwelling older adults with a diagnosis of hip OA. Additionally, Ikutomo et al.[113] found the prevalence of falls among Japanese THA patients to be 36%, approximately the same as for healthy community-dwelling older adults. Limited research has examined fear of falling among these patient groups. However, Arnold et al.[2] determined that hip OA was significantly related to lower falls efficacy and predicted decreased balance.[2] These findings suggest that both fear of falling and balance impairments accompany hip OA, and may contribute to the elevated falls risk seen in this population. Additionally, Nagai et al.[114] found that individuals who underwent THA had a significant fear of falling during ADL's such as taking a bath, and ascending or descending stairs. This study also reported an association between fear of falling and older age, lower walking capacity, and lower functional outcome.[114] Despite these findings, the effect of THA on falls risk and fear of falling has received limited attention in previous literature.

1.6 Summary

OA is a chronic degenerative disease that most commonly affects the lower limb joints. OA affects the entire joint and results in several functional deficits including impaired balance, reduced lower extremity strength, and altered walking patterns. The indicated treatment for hip OA is joint replacement surgery in the form of THA which is successful for pain reduction and

restoration of joint function. Despite documented successes, the physical deficits that pre-existed surgery have been observed in individuals having undergone a THA months to years after surgery.

Falls in older adults are a complex issue rooted in deficits of balance, lower extremity strength and gait. These deficits that exist in individuals with hip OA and following THA, have been shown to increase falls risk in the TKA population but have been understudied in people who have had a THA. The lack of previous studies examining falls in THA despite prevalent physical deficits supports the need for further research in this area.

Chapter 2: Objectives

1. To determine the prevalence of falls as well as the details and circumstances of the falls in individuals having undergone a THA procedure in the 12-month period following surgery.
2. To examine factors that contributed to falls in the 12-month period following surgery.
3. To quantify future falls risk and physical deficits at 12 months post-operatively.
4. To assess general knowledge of falls risk factors and fall prevention strategies in those having had a THA.

We hypothesized that there will be a greater prevalence of falls in the 12-month period following THA surgery than that of average community-dwelling older adults. We expect that physical measures of balance, lower extremity strength and gait will be reduced compared to normative values of community-dwelling older adults indicating an increased falls risk in the future 12 months for patients who have a THA.

Chapter 3: Material and Methods

3.1 Study Design

This study was a single-site, cross-sectional study of patients who underwent total hip arthroplasty (THA) at London Health Sciences Centre – University Hospital in London, Ontario. This study took place from March 24, 2017 – November 30, 2017 and was approved by the University of Western Ontario Health Sciences Research Ethics Board and the Clinical Resources Impact Committee of Lawson Health Research Institute (Appendix A).

3.2 Eligibility Criteria and Study Population

The inclusion criteria for the study were:

- 50 years of age or older.
- Attending their one-year follow-up appointment for primary unilateral THA
- OA of the hip was the necessitating factor for THA.
- Surgery was performed via either the direct anterior (DA) or direct lateral (DL) surgical approach.
- Person able to ambulate a minimum of 10 meters without the assistance of another person, with or without the use of a gait aid.

The exclusion criteria were:

- An inability to ambulate 10 meters unassisted.
- Inability to communicate in English.
- Participant was unable to provide informed consent for themselves.

3.3 Study Protocol

Patients were screened by their orthopaedic surgeon for eligibility to participate in the study. If interested in study participation, a member of the research team met with them to provide more details of the study, review the letter of information and answer all questions to their satisfaction. If the patient was still interested and met all eligibility criteria, the consent document was signed. Once informed consent was obtained, participants proceeded with their appointment as per standard of care with the addition of study-related assessments (outlined below).

3.4 Outcome Measures

Study-related measures included 5 assessments of physical function and 7 questionnaires assessing various fall-related variables.

3.4.1 Primary Outcome Measure

The primary outcome of this study was the prevalence of falls. This was measured through self-report with participants being asked to recall any falls they had experienced since the date of surgery until their return to clinic at the one-year follow-up time point. A 12-month recall of falls has been shown to have an 89% agreement with medical charts data and is the standard in clinical practice.[96,115] A fall was defined as "any unexpected event in which the participant comes to rest on the ground, floor or a lower level".[1] Participants also reported: the number of falls, time after surgery in which the most recent fall took place, injuries incurred as a result of falling and whether or not medical attention was sought. Injuries were defined as major or minor. Major injury constituted any event in which medical attention was required for care of a fracture or head trauma, such as concussion, while minor injury was an injury such as a bruise or laceration in which medical attention may or may not have been required. Individuals who fell were asked to describe the activity they were doing when they fell and whether or not there was any effect on their confidence in performing activities of daily living.

3.4.2 Secondary Outcome Measures

Participants underwent 8 assessments examining known risk factors for falls which were selected based on existing literature of post-surgical deficits relevant to this patient population. Participants were tested on spatiotemporal parameters of gait, lower extremity strength, balance, fear of falling, falls knowledge, future falls risk, cognition, pain, quality of life and functional mobility. No specific ordering of assessments was used. The order was selected based on the patient flow in the clinic on a given day and availability of participants during their appointment time.

3.4.2.1 Gait

Gait assessment was conducted using body-worn accelerometers, LegSys+^{TM} (Biosensics LLC, Watertown, MA), which measure spatiotemporal parameters of gait. The main gait parameter

examined was gait speed, as velocities of less than 1.0 m/s have previously been linked to an increased falls risk.[116] Additionally, we examined cadence, stride length, stride time, swing time, stance time, double support times, as well as variability in stride length, stride time and stride velocity. These parameters were examined to assess for significant deviation from normal human ambulation which has been previously defined and well documented after hip arthroplasty.[117–119] Variability in walking that deviates from a normal rhythmic gait pattern has previously been linked to an increased falls risk.[120] Five sensors were positioned along the coronal plane using visual estimation. The first sensor was positioned around the waist, one around the midpoint of each thigh and the final two around the midpoint of each calf. All sensors contain a tri-axial accelerometer that acted in co-ordination to collect data on sensor displacement as the participant ambulated. The sensors were connected via Bluetooth technology transmitting at a frequency of 100Hz. Body-worn sensors have been shown to have good concurrent validity with the GAITRite® electronic walkway, a frequently used tool in clinical gait assessment.[121] Participants were permitted to use their regular mobility aid during this assessment. Data for gait velocity was compared to normative data to determine the proportion of participants below 1.0 m/s.[116]

Temporal and spatial gait parameters were measured while the participants walked a distance of 6 meters. This distance is valid and reliable for collection of gait performance data.[122] Further, a 6-meter distance has been successful in showing lower extremity limitations in previous study populations including community-dwelling older adults.[122] Single and dual-task gait testing protocols were utilized in the assessment to examine the effect of performing a secondary cognitive task on gait speed. Previous literature examining the use of a secondary cognitive or motor task while walking has found deterioration in gait performance and increased falls risk compared to single-task conditions in older adults.[120] For the assessment of single-task gait, participants were asked to wait for the instructor's command of "go" and then to begin walking at their normal walking pace at which point timing began. When participants reached the 6-meter mark the timer was stopped. Gait was then assessed under a dual-task condition using a concurrent cognitive task of serial subtractions by 3s from a number randomly chosen between 100 and 150.[123] The task of counting backwards by 3's while walking has been shown to significantly reduce gait speed in older adults when compared with normal walking speed.[124] Walking and counting backwards by 3's has been shown to have excellent test-retest reliability

for gait velocity (ICC=0.93, 95% CI 0.75 to 0.98).[125] The same instructions for the single-task gait test were repeated for the dual-task condition. Performance on the cognitive task was also assessed as a single-task while the participant was seated in a chair - participants were instructed to count backwards by 3s from 100 for 9 numbers while being timed (timing was done to the nearest hundredth of a second using a stopwatch).

Two dual-task costs were calculated for gait velocity on the walking tests - the cognitive dual-task cost (DTCcog) and the gait dual-task cost (DTCgait). The DTCgait was determined as [(single-task value - dual task value)/single-task value] × 100%. When calculating DTCcog, a corrected response rate (CRR) was used to account for participant response rate and accuracy of responses while performing the cognitive task (e.g. subtraction while seated).[126] The CRR was calculated as: response rate per second x percent correct.[126] The DTCcog was then quantified using the CRR with the following formula: (– 1) [(CRR seated – CRR walking)/CRR seated] × 100%. Positive values for DTCcog indicated greater cognitive performance in the dual-task test condition, while negative values represented poorer cognitive performance. Similarly, positive DTCgait values indicated better walking performance in the dual-task test condition, while poorer performance was shown with negative values.

3.4.2.2 Thirty Second Chair Stand Test (30CST)

The 30 Second Chair Stand Test (30CST) is a valid and reliable measure of lower extremity strength in community-dwelling older adults with hip and knee OA.[127,128] Participants were instructed to begin seated on the edge of a chair (seat height of 45cm) with arms folded across their chest and feet planted firmly on the floor. On the examiner's instruction of "go" participants stood fully erect and returned to the seated position as many times as possible in 30 seconds while keeping their arms folded across their body. Participants were not permitted to use a gait aid for this assessment. Scores were compared to normative data for community-dwelling older adults, presented by Rikli and Jones.[129] See Appendix C for normative data. The 30CST has excellent reported inter-rater and intra-rater reliability (ICC=0.98, 95% CI 0.96 to 0.99) in patients with hip OA.[127] Gill et al.[128] reported a moderate convergent validity between the 30CST and the Western Ontario McMaster Osteoarthritis Index (WOMAC).

3.4.2.3 Step Test

The Step Test is a measure of dynamic balance during activity that requires the participant to weight-shift and spend time in single leg stance. Participants were required to stand with feet parallel and approximately 10cm apart, with a step measuring 15cm in height placed 5cm in front of them. Participants were instructed to place their entire foot on the step and then back to the floor as rapidly as possible over 15 seconds. Each leg was tested separately and the total number of times the foot was placed on the step for each side was recorded. Each side was analyzed, and compared to normative data for community-dwelling older adults, presented by Isles et al.[130] See Appendix C for normative data.

The Step Test has been used to assess balance in several older adult populations and its validity and reliability have also been demonstrated in patients with hip OA. The Step Test has excellent inter-rater reliability among older adults with hip OA while standing on the study limb (ICC = 0.94, 95% CI (0.88 to 0.97)) and non-study limb (ICC = 0.85, 95% CI (0.88 to 0.97) with a minimal detectable change (MDC) of 3 steps.[131]

3.4.2.4 Timed-Up-and-Go Test (TUG)

The Timed-Up-and-Go Test (TUG) is a measure of a person's functional mobility (i.e., balance and gait maneuvers used in everyday life).[132] When performing the TUG, participants started in a seated position in a standard chair with arms (seat height of 45cm). Upon the examiner's instruction of "go", participants rose from the chair, walked at their usual pace for 3 meters, turned around a cone and returned to the chair to assume their initial seated position. The time to complete this activity was recorded to the nearest hundredth of a second with use of a stopwatch. Participants were allowed to use their standard mobility aid while completing the TUG if needed. Higher scores (i.e., longer time to complete) are indicative of poorer functional mobility; however, there is limited scientific support for a specific cut-off score that indicates an increased falls risk.[112,132] Scores were compared to normative data for community-dwelling older adults, presented by Steffen et al.[133] See Appendix C for normative data.

The TUG has good test-retest reliability in patients with hip OA who underwent a THA procedure with an intraclass correlation coefficient (ICC) of 0.75 (95% CI (0.51 to 0.89)) and the MDC is 2.49 seconds.[134] Additionally, the TUG has demonstrated excellent inter-rater reliability among hip OA patients (ICC = 0.87, 95% CI (0.74 to 0.94)).[135]

3.4.2.5 Activities-specific Balance Confidence Scale (ABC)

The Activities-specific Balance Confidence (ABC) Scale is a 16-item self-report measure of a person's confidence in performing various activities of daily living without falling or experiencing a sense of unsteadiness. Each item is rated on a scale of 0 to 100%, with a score of 0 representing no confidence, while a score of 100 represents complete confidence. A summary score is calculated by adding responses on each item and dividing by the total number of items. See Appendix D for the questionnaire.

3.4.2.6 Falls Risk for Older People - Community Setting Questionnaire (FROP-Com)

The Falls Risk for Older People - Community Setting (FROP-Com) questionnaire is a multi-factorial falls risk assessment tool that assesses 25 risk factors for falls in 13 areas of risk. The assessment consists of 28 self-report items ranked on either a dichotomous scale of yes or no questions, or an ordinal scale of 0 to 3. Individual responses to each question are tallied to generate a summary score that was used to determine falls risk. The maximum achievable score on the assessment was 60. Scores of 0 to 10 are considered indicative of a mild falls risk, whereas scores of 11 to 18 depict moderate risk and scores greater than 19 are designated high falls risk, warranting further action. The FROP-Com has excellent intra-rater reliability (ICC=0.93, 95% CI 0.84 to 0.97) and good inter-rater reliability (ICC=0.81, 95% CI 0.59 to 0.92). The FROP-Com shows a moderate predictive validity of future falls in adults 60 years of age and older, with a sensitivity of 71.3% (95% CI 64.4 to 78.3) and specificity of 56.1% (95% CI 48.9 to 63.4) as reported by Russel et al.[136] See Appendix D for the full questionnaire.

3.4.2.7 Falls Knowledge Questionnaire

A standardized set of questions was asked of participants on their knowledge of falls risk factors and falls prevention strategies. Sixteen questions assessed knowledge, while 6 examined participant perceptions of falls and an additional 6 explored falls prevention strategies. These

questions were previously developed by Braun et al.[89] to evaluate falls risk awareness in community-dwelling older adults. Participants rated, on a scale of 0 (not at all likely) to 10 (most likely), how important specific factors were in making an average community-dwelling older adult fall, regardless of having a hip replacement. The questions covered 4 areas of falls risk factors: physical factors, psychological factors, interior environmental factors and exterior environmental factors.

Additionally, we asked open-ended questions for which participants described any falls prevention strategies they had implemented since their surgery and their confidence in their ability to implement these changes.[137] The questions were based on the work by Hill et al.[137] with adaptations made to assess participants in the time frame since their surgery. The responses were categorized as: 1) behavioural (behavioural strategies reported to reduce their risk of falls), 2) support while mobilizing (reported using supportive equipment or items, such as canes or walkers, to remain upright to avoid falling), 3) movement related (reported moving and/or ambulating in a specific pattern in order to reduce the risk of and avoid falling), 4) physical environment (reported physical modifications to the home environment to reduce the risk of falling), and 5) activity and exercise (reported engagement in activities expected to improve their physical function and, therefore, reduce their risk of falling).[137] See Appendix D for the full questionnaire.

3.4.2.8 Montreal Cognitive Assessment (MoCA)

The Montreal Cognitive Assessment (MoCA) is a test of global cognitive function. Developed as a test for mild cognitive impairment, the MoCA measures 9 cognitive domains: attention and concentration, executive function, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. The maximum achievable score on this assessment is 30, with scores ≤ 25 generally indicating mild cognitive impairment. An additional point is given to participants who have less than 12 years of education. See Appendix D for questionnaire.

3.4.2.9 Western Ontario and McMaster Osteoarthritis Index (WOMAC)

The Western Ontario and McMaster Osteoarthritic Index (WOMAC) was initially developed for assessing symptoms and physical disability associated with lower extremity OA. The WOMAC

has since become a widely used, self-administered health status questionnaire for assessing pain, joint function and stiffness in various orthopaedic patient groups. The tool is comprised of 24 questions divided into three domains: 5 questions assess pain, 2 questions assess stiffness and 15 questions assess physical function. All questions are rated on an ordinal scale of 0 – 4, with 0 indicating the absence of pain, stiffness or difficulty in function and higher scores indicating worse pain, stiffness and overall joint function. The maximum achievable scores on the WOMAC are 20 for pain, 8 for stiffness and 68 for function, for a total possible score of 96.[138] Our institution uses a weighted and inverted conversion such that there is a score out of 100 on each domain and higher scores indicate better overall health status. The WOMAC is a highly responsive measure post-operatively among individuals having undergone a THA with large effect sizes being noted in each of the 3 subsections. Additionally, the WOMAC has a high convergent validity with the Harris Hip Score and certain spatiotemporal parameters of gait.[138] See Appendix D for the full scale.

3.4.2.10 Harris Hip Score (HHS)

The Harris Hip Score (HHS) is a physician-completed assessment. It consists of 10 questions that examine the 4 domains of pain, function, deformity and ROM after hip surgery. The function domain is further expanded into the subsections of gait and functional activities. The gait subsection encompasses the subsections examining limp, use of mobility aid and distance that can be walked without pausing. Additionally, the functional activities section is expanded to include tying shoes, transport, sitting and climbing stairs. Each question is rated on a two to six-point ordinal scale, with the scores for each subsection added together for a total achievable score of 100, which indicate excellent outcomes following surgery. Scores of less than 70 are indicative of poorer outcomes after hip replacement surgery.[139] See Appendix D for a copy of the assessment.

The HHS has excellent test-retest reliability when completed by physiotherapists or orthopaedic surgeons (r=0.93 and 0.98 respectively). Additionally, the HHS was found to have high convergent validity with the WOMAC.[139]

3.4.2.11 Short Form-12 Survey (SF-12)

The Short Form-12 Survey (SF-12), a condensed version of the Short-Form 36, is a 12-question self-report questionnaire used to assess a person's overall health-related quality of life (HRQoL). The assessment does not provide a summary score, but rather generates an individual score for each of mental (MCS) and physical (PCS) health subdomains. Each question is rated on either a 3, 5 or 6-point Likert scale, or on a dichotomous (yes/no) scale. It assesses the person's life participation, negative and positive affect, bodily pain, mental health, and quality of life (QoL).[140] Higher scores on the MCS and PCS are indicative of better mental and physical health. See Appendix D for the full survey.

3.4.2.12 Patient Characteristics and Surgical Details

Demographic information collected from each participant included: age at assessment, sex, comorbidities, mobility aid use and type, physical activity level with four categories 1) very active defined as exercises 3 times per week, 2) moderately active defined as exercises less than twice per week, 3) not very active defined as rarely leaves the house and 4) inactive defined as rarely leaves one room in the house. Prescription medication use was also recorded and number of medications quantified as a summary score. A simple sum was used in order to assess the effect the number of total prescription medications had on falls risk. Use of a greater number of prescription medications has previously been shown to increase the risk of falling in older adults.[79] Surgical information collected included: date of surgery, surgical approach, and surgical side. We also recorded the presence of other lower limb joint replacements.

3.5 Sample Size

The sample size for the present study was determined as a convenience sample of the number of eligible people who could be recruited during the fixed time-frame of the study (8 months). A formal sample size calculation was not performed, though the number of participants is consistent with research previously done on falls in people with OA.[112]

3.6 Statistical Analysis

Baseline demographics and medical information were summarized using means and standard deviations or frequencies and proportions where appropriate. Measures of physical function,

cognition, fear of falling, and falls risk was summarized as means and proportions where appropriate.

3.6.1 Objective 1

To determine the prevalence of falls in the 12-month period following surgery, this was analyzed with descriptive statistics calculating the proportion of participants who fell, the number of falls reported and the frequencies and nature of injuries reported. A Kaplan-Meier curve of cumulative survival of time to first fall was plotted. Patients were categorized by faller status as those who experienced one or more falls and those who did not fall in the 12-month period after surgery. Circumstances of reported falls were recorded as proportions and percentages where appropriate. A pie chart was generated depicting the cause of fall for the most recent event among participants who reported falling.

3.6.2 Objective 2

In determining factors associated with falls in the previous 12 months, factors that were constant or fixed features were selected as independent variables and analyzed for association to the outcome of any fall using univariate logistic regression. Variables that were statistically significant in univariate analysis were placed in a single model to be evaluated using multivariable logistic regression. Goodness of fit was determined using a Hosmer-Lemeshow goodness-of-fit test, additionally a test of multicollinearity was performed to assess the similarity between independent variables. Comparisons were also performed by faller status using independent t-tests on several *a priori* determined factors, including sex, age and surgical approach. Multiple comparisons were controlled for using the Bonferroni correction.

3.6.3 Objective 3

Future falls risk was analyzed through a comparison of participants' scores on the 30CST, Step Test and TUG with normative data for average community-dwelling older adults. These results were used to determine the proportion of the sample below these established values. Some age groups did not have normative data available for all tests; specifically, on the TUG and 30CST for the 50 – 59 age decade, and the Step Test for the 80+ group. The data for these groups were summarized descriptively as means and proportions where appropriate and excluded from the

comparison to normative values. Gait velocity was also compared to defined scores to determine the proportion of participants below threshold values and at a greater risk of falling. Gait parameters collected with the accelerometers were summarized as means and standard deviations along with median, interquartile range as well as minimum and maximum values.

A performance-resource operating characteristic graph was generated to compare performance on DTCcog compared to DTCgait during gait testing. Each point on the graph indicates the interaction between gait and cognition. The upper right quadrant indicates an overall improvement on gait and cognitive performance, while the upper left quadrant shows participants with improved gait and worsening cognitive performance. The lower left quadrant indicates worsening performance in both domains, while the bottom right quadrant shows improved cognitive performance with declining gait speed.

The analysis of the FROP-Com was completed on participants older than 60 years as this scale has only been validated in this age range by Russel et al[136]. Scores were reported as means and standard deviations, with these scores being used to determine classification of falls risk as mild, moderate or severe. Additionally, the scores for participants 50 – 59 years of age are not interpretable for future falls risk prognostication and are not reported. We examined the risk factors identified to determine the number of modifiable factors, and non-modifiable factors as means and standard deviations. Modifiable risk factors were defined as factors that could be changed to reduce their risk of falling, such as exercising or consuming less alcohol. Non-modifiable factors, conversely, were factors that the participant could not control and still contributed to falls risk, such as comorbid conditions or a history of falling. A table was created showing responses for each question on the FROP-Com. The question “does the home appear safe” was excluded from our analysis as participants were assessed outside the home and a home assessment was not performed. The percentage of participants with scores below normative values on the 30CST, TUG, Step Test and gait velocity was examined across the falls risk categories derived from the FROP-Com. Scores on the ABC were summarized as means with standard deviations for each question.

3.6.4 Objective 4

To address the fourth objective of participants' knowledge of falls, the data were summarized descriptively as means and proportions where appropriate. Data analyses were performed using SPSS version 22.0 (IBM Corporation, Armonk, NY).

Chapter 4: Results

4.1 Study Population and Demographics

One-hundred thirty-six patients were recruited for this study. There were 305 patients scheduled for a one-year follow-up appointment during the study time frame – 59 were not eligible, 35 were missed while the examiner was completing study assessments with other study participants, 35 did not show up for their scheduled appointment and 40 declined to participate due to time constraints or lack of interest in the study. One participant was excluded from the study because their follow-up appointment was for a revision hip arthroplasty and was not accurately identified as such until after enrollment. One-hundred thirty-five participants were included in the final analysis. (Figure 4.1)

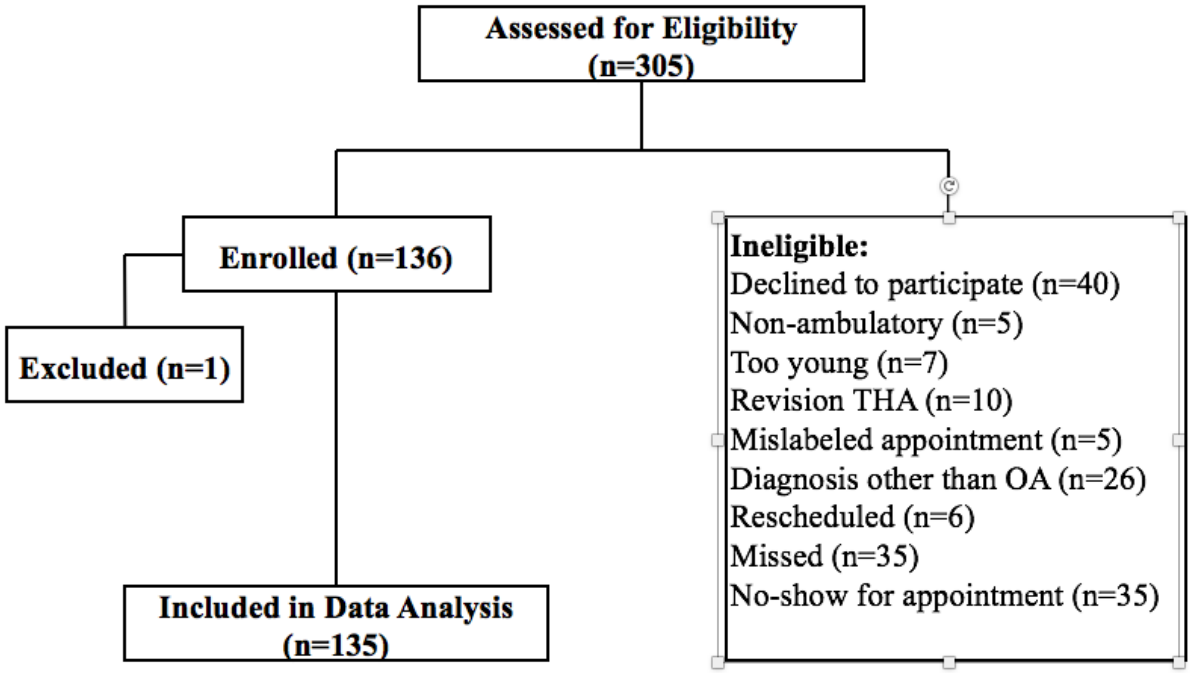

Figure 4.1 Flow diagram illustrating participant recruitment.

Demographic and clinical information is presented in Table 4.1. The average age of our sample was 68.97 ± 9.08 years and ranged from 50 to 88 years. There was a comparable number of male (60) and female (75) participants. The majority of the sample, 114 (84.4%), reported being

moderately to vigorously physically active. Only 24 participants reported using mobility aids, of whom 10 participants reported use was in response to their THA surgery. The mean value on the MoCA was 26.43 ± 2.71. Thirty-six participants (26.7%) had scores lower than 26 said to be indicative of mild cognitive impairment.

Table 4.1 Demographic and clinical characteristics for people 12 months after a unilateral total hip arthroplasty surgery (n=135).

Participant Characteristics	
Age (years), mean ± SD, [95% CI]	69 ± 9, [62.5 – 84.9]
Sex, n (% female)	75 (55.6)
Height (cm), mean ± SD, [95% CI]	168.8 ± 9.3, [142.9 – 190.7]
Weight (kg), mean ± SD, [95% CI]	83.1 ± 6.5 [18.1 – 129.1]
BMI, mean ± SD, [95% CI]	29.13 ± 5.10 [9.34 – 43.10]
Number of Prescription Medications ± SD, [95% CI]	3 ± 3, [0.1 – 12.6]
Number of Comorbidities ± SD, [95% CI]	4 ± 2, [-2.6 – 9.9]
WOMAC scores ± SD, [95% CI]	85.66 ± 14.58, [60.40 – 115.10]
HHS Scores mean ± SD, [95% CI]	93.50 ± 9.88, [91.16 – 105.50]
SF-12 Mental Component Scores ± SD, [95% CI]	55.45 ± 7.86, [34.48 – 69.22]
SF-12 Physical Component Scores ± SD, [95% CI]	46.72 ± 9.78, [33.92 – 67.11]
Surgical Side, n (% left)	64 (47.4)
Surgical Approach, n (% DL)	74 (54.8)
Physical Activity Level, n (%)	
Inactive	0 (0.0)
Not Very	21 (15.5)
Moderate	56 (41.5)
Vigorous	58 (43.0)
Mobility Aid, n (%)	
None	110 (81.5)
Single Point Cane	20 (14.8)
Rollator Walker	5 (3.7)
Joint Replacements, n (%)	
Single Hip	85 (63.0)
Multi-joint	50 (37.0)

Notes: Multi-joint, participants who had one or more lower-limb joint replacements in addition to the total hip arthroplasty of interest; DL, Direct Lateral approach; WOMAC, Western Ontario and McMaster Osteoarthritis Score; HHS, Harris Hip Score; SF-12, Short-Form 12 Survey.

4.1.1 Missing Data

Missing data were noted for 13 subjects (9.6%). One subject left the assessment early, failing to complete the gait tests, Step Test, and TUG. This participant refused to return to the clinic to complete testing, citing long travel distances. Additionally, the following scores were not

available: HHS scores for 10 participants (7.4%), WOMAC scores for 9 participants (6.7%) and SF-12 scores in 5 cases (4.7%). The data for the WOMAC, HHS and SF-12 were extracted from participant charts at the end of clinic each day. Missing data for the WOMAC and SF-12 resulted from a failure of participants to complete the assessment during the in-clinic visit. Missing values for the HHS were a failure on the part of participants to present their surgeon with the scale before returning their assessments to the front counter of the clinic. Missing data values were not imputed.

4.2 Objective One: Falls

4.2.1 Falls Prevalence

Twenty-nine participants (21.5% 95%CI (14.9% to 29.4%)) reported at least one fall in the previous 12 months since the surgery and there was a total of thirty-five falls among those who fell. One fall was reported by twenty-five participants, two participants fell twice and two reported falling three or more times. Injuries occurred in fourteen (40.0%) fall events. Three (8.6%) falls resulted in major injury, including two fractures and a shoulder dislocation, while the remaining eleven (31.4%) resulted in minor injury such as bruising or laceration. Greater than half of the reported falls came in the latter half of the year following surgery. No falls were reported during the hospital stay. (Figure 4.2)

More than one body part was injured due to a fall in five of the fourteen falls in which injury occurred. These five falls all resulted in a minor injury and included injuries to the leg and arm in all five cases, as well as to the trunk in three incidences and head/neck in two. A single injury site occurred in the remaining nine falls, of which three were graded as major injuries with an injury to the head/neck in one case, arm in three incidences and leg in five. Medical attention was sought in seven cases. Among the participants injured from falling, seven stated that the fall affected their confidence, and three reported that they had stopped performing activities they were physically capable of doing due to a fear of falling. Fallers and non-fallers had significant differences in the number of prescription medications and multiple joint replacements. (Table 4.3)

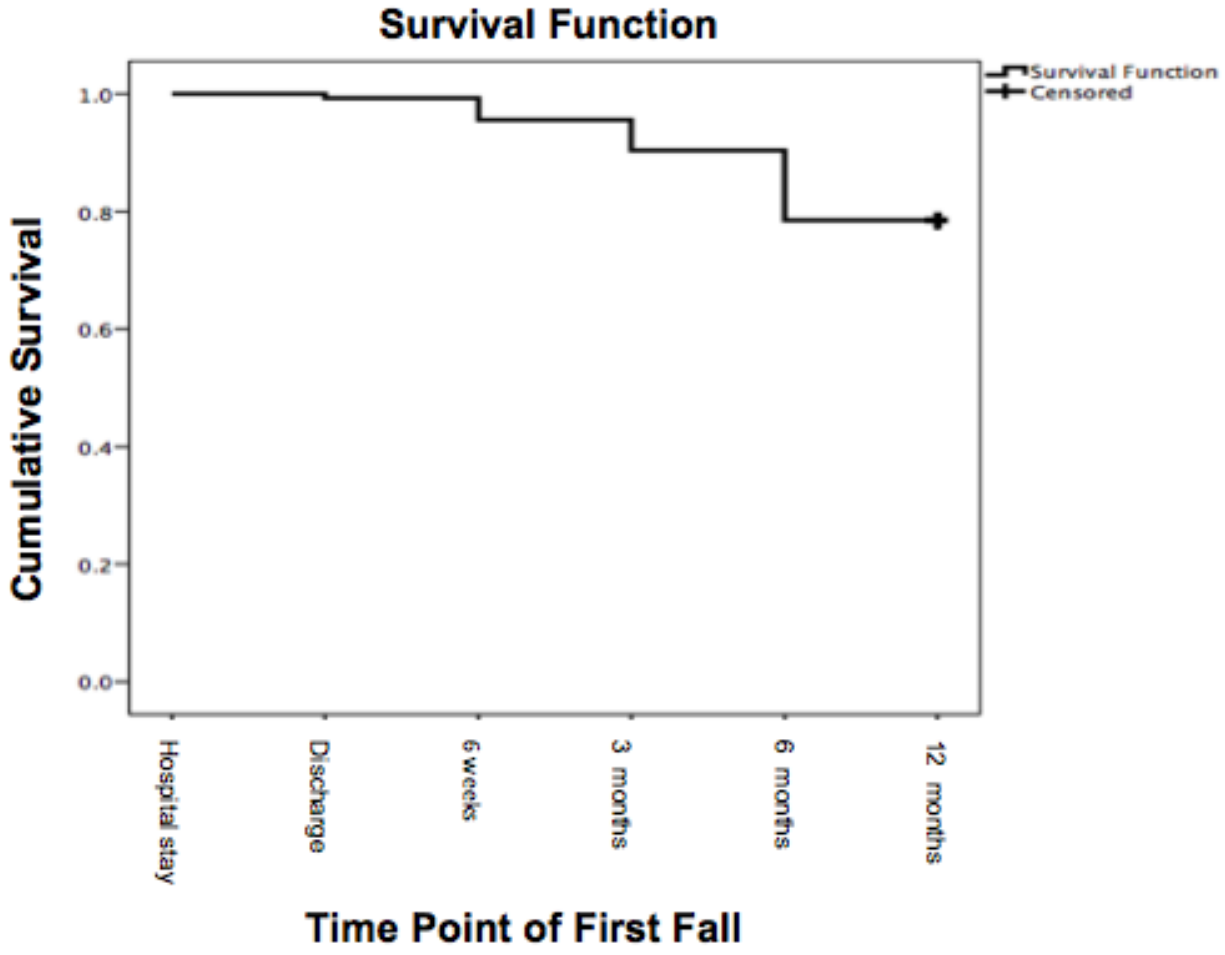

Figure 4.2 Kaplan-Meier curve depicting the time to first fall over 12 months in people after unilateral total hip arthroplasty.

4.3 Objective Two: Factors Associated with Falls 12 Months After Total Hip Arthroplasty Surgery

Sex, number of prescription medications and multiple joint replacements were independently associated with the outcome of sustaining any fall. (Table 4.2) The factor with the greatest magnitude of risk was having multiple joint replacements (OR=5.76 (95%CI, 2.10 to 15.81)). Additionally, surgical approach was not shown to increase falls risk OR=0.95 (95% CI, 0.35 to 2.60)). The results of a Hosmer Lemeshow goodness-of-fit test gave a p= 0.58, and the model had satisfactory scores, with no significant difference between expected and observed frequency of fallers (chi-square = 6.61). Additionally, none of the variables included in the model were

found to have multicollinearity. Significant differences were also seen between fallers and non-fallers in the number of prescription medications and multiple joint replacements. (Table 4.3)

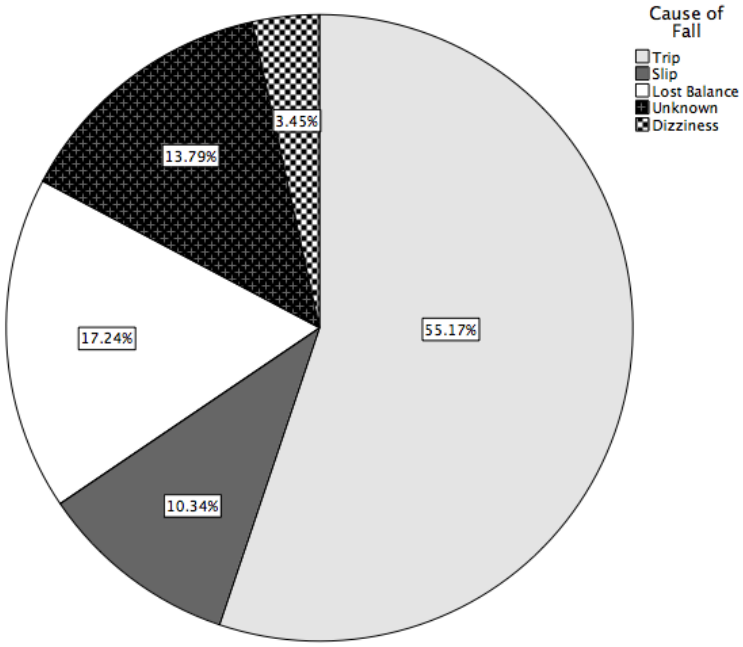

Figure 4.3 Reported cause of falling over the 12 months following a unilateral total hip arthroplasty. (n=29).

Table 4.2 Results of univariate and multivariable logistic regression modeling of factors associated with the occurrence of falls in the 12 months after total hip arthroplasty.

Variable	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Sex (female)	3.14 (1.24 to 7.98)	p=0.02	3.82 (1.54 to 13.78)	**p=0.006***
Age	1.00 (0.96 to 1.05)	p=0.91	0.96 (0.91 to 1.02)	p=0.96
Surgical Approach	1.76 (0.75 to 4.14)	p=0.19	0.95 (0.35 to 2.60)	p=0.92
Number of Medications	1.91 (1.05 to 1.34)	p=0.005	1.23 (1.10 to 1.40)	**p=0.008***
Multiple Joint Replacements	5.63 (2.35 to 13.75)	p<0.001	5.76 (2.10 to 15.81)	**p=0.001***

Notes: *, indicates statistical significance at p<0.05; OR, odds ratio.

Table 4.3 Comparison of characteristics between participants who did and did not experience a fall in the 12 months after total hip arthroplasty surgery. (n=135)

Participant Characteristics	Fallers (n=29)	Non-fallers (n=106)	p-value
Average age ± SD (years)	69 ± 8	69 ± 9	p=0.91
Sex, n (% Female)	22 (75.9)	53 (50.0)	p=0.01
Number of Prescription Medications ± SD	5 ± 4	3 ± 3	p=0.002*
Number of Comorbidities ± SD	4 ± 2	4 ± 2	p=0.12
Surgical Approach, n (% Direct Lateral)	19 (65.5)	55 (51.9)	p=0.19
Mobility Aid Use, n (%)	6 (20.7)	19 (17.9)	p=0.73
Joint Replacements, n (%) Single hip Multi-joint	 9 (31.0) 20 (69.0)	 76 (69.7) 30 (31.3)	 p<0.001*

Notes: Statistical analysis is independent t-test comparing participants who did and did not fall; SD, standard deviation; *, statistical significance corrected for multiple comparisons using a Bonferroni correction, p<0.007; mobility aid use refers to the consistent or intermittent use of any type of walker or cane by a study participant.

4.4 Objective Three: Future Falls Risk

4.4.1 Gait

One participant left the assessment before completion of all study components and did not perform the gait testing portion of the study, therefore, results are reported for the remaining 134 participants.

4.4.1.1 Gait Velocity

The average gait velocity was 1.14 ± 0.21m/s and 0.95 ± 0.28m/s for single and dual-task conditions, respectively. Twenty-nine participants (21.6%) walked at speeds slower than 1.0 m/s in the single-task condition and 77 (57.5%) in the dual-task condition

4.4.1.2 Other Spatiotemporal Parameters of Gait

The average number of steps/min among the sample was 109.45. Participants spent approximately 40% of the time while walking in the swing phase of the gait cycle and 60% in the stance phase. Additionally, gait variability was generally low, with the greatest variability being in stride velocity (5.3% ± 2.7%). (Table 4.4)

Table 4.4 Average, median, interquartile range and range of values for gait parameters during usual pace walking in individuals 12 months after total hip arthroplasty.

Gait Parameter	Average	Median	Range	IQR
Cadence (steps/min)	109.5 ± 10.0	108.6	83.6 – 138.2	103.0 – 116.2
Stride Length (m)	1.24 ± 0.19	1.25	0.64 – 1.68	1.14 – 1.38
Stride Time (s)	1.11 ± 0.10	1.11	0.87 – 1.44	1.03 – 1.17
Stride Velocity (m/s)	1.13 ± 0.22	1.15	0.35 – 1.83	1.01 – 1.27
Variability in Stride Length (%)	2.7 ± 1.5	2.5	0.2 – 7.7	1.57 – 3.72
Variability in Stride Time (%)	3.9 ± 2.2	3.7	0.03 – 9.5	2.00 – 5.39
Variability in Stride Velocity (%)	5.3 ± 2.7	5.3	1.0 – 11.7	2.87 – 7.70
Left Leg Swing (%)	39.7 ± 3.0	40.1	31.4 – 45.5	38.2 – 41.5
Right Leg Swing (%)	39.6 ± 3.3	39.8	28.0 – 47.1	37.5 – 41.6
Left Leg Stance (%)	60.3 ± 3.0	59.9	54.4 – 68.6	58.5 – 61.8
Right Leg Stance (%)	60.4 ± 3.2	60.2	52.9 – 72.0	58.5 – 62.4
Initial Double Support (%)	10.9 ± 3.2	9.8	2.2 – 19.9	9.0 – 12.9
Terminal Double Support (%)	9.9 ± 3.1	10.9	1.3 – 77.7	8.1 – 11.3

Notes: IQR, Interquartile range

4.4.1.3 Dual-Task Cost (DTC)

The average DTCgait for the sample was -26.7 ± 41.1% and the average DTCcog was 12.8 ± 59.8%. Overall, gait performance deteriorated and cognitive performance improved during the dual-task test condition as indicated by the negative DTCgait and positive DTCcog values. (Figure 4.4)

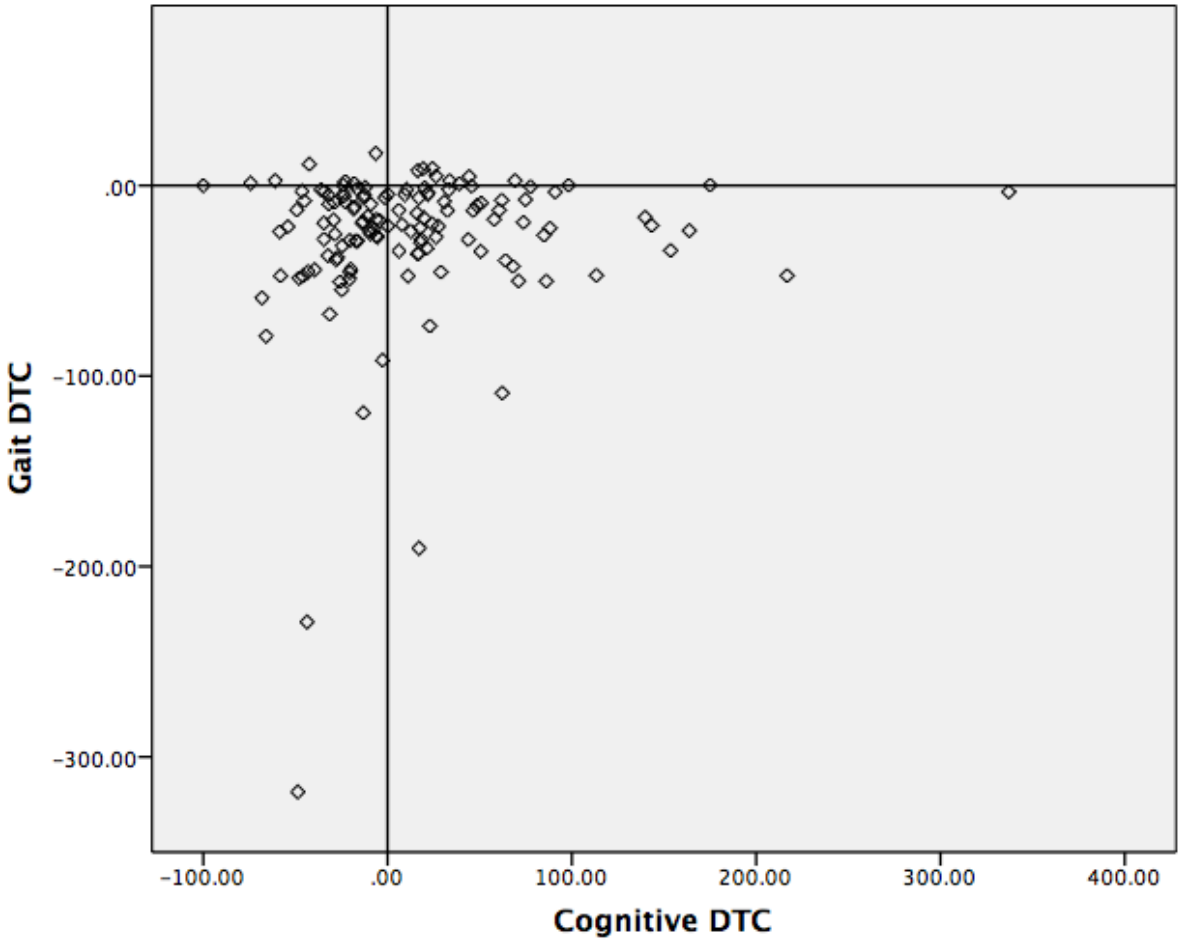

Figure 4.4 Performance-resource operating characteristic graph of gait and cognitive dual-task costs (DTC) during 6-meter gait test in people one-year after total hip arthroplasty surgery.

4.4.2 Thirty-Second Chair Stand Test (30CST)

Scores ranged from 0 to 21, with an average of 10.91 ± 3.87. (Table 4.5) Three male and three female age groups had scores within normal limits, however, 71 participants (65.7%) still had scores lower than normative data for community-dwelling older adults.

Table 4.5 Results of 30 Second Chair Stand Test in people 12 months after total hip arthroplasty compared to normative values stratified by age and sex. (n=108)

Age Group (Male)	**Number of participants per age grouping**	**Mean ± SD**	**Normative Data (Mean)**[129]	**n (%) of participants with deficits**
60 – 64	5	10.8 ± 2.2	<14	4 (80.0)
65 – 69	9	12.0 ± 3.1	<12	7 (77.8)
70 – 74	13	9.9 ± 4.3	<12	9 (69.2)
75 – 79	9	10.6 ± 2.6	<10	4 (44.4)
80 – 84	6	11.3 ± 2.9	<10	3 (50.0)
85 – 89	1	14	<8	0 (0.0)
Age Group (Female)	**Number of participants per age grouping**	**Mean ± SD**	**Normative Data (Mean)**[129]	**n (%) of participants with deficits**
60 – 64	8	11.8 ± 2.6	<12	5 (62.5)
65 – 69	21	11.1 ± 3.1	<11	15 (71.4)
70 – 74	13	10.9 ± 1.9	<10	5 (38.5)
75 – 79	11	8.9 ± 6.1	<10	7 (63.6)
80 – 84	11	6.6 ± 4.0	<9	8 (72.7)
85 – 89	1	8	<8	1 (100.0)

Notes: No normative data available for participants age 50 – 59 years

4.4.3 Step Test

The average number of steps for entire sample on the operative and non-operative leg were 11.53 ± 3.72 and 11.69 ± 3.73, respectively. Average scores were lower for our sample compared to normative data in age-matched community-dwelling older adults. (Table 4.6) There were no normative values for the oldest age group (80 – 89), who displayed an average of 9.26 ± 3.91 steps on the operative side and 9.00 ± 3.28 steps for the non-operative. Similar deficits were seen on both surgical and non-surgical sides, with 83.5% of the sample showing deficits in the operative limb and 82.6% in the non-operative. The greatest discrepancy was seen for those aged 60 – 69 years, who had an average difference of 4.00 steps on the operative side.

Table 4.6 Results of Step Test in people 12 months after total hip arthroplasty compared to normative values stratified by age and sex. (n=115)

Age Group	Normative Data (Mean)[130]	Number of participants	Mean ± SD (OS)	n (%) with deficits (OS)	Mean ± SD (N-OS)	n (%)with deficits (N-OS)
50 – 59	17.1	27	14.4 ± 3.5	22 (81.5)	14.7 ± 3.7	21 (77.8)
60 – 69	15.6	43	11.6 ± 3.3	37 (86.0)	11.9 ± 3.4	38 (88.4)
70 – 79	13.7	45	10.7 ± 3.2	37 (82.2)	10.8 ± 3.0	36 (84.0)
80 – 89	-	19	9.3 ± 3.9	-	9.0 ± 3.3	-

Notes: OS; Operative Side, N-OS; Non-operative side, (-) indicates that there are no defined normative scores for this age group, table was created using the side with the least number of steps.

4.4.4 Timed-Up-and-Go (TUG) Test

The average time on the TUG was 10.29 ± 3.07 seconds and ranged from 6.13 to 32.38 seconds. Time to complete the TUG was slower across all age decades compared to normative values. (Table 4.7) The greatest discrepancy was seen for females 80 – 89 years of age, who completed the assessment on average 3.6 seconds slower than normative values. Overall, 83 participants (77.6%) had TUG times slower than average community-dwelling older adults.

Table 4.7 Results of Timed Up-and-Go Test in people 12 months after total hip arthroplasty compared to normative values stratified by age and sex. (n=108)

Age Group	Number of participants per age grouping	Mean ± SD	Normative Data (Mean)[133]	n (%) of participants with deficits
50 – 59	27	8.37 ± 1.10	-	-
60 – 69	43	9.84 ± 2.47	8	36 (83.7)
70 – 79	45	10.70 ± 2.13	9	35 (77.8)
80 – 89 (male)	7	10.51 ± 2.56	10	2 (28.6)
80 – 89 (female)	12	14.6 ± 5.90	11	10 (83.3)

Notes: (-) indicates that there are no defined normative scores for this age group.

4.4.5 Activities-specific Balance Confidence (ABC) Scale

Scores on the ABC scale ranged from 30.6% to 100.0% with an average score of 86.2 ± 15.1%. Confidence was highest among participants for question 4: "reach for a small can off a shelf at eye level" (97.1 ± 8.2%), and question 8: "walk outside the house to a car parked in the driveway" (94.8 ± 12.4%). The lowest balance confidence was seen for questions 16: "walk outside on icy sidewalks" (61.2 ± 30.0%) and 15: "step on/off of an escalator while holding parcels" (72.8 ± 32.1). Similar results were seen for each question when stratifying by faller status. (Table 4.8).

Table 4.8 Average score and range of scores on the individual questions within the Activities-specific Balance Confidence Scale between participants who did and did not experience a fall in the 12 months after total hip arthroplasty surgery. (n=135)

ABC Question	**Non-fallers (n=106)** (mean ± SD, [min – max]	**Fallers (n=29)** (mean ± SD, [min – max]
Question 1	92.8 ± 14.2 [10.0 - 100.0]	91.0 ± 13.9 [40.0 – 100.0]
Question 2	86.0 ± 18.2 [10.0 – 100.0]	78.2 ± 23.7 [20.0 – 100.0]
Question 3	87.5 ± 18.9 [0.0 – 100.0]	87.4 ±15.2 [40.0 – 100.0]
Question 4	97.4 ± 8.4 [40.0 – 100.0]	96.2 ± 7.3 [70.0 – 100.0]
Question 5	89.2 ± 18.5 [0.0 – 100.0]	83.6 ± 24.9 [10.0 – 100.0]
Question 6	66.7 ± 35.5 [0.0 – 100.0]	67.9 ±32.1 [0.0 – 100.0]
Question 7	94.5 ± 16.6 [0.0 – 100.0]	93.1 ± 20.0 [0.0 – 100.0]
Question 8	94.8 ± 12.4 [20.0 – 100.0]	94.3 ± 9.0 [60.0 – 100.0]
Question 9	93.5 ± 11.5 [50.0 – 100.0]	92.9 ± 9.2 [60.0 – 100.0]
Question 10	93.0 ± 15.3 [20.0 – 100.0]	92.2 ± 12.6 [60.0 – 100.0]
Question 11	91.1 ± 15.5 [10.0 – 100.0]	90.5 ± 13.8 [50.0 – 100.0]
Question 12	89.8 ± 18.1[0.0 – 100.0]	84.5 ± 23.1 [0.0 – 100.0]
Question 13	85.9 ± 19.3 [0.0 – 100.0]	81.0 ± 23.0 [0.0 – 100.0]
Question 14	86.3 ± 25.5 [0.0 – 100.0]	83.9 ± 25.9 [0.0 – 100.0]
Question 15	72.8 ± 32.1[0.0 – 100.0]	72.1 ± 31.0 [0.0 – 100.0]
Question 16	61.1 ± 30.0 [0.0 – 100.0]	60.7 ± 32.3 [0.0 – 100.0]

4.4.6 Falls Risk for Older People - Community Setting Questionnaire (FROP-Com)

There were 108 participants included in the analysis of the FROP-Com. Scores ranged from 2 – 20 with an average of 8.20 ± 3.61, indicating an overall mild falls risk. (Table 4.9) A total of nineteen risk factors were identified using the FROP-Com, with an average of 5.41 ± 2.00 risk factors in the sample. Greater than half of these risk factors, an average of 3.73 ± 1.65, were considered modifiable. In our sample of adults 60 years of age and older, 83.3% were deemed to be at a mild risk of future falls (n=90), 15.7% were at a moderate risk (n=17) and only 0.9% were considered high risk (n=1). The most prevalent risk factors were: medical condition affecting balance/mobility (100.0%), number of prescription medications (88.0%) and alcoholic drinks in the past week (62.0%).

Overall, the majority of participants in the mild falls risk category showed deficits in the TUG (77.8%) and Step Tests (89.6%), with a smaller proportion (38.9%) showing deficits on the 30CST. Additionally, only 17 (18.9%) participants showed gait velocities below 1.0m/s. All other participants showed deficits in the physical assessments, except for 6 participants in the moderate group (35.3%) on the gait testing and 2 (11.8%) in the moderate group on the 30CST. (Table 4.10)

4.5 Objective Four: Falls Knowledge

The majority of participants (51.1%) agreed that a hard fall, one in which the participant strikes a flat, hard surface at a lower level with a body part other than their hands would cause them to be injured. However, 51.1% of participants also believed they would be able to return to their current living situation despite an injurious fall. Ninety-nine participants (73.4%) stated an interest in learning more about how to prevent falls, while the rest were undecided (21.5%) or did not want to learn more (5.3%). (Table 4.11).

The two falls risk factors rated lowest as increasing falls occurrences were “people are forgetful” (5.46 ± 2.69) and “personal grab bars are poorly positioned” (6.81 ± 2.70). Conversely, the two factors rated highest for leading to falls were “sidewalks and streets are not clear of ice/snow” (8.41 ± 2.01) and “doing unsafe or risky things” (8.41 ± 2.01). Both are attributable to extrinsic risk factors. (Figure 4.5)

Table 4.9 A listing of responses on the Falls Risk for Older People - Community setting scale by people 60 years of age and older 12 months after a total hip arthroplasty. (n = 108)

FROP-Com Item	**Response**	**n (%)**
Falls in past 12 months? (Yes/no)	Yes	25 (23.1)
Injury related to falls?	Yes	14 (13.9)
Number of prescription medications	1 or more	95 (88.0)
Number of pre-identified medications	1 or more	37 (34.3)
Medical condition affecting balance/mobility	1 or more	108 (100.0)
Sensory or vision impairment	Yes	4 (3.7)
Foot problems	Yes	24 (22.2)
Inappropriate footwear	Yes	1 (0.9)
Cognitive impairment*	Yes	33 (30.5)
Is individual continent?	Yes	94 (87.0)
Goes to washroom 3 or more times at night?	Yes	19 (17.6)
Decline in food intake in past 3 months	Yes	11 (10.2)
Weight loss in last 3 – 12 months	Yes	29 (26.9)
Number of alcoholic drinks in past week	1 or more	94 (62.0)
Does the home appear safe?	-	-
Behaviours during ADLs	Aware of abilities Under/overestimates abilities	66 (61.1) 42 (38.9)
Prior to fall, how much assistance required in ADL's	Supervision required	0 (0.0)
Has this changed since most recent fall?	Yes	0 (0.0)
Prior to fall, how much assistance required in IADL's	Supervision required	0 (0.0)
Has this changed since most recent fall?	Yes	0 (0.0)
Appears unsteady when walking?	Yes	24 (22.2)
Walk safely in home?	No	8 (7.4)
Walk safely in community?	No	23 (21.3)
Physical activity level	Not very to inactive Moderate to very	45 (41.7) 63 (58.3)

Notes: Cognitive impairment determined as scores<26 on the Montreal Cognitive Assessment; ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living.

Table 4.10 Percentage of people 12 months after unilateral total hip arthroplasty with scores below normative values on physical measures stratified by FROP-Com classification. (n=108)

FROP-Com Classification	Total (n)	TUG scores below average [n (%)]	30CST scores below average [n (%)]	Step Test scores below average [n (%)]	Gait velocity below 1.0m/s [n(%)]
Mild	90	70 (77.8)	35 (38.9)	69 (89.6)	17 (18.9)
Moderate	17	17 (100)	15 (88.2)	11 (100)	11 (64.7)
Severe	1	1 (100)	1 (100)	1 (100)	1 (100)

Note: There were no defined normal values for the 80 – 89 age group for the Step Test, therefore, these participants were excluded and the Step Test results calculated using n=89.

Table 4.11 Falls prevention measures and perception of falls in people 12 months after a unilateral total hip arthroplasty.

Questionnaire Item	Response Option	n (%)
Do you think falls after THA can be prevented?	Yes	122 (90.4)
Do you feel unsteady when walking?	Yes	24 (17.8)
Do you think you will you fall at some point in the next 12 months?	Yes	18 (13.3)
Were you taught how to prevent falls in post-operative physiotherapy?	Yes	58 (43.0)
Were you taught how to get up after a fall in post-operative physiotherapy?	Yes	33 (24.4)

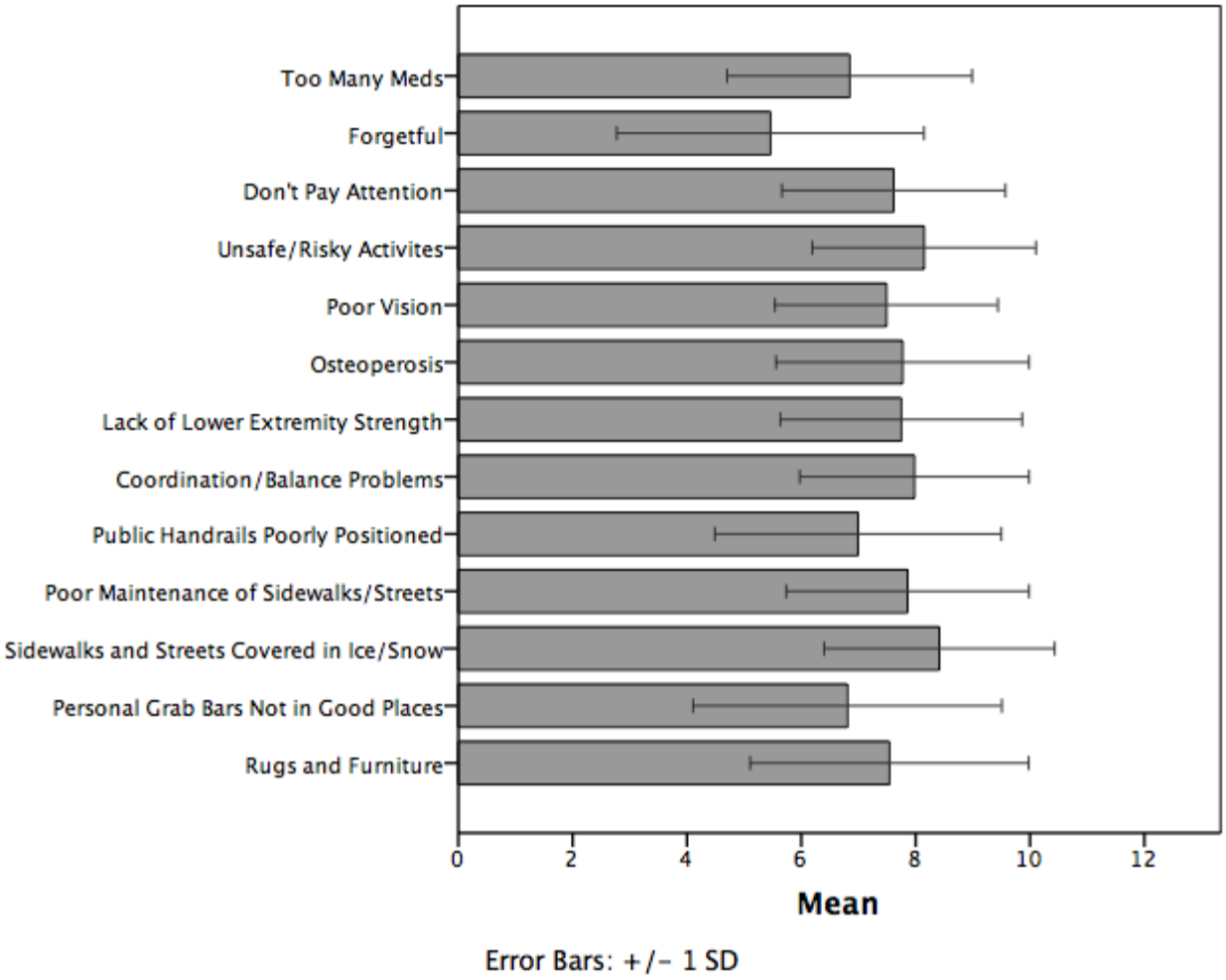

Figure 4.5 Average participant ratings for belief in how likely different factors contribute to falls in community-dwelling older adults. (0 as “not at all likely” and 10 as “most likely”).

When rating the importance of falling compared with their other health concerns on a ten-point ordinal scale, 88 (65.2%) participants gave it a value of ≥6. The mean value for this question was 6.54 ± 3.09. Further, 28 (20.7%) participants rated falling as their most important health concern. (Figure 4.6)

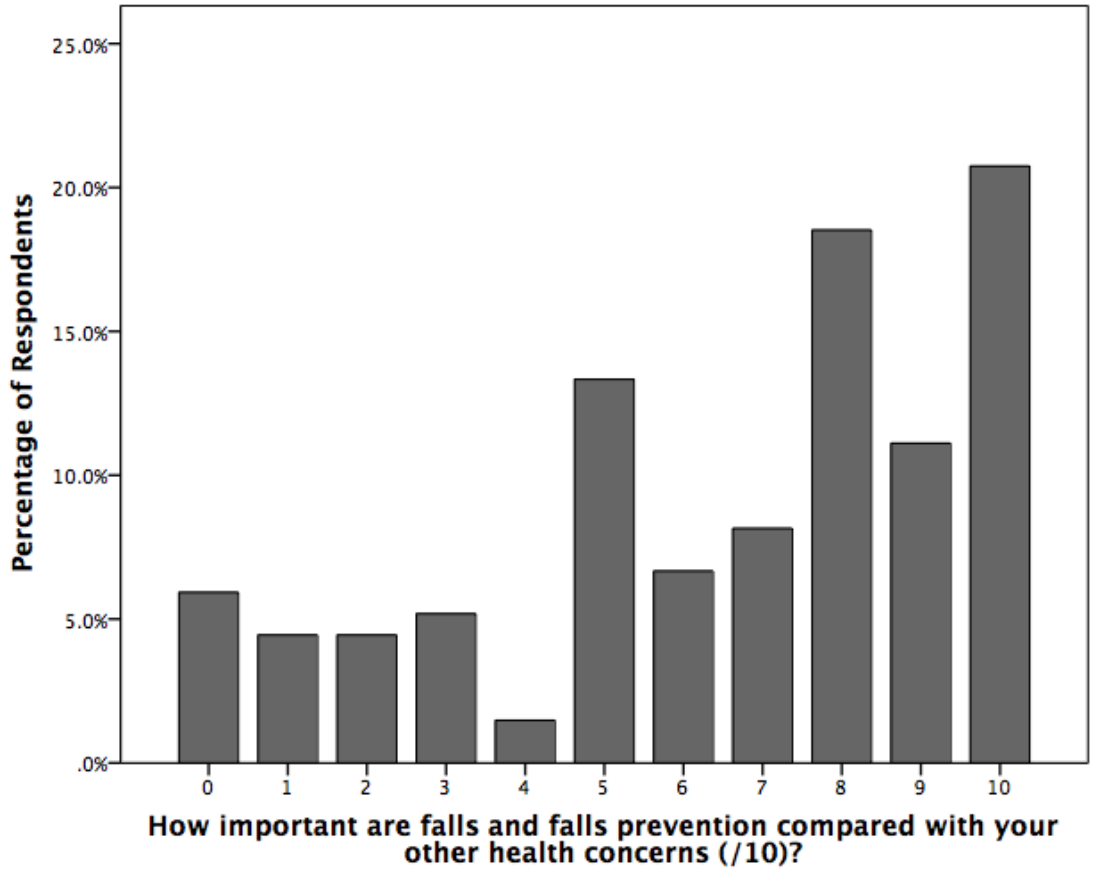

Figure 4.6 Number of participants reporting the importance of falling compared with other health concerns (0 as “not at all important” and 10 as “most important”).

Modifications made to home or daily activities since surgery to reduce the risk of falling were reported by 80 (59.3%) participants, who collectively provided 97 responses. (Figure 4.7) The most common modifications were to the physical environment through the addition of grab bars or railings.

Forty-six (34.1%) participants gave 48 responses for modifications they planned to make to their homes to prevent falls. The most commonly reported plan for modification was also to the physical environment. (Figure 4.8) Six participants believed making their planned modifications would be difficult. Reasons for difficulty included: increased bodyweight, upcoming additional joint replacement surgery, difficulty with exercise, financial considerations, family and other responsibilities, and limitations in the physical environment.

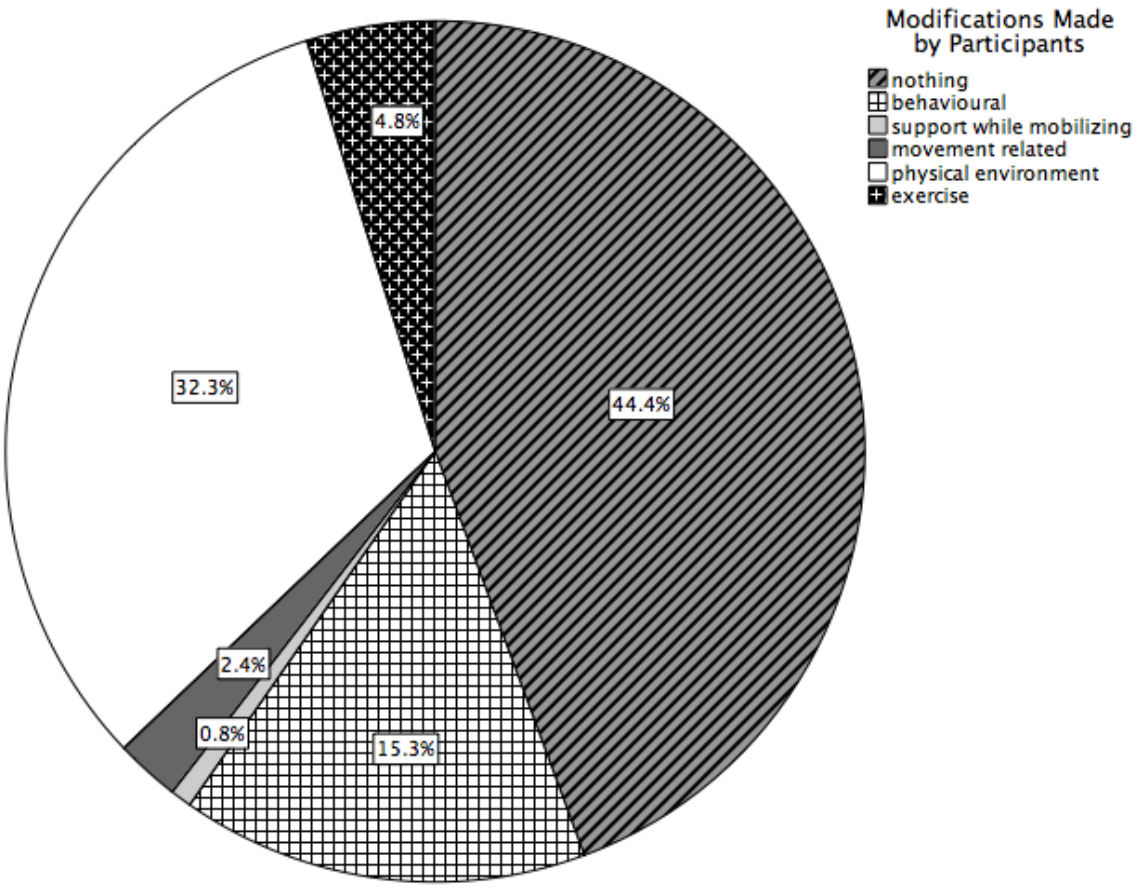

Figure 4.7 Modifications made by people in the 12 months following a unilateral total hip arthroplasty to reduce their risk of falling.

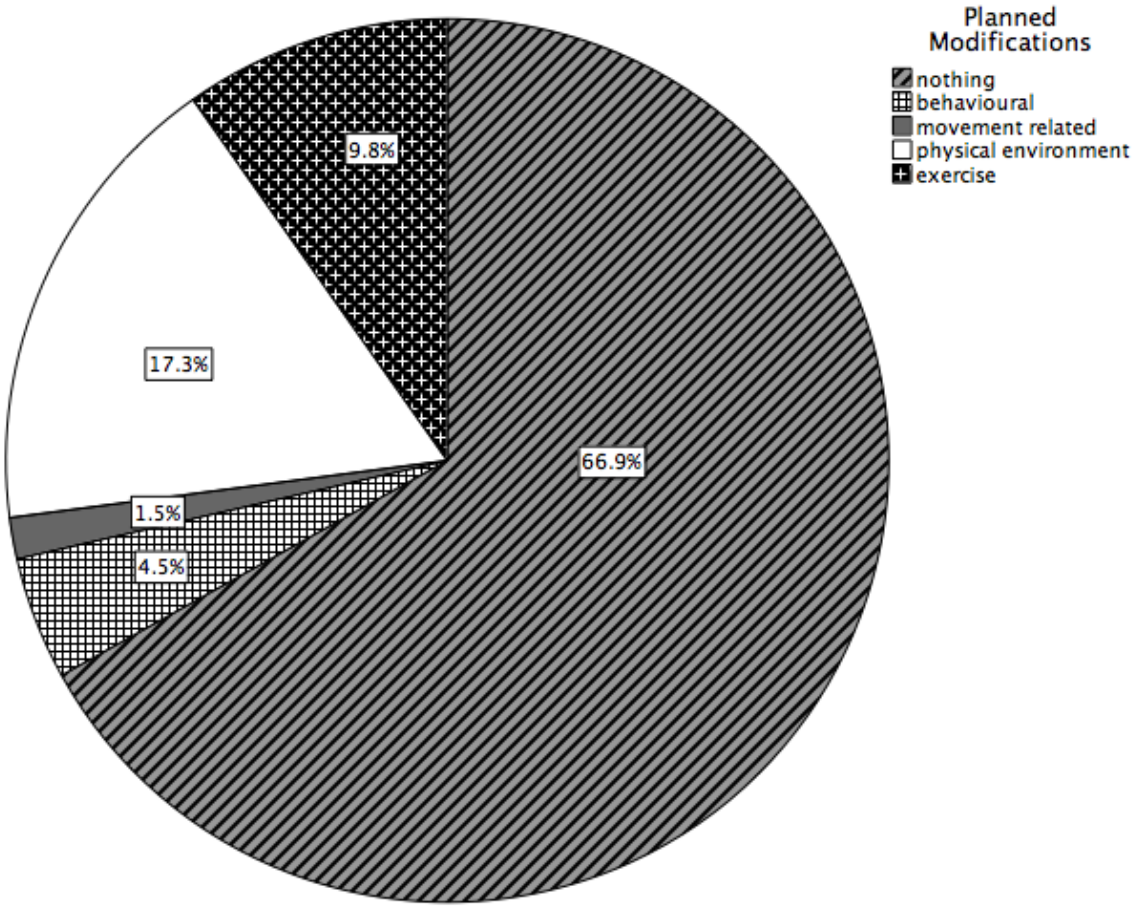

Figure 4.8 Modifications planned to reduce their risk of falling by people who are 12 months after a total hip arthroplasty surgery.

5.0 Discussion

The present study found that during the 12 months after THA surgery, 21.5% of participants reported sustaining a fall. Results of the FROP-Com showed the majority of participants to be at an overall mild risk of future falls. The FROP-Com identified several modifiable risk factors among participants, including the number of prescription medications and drinking habits. Additionally, our in-depth falls risk assessment found deficits in several physical parameters that have previously been identified after THA and are factors known to increase the risk of falling in older adults. Upon examination of participants' knowledge surrounding falls, we found a lack of overall understanding of known falls risk factors and falls mechanisms. These findings are very novel within this patient population and the results have important implications for understanding falls risk for individuals in the year following THA surgery.

Annual falls prevalence among community-dwelling older adults is approximately 33%[68] and becomes further elevated to 45% among those with hip OA.[112] In the lone study examining falls after THA, Ikutomo et al.[113] found a falls prevalence of 36%. Our study partially agrees with the results of Ikutomo et al.[113] as the prevalence of falls observed after THA was less than that reported for people with hip OA. However, contradictory to the former study we found that participants in our sample fell less often than that experienced among community-dwelling older adults. The reduced prevalence of falls seen in our study may be a result of differences in the samples evaluated. Firstly, the study by Ikutomo et al. consisted of a predominantly female cohort (95%), whereas our study consisted of a near equal number of both sexes. Our study was able to demonstrate that females had a 4 times increased likelihood of sustaining any fall compared to males. Additionally, the time frame after surgery for which participants were assessed differed between the studies. Ikutomo et al.[113] examined the prevalence of falls in the previous year for participants greater than 1 year post-operatively, with individuals being an average of 5 years removed from surgery. Our study examined falls during the first post-operative year when physical deficits and changes in mobility are greatest. Similar to Ikutomo et al.[113] the present study also examined fall injuries and fall mechanisms, for which analogous results were noted.

While one in every three older adults falls annually, approximately 5 to 10% of these falls will cause major injury and 30 to 50% result in minor injury.[68,77,141] Falls occur most frequently as the result of a trip or slip in the home or surrounding areas.[68,142,143] The circumstances surrounding falls and injuries that occurred from falling in our sample did not differ from that reported for the average community-dwelling older adult population.

There are many risk factors known to increase the likelihood of a fall among community-dwelling older adults, such as female sex or polypharmacy.[78,81,98] Our finding that both sex and a greater number of prescription medications were significantly related to falls was consistent with previous literature.[78,98,113] While both of these factors have been extensively documented in older adults in general, there has been no research examining the effects among people after a total hip arthroplasty. Our finding that more than one joint arthroplasty increased the likelihood of falls by almost a factor of 6 has not been identified before. The increased risk of falling in these participants may be partially explained by ongoing deficits in physical function that are compounded with multiple arthroplasty surgeries. An additional explanation is the possibility for residual pain from OA following surgery. Pain has been shown to be the greatest predictor of falls among individuals presenting with hip OA.[109,110,112] Dore et al.[144] found that falls risk increased for each additional symptomatic OA joint. Whether this pain still contributes to risk beyond the replacement of the symptomatic joint is unknown based on our study findings. Future falls research in this population will benefit from examining pain in other lower extremity joints.

It is well known that deficits in lower extremity strength and balance are associated with an increased risk of falling in older adults.[68–70] Several studies have found that lower extremity strength does not return to normal after THA surgery, with one study citing reduced hip extensor moment and hip power 10 years post-operatively.[61,65,145] Additionally, while there have been contradictory results for balance, deficits have commonly been observed following a THA.[63,145] Our results were consistent with these findings as a large proportion of our sample displayed deficits on the 30CST, the Step Test and TUG compared to normative values for average community-dwelling older adults.

The majority of functional gains after THA surgery are usually achieved by 6 months.[8] At this point individuals should have regained a higher level of functioning compared to the immediate post-operative phase.[61] We found that the majority of falls in our sample occurred in the latter 6-month period following surgery. Participants likely would have returned to normal activities, thus increasing exposure to situations in which falls could potentially occur. This finding is meaningful when considering the majority of participants displayed intrinsic deficits in lower extremity strength and balance as identified using the 30CST and Step Test. These impairments could increase the likelihood of a fall and fall-related injuries. It is proposed that falls risk assessment should be performed in this population beyond the first 3 to 6 months when people are receiving physiotherapy.[8]

The FROP-Com is a valid and reliable tool with a moderate capacity to predict future falls in community-dwelling older adults.[136] The majority of our sample was shown to be at a mild risk of falling, warranting action on individual risk factors along with health behaviour recommendations. Several identified risk factors were considered modifiable, for which action at an individual level can assist in reducing falls risk. While the FROP-Com is an in-depth and comprehensive falls risk assessment it examines predominantly non-physical risk factors, such as medications or food intake. Following a THA the greatest expected risk factors for falling would lie predominantly in physical deficits, a domain that receives limited assessment on the FROP-Com. Indeed, results of the current study and previous research indicate that physical deficits are apparent for individuals having undergone a THA.[59,61,63] The FROP-Com is a useful tool for health care professional to assess falls risk, yet there is need to include additional measures that are specifically aligned with where deficits would be predicted in this patient population. Physical deficits in lower extremity strength and balance should be assessed with tests such as the 30CST, TUG, Step Test and 6-Meter Walk Test to complement use of the FROP-Com. During clinical visits it may not be time-efficient to utilize all measures, it would best to employ a measure of gait velocity, which has been previously associated with falls risk, in conjunction with the TUG as it mimics movements performed in everyday activities.

Physical deficits are important factors to consider when assessing falls risk, however, none of the physical measures employed have robust predictive validity for future falls like that of the

FROP-Com. The only examined parameter with predictive validity for falls was gait velocity. Gait velocities of less than 1 m/s are considered one of the most important predictors of future falls in older adults.[116,146,147] Small decreases in gait speed of 0.10m/s are associated with a 7% increased risk of falling with 0.70 m/s being considered a slow gait.[116] Findings of the current study indicated that almost one quarter of participants walked at speeds slower than 1 m/s under single-task conditions. Furthermore, gait performance deteriorated in the dual-task condition for greater than half of the participants who walked slower than 1 m/s. Utilization of a clinical measure of gait velocity at follow-up appointments using a stop watch over a 6-meter distance may aid health care professionals in assessing falls risk among patients following a THA. This measurement tools provides an easy, inexpensive and receptive way to objectively examine gait and assess falls risk.

Measurement of gait speed is important for preventing falls when considering that walking is the most commonly reported activity by older adults at the time of a fall. Our results were consistent with previous literature in demonstrating that most falls occurred while walking. Dynamic balance is important to maintaining stability while walking, deficits in this area impact falls risk. When examining balance as a risk factor for falls, measuring dynamic balance can elucidate deficits that are not apparent when assessing static balance.[148] Previous research assessing static balance following THA found no deficits compared to the non-operative limb beyond 6 months post-operatively.[145] Nallegowda et al.[63] assessed both static and dynamic balance in healthy controls and THA patients, and found significant differences for dynamic balance. We used the Step Test as a measure of dynamic balance in the present study, requiring participants to weight shift and spend time in single leg stance, similar to walking. We saw persistent dynamic balance deficits in our sample when comparing scores to normative data from healthy community-dwelling older adults. The control of balance is complex and multidimensional.[148] Factors such as postural control and anticipatory postural adjustments, among others, play a major role in coordinating the body's movements to ensure stability. The findings highlight how balance is assessed and which assessment tools are used are important for quantifying function in this population.[148]

It is also important that individuals at a greater risk of falling understand factors associated with an increased risk and how to prevent the occurrence of falls. Older adults generally have a poor understanding of falls, falls risk factors and preventative measures.[149] Our results were consistent with previous findings in that there was a limited overall understanding of falls and fall mechanisms among our participants. Participants though did rank falling as an important health concern, demonstrating comprehension of the potential serious consequences associated with falls. However, there was a tendency to rate extrinsic risk factors higher than intrinsic factors on the likelihood to contribute to falls. Falls result from the interaction of intrinsic and extrinsic risk factors, managing intrinsic risk is important to reduce the likelihood of the environment leading to a fall.[70,78,143] Previous research has shown that falls prevention strategies and interventions focused purely on environmental risk factors do not reduce the occurrence of falls.[150]

Consistent with beliefs about the importance of extrinsic risk factors, the majority of modifications made or planned by participants in our study were to the physical environment. Very few participants reported making or planning to make modifications to their lifestyle, including participation in exercise. A greater emphasis on exercise-related modifications would benefit participants as Sherrington et al.[151] found that exercise interventions that challenged balance and consisted of more than 3 hours per week of activity had the greatest benefit in reducing falls risk. These exercise programs reduce intrinsic risk factors, such as balance impairment, which in turn reduce environmental risk contributing to cause a fall.[70] Several participants stated feeling unsteady while walking or a belief they would fall in the next 12 months, beginning to exercise would be particularly beneficial to these individuals.

Additionally, less than half of our participants reported being taught to prevent falls during post-operative physiotherapy and less than one quarter were shown how to get up after a fall. The majority of participants agreed that they would be interested in learning more on how to prevent falls. It may be appropriate to provide falls information through alternate routes of communication beyond post-operative physiotherapy, such as pre-operative booklets or during follow-up appointments. It is also important to frame falls prevention information in a positive manner, such as maintenance of independence and quality of life.[149] Our study establishes that

falls prevention strategies are relevant interventions in this patient group and this can drive increased uptake into clinical practice.

The results of the present study have implications for clinical practice and the following recommendations are suggested. The potential for falls should be addressed with patients preparing to undergo THA surgery in order to begin education and implementation of falls prevention strategies pre-operatively. Another important recommendation is to implement functional assessments including gait speed in individuals with hip OA and in the proceeding visits following THA in order to assess the mobility of patients. Considering the ongoing functional limitations identified at the one year mark, long term follow-up and monitoring of balance, strength and gait in people up to one year after surgery will allow for continued intervention as appropriate.

5.1 Strengths and Limitations

The major strength of this study lies in our comprehensive assessment of falls and falls risk factors. The physical assessments chosen were targeted to examine deficits that have been shown in previous literature to be prevalent following THA. Another strength of this study is that it was a representative sample of individuals one-year after their THA surgery at the hospital, as the majority of patients approached agreed to participate. Additionally, all participants were consecutive patients of five different surgeons at the same institution improving the generalizability of the present study.

There are limitations in the present study that must be acknowledged. The limitation is the cross-sectional design that prompted the use of self-report for falls in the previous 12 months, rather than prospective collection of falls data. Despite having good specificity and sensitivity; retrospective self-report may result in an under-reporting of falls compared with prospective falls reporting.[152] There has the potential for participants to forget falls during the recall interval which would in turn create a recall bias of an under-reporting of fall events. Therefore, the measures of association for falls likely represent a conservative estimate of risk in the population of people who have a THA. Importantly, the present study utilized assessment scales that are used in clinical practice for the assessment of falls risk, such that the assessment protocol could

be repeated easily at a low cost in routine practice. A second limitation arises from the inability to assess individuals that did not attend their one-year follow-up appointment or declined participation but were eligible for the present study. The absence of these participants may have altered our outcomes of prevalence and risk as there is possibility their lack of attendance was the result of catastrophic falls. Considering this possibility, the results of the present study likely provide a conservative estimate of the risk of falling for individuals who have had a THA. Additionally, there was a lack of normative data available for community-dwelling adults; specifically, individuals 80 years of age and older on the Step Test, and for those in their fifth decade of life on the TUG and 30CST. The absence of these values prevented us from evaluating deficits on physical measures for our entire sample, and confined us to the age groups defined in previous literature. Despite the lack of normative values for these age groups, among the sample whose scores were compared the number of people with deficits was high. A final limitation exists in our use of prescription medications as a risk factor for falls. The use of a summary score to account for multiple prescription medications as a risk factor for falls is valid, however, specific medications such as narcotics or antidepressants have also been frequently linked to falls. While specific medications were not evaluated, it is an area that warrants future evaluation.

5.2 Future Directions

Future research in this area should employ a longitudinal cohort study design to assess similar parameters to the present study among individuals undergoing THA. Beginning pre-operatively and concluding at the one-year follow-up appointment, assessment at several time points would provide greater accuracy in falls reporting and eliminate potential recall biases. Further, it would be interesting to assess falls risk beyond one year given the persistent functional deficits and number of falls observed at the one-year follow-up appointment of this study. Given the lack of knowledge regarding falls among this patient population an additional area of focus for future research should be to examine the perception of falls among therapists who work with individuals following THA.

6.0 Conclusion

This study examined the prevalence of falls and risk of future falls after the first post-operative year in individuals having undergone a THA. Our results indicated that falls prevalence was lower than several other relevant comparator at-risk groups. On average, participants presented as having a mild falls risk on the FROP-Com, however, we found several prevailing physical deficits that would likely influence the risk of future falls beyond one year. The FROP-Com, while not designed to assess multiple dimensions of physical function would be a good complement to specific assessments of gait, balance and lower extremity strength. Examining falls knowledge also revealed that falls risk factors and mechanisms leading to falls was limited among our participants. It is important for these individuals to understand that intrinsic factors outweigh the risk of extrinsic ones, especially given the abundance of intrinsic deficits noted in the present study. Given the lack of knowledge surrounding falls and the lingering deficits found in the present study it seems an appropriate precaution to include a falls risk assessment at the one-year mark following THA.

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Appendices

Appendix A: Ethics Approval Notice

Western Research

Research Ethics

Western University Health Science Research Ethics Board
HSREB Delegated Initial Approval Notice

Principal Investigator: Susan Hunter
Department & Institution: Health Sciences\Physical Therapy,Western University

Review Type: Delegated
HSREB File Number: 108741
Study Title: Assessment of Fall Risk in Individuals One Year After Total Hip Arthroplasty Surgery

HSREB Initial Approval Date: December 16, 2016
HSREB Expiry Date: December 16, 2017

Documents Approved and/or Received for Information:

Document Name	Comments	Version Date
Western University Protocol	Received November 18, 2016	
Letter of Information & Consent		2016/12/13
Data Collection Form/Case Report Form	Version 1	2016/11/16
Instruments	FROP-Com	
Instruments	Montreal Cognitive Assessment - Version 7.1	
Instruments	MoCA - Administration and Scoring Instructions (Received for information)	
Instruments	6 Meter Walk Test Instument	
Instruments	Timed Up and Go Assessment	
Instruments	Step Test Instrument	
Instruments	Timed Sit to Stand Instrument	
Instruments	ABC Fear of Falling Instrument	
Instruments	FROP-Com Guidelines (Received for information)	

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above named study, as of the HSREB Initial Approval Date noted above.

HSREB approval for this study remains valid until the HSREB Expiry Date noted above, conditional to timely submission and acceptance of HSREB Continuing Ethics Review.

The Western University HSREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use Guideline for Good Clinical Practice Practices (ICH E6 R1), the Ontario Personal Health Information Protection Act (PHIPA, 2004), Part 4 of the Natural Health Product Regulations, Health Canada Medical Device Regulations and Part C, Division 5, of the Food and Drug Regulations of Health Canada.

Members of the HSREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940

[redacted]

Ethics Officer: Erika Basile ___ Nicole Kaniki ___ Grace Kelly ___ Katelyn Harris___ Vikki Tran ___ Karen Gopaul ✓

Western University, Research, Support Services Bldg., Rm. 5150
London, ON, Canada N6G 1G9 t. 519.661.3036 f. 519.850.2466 www.uwo.ca/research/ethics

LAWSON
HEALTH RESEARCH INSTITUTE

LAWSON FINAL APPROVAL NOTICE

LAWSON APPROVAL NUMBER: R-17-006

PROJECT TITLE: Assessment of Fall Risk in Individuals One Year After Total Hip Arthroplasty Surgery

PRINCIPAL INVESTIGATOR: Dr. Susan Hunter

LAWSON APPROVAL DATE: January 13, 2017

Health Sciences REB#: 108741

Please be advised that the above project was reviewed by the Clinical Research Impact Committee and Lawson Administration and the project:

Was Approved

Please provide your Lawson Approval Number (R#) to the appropriate contact(s) in supporting departments (eg. Lab Services, Diagnostic Imaging, etc.) to inform them that your study is starting. The Lawson Approval Number must be provided each time services are requested.

Dr. David Hill
V.P. Research
Lawson Health Research Institute

All future correspondence concerning this study should include the Lawson Approval Number and should be directed to Sherry Paiva, Research Approval Officer, Lawson Health Research [redacted]

cc: Administration

Appendix B: Letter of Information and Consent

Western HealthSciences

School of Physical Therapy

Letter of Information

Assessment of Fall Risk in Individuals One Year After Total Hip Arthroplasty Surgery

Study Principal Investigator: Susan Hunter PT PhD

Introduction

You are being invited to participate in a research study because you had a total hip joint replacement. The study will be looking at how a hip joint replacement affects a person's fall risk in the year following surgery. There has been very little research evaluating the risk of falls after people have a total hip joint replacement; however, there have been several studies that have found an increased falls risk after a total knee joint replacement. There may be an increased risk of falling because of balance problems, leg weakness and walking difficulty. Currently, we do not know how many people fall, the type of risk factors that increase falling or the consequences of falling after hip joint replacement surgery.

The purpose of this letter is to provide you with the information that will help you to decide whether you wish to participate in this study. It is important that you know why this study is being conducted and what it will involve. Please take your time to make a decision, and discuss this proposal with your orthopaedic surgeon, family members, and friends, as you feel inclined. Participation in this study is voluntary.

Description of study

Falls in older adults are common and a significant public-health problem, occurring in one third of people over the age of 65 each year. The risk of falling can increase for several reasons, for example older age, balance problems, weak muscles, and prescription medications. Falls can cause serious injuries, such as fractures and injuries to the head.

Osteoarthritis can lead to losses in strength, and balance and gait problems due to pain and reduced activity before the surgery. Hip joint replacement surgery (total joint arthroplasty) leads to pain relief and gains in function, but muscle weakness in the knee and hip can remain up to 12 months after surgery. Muscle weakness in the leg after surgery can have a significant impact on the quality and characteristics of walking and balance, making some people unsteady and at risk for falling. At this time, we do not know how common falls are in the first year after hip joint replacement surgery. This information is important for physical therapists as it will improve our understanding of the types of exercises that can be used to improve balance, walking, and functional independence and prevent falls in individuals after hip joint replacement surgery.

If you agree to participate in this study, personal information (e.g., your age, medical history, prescription medications) will be collected by interview, physical function will be tested with a series of tests and information in your medical chart related to surgery will be collected through a chart audit. During the interview, we will also collect information about any falls that occurred since your hip surgery. You will complete 5 tests of your physical ability (i.e., 1 test of your balance, 1 test of general mobility, 1 test of leg strength and 2 tests of your walking) and 2 questionnaires that assess fall risk and fear of falling. You will also complete one test of your memory. In the physical ability tests you will be asked to do the following activities: 1) while in standing repeatedly place one foot on a step (repeated for left and right foot) to test your balance 2) rise out of a chair and walk 3 meters before turning around and returning to the chair to test your general mobility, and 3) rise out of a chair as many times as possible in a 30 second time period to test your leg strength. During the two tests of your walking, we will have you wear five small accelerometers (size is 4cmx5cm), a device that records how you walk, that will be attached with a Velcro strap to your arms and legs while walking a 6-meter distance. The first test will have you walk the 6-meter distance at your usual comfortable walking speed. In the second test, you will walk at your usual comfortable walking speed and count backwards by 3's at the same time. We will also ask you to count backwards by 3's while sitting. A qualified research assistant will be present at all times to ensure a safe environment and prevent possible falls. The whole study assessment requires only one visit that will take place in the orthopaedic surgery outpatient clinic of the London Health Sciences Centre – University Campus and will take approximately 30 – 40 minutes to complete.

Participation

We are seeking 200 volunteers 50 years of age or older who are attending their one-year follow-up appointment after hip joint replacement surgery. Volunteers must be able to walk independently with or without a mobility aid (e.g., a cane or walker) for 10 meters without the help of another person, and be able to provide informed consent for themselves. However, there are certain conditions that would ***exclude*** you from participating in the study. These conditions are as follows: inability to communicate in English and the inability to walk 10 meters unassisted. If you are unsure whether any of these situations applies in your case, please feel free to ask the research staff.

Withdrawal

Participation in this study is voluntary. You may refuse to participate, refuse to answer any of the questions, or withdraw from the study at any time with no effect on your future care or academic status. If you choose to withdraw from the study, any information that was provided will not be used for any study purposes.

Risk and Benefits

Risks
The risks associated with taking part in this study are minor. The physical tests involve movements that are common in daily activities and thus do not pose any extra risk beyond these levels of activity. All tests will be conducted by a research assistant with experience in the assessment of physical function in older adults.

Benefits
You may not benefit directly from your participation in this study. You will be contributing information that will help to increase scientific understanding of fall risk, walking, and balance in adults who have had hip joint replacement surgery.

Reimbursement for Participation in the study
You will not be paid to participate in this research project.

Confidentiality
All records and research materials that would identify you will be held confidential and, to the extent permitted by the applicable laws and regulations, will not be made publicly available. If you agree to participate in this study, you will be assigned a unique identification number that will be used on all the documents related to this study. This unique number will be linked to your name and contact information on another "master list" of participants. This master list will be kept separately from the other research information in a locked office. All information collected will be kept for a period of 15 years. If the results of this study were to be published in the medical literature, your identity will not be revealed. Lawson Health Research Institute will retain the right to access data collected in this study in accordance with the Quality Assurance Evaluation Program (QAEP).
Representatives of the University of Western Ontario's Health Sciences Research Ethics Board (HSREB) may contact you, or require access to your study related records in order to monitor the conduct of the research.

Contacts
If you have any questions about this project, please contact the Principal Investigator: Dr. Susan Hunter by phone at [redacted] extension [redacted] or e-mail: [redacted]
If you have any questions about your rights as a research participant or the conduct of this study, you may contact The Office of Research Ethics at [redacted] or by email at [redacted].

You do not waive any legal rights by signing the attached consent forms. Participation in this study is completely voluntary.

Study participant

Western HealthSciences

School of Physical Therapy

Consent Form

Study Title: Assessment of Fall Risk in Individuals One Year After Total Hip Arthroplasty Surgery

Principal Investigator: Dr. Susan Hunter PT PhD

I have read the *Letter of Information*, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

_____

Participant's Name (Printed)

_____

Participant's Signature *Date (dd/mm/yy)*

I confirm that I have explained the nature, purpose, and foreseeable effects of the trial to the participant whose name is printed above. The participant consented to participate by his/her personally signed signature.

_____

Name of Person Obtaining Consent *Role in Study*

_____

Signature of Person Obtaining Consent *Date (dd/mm/yy)*

Appendix C: Normative Data

Average values on the 30 Second Chair Stand Test for community-dwelling older adults stratified by age and sex.

Age Group (Male)	Normative Data (average number of stands)[129]
50 – 54	Not evaluated
54 – 59	Not evaluated
60 – 64	<14
65 – 69	<12
70 – 74	<12
75 – 79	<10
80 – 84	<10
85 – 89	<8
Age Group (Female)	**Normative Data (average number of stands)[129]**
50 – 54	Not evaluated
54 – 59	Not evaluated
60 – 64	<12
65 – 69	<11
70 – 74	<10
75 – 79	<10
80 – 84	<9
85 – 89	<8

(Study Design: Multi-site, cross-sectional; Sample size: n=7183; Applicability to study population: community-dwelling older adults)

Average values on the Timed Up & Go Test for community-dwelling older adults stratified by age decade.

Age Group	Normative Data (average time to complete)[133]
50 – 59	Not evaluated
60 – 69	8
70 – 79	9
80 – 89 (male)	10
80 – 89 (female)	11

(Study Design: Cross-sectional; Sample size: n=96; Applicability to study population: community-dwelling older adults)

Average values on the Step Test for community-dwelling adults stratified by age decade.

Age Group	**Normative Data (average number of steps)**[130]
50 – 59	17.1
60 – 69	15.6
70 – 79	13.7
80 – 89	Not evaluated

(Study Design: Cross-sectional; Sample size: n=456; Applicability to study population: community-dwelling older adults)

Average values of gait velocity for community-dwelling adults stratified by age decade.

Age Group (Male)	**Normative Data (average speed (m/s))**[148]
50 – 59	1.43
60 – 69	1.34
70 – 79	1.26
80+	0.97
Age Group (Female	**Normative Data (average speed (m/s))**[148]
50 – 59	1.31
60 – 69	1.24
70 – 79	1.13
80+	0.94

(Study Design: Literature review and meta-analysis; Sample size: n=23111; Applicability to study population: community-dwelling older adults)

The Activities-specific Balance Confidence (ABC) Scale*

Instructions to Participants:

For each of the following, please indicate your level of confidence in doing the activity without losing your balance or becoming unsteady from choosing one of the percentage points on the scale form 0% to 100%. If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity. If you normally use a walking aid to do the activity or hold onto someone, rate your confidence as it you were using these supports. If you have any questions about answering any of these items, please ask the administrator.

The Activities-specific Balance Confidence (ABC) 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. …walk around the house? ____%
2. …walk up or down stairs? ____%
3. …bend over and pick up a slipper from the front of a closet floor ____%
4. …reach for a small can off a shelf at eye level? ____%
5. …stand on your tiptoes and reach for something above your head? ____%
6. …stand on a chair and reach for something? ____%
7. …sweep the floor? ____%
8. …walk outside the house to a car parked in the driveway? ____%
9. …get into or out of a car? ____%
10. …walk across a parking lot to the mall? ____%
11. …walk up or down a ramp? ____%
12. …walk in a crowded mall where people rapidly walk past you? ____%
13. …are bumped into by people as you walk through the mall?____%
14. … step onto or off an escalator while you are holding onto a railing? ____%
15. … step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? ____%
16. …walk outside on icy sidewalks? %

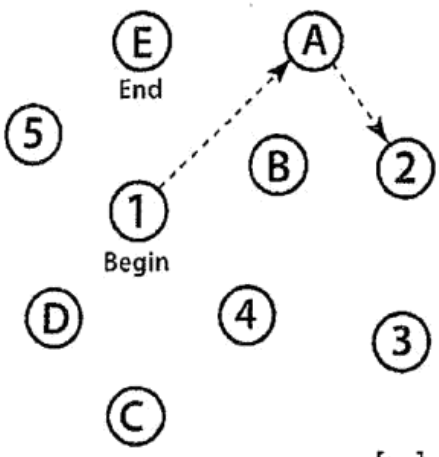
ID# _____

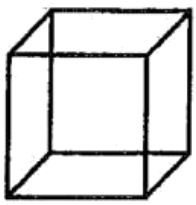
MONTREAL COGNITIVE ASSESSMENT (MOCA)

Version 7.1 Original Version

DATE: _____

VISUOSPATIAL / EXECUTIVE





Copy cube

[ ] [ ]

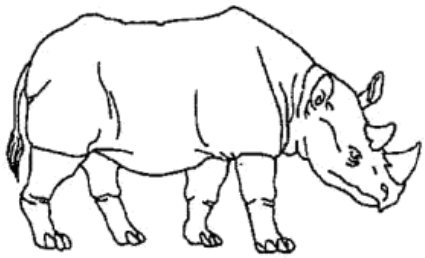
Draw CLOCK (Ten past eleven) (3 points)

[ ] Contour [ ] Numbers [ ] Hands

POINTS __/5

NAMING

[ ]



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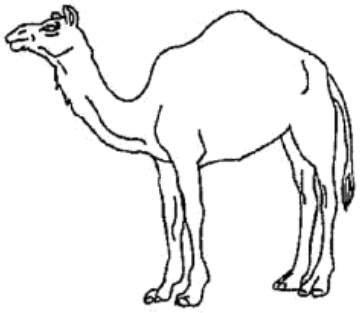

[ ]

__/3

MEMORY

Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

ATTENTION

Read list of digits (1 digit/ sec.).

Subject has to repeat them in the forward order [ ] 2 1 8 5 4

Subject has to repeat them in the backward order [ ] 7 4 2

__/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors

[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B

__/1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65

4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt**

__/3

LANGUAGE

Repeat : I only know that John is the one to help today. [ ]

The cat always hid under the couch when dogs were in the room. [ ]

__/2

Fluency / Name maximum number of words in one minute that begin with the letter F [ ] _____ (N ≥ 11 words)

__/1

ABSTRACTION

Similarity between e.g. banana - orange = fruit [ ] train – bicycle [ ] watch - ruler

__/2

DELAYED RECALL

	Has to recall words WITH NO CUE	FACE [ ]	VELVET [ ]	CHURCH [ ]	DAISY [ ]	RED [ ]
Optional	Category cue					
	Multiple choice cue					

Points for UNCUED recall only

__/5

ORIENTATION

[ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City

__/6

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Normal ≥ 26 / 30

TOTAL __/30

Add 1 point if ≤ 12 yr edu

Administered by: _____

NARI NATIONAL AGEING RESEARCH INSTITUTE LTD Bringing research to life

Falls Risk for Older People – Community setting (FROP-Com)

Personal details

Name: _____

Personal Code #: _____

Date of Assessment: / /

Address: _____

DOB: _____ **Telephone:** _____

Marital Status:

Single / Married (defacto) / Widowed / Divorced (separated) / Unknown (circle)

Usual living arrangements: _____

Recent health / community services use:

1. Community Aged Care Packages/Services	Y/N	2. Community Rehabilitation	Y/N
3. Doctors Appointment	Y/N	4. Doctor Home Visit	Y/N
5. Home Help	Y/N	6. Home Modifications	Y/N
7. Home Rehabilitation	Y/N	8. Linkages Package	Y/N
9. Meals on Wheels	Y/N	10. OT Home visit	Y/N
11. Outpatient Appointment	Y/N	12. Other	Y/N
13. Post Acute Care	Y/N	14. Personal Care	Y/N
15. Respite Care	Y/N	16. District Nursing Services	Y/N
17. Physiotherapist Appointment	Y/N	18. Dietician	Y/N
19. Podiatrist	Y/N	20. Personal Alarm	Y/N
21. Day Centre	Y/N	22. Falls and Balance clinic	Y/N

Comments _____

_____

• Is English the individuals preferred language? If not, what is?	o Yes o No
• Does the individual have functional English?	o Yes o No

History of falls *(0-3points)*		**SCORE**
1. Number of falls in the past 12 months?	o No falls (0) o 1 fall (1) o 2 falls (2) o 3 or more (3)	[ ]
2. Was an injury sustained in any of the fall/s in the past 12 months? *(rate most severe injury due to a fall in the past 12 months)*	o No (0) o Minor injury, did not require medical attention (1) o Minor injury, did require medical attention (2) o Severe injury (fracture, etc) (3)	[ ]
3. Describe the circumstances of the most recent fall in the past 12 months. **Time of fall**: AM / PM *(please circle)* **Location of fall**: inside home / outside home / community **Direction of fall**: left / right / forward / backward / down / can't remember / other **Cause of fall**: trip / slip / loss of balance / knees gave way / fainted / feeling dizzy or giddy / alcohol or meds / fell out of bed / unknown Comments: **Injuries:**		
	Sub total for this page	[ ]

Medications *(0-3 points)*		
4. List all medications currently taken.	+ + + + + + + + + + + + + + + +	
5. Number of prescription medications.	o No medication (0) o 1–2 medications (1) o 3 medications (2) o 4 or more medications (3)	[ ]
6. Does the individual take any of the following type of medication? o sedative o antidepressant o anti-epileptics o central acting analgesic o digoxin o diuretics o type 1a antiarrythmic o vestibular suppressant	o None apply (0) o 1–2 apply (1) o 3 apply (2) o 4 or more apply (3)	[ ]
Medical conditions *(0-3 points)*		
7. Does the individual have a chronic medical condition/s affecting their balance & mobility? o Arthritis o Respiratory condition o Parkinson's Disease o Diabetes o Dementia o Peripheral neuropathy o Cardiac condition o Stroke o Other neurological conditions o Lower Limb Amputation. o Osteoporosis o Vestibular Disorder o Other dizziness o Back pain o lower limb joint replacement	o None apply (0) o 1-2 apply (1) o 3-4 apply (2) o 5 or more apply (3) Osteoporosis: o Unknown o does not have	[ ]
Sensory loss		
8. Does the client have an uncorrected sensory deficit/s that limits their functional ability?	Vision Somato Sensory o no (0) o no (0) o yes (1) o yes (1)	[ ]
Feet & footwear		
9. Does the client have foot problems, e.g. corns, bunions, swelling etc.	o no (0) o yes (1) (specify):	[ ]
10. Does the client have inappropriate, poorly fitting or worn footwear?	o no (0) o yes (1) (specify):	[ ]
Cognitive status*: (score 0-3 points).*		
11. AMTS score o Age o Time to the nearest hour o Address to recall – 42 West St o Current year o Current location (where are we?) o Recognition of two persons (Dr, nurse) o Date of birth o Years of first World War o Name of current prime minister o Count backwards from 20 by ones	Number of correct responses: o 9-10 (0 point) o 7-8 (1 point) o 5-6 (2 points) o 4 or less (3 points) Score: ...../10	[ ]
Continence:		
12. Is the individual continent?	o Yes (0) o No (1)	[ ]
13. Does the individual regularly have to go to the toilet in the night (3 or more times)?	o No (0) o Yes (1) (if uses a bottle, rate as 0)	[ ]
	Sub total for this page	[ ]

Nutritional status *(score 0-3 points)*		
14. Has the individual's food intake declined in the past three months due to a loss of appetite, digestive problems, chewing or swallowing difficulties?	o No (0) o Small change, but intake remains good (1) o Moderate loss of appetite (2) o Severe loss of appetite / poor oral intake (3)	[ ]
15. Weight loss during the last 3-12 months.	o Nil (0) o Minimal (<1 kg) or unsure (1) o Moderate (1-3kg) (2) o Marked (>3kg) (3)	[ ]
16. Number of alcoholic drinks consumed in the past week	o Nil (0) o 1-3 (1) o 4-10 (2) o 11+ (3)	[ ]
Environment *(score 0-3 points)*		
17. Did the home environment appear safe? *(NOTE: only rate if undertaking a home visit assessment, leave blank otherwise)*	o Yes (0) o Minimal environmental hazards (1) o Moderate environmental hazards requiring modification (2) o Extremely unsafe environment (3)	[ ]
Functional Behaviour *(score 0 –3 points)*		
18. Observed behaviours in Activities of Daily Living and Mobility indicate	o Consistently aware of current abilities /seeks appropriate assistance as required (0) o Generally aware of current abilities /occasional risk-taking behaviour (1) o Under-estimates abilities / inappropriately fearful of activity (2) o Over-estimates abilities/frequent risk-taking behaviour (3)	[ ]
Function *(score 0-3 points)*		
19. Prior to this fall, how much assistance was the individual requiring for personal care activities of daily living (eg dressing, grooming, toileting)? *(NOTE: If no fall in last 12 months, rate current function)*	o none (completely independent) (0) o supervision (1) o some assistance required (2) o completely dependent (3)	[ ]
20. Has this changed since the most recent fall? *(leave blank if no falls in 12 months)*	o No (0) o Yes (1) (specify):	[ ]
21. *Prior to this fall, how much assistance was the individual requiring for instrumental activities of daily living (eg shopping, housework, laundry)? (NOTE: If no fall in last 12 months, rate current function)*	o none (completely independent) (0) o supervision (1) o some assistance required (2) o completely dependent (3)	[ ]
22. Has this changed since the most recent fall? *(leave blank if no falls in 12 months)*	o No (0) o Yes (1) (specify):	[ ]
	Sub total for this page	[ ]

Balance *(score 0-3 points)*		
23. Does the individual, upon observation of walking and turning, appear unsteady or at risk of losing their balance? *(NOTE: Rate with usual walking aid. Tick one only, if level fluctuates, tick the most unsteady rating)*	o No unsteadiness observed (0) o Yes, minimally unsteady on walking or turning (1) o Yes, moderately unsteady on walking or turning (needs supervision) (2) o Yes, consistently and severely unsteady on walking or turning (needs constant hands on assistance (3)	[ ]
Gait / Physical Activity *(score 0-3 points)*		
24. Can the individual walk safely around their own home?	o Independent, no gait aid needed (0) o Independent with a gait aid (1) o Safe with supervision / physical assistance (2) o Unsafe (3)	[ ]
25. Can the individual walk safely in the community?	o Independent, no gait aid needed (0) o Independent with a gait aid (1) o Safe with supervision / physical assistance (2) o Unsafe (3)	[ ]
26. If a walking aid is used, list the aid and when it is used.	Aid..... o indoors o outdoors Comments:	
27. How physically active is the individual?	o Very active (exercises 3 times per week) (0) o Moderately active (exercises less than twice per week) (1) o Not very active (rarely leaves the house) (2) o Inactive (rarely leaves one room of the house) (3)	[ ]
28. Has this changed since the most recent fall?	o No (0) o Yes (1) (specify):	[ ]
	Sub total for this page	[ ]
	Sub total for page 1	[ ]
	Sub total for page 2	[ ]
	Sub total for page 3	[ ]
	Total Risk Score	[ ]

Grading of falls risk:

o Mild falls risk	0 –11	Implement actions for identified individual risk factors, & recommend health promotion behaviour to minimise future ongoing risk (eg – increased physical activity, good nutrition)
o Moderate falls risk	12-18	Implement actions for identified individual risk factors
o High falls risk	19 - 60	Implement actions for identified individual risk factors, and implement additional actions for high falls risk (e.g. refer to a specialist Falls Clinic)

(maximum =60)

Your Full Name: _____ **Today's Date:**
_____/_____/_____
Month Day Year

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.	☐	☐	☐	☐	☐

SF-12 Health Survey

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. **Answer each question by choosing just one answer**. If you are unsure how to answer a question, please give the best answer you can.

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

☐1 Excellent ☐2 Very good ☐3 Good ☐4 Fair ☐5 Poor

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

	YES, limited a lot	YES, limited a little	NO, not limited at all
2. **Moderate activities** such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.	☐1	☐2	☐3
3. Climbing **several** flights of stairs.	☐1	☐2	☐3

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?

	YES	NO
4. **Accomplished less** than you would like.	☐1	☐2
5. Were limited in the **kind** of work or other activities.	☐1	☐2

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)?

	YES	NO
6. **Accomplished less** than you would like.	☐1	☐2
7. Did work or activities **less carefully than usual**.	☐1	☐2

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

☐1 Not at all ☐2 A little bit ☐3 Moderately ☐4 Quite a bit ☐5 Extremely

These questions are about how you have been feeling 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	A good bit of the time	Some of the time	A little of the time	None of the time
9. Have you felt calm & peaceful?	☐1	☐2	☐3	☐4	☐5	☐6
10. Did you have a lot of energy?	☐1	☐2	☐3	☐4	☐5	☐6
11. Have you felt down-hearted and blue?	☐1	☐2	☐3	☐4	☐5	☐6

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

☐1 All of the time ☐2 Most of the time ☐3 Some of the time ☐4 A little of the time ☐5 None of the time

Patient name: Date: PCS: MCS:

Visit type (circle one)
Preop 6 week 3 month 6 month 12 month 24 month Other:_____

Harris Hip Score

Hip ID:

Study Hip: ☐ Left ☐ Right

Examination Date (MM/DD/YY): / /

Subject Initials: |____|____|____|

Medical Record Number:

Interval: _____

Harris Hip Score

Pain *(check one)*

- ☐ None or ignores it (44)
- ☐ Slight, occasional, no compromise in activities (40)
- ☐ Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
- ☐ Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require Occasional pain medication stronger than aspirin (20)
- ☐ Marked pain, serious limitation of activities (10)
- ☐ Totally disabled, crippled, pain in bed, bedridden (0)

Limp

- ☐ None (11)
- ☐ Slight (8)
- ☐ Moderate (5)
- ☐ Severe (0)

Support

- ☐ None (11)
- ☐ Cane for long walks (7)
- ☐ Cane most of time (5)
- ☐ One crutch (3)
- ☐ Two canes (2)
- ☐ Two crutches or not able to walk (0)

Distance Walked

- ☐ Unlimited (11)
- ☐ Six blocks (8)
- ☐ Two or three blocks (5)
- ☐ Indoors only (2)
- ☐ Bed and chair only (0)

Sitting

- ☐ Comfortably in ordinary chair for one hour (5)
- ☐ On a high chair for 30 minutes (3)
- ☐ Unable to sit comfortably in any chair (0)

Enter public transportation

- ☐ Yes (1)
- ☐ No (0)

Stairs

- ☐ Normally without using a railing (4)
- ☐ Normally using a railing (2)
- ☐ In any manner (1)
- ☐ Unable to do stairs (0)

Put on Shoes and Socks

- ☐ With ease (4)
- ☐ With difficulty (2)
- ☐ Unable (0)

Absence of Deformity (All yes = 4; Less than 4 =0)

- Less than 30° fixed flexion contracture ☐ Yes ☐ No
- Less than 10° fixed abduction ☐ Yes ☐ No
- Less than 10° fixed internal rotation in extension ☐ Yes ☐ No
- Limb length discrepancy less than 3.2 cm ☐ Yes ☐ No

Range of Motion (**indicates normal*)

- Flexion (*140°) _____
- Abduction (*40°) _____
- Adduction (*40°) _____
- External Rotation (*40°) _____
- Internal Rotation (*40°) _____

Range of Motion Scale

211° - 300° (5)	61° - 100 (2)
161° - 210° (4)	31° - 60° (1)
101° - 160° (3)	0° - 30° (0)

Range of Motion Score _____

Total Harris Hip Score _____

Falls Knowledge:

1. At a guess, if you talked to 100 people one year after they had a total hip joint replacement surgery, how many do you think would have had at least one fall?

_____

2. Do you believe that falls among people who have had a total hip joint replacement surgery can be prevented?
   - ☐ Yes
   - ☐ No

For each of the next 13 questions, please rate how important each of these scenarios are in making a person more likely to fall, whether they have had a total hip joint replacement surgery or not.

3. People are likely to fall because things such as rugs and furniture get in the way.

   0 1 2 3 4 5 6 7 8 9 10

   Not at all likely Most likely

4. People are likely to fall because grab bars are not present or are not in a helpful position <u>in their house or apartment</u>.

   0 1 2 3 4 5 6 7 8 9 10

   Not at all likely Most likely

5. People are likely to fall because sidewalks and streets are not clear of ice and snow.

   0 1 2 3 4 5 6 7 8 9 10

   Not at all likely Most likely

6. People are likely to fall because sidewalks and streets are poorly maintained (e.g. cracked or irregular pavement).

   0 1 2 3 4 5 6 7 8 9 10

   Not at all likely Most likely

7. People are likely to fall because handrails are not present or are poorly positioned in public places.

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

8. People are likely to fall because they have a coordination or balance problem.

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

9. People are likely to fall because they do not have enough muscle strength or endurance in their legs.

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

10. People are likely to fall because their bones are weakened with age (osteoporosis).

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

11. People are likely to fall because they have poor vision.

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

12. People are likely to fall because they do unsafe or risky things.

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

13. People are likely to fall because they do not always pay close attention to their surroundings.

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

14. People are likely to fall because they are forgetful.

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

15. People are likely to fall because they take many medications.

0 1 2 3 4 5 6 7 8 9 10

Not at all likely Most likely

16. On a scale from 0 to 10, where 0 means “not at all important” and 10 means “most important”, how important is falling compared with your other health concerns?

0 1 2 3 4 5 6 7 8 9 10

Not at all important Most important

17. Do you feel unsteady when walking?
    - Yes
    - No

18. Do you think you will fall at some time in the next 12 months?
    - Yes
    - No

19. If you were to fall hard, do you think you would seriously injure yourself?

Strongly agree Agree Undecided Disagree Strongly disagree

20. If you fell and seriously injured yourself, do you think you would be able to return to your current living situation?

Strongly agree Agree Undecided Disagree Strongly disagree

21. During your physiotherapy treatments after your surgery were you taught how to prevent falls?
    - Yes
    - No

22. During your physiotherapy treatments after your surgery, were you taught how to get up after a fall (i.e., how to get up off the floor)?
    - Yes
    - No

23. Please describe any things <u>you have modified</u> in your daily activities and/or home to reduce the risk of falling since having your total hip joint replacement surgery.

_____

_____

_____

_____

_____

_____

24. Please list any things that <u>you plan to modify</u> in your daily activities and/or home to reduce the risk of falling.

_____

_____

_____

_____

_____

_____

25. Do you feel confident you will be able to make the changes you have listed in question #34.
    - ☐ Yes
    - ☐ No

26. Is there something that might make it difficult for you to do the changes you listed in question #34 are?

_____

_____

_____

27. I am very keen to lower my risk of falling by using the strategies I listed in question #34.

Strongly agree Agree Undecided Disagree Strongly disagree

28. I am interested in learning more about how to prevent falls.

Strongly agree Agree Undecided Disagree Strongly disagree

Curriculum Vitae

W. C. Ian Janes

EDUCATION

Masters of Science – Faculty of Health and Rehabilitation Sciences 2016 – 2018
Western University, London, ON

- Title: *Assessing the risk of falling in older adults one-year after total hip arthroplasty*

Bachelor of Kinesiology Honours (co-operative) degree 2012 – 2016
Memorial University, St. John's, NL

- Coursework included human anatomy, human physiology, exercise physiology, motor learning, biomechanics, psychology/exercise psychology, nutrition/exercise nutrition, research methods and statistics
- Dean's list honours for 2014 – 2015 academic year

Level III High School Diploma 2012
Mount Pearl Senior High School, Mount Pearl, NL

- Graduated with honours status

PUBLICATIONS

a) Summary (Total Lifetime Numbers)

TYPES	TOTAL
Books	0
Chapters in Books	0
Articles in Peer-Reviewed Journals (in-press articles)	2
Articles in Peer-Reviewed Conference Proceedings	9
Abstracts, Presentations at Professional Meetings	0
Technical Writings	0
Other: (e.g., Book Reviews, Letters to the Editor)	0
Submitted Manuscripts and/or Work in Preparation	6

i) Papers in Peer-Reviewed Journals

1. Janes, W. C. I., Silvey, D., & Dubrowski, A. (2016). Are Educators Actually Coaches? The Implication of Teaching and Learning via Simulation in Education in Healthcare Professions. Cureus. doi: dx.doi.org/10.7759%2Fcureus.734 [ePub: Aug, 2016] (Role in publication: writing of first draft and writing final version of manuscript. Percentage contribution: 60%. Citations: 4. Impact factor rating: 0)
2. Janes, W. C. I, Snow, B. B., Watkins, C. E., Noseworthy, E. A., Reid, J. C., & Behm, D. G. Effect of participants' static stretching knowledge or deception on the responses to prolonged stretching. Applied Physiology, Nutrition, and Metabolism. doi:

10.1139/apnm-2016-0241 [ePub: June 14, 2016]. (Role in publication: concept and design of the study, acquisition of subject's data, interpretation of data and statistical analysis, writing first draft. Percentage contribution: 70%. Citations: 2. Impact factor rating: 2.009).

ii) Papers Submitted for Publication/Under Review

1. Thompson, S., Frengopoulos, C., Janes, W. C. I., Modaressi, S., Cox, K., Lautenschlager, N. T., Hunter, S. W. (2016) Exercise programs to improve physical function in older adults with dementia living in long-term care: a systematic review. *Submitted to Journal of Aging and Physical Activity Canada on December 03, 2017.*
2. Silvey, D, Buote, R., Janes, I., Cameron, E., Donovan, C., & Dubrowski, A. (2018) The implementation and evaluation of an Olympic wrestling program in Conne River, Newfoundland, Canada. *Submitted to The Physical Health and Education Journal on January 20, 2018*
3. Silvey, D, Buote, R., Janes, I., Donovan, C., & Dubrowski, A. (2018). The impacts of an Olympic wrestling program on the academic achievements, physical and mental health of a 13-year-old Indigenous youth: a case study. *Submitted to The Physical Health and Education Journal on February 15, 2018*

iii) Papers in Progress (Manuscripts in Preparation)

1. Janes, W. C. I., Lanting, B., Somerville, L., Howard, J., Vasarhelyi, E. M., MacDonald, S., Naudie, D., Hunter, S. W. Assessment of fall risk in individuals one-year after total hip arthroplasty surgery.
2. Janes, W. C. I., Lanting, B., Somerville, L., Howard, J., Vasarhelyi, E. M., MacDonald, S., Naudie, D., Hunter, S. W. Investigating falls knowledge and falls prevention among total hip arthroplasty patients: a cross-sectional study.
3. Janes, W. C. I, Frengopoulos C., Modaressi, S., Thompson, S., Hunter S. W., Influence of path configuration on gait performance during dual-task testing in young and older adults.

iv) Abstracts, Presentations to Professional Meetings (*, presenter at conference)

1. **Janes, W. C. I.**, Lanting, B., Somerville, L., Howard, J., Vasarhelyi, E. M., MacDonald, S., Naudie, D., Hunter, S. W. Examining the prevalence of falls and future falls risk in older adults one-year after total hip arthroplasty. Canadian Physiotherapy Association Congress. Montreal, Canada. November 1 – 3, 2018. *(Poster Presentation)*
2. **Janes, W. C. I.***, Lanting, B., Somerville, L., Howard, J., Vasarhelyi, E. M., MacDonald, S., Naudie, D., Hunter, S. W. Examining falls prevalence and future falls risk in adults one-year after total hip arthroplasty. Canadian Falls Prevention Conference. St. John's, Canada. June 11 – 12, 2018. *(Oral Presentation)*
3. **Janes, W. C. I*.**, Lanting, B., Somerville, L., Howard, J., Vasarhelyi, E. M., MacDonald, S., Naudie, D., Hunter, S. W. Investigating falls knowledge and falls prevention among total hip arthroplasty patients: a cross-sectional study. Canadian Falls Prevention Conference. St. John's, Canada. June 11 – 12, 2018. *(Poster Presentation)*
4. **Janes, W. C. I**.*, Lanting, B., Somerville, L., Howard, J., Vasarhelyi, E. M., MacDonald, S., Naudie, D., Hunter, S. W. Investigating falls knowledge and falls prevention among total hip arthroplasty patients: a cross-sectional study. London Health Research Day. London, Canada. May 10, 2018. *(Poster Presentation)*
5. **Janes, W. C. I.***, Lanting, B., Somerville, L., Howard, J., Vasarhelyi, E. M., MacDonald, S., Naudie, D., Hunter, S. W. Examining the prevalence of falls and future falls risk in older adults one-year after total hip arthroplasty. Health and Rehabilitation Sciences

Graduate Research Conference. London, Canada. January 31 – February 1, 2018. *(Oral Presentation) – Awarded Best Masters Student Presentation.*

6. Frengopoulos, C., **Janes, W. C. I**., Modaressi, S., Thompson, S., Hunter, S. Influence of path configuration on gait performance during dual-task testing in young and older adults. World Confederation for Physiotherapy Congress Congress. South Africa. July 2 – 4, 2017. *(Oral Presentation).*
7. Thompson, S., Frengopoulos, C., **Janes, W. C. I**., Modaressi, S., Cox, K., Lautenschlager, N. T., Hunter, S. W. (2016) Exercise programs to improve physical function in older adults with dementia living in long-term care: a systematic review. Exercise is Medicine Student Research Conference. London, Canada. June 23 – June 24, 2017. *(Oral Presentation).*
8. **Janes, W. C. I.***, Lanting, B., Somerville, L., Howard, J., Vasarheyli, E., Hunter, S. W. Assessing the need for fall preventative exercise and rehabilitation protocols following total hip arthroplasty. Exercise is Medicine Student Research Conference. London, Canada. June 23 – June 24, 2017. *(Oral Presentation)*
9. **Janes, W. C. I**.*, Lanting, B., Somerville, L., Hunter, S. W. Assessment of fall risk in individuals one-year after total hip arthroplasty surgery. Health and Rehabilitation Sciences Graduate Research Conference. London, Canada. January 31 – February 1, 2017. *(Oral Presentation).*

HONOURS AND AWARDS

Ontario Graduate Scholarship	2017 – 2018
Academic All-Canadian Award	2014 – 2015
Human Kinetics and Recreation Dean's List	2014 – 2015
General Hospital Auxiliary Scholarship	2014 – 2015
The School of HKR 30th/25th Anniversary Scholarship	2014 – 2015
Denis and Damien Collier Scholarship	2013 – 2014
Denis and Damien Collier Scholarship	2013 – 2014
Memorial University Entrance Scholarship	2012
William Kenneth McLeod Scholarship	2012